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Composition, prevalence and abundance of Ixodid cattle ticks at Ethio-Kenyan Border, Dillo district of Borana Zone, Southern Ethiopia

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Ixodid ticks are common and a major obstacle to development and utilization of animal resource in tropical countries like Ethiopia. Ethiopia shares long international frontiers with adjacent countries, tick dynamics and influx of ticks across the border are major obstacles of tick control and management. Thus, border-oriented epidemiological surveys are of paramount importance to identify a potential port of cross border diseases, particularly ticks and to formulate complimentary bilateral policies. The current study was therefore, designed with the objectives to assess prevalence, abundance and to identify genera and species of major ixodid tick of cattle circulating at Ethio-Kenyan border. A cross-sectional study was conducted from November 2016 to January 2017 in purposively selected four Pastoral Associations of Dillo district, Southern Ethiopia. A total of 7524 adult ticks were randomly collected from 384 cattle and examined with a stereomicroscope. Logistic regression was used to determine the association of risk factors with positivity for Ixodid ticks. The study revealed an overall prevalence of 98.2% of Ixodid ticks of cattle. Three genera of ticks, *Rhipicephalus* (including the subgenus *Boophilus*), *Amblyomma* and *Hyalomma* and seven species of ticks were identified and found to be abundant with overall mean burdens of 40 ticks/head. The association of age and body condition of animals to tick infestation were statistically significant but there was no significant association between sex and tick infestation (OR=3, P=0.007). Animals in poor body condition were twice more likely to be infested with tick than animals with good body condition (OR=2, P=0.031) and animals with medium body condition were also found more prone to tick infestation than animals in good body condition (OR=1.7, P=0.043). Ixodid ticks that were less abundant in most parts of the country were encountered as well adapted and widely distributed in this area. Uncontrolled animal movement across the border may play a great role in high density and diversification of tick in Dillo district. Therefore, collaborative nationwide studies was done to have the country-wide distribution figures and to identify a potential port of cross border diseases particularly ticks and to formulate complimentary bilateral policies for prevention and control of ticks.

Key words: Ixodid, tick, cattle, Dillo, Borena, cross border disease.

INTRODUCTION

Ethiopia is endowed with a very large and diverse livestock resource, composed of approximately 56.71 million cattle, 29.33 million sheep, 29.11 million goats, 2.03 million horses, 7.43 million donkeys, 0.4 million mules, 1.16 million camels, 56.87 million poultry and 5.88 million bee hives (CSA, 2016). The livestock subsector

contributes to 12 and 33% of the total and agricultural GDP, respectively, and accounts for 12 to 15% of the total export earnings, second in order of importance (Ayele et al., 2003; Minjauw and Mcleod, 2003; Argaw, 2014). Nevertheless, cattle productivity is low, with hide represents a major source of foreign exchange earnings for the country that accounts for 14 to 16% of the total export revenue. In addition to a large contribution to the export earnings, hides and skins also contribute much to the domestic leather industry (Argaw, 2014).

Despite the relatively large animal population with a high potential for production, its utilization is far lower than could be expected due to cattle production in Ethiopia is constrained by the compound effects of animal diseases, poor management and low genetic performance (Dabassa et al., 2013; Abdela and Jilo 2016; Jilo and Tegegne 2016; Jilo and Adem 2016; Jilo et al., 2016; Jilo 2016; Jilo et al., 2017; Dabasa et al., 2017). External parasites are common and a major obstacle to development and utilization of animal resources in tropical countries because of the favorable climatic conditions for their development and the poor standards of husbandry practices (Solomon et al., 1998; Mungube et al., 2008; Yalew et al., 2017; Dabassa et al., 2017). In Ethiopia, ticks occupy the first place amongst the external parasites that cause serious economic loss to small holder farmers, the tanning industry and the country as a whole through mortality of animals, decreased production, downgrading and general rejection of skins and hides (Tikit and Addis, 2011; Dabassa et al., 2017).

Beside direct effect of irritation, discomfort, tissue damage, blood loss, toxicosis, allergies and dermatitis ticks are the most important ecto-parasites of the livestock in tropical and sub-tropical areas due to their ability to transmit protozoan, rickettsial and viral diseases of livestock, which are of great economic importance world-wide (Jaswal et al., 2014; Salih et al., 2015; Dabassa et al., 2017). The most economically cover important ixodid ticks of livestock in tropical regions belong to the genera of *Hyalomma*, *Rhipicephalu*s and *Amblyomma* (Jongejan and Uilenberg, 2004). Several tick genera are widely distributed in Ethiopia. The major tick genera recorded are *Amblyomma*, *Haemaphysalis*, *Hyalomma* and *Rhipicephalus*. Over 60 tick species are known to exist in Ethiopia and the most economically important and wide spread ticks are *A. variegatum* and *R. pulchellus*. In Ethiopia, more than half of total ticks are confined to arid and semi-arid areas at periphery for advantage of suitable climate condition and abundance of hosts (livestock) while tick densities are usually greater in lowland than highland areas (Pegram et al., 1981). In addition to the climatic advantages and adequacy of host animals, insufficient veterinary extension services combined with extensive management systems have exacerbated tick burdens in arid and semi-arid parts of the country (Jilo et al., 2016). Given the long international borders (mainly covered by lowlands) that Ethiopia shares with adjacent countries, tick dynamics and influx of ticks from neighboring countries are major obstacles of tick control and management.

Although, a number of studies have attempted to know burden, distribution and abundance of tick species in different parts of the country, they were largely restricted to central highlands for accessibility and availability of infrastructures. However, the most infested peripheral lowlands bordering adjacent countries are not yet studied well to have the country wide distribution figures, to identify a potential port of cross border diseases particularly ticks and to formulate complimentary bilateral policies for prevention and control of ticks. Thus, the current study was designed to be conducted at the arid area of Southern lowland at the Ethiopia-Kenya border in Dillo district, possessing a large livestock population and where no single study from any scientific discipline has been conducted before, with the objectives of assessing prevalence and abundance, identifying genera and species of major ixodid tick of cattle circulating at the border and to recommend formulation and implementation of joint policy for prevention and control of tick and tick induced losses.

MATERIALS AND METHODS

Description of study area

The study was conducted in Dillo district located at 695 km at South of Addis Ababa, the capital city of Ethiopia. Dillo district is one of the entirely pastoral areas in Borana zone located at the South most part of the country and bordered on the south and southwest (Kenya), Northwest (Teltelle district), Northeast (Yabello district) and East (Dubluk and Dirre districts). Agroecologically, its characterized by an arid climate with altitude ranging from 521 to 1420 m above sea level and temperatures from 22 to 40°C. The area receives low, erratic and bimodal with a mean annual rainfall about 450 mm. There is considerable spatial and temporal variability in quantities and distribution of rainfall, where about 60% is covered by long rainy season (*Ganna*) extending from mid-March to May and erratic short rain season (*Hagayya*) is received from mid-September through mid-November.

Study design and study population

Cross-sectional study design was used to determine the tickspecies, population dynamics and mean burden of adult tick species in different predilection site, age groups and sex of animal. The study animal was cattle from four purposively selected PAs of

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Dillo district based on distribution of tick as told by woreda animal health experts and indigenous knowledge of the community. Accordingly, lowland areas with reddish brown fragile soil, locally called "*Golbo*" like Arbale and Kadim are relatively free of tick, while Northern and Northeastern part of Dillo covered by dark cracking soil (clay), locally called "*Koticha*" are pointed out for study as severe infestation of ticks is found abundant. Likewise, four PAs from *Koticha* land (Goray, Liso, Kancharo and Magole) were selected and adult ticks were randomly sampled from 384 indigenous cattle by considering age, sex and body condition as risk factors. Body conditions were determined as described previously by Eversole et al. (2005). For convenience, animals <1.5 and ≥1.5 year were considered as young and adult, respectively.

The desired sample size for the study was calculated using the formula given by Thrusfield (2005) with 95% confidence interval and 5% absolute precision. $N = 1.96^2 * P_{exp}(1\text{-}Pexp)/D^2$ Where; n = sample size, Pexp = expect prevalence and D = absolute precision (5%). There was no previously published and documented prevalence in the study area and therefore, sample size was calculated using expected prevalence of 50% by substituting the value, the required sample size was calculated and found to be 384 (Thrusfield, 2005). Study was conducted during short rainy season in November, the collected ticks were transported to Yabello Regional Veterinary Laboratory for acaroscopy. Counting and identification of ticks were done using hand lens and stereomicroscope according to standard taxonomic identification procedure described by (Keirans et al., 1999).

Data management and statistical analysis

All collected data were entered to Micro-Soft Excel sheet 2010 and analyzed by SPSS version 20. Descriptive statistics was used to determine the frequency and percentage of both dependent and independent variables. The prevalence was calculated as percent of infested animals from the total number of animals examined. Logistic regression was applied to assess association of risk factors and strength of the association. For statistical analysis, a confidence level of 95% and a *P*-values less than 5% were judged as significant.

RESULTS

Overall prevalence and distribution of ticks in the different PAs in the study area

From this study, Ixodid ticks of cattle were found highly prevalent in Dillo district with overall prevalence of 98.2% (377/384) and within different PAs of current study area 100, 97.9, 97.7 and 97% prevalence of Ixodid ticks of cattle were recorded in Kancharo, Liso, Magole and Goray, respectively (Table 3). *Rhipicephalus* (including *Rhipicephalus Boophilus*), *Amblyomma*, *Hyalomma* and *Boophilus* were the four important genera of ticks identified with a total prevalence of 98.2, 96.8, 64.3 and 42.4%, respectively. While eight species of ticks with their total prevalence were *Rhipicephalus pulchellus* (68.7%), *Rhipicephalus decoloratus* (42.4%) *Rhipicephalus pravus* (29.4%), *Ambylomma* (65.8%), *Ambylomma lepidum* (30.9%), *Hyalomma truncatum* (19.2%), *Hyalomma* rufipes (25.7) and Hyalomma impeltatum (19.2%) (Table 6 and 7).

Relative abundance of tick genera and species

A total of 7524 adult ixodid ticks were collected from different body regions of 377 cattle that were found to be positive for tick infestation and consequently sampled. Generally, three Ixodidae tick genera and eight species were identified from the study area. The genera *Rhipicephalus* (81.1%, of which 1.1% belonged to the subgenus *Boophilus*), *Ambylomma* (16.5%) and *Hyalomma* (3.2%) were abundant in this study area (96.2%) (Table 2). Regarding tick species distribution, *R. pulchellus* was the most abundant tick species, representing 75.2% of the total ticks in Dillo district, followed by *R. pravus* (35.5%), *Ambylomma gemma* (11.6%) and *A. lepidium* (4.8%), respectively. In contrast, *H. rufipes* (1.8%), *R. decoloratus* (1.1%) and *H. impeltatum* (0.09%) were the least abundant Ixodid species in the study district (Table 4 and 5).

Male to female ratio for tick genera and species

Male to female ratio for tick genera of this result indicates higher number of males for most species except genus *Boophilus* that have higher ratio of female tick. Similarly, at the level of species of ticks higher ratio of male to female was obtained except, *R. decoloratus* (Table 6 and 7).

Tick distribution

The spatial distribution of tick genera and species on the body of the animal was considered in this study. As a result, ticks were found widely distributed in different parts of the hosts' body such as ear, sternum, dewlap, scrotum, udder, anal-vulval area and tail. Ear (13 ticks/head), scrotum (10 ticks/head), udder (10 ticks/head), sternum (8 ticks/head), dewlap (8 ticks/head), anal area (6 ticks/head) and vulvar regions (6 ticks/head) were heavily infested but the tail (3 ticks/head of animal) was lightly infested with ticks (Tables 5 and 6). Among three genera of Ixodid ticks, *Rhipicephalus* was found as the only genus infesting the ear of the animal while the other two genera were spread on different body parts of the animal, except the ear.

Risk factors

Age of the animal was found statistically significant for infestation of Ixodid tick and from two age groups prevalence of tick were relatively higher in adult (100%) than the young (92%) and multivariable logistic regression revealed that adults are about three times more likely to be prone to tick infestation than young animals (OR=3, P =0.007) (Table 1). Regarding sex of animal, the tick prevalence was 98.6 and 96.7% in

Table 1. Logistic regression analysis (univariable and multivariable) output of risk factors associated with Ixodid ticks in cattle in Dillo district.

Risk factor		No. of animal examined	No. of animal positive	Prevalence	Univariable regression		Multivariable	
					COR (95% CI)	P-value	AOR (95% CI)	P-value
Age	<1.5year	87	81	92%	4(11.8-83.21)	0.000	10.23(1.89-55.19)	0.007
	≥1.5year	297	297	100%				
Sex	Male	91	88	96.7%	0.8(0.586-1.578)	0.77	0.34(0.063-1.87)	0.914
	Female	293	289	98.6%				
Body condition	Poor	201	201	100%	3.2(2.82-5.84)		2(2.55-4.67)	0.331
	Medium	149	148	99.3%	2.12(1.27-7.52)	0.032	1.7(1.25-6.73)	0.043
	Good	34	28	82.4%	Ref*		Ref*	

Table 2. Distribution and prevalence of tick genera among age, sex and body conditions of cattle in Dillo district.

Parameters		Tick genera identified, Total animal examined(n=384)									
		Rhipicephallus		*Ambylomma*		*Hyalomma*		*Rhipicephallus (Boophilus)*		Multispecies	
		Examined/+ve animal	% from total	Examined /+ve animal	% from total	Examined /+ve animal	% from total	Examined /+ve animal	% from total	Examined /+ve animal	% from total
Age	<1.5	87/80	20.8	87/76	19.7	87/53	13.8	87/47	12.2	87/76	19.7
	≥1.5	297/297	77.3	297/296	77.0	297/194	50.5	297/116	30.2	297/296	77.0
Sex	M*	91/88	22.9	91/84	21.8	91/64	16.7	91/57	14.8	91/84	21.8
	F	293/289	75.2	293/288	75.0	293/183	47.6	293/106	27.6	293/288	75.0
BCS	P	201/201	52.3	201/200	51.5	201/103	26.8	201/71	18.5	201/198	51.5
	M	149/148	38.5	149/146	37.2	149/118	30.7	149/80	20.8	149/143	37.2
	G	34/28	7.3	34/26	6.7	34/26	6.7	34/12	3.1	34/31	8.0

Table 3. Prevalence of Ixodid tick of cattle among PAs in Dillo district.

PA	Animal examined	Prevalence
Goray	100	97(97%)
Liso	96	94(97.9%)
Kancharo	98	98(100%)
Magole	90	88(97.7%)
Total	384	377(98.2)

Table 4. Distribution of tick genera on the animal.

Genus	No. of animal positive	Prevalence	Mean burden
Rhipicephallus	377	98.2%	31.6
Ambylomma	372	96.8%	6.6
Hyalomma	247	64.3%	2
Rh.(Boophilus)	163	42.4%	1
Multispecies	372	96.2%	6.6

Total animal examined (n=384).

Table 5. Distribution of major Ixodid ticks of cattle on predilection sites of animal body in Dillo district.

Body region	*Rhipicephallus*	*Ambylomma*	*Hyalomma*	*Boophilus*	Total	Mean burden
Ear	2383	0	0	6	2389	13
Sternum/dew	894	555	11	21	1481	8
Scrotum/udder	1488	495	5	24	2012	10
Ano-vulva	714	181	224	3	1122	6
Tip of Tail	477	8	3	32	520	3
Total	5956	1239	243	86	7524	40
Mean burden	31.6	6.6	2	1	40	

Table 6. Male to female ratio and percentages of identified genera of Ixodid ticks of cattle and their predilection site on the animal body in Dillo district, Southern Ethiopia.

Genus	Male : Female (Male/Female)	Percentage of total tick	Predilection sites
Rhipicephallus	2.3:1(4167/1783)	79%(5950/7524)	Ear
Ambylomma	2.6:1(899/346)	16.5%(1245/7524)	Sternum,dew,scrotum,udder, ano-vulva and tail
Hyalomma spp.	3.4:1(188/55)	3.2%(243/7524)	Sternum,dew,scrotum,udder, ano-vulva and tail
Boophilus spp.	0.4:1(24/62)	1.1%(86/7524)	Sternum,dew,scrotum,udder, ano-vulva and tail

female and male. There was no statistical (P=0.914) significance between the two sexes (Table 1). Out of the 384 animals examined, 34 were in good body condition, of which 28 (82.4%) were positive to tick infestation, 149 (38.8%) were in medium body condition and 148 (99.3%) were positive for tick infestation and the remaining 201 animals were of poor body condition and all of them, 201 (100%) were positive to tick infestation. Tick prevalence among body condition of animal varies and it was statistically significant. By multivariable logistic regression analysis animal with poor body condition was twice more likely to be infested with tick than animal with good body condition (OR=2, P=0.031) and animal with medium body condition was also found more prone to tick infestation than the animal in state of good body condition (OR=1.7, P=0.043) (Table 1).

DISCUSSION

A number of researchers have reported that different tick genera are widely distributed in Ethiopia (Solomon et al., 2001). In the present study, a total of 7524 adult ticks were sampled from 384 cattle and overall prevalence of tick infestation was found to be 98.2%. To the best of the authors' knowledge, this finding is the highest report ever reported from Ethiopia. For instance, lower prevalence of 16.0% in Benchi Maji Zone, Southern Ethiopia (Tesfahewet and Simeon, 2013), 33.21% in Haramaya district, Eastern Ethiopia (Kassa and Yalew, 2012), 40.26% in and round Haramaya town, Eastern Ethiopia (Yalew et al., 2017), 81.25% in Dembia district, Northern Ethiopia (Alemu et al., 2014), 82% in Borena province of southern Oromia (Regassa, 2001), 88.8% in Jimma district, Western Ethiopia (Chali *et al.,* 2017), 89.4% from Western Amhara Region, Northern Ethiopia (Nigatu and Teshome, 2012) and 95.2% in Bedelle district, Southwestern Ethiopia (Abera et al., 2010), were reported from different parts of the country. The highest prevalence in the current study area could be largely by presence of wide range of cracking soil that helps larva of ticks to stay long and survive, season of study (wet season), short and sticky grasses used for adherence of adult ticks and their transmission to grazing animals, large livestock population and herd size may also contribute as ticks can easily get access to host and complete their life cycle to perpetuate rapidly. Furthermore, arid agro-ecology, poor veterinary extension service, sedentary management practice employed by herders might also pave the way for the highest tick infestation. Ecto-parasites are common in tropical countries because of the favorable climatic conditions for their development and the poor standards of husbandry practices (Mungube et al., 2008).

Rhipicephalus (including ticks of the subgenus *Boophilus*), *Amblyomma* and *Hyalomma* were the three important genera of ticks identified with a total prevalence of 98.2, 96.8, 64.3 and 42.4%, respectively. While eight species of ticks have total prevalence of: *R. pulchellus* (68.7%), *R. pravus* (29.4%), *R. decoloratus* (42.4%) *A. gemma* (65.8%), *A. lepidium* (30.9%), *H. truncatum* (19.2%), *H. rufipes* (25.7%) and *H. impeltatum* (19.2%). Among the total, *R. pulchellus* (68.7%) was found to be highly prevalent in this area and this finding was higher

Table 7. Male to female ratio, percentages and prevalence of identified species of Ixodid ticks of cattle and their predilection site on the animal body in Dillo district, Southern Ethiopia.

Species	Male : Female	Percentage of tick	N(Prevalence)	Predilection sites
Rhipicephalus pulchellus	2.4:1(3994/1665)	75.2%(5659/7524)	264(68.7%)	Ear
Rhipicephalus pravus	1.46:1(173/118)	35.5%(291/7524)	113(29.4%)	Ear
Ambylomma gemma	2.47: 1(621/251)	11.6%(872/7524)	253(65.8%)	Sternum, dew, scrotum, udder, ano-vulva and tail
Ambylomma lepidium	2.8:1(278/95)	4.8%(373/7524)	119(30.9%)	Sternum, dew, scrotum, udder, ano-vulva and tail
Hyalomma truncatum	4.2:1(75/18)	1.2%(93/7524)	74(19.2)	Sternum, dew, scrotum, udder, ano-vulva and tail
Hyalomma marginatum rufipes	3.25:1(108/34)	1.8%(142/7524)	99(25.7)	Sternum, dew, scrotum, udder, ano-vulva and tail
Hyalomma impeltatum	2:1(5/3)	0.09%(8/7524)	74(19.2%)	Sternum, dew, scrotum, udder, ano-vulva and tail
Boophilus decolaratus	0.38:1(24/62)	1.1%(72/7524)	163(42.4%)	Sternum, dew, scrotum, udder, ano-vulva and tail

than 5.46% in East Hararghe (Bedasso et al., 2014), or 6.4% from East Hararghe (Yalew et al., 2017). This could be due to arid climate condition and savanna and steppe vegetation in thr current study area. *R. pulchellus* is prevalent in the arid and desert climatic regions with savanna and steppe grasses (Pegram et al., 1981; Feseha, 1983).

On the other hand, *A*. *gemma* (65.8%) was the second most prevalent tick species in the present study which was by far more than 2.42% from Jimma high land (Chali et al., 2017) and 8.3% from Mizan Teferi (Tadesse et al., 2012). Higher prevalence of *A. gemma* in Dillo district could be due to the arid climate condition which as reported by many scholars are very suitable for *A. gemma*. Pegram et al. (1981) stated that *A. gemma* is confined to semi-arid lands due to humidity of highland which is not favorable to their survival. As a result, this tick species was collected from restricted area of arid, semi-arid plain and bush land receiving 100 to 800 mm rainfall annually (Morel, 1980). Morel (1980) also stated that *A. gemma* is widely distributed in woodland, bush land, wooded and grassland in arid and semiarid area between altitude 500 and 1750 m above sea level and receiving 350 to 750 mm annual rain fall.

Rhipicephalus (Boophilus) decolaratus was third abundant tick species in the current study area with prevalence of 42.4%. Similar finding has also been reported from Rift Valley (Solomon et al., 2001) and in Girana valley of North Wollo (Zenebe, 2001) and Western Ethiopia (Amante et al., 2014). Contrary to our results, Morel (1980) stated that *R. decoloratus* is often collected in Ethiopia and does not seem really abundant anywhere. Pegram et al. (1981) also added that this tick species is abundant in wetter highlands and sub-highlands receiving more than 800 mm rainfall annually and has similar distribution to *A. variegatum*. *R. (Boophilus) decolaratus* can transmit *Babesia bigemina* and *Anaplasma marginale* to cattle and severe tick infestation can lead to tick problem, anorexia and anemia (Singh et al., 2000; Silashi et al., 2001).

A. lepidium (30.9%), and *R. pravus* (29.4%), was also a prevalent species collected from this study area. Regassa (2001) reported that *R. pravus* (about 8%) is from Southern Ethiopia which disagrees with the current result on *R. pravus*. Wasihun and Doda (2013) reported lower finding of 6.68% *A. lepidum* from Humbo district. It was also reported that *A. lepidum* was common but not abundant in Wolaita zone according to Dessie and Getachew (2006). It is limited by semi-desert conditions (Morel, 1980). It is also known as the “East African bont tick” and is common in many of the semi-arid regions of East Africa (Walker et al., 2003). This is also similar with the findings of Mesele et al. (2010) in Bedelle district. In southwest of Ethiopia including Gambella region and western Oromiya, this tick species was also reported with less abundance by several workers (Pegram et al., 1981) which agrees with the current result. In Gambella region, *A. lepidum* transmits *Rickettsia. ruminantium*, the organism that causes cowdriosis. *A. lepidum* was irregularly dispersed throughout most of the country and was collected from Tigray, Amhara, Oromiya, SNNP and Harare Regional States (Sileshi et al., 2007).

H. rufipes was the sixth most prevalent tick with prevalence of 25.7%. This result was higher than 2.5% report from Asella (Tessema and Gashaw, 2010). This tick species was restricted to warm, moderately dry mid lands areas between altitudes of 1800 and 1950 masl (Tessema and Gashaw, 2010). Hoogstraal (1956) stated that *H. rufipes* is widely distributed in the most arid parts of tropical Africa, receiving 250 to 650 mm annual rainfall and his results concur with the current study findings.

Risk factors (age, sex and body condition) were also

involved in the variations of the prevalence of ticks in the study area. Statistically significant association of tick infestation with age and body condition score of study animal was found. However, association of tick infestation and sexes of study animal were not statistically significant. Multivariable logistic regression analysis revealed that adults are about three times more likely to be prone to tick infestation than young animals (OR=3, P =0.007). These results were lined with findings of Bossena and Abdu (2012), Gedilu et al. (2014) and Admassu et al. (2015) but different from that of Kassa and Yalew (2012) and Tesfaheywet and Simeon (2013). This variation could be due to management; animals in different age groups were managed differently. In the current study area, younger animals (<1.5 year) are kept indoor for 1.5 to 2 years in a small separate housing locally called “dokoba” and as a result, unlike adult animals, younger animals have no access to harbor ticks from the field. Young animals are affected less than adult animals due to the less exposure to field grazing with other animals in the field and adults are exposed due to the communal grazing habit (Admassu et al., 2015).

By multivariable logistic regression analysis, animal with poor body condition was twice more likely to be infested with tick than animal with good body condition (OR=2, P=0.031) and animal with medium body condition was also found more prone to tick infestation than the animal in the state of good body condition (OR=1.7, P=0.043). This may due to the fact that ticks have contributed to emaciation of infested animals by causing anemia and stress. Insignificant association obtained between sex of animals and tick infestation concurred with the results of Kassa and Yalew (2012) and this might be due to equal opportunities of oxen and cows to tick infestation since they are kept extensively under similar agro-ecology and management condition.

Concerning predilection sites of ticks on the host body, different tick species were found to be having preference for predilection sites in this study. Accordingly, *R. pulchellus* and *R. pravus* had strong preference for ear, while *Ambylomma, Hyalomma* and the *Boophilus* subgenus were distributed on sternum, dewlap, scrotum, udder, ano-vulva and tail. This result was in line with the results of Stachurski (2000) and Tesgera et al. (2017), who stated that short hypostome ticks like *Rhipicephalus* usually prefer soft tissues like ear while, long hypostome ticks like *Amblyomma* attaches to lower parts of the animal body which is also the case in the current study. Cattle in this study were heavily infested and mean burden of tick was high (mean = 40 ticks/head). This finding was higher that reports of Alemu et al. (2014) from North west Ethiopia with mean = 13.1 tick/head. This variation in mean burden could be justified as tick densities are usually greater in lowland than highland areas (Pelgram, 1981).

The male to female sex ratio of the ticks were higher and similar to previous reports (Solomon et al., 2007; Chali et al., 2017). In all cases, except *R. decoloratus,* males outnumbered females. This is due to fully engorged female ticks drop off on the ground to lay egg while the male tends to remain on the host before dropping off and hence males normally remain on the host longer than females (Solomon et al., 2001).

CONCLUSION AND RECOMMENDATIONS

From this study Ixodid ticks of cattle were found to be highly prevalent in Dillo district with overall prevalence of 98.2%, the highest prevalence ever reported in Ethiopia to the best of the authors’ knowledge. Three important genera of ticks, *Rhipicephalus* (including the subgenus *Boophilus*), *Amblyomma* and *Hyalomma* were identified and were found to be highly prevalent and abundant with overall mean burden of 40 ticks/head which was again highest burden of tick in Ethiopia. Eight species of Ixodid tick that were less abundant in most parts of the country were encountered as well as adapted and widely distributed in this area. Climatic advantage and adequacy of host animals for ticks, insufficient veterinary extension service combined with extensive management system may have contributed to the highest tick burden in the current study area. Additionally, Since, Ethiopia shares border of about 600 km with Kenya at this district and animal movement across the border during shortages of pasture and water may play a great role in high density and diversification of tick genera and species circulating around Dillo district. Therefore, both countries need to conduct collaborative nationwide studies to show the country wide distribution figures and to identify a potential port of cross border diseases particularly ticks and to formulate complimentary bilateral policies for prevention and control of ticks. Moreover, researchers in this regard should pay more attention on neglected lowland areas at peripheries that are at risk of tick and tick-borne diseases than any other part of the country.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

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