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Seasonal epidemiology of ticks (Ixodidae) infesting domestic cattle and buffalos of ballari region, Karnataka

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Abstract
Background: The main objective of this study was to evaluate the prevalence of tick infestation in cattle and buffaloes in Ballari. The prevalence was studied in relation to seasonal diversity.
Results: The tick infestation was higher in cattle (73.47%) when compared to that of buffaloes (64.10%). The infestation rate was dominated by *R. sanguineus* (7.26%) followed *R.haemophysaloides* (6.96), *R.evertsi* (6.65) and *B.microplus* (6.65). The infestation *of Haemaphysalis Canestrini* was least with (3.74%) followed by *Hyalomma Spp* (2.90 %). The results of the present work confirm that the following ticks are dominant in domestic cattle and buffalo in Ballari region.
Conclusions: The present study revealed that the rate of tick infestation was higher in monsoon followed by summer and winter. The study has been able to document the common species of ticks infesting cattle and buffaloes. The epidemiological data can be used for strategic tick control programme and the study recommends that care should be taken in proper maintenance of the animals, sanitation and also awareness needs to be created among the cattle owners. Regular treatment to be provided to animals infected with ticks, proper and regular feeding techniques to be undertaken, upgradation of management practices to be done in order to reduce and prevent the ectoparasitic infestations in Ballari region, Karnataka.

Keywords: acari, hard ticks, prevalence, seasonal diversity, livestock

Introduction

Background

India is an agricultural country and agriculture is the backbone of Indian economy. About 70-75% of its population is involved in agriculture and animal husbandry. The population of these livestock contribute to the maximum production of meat and milk products. As per the 20th Livestock Census 2019, India has a total livestock population of 535.78 million showing an increase of 4.6 percent, over the livestock census of 2012, and is a home of about 11.54 percent of the total livestock population in the world (Devendra Swaroop, 2020) [9] (Placeholder1). Livestock is a major source of employment in rural societies because owners earn revenue through the trade of their animals (Irshad *et al.* 2010; Ramzan *et al*. 2018; Ramzan *et al*.2020) [15, 35, 36]. These domestic animals play a major role as source of energy, food, raw material and manure for the primarily rural farmers (Roop Raj *et al.* 2015) [41]. Cattle serve as a major source of beef and dairy products to the livestock industry and are of great economic significance to both the government and the herdsmen (Olabode *et al.* 2010) [29]. They are also useful to humans especially during periods of cyclical and unpredictable food shortages. However, diseases and poor health are considerable obstacles to good productivity of the livestock industries (Colebrook *et al.* 2004; Onu *et al.* 2013) [5, 30]. Parasites are generally referred to organisms that live on or in and organism of another species (host) and obtain nutrient from them (Sadiksha Khanal *et al*. 2020) [42]. Ectoparasites are organisms, which inhabit the skin or outgrowth of the skin of the host for various periods (Hopla *et al.* 1994; Changunjong *et al*. 2009) [14]. Ectoparasites, commonly ticks, mites, lice, flea, and ked are important parasites found in the cattle because of their disease transmission, blood feeding habit and skin damage in most of the livestock population (CSA, 2004; Sadiksha Khanal *et al.* 2020) [42]. Ectoparasites of cattle cause blood loss and even lead to anaemia. Moreover, they are the most important vector of protozoan, bacterial, viral and Rickettsial diseases (Radostits, *et al*. 2007) [33]. It has been observed that the ectoparasites do not only have direct effects on their host, they may also transmit pathogens, there by acting as vectors of diseases (Parola *et al*. 2001) [31]. All ectoparasites cause intense irritation to the skin, the extent depending upon the parasites involved. Infested animal scratch, rub and bite the affected areas and this end up with skin damage (Radostits, *et al*. 2007) [33]. Among various ectoparasites ticks are probably considered the significant one for causing various tick borne diseases like Theleriosis, Anaplasmosis, and Babesiasis etc. leading to anaemia, dermatosis, toxicities and paralysis (Gebre *et al*. 2001) [10]. Ticks are considered potential vectors of many pathogenic agents of because of: (a) the wide host range and tendency to feed on several hosts during life cycle which ensures ample opportunity to acquire and transmit pathogens, (b) hardiness and longevity enable them to survive long periods in unfavourable environmental conditions, (c) high reproductive potential and (d) slow feeding habit and in the case of ixodids, attachment with hosts for relatively longer periods allowing sufficient time for pathogen acquisition and transmission (Ghosh and Nagar 2014,) [12]. The major damage that the tick could lead is probably lowering the value of skin (Desta, 2010) [8]. As result there is decrease in productivity, reproductive activity and milk yielding capacity in cattle and buffaloes which finally leads to death in extreme conditions. There is a paucity of information regarding the prevalence of ectoparasites in cattle in Ballari provided by (Hegde SS *et al*. 2020) [48]. The study aims to overcome the

lack of data regarding the presence of ticks on domestic cattle and buffalo and also to improve the knowledge of ticks inhabiting Ballari region, Karnataka.

Methods

Study area

The villages of Ballari taluk where the cattle population was maximum was selected as the study area (Fig 1). Ballari taluk is situated at a coordinate 15.1394°N Latitude and 76.9214°E Longitude in north-eastern part of Karnataka state. The climate comprises of lower tropical climatic zone with an average rainfall of 639 mm, temperature of 31°C in summer, 26°C in winter and humidity 23% respectively. A survey was conducted from January 2021 – December 2021 on 1900 animals' (cattle and buffaloes) to detect the prevalence and percentage of tick infestation.

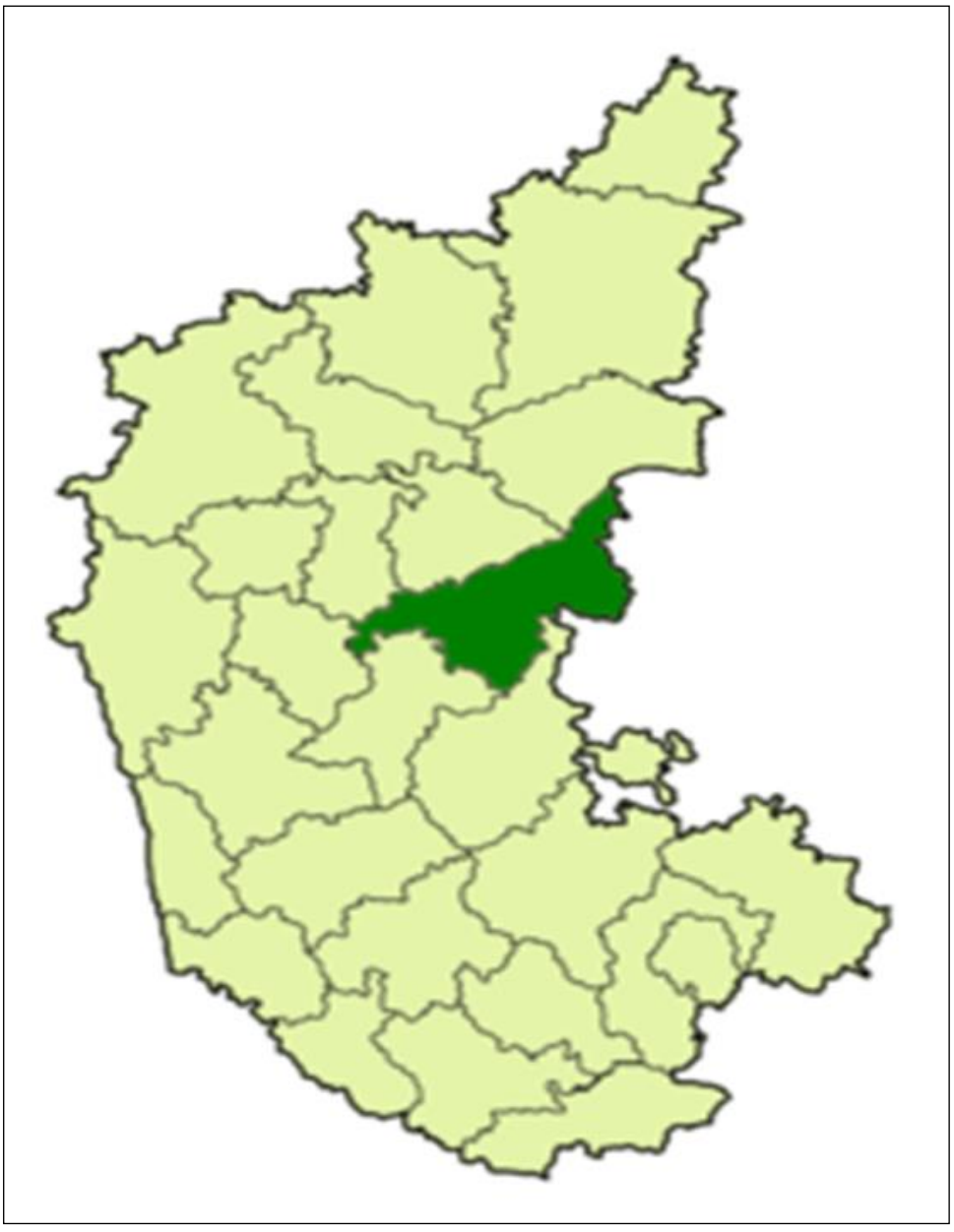

Fig 1: Location of study area

Study Design

The survey was done on domestic cattle and buffaloes by direct visit to the houses of farmers/owners of livestock, agricultural fields, grassland areas and on stray cattle. Ticks were removed from the cattle's body by hand picking method and those which could not be removed easily were collected by the use of forceps (and cotton balls dipped in formalin) without causing any damage to the mouth parts and care was taken to avoid decapitulation and shedding of the legs.

Tick Collection

Altogether 1900 animals were examined for the present study and the total number of cattle and buffaloes were 950 each. Ticks were collected in the morning hours for about 12 months i.e. January to December by close examination of the animal's skin in the regions of head, ear, thigh, dewlap, back, neck, hooves, testes, udder, tail and anal region (Fig 2). There were also other ectoparasites such as flies, lice and fleas all over the body. Only ticks were collected for the present study and were stored in 70% ethanol. Data regarding location of study area, date of collection, age, sex, site of tick location on the animal body, and the breed of the animal were recorded on the labels of each vials.

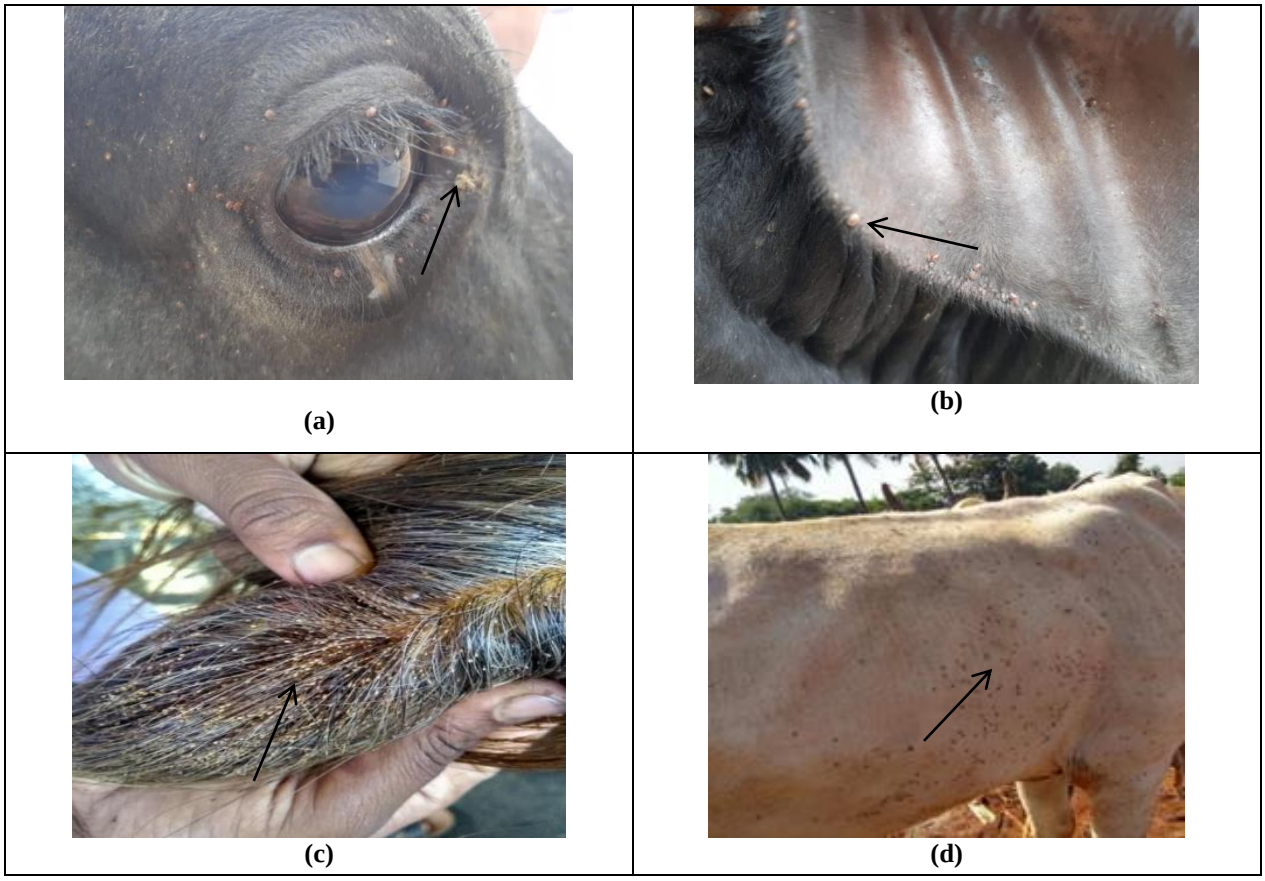

Fig 2: Infestation of ticks at (a) Eye region, (b) Ear, (c) Tail region (d) All over the body (Source: Author)

Tick infestation level

The infestation level was studied by grouping all the survey animals into three categories like low infested, moderately infested and highly infested animals. The animals with <25 ticks were characterised as low infested and that with <50 ticks as moderately infested and the animals with >51 ticks were grouped as highly infested as suggested by Muhammad *et al.* 2008; Ahmad *et al.* 2019 (Table 1) [27, 2].

Table 1: Categorization of tick infestation level

Sl. No	No of ticks found	Infestation level
1	1-25	Low
2	26-50	Moderate
3	>50	High

Identification of ticks on cattle and buffaloes

The collected specimens were subjected to further processing. Prior to identification the stored ticks were washed thoroughly with fresh water to remove debris and then transferred to a test tube containing KOH. Ticks were boiled for about 07- 14 minutes until ticks appeared to be transparent. The ticks were washed thoroughly to remove KOH. After washing, the ticks were subjected to dehydration processes by passing through series of alcohol grades of 30, 50, 70, 90 and 100% for fifteen minutes. Transparent ticks were mounted on a clean glass slide, covered with cover slip. The identification was carried out in the Department of Zoology, KUD. Ticks were identified using the taxonomic keys described by (Krantz, 1940; Sen, 1938; Geevarghese *et al.* 1997; Richard Wall *et al.* 1997; Walker *et al.* 2003) [20, 11, 39].

- KOH: Potassium hydroxide
- KUD: Karnatak University, Dharwad

Statistical analysis

The data were entered in Microsoft-excel sheet. Statistical analyses were carried out by using SPSS version 20.0. The prevalence (P) was estimated according to standard methods (Thrusfield 2007) [49] and by the formula as given below:

$$P = \frac{\text{No. of infested cattle during specified period}}{\text{Total cattle surveyed}} \times 100$$

- SPSS: Statistical package for social science

Ticks

Ticks are arachnids, in the sub-class Acari, closely related to the mites (Richard Wall *et al.* 2001) [38]. A single family, the Ixodidae, known as the hard ticks, contains almost all the species of tick of veterinary importance. A second family, the Argasidae known as the soft ticks, contains a relatively small number of species of veterinary importance. A third family of tick, the Nuttalliellidae contains only a single, little-known species (Richard Wall *et al.* 1997) [39]. Ticks are primarily parasites of wild animals and only about 10% of species feed on domestic animals, primarily sheep and cattle (Lane *et al.* 1993; Jongejan *et al.* 2004) [22, 16]. The ticks are obligate, blood-feeding ectoparasites of vertebrates, particularly mammals and birds (Richard Wall *et al.* 1997) [39]. Ticks are remarkable in their vector ability to transmit diverse pathogens including protozoa, bacteria, and viruses (Ray M Kaplan 2020) [37]. Tick-borne pathogens are the cause of transboundary cattle diseases (Adalberto *et al.* 2020) [1]. Bovine babesiosis, anaplasmosis, and theileriosis

are among the diseases listed as notifiable by the World Organization for Animal Health caused by tick-borne pathogens that affect cattle (World Animal Health Organization, 2019).

Results

1. Overall prevalence of tick infestation

In the present study a total of 1900 animals consisting of 950 cattle and 950 buffaloes were screened for tick infestation. Among these 1307 (68.78%) animals were found to be infested with ticks. In cattle a total of 698 animals were infested and in buffaloes a total of 609 were infested out of 950.The tick infestation was higher in cattle (73.47%) when compared to that of buffaloes (64.10%) (Table 2 & Fig 3). Ticks collected were grouped into 5 genera and 18 species. One tick species collected from buffaloes was identified only up to generic level. The species identified were *Rhipicephalus sanguineus, R.annulatus, R.evertsi, R.haemophysaloides, Boophilus microplus, B.annulatus, Amblyomma robertsi, A. americana, A. persicus, Hyalomma spp, H. anatolicum, H. hussaini, H. truncatum, Haemaphysalis intermedia, H. aculeate H. kinneari, H. Canestrini, H. turturis, H. Bispinos.* The infestation rate was dominated by *R. sanguineus* (7.26%) followed *R.haemophysaloides* (6.96), *R.evertsi* (6.65) and *B.microplus* (6.65) which were observed both in cattle and buffaloes. The infestation of *Haemaphysalis Canestrini* was least with (3.74%) followed by *Hyalomma Spp* (2.90 %) which was found only in buffalo (Table 3). A graph representing the total percentage and genera of tick infestation both in cattle and buffaloes is shown in Fig 3. All the above 18 species and one genera of ticks identified are categorised into a single family known as Ixodidae. The results of the present work confirm that the following ticks are dominant in domestic cattle and buffalo in Ballari region.

Table 2: Rate of tick infestation on the host

Host		No. of animals surveyed	No. of animals infested	Animals free from infestation	Prevalence (%)	Positive for the tick genera
Cattle	Males	475	311	164	65.47	*Rhipicephalus*
						Boophilus
	Females	475	387	88	81.47	*Hyalomma*
						Haemaphysalis
	Total	950	698	252	73.47	
Buffalo	Males	475	242	233	50.94	*Rhipicephalus*
						Amblyomma
	Females	475	367	108	77.26	*Hyalomma*
						Haemaphysalis
	Total	950	609	341	64.10	
Total		1900		593	-	05

Table 3: List of major tick species collected and identified on cattle and buffaloes

Genus	Species	Summer	Monsoon	Winter	Infested No	% of Infestation	Host
Rhipicephalus	*R. sanguineus*	38	47	10	95	7.269	Buffalo, Cattle
	R. annulatus	29	42	11	82	6.274	Buffalo, Cattle
	R. evertsi	34	41	12	87	6.656	Buffalo, Cattle
	R.haemophysaloides	39	52	0	91	6.963	Cattle
Boophilus	*B. microplus*	36	43	8	87	6.656	Cattle
	B. annulatus	34	37	12	83	6.350	Cattle
Amblyomma	*A. robertsi*	29	49	0	78	5.968	Buffalo
	A. americana	27	45	9	81	6.197	Buffalo
	A. persicus	27	31	19	77	5.891	Buffalo
Hyalomma	*H.spp.*	0	27	11	38	2.907	Buffalo
	H. anatolicum	17	29	10	56	4.285	Cattle
	H. hussaini	27	39	0	66	5.050	Buffalo
	H. truncatum	17	36	6	59	4.514	Buffalo
Haemaphysalis	*H. intermedia*	16	28	7	51	3.902	Cattle
	H. aculeata	18	38	6	62	4.744	Cattle
	H. kinneari	0	41	12	53	4.055	Buffalo, Cattle
	H. Canestrini	15	34	0	49	3.749	Buffalo
	H. turturis	0	35	23	58	4.438	Buffalo, Cattle
	H. Bispinosa	25	29	0	54	4.132	Buffalo, Cattle

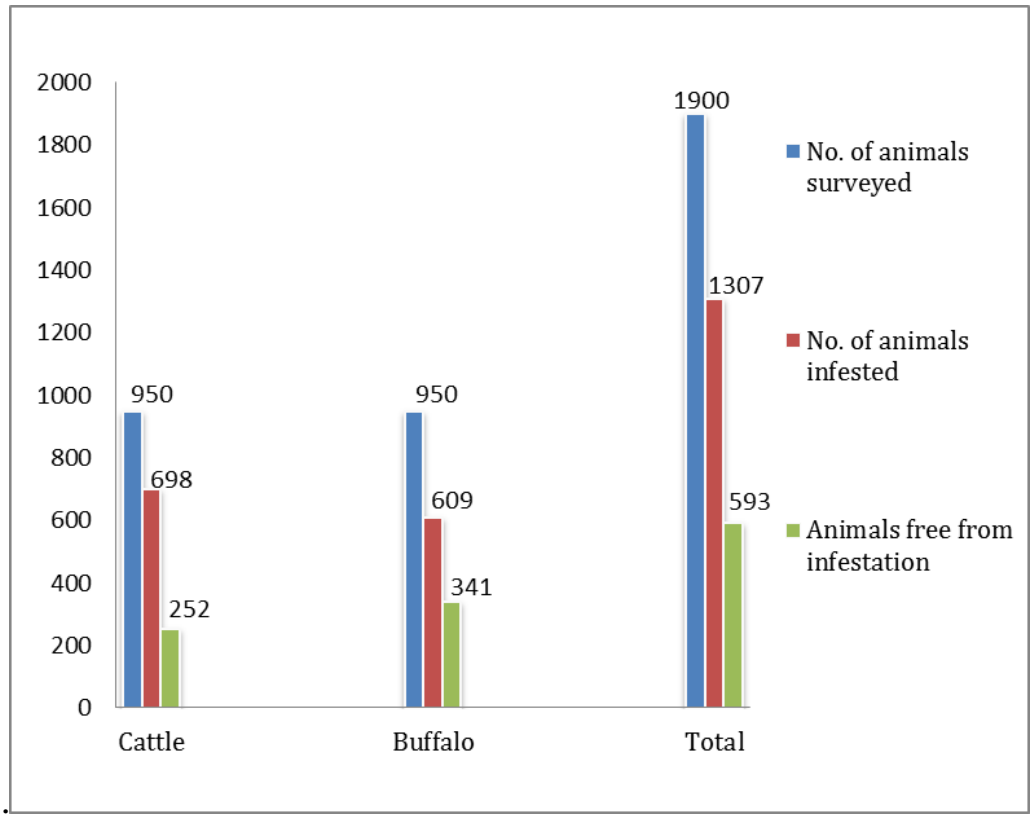

Fig 3: Graph representing the total infestation rate

2. Seasonal prevalence of tick infestation

The present study revealed that the rate of tick infestation was higher in monsoon followed by summer and winter (Table 4 & fig 4). Similar findings were also reported by Sanjay *et al.* (2007) [44], Patel *et al.* (2013) [32] and Kaur *et al.* (2015) [18]. The higher prevalence of ticks in monsoon season suggests that humidity seems to be macroclimatic factor influencing infestation rate of ticks (Vatsya *et al.* 2008) [51]. Whereas, the cold and dry conditions of the winters are unfavourable for the survival and also tick hibernates during the winter months by hiding into the cracks and crevices thus leading to low infestation level (Singh and Rath 2013) [47]. In contrast to the present finding, Rony *et al.* (2010) [40] and Mohanta *et al.* (2011) [26] reported higher rate of infection in summer season. The difference between the present and earlier findings may be due to variations in geographical locations, topography and composition of soil type, temperature and humidity of the study area (Singh and Rath 2013; Kaur *et al.* 2015; Debbarma *et al.* 2018) [47, 18]. Graph representing parameters of different diversity indices for the present study is shown in (Fig 5).

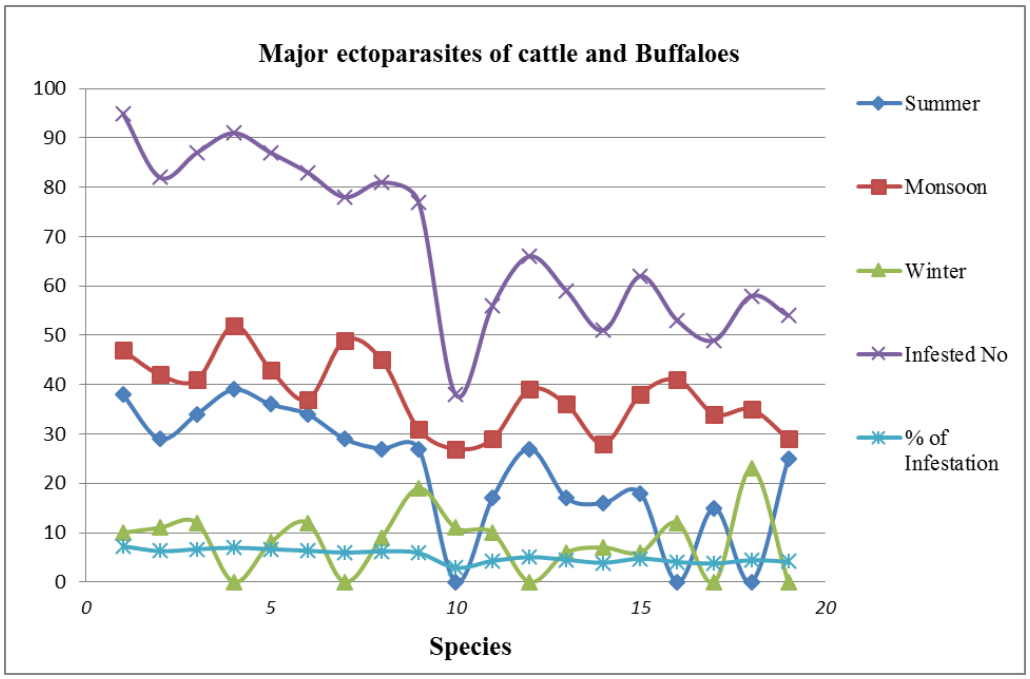

Fig 4: Graph representing the percentage and Species of tick infestation observed in cattle and buffaloes

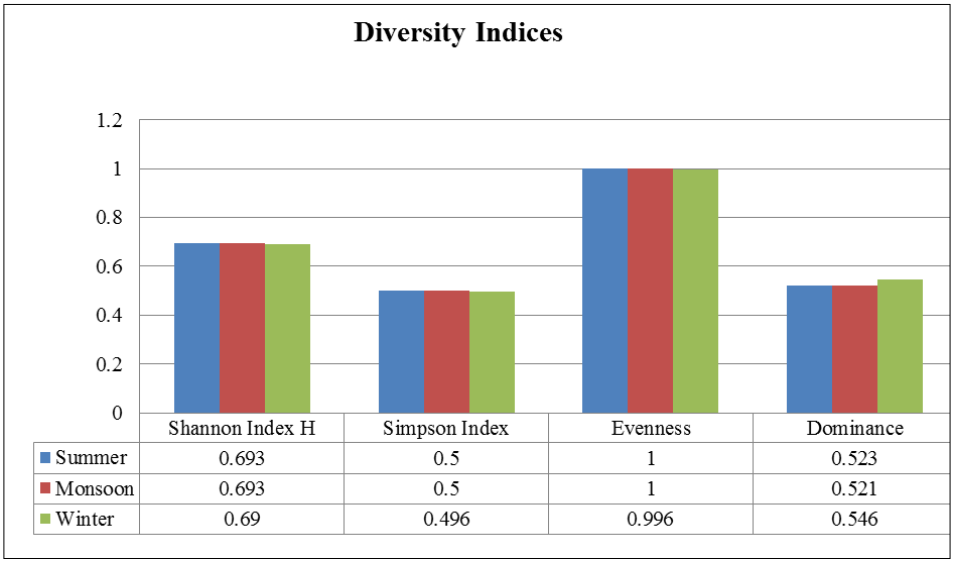

Fig 5: Graph representing the diversity indices of tick species

Table 4: Seasonal diversity of ticks

Seasons	Summer				Monsoon				Winter			
Parameters	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	**January**	**February**
Total no of animals surveyed	158	158	158	158	158	158	158	158	158	158	160	160
Total no of animals infested	128	132	107	122	117	138	129	127	76	87	69	75
Month wise total species	03	04	04	05	04	05	05	05	03	04	03	04
Season wise total species	16				19				14			
Shannon Index H	0.693				0.693				0.69			
Simpson Index	0.5				0.5				0.496			
Evenness	1				1				0.996			
Dominance	0.523				0.521				0.546			

Discussion

The current survey was undertaken to determine the infestation rate on cattle and buffaloes. The rate of infestation majorly depends on the geographical location of the areas, the way of feeding, maintenance of animals (Hygienic & unhygienic conditions) and also on the seasonal climatic changes. The study was carried out for a period of twelve months from January 2021 – December 2021 on 1900 animals. Out of 1900 animals about 1307 animals were found to be infested with one or the other species of ectoparasites. A total of 950 cattle and 950 buffaloes were surveyed and the remaining 593 animals were free from infestation. Overall prevalence of ticks was found to be 68.78%. The present study findings are in accordance with the findings reported by Manan *et al.* 2007; Vatsya et al. 2007 [50]; Vatsya *et al.* 2008 [51] and Sajeed et al. 2009; reported that the infestation of ticks in cattle were 20.40 and 41.78 %, respectively. Difference among the results of present and previous study might be due to variation in geographical locations, climatic conditions of the experimental area, region and method of study and selection of samples (Kabir *et al.* 2011; Patel *et al.* 2013; Kaur *et al.* 2015) [32]. The present study revealed that the prevalence rate of ticks is highest in rainy season (55.31%) followed by summer (32.74%) and least in winter season (11.93 %). The findings of this study are in agreement with earlier reports from different parts of India and abroad (Rony *et al.* 2010; Nonga *et al.* 2012; Chhillar *et al.* 2014; Kaur *et al.* 2015; A. Debbarma *et al.* 2018) [18]. The Rhipicephalus (Boophilus) sp. was found to be the predominant tick of cattle in the study area. Similar result had also been reported from various other states of India *viz.* West Bengal (A. Debbarma *et al.* 2018), Uttar Pradesh (Patel *et al.* 2013) [32], Punjab (Haque *et al.* 2011), Uttarakhand (Vatsya *et al.* 2008) [51], Tamilnadu (Latha *et al.* 2004), Andhra Pradesh (Rajendran and Hafeez 2003) [24], Karnataka (Kumar *et al.* 2002) [21], Maharastra (Shahardar *et al.* 1998) [46] and Assam (Miranpuri *et al.* 1978) [25].

Conclusions

The present study confirms that the above mentioned tick species are dominant in the domestic cattle and buffalos in Ballari region. Amongst the total animals surveyed about 68.78% of the animals were found to be affected with one or the other ectoparasitic infestation. The tick infestation rate was observed to be 73.47% in cattle as compared to buffaloes 64.10%. The study has been able to document the common species of ticks infesting cattle and buffaloes. The epidemiological data can be used for strategic tick control programme and the study recommends that care should be

taken in proper maintenance of the animals, sanitation and also awareness needs to be created among the cattle owners. Regular treatment to be provided to animals infected with ticks, proper and regular feeding techniques to be undertaken, upgradation of management practices to be done in order to reduce and prevent the ectoparasitic infestations in Ballari region, Karnataka.

List of abbreviations

- KOH: Potassium hydroxide
- KUD: Karnataka University, Dharwad
- SPSS: Statistical package for social science

Declarations

- **Ethics approval and consent to participate**

Ethical approval was not required for the animal study because the sampling of ticks on cattle did not require any ethical approval. However oral consent was taken from the owners of livestock in this study.

- **Consent for publication**

There is no personal data of any individual in any form.

- **Availability of data and materials**

Can contact the author

- **Competing interests**

The author declares no competing interests.

- **Funding**

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- **Authors' contributions**

The entire study was carried out by the author only. Author was involved in field visit, sampling, laboratory work, preparation and submission of manuscript.

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- **Authors' information (optional)**

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