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Prevalence of tick infestation of sheep and goats in Bui and Donga-Mantung Divisions of the North West Region of Cameroon

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ABSTRACT: This study was carried out to determine the prevalence, intensity and management systems associated with tick infestation in sheep and goats from Bui and Donga-Mantung Divisions. A total of 704 animals consisting of 342 males and 362 females (463 adults and 241 young (kids/lambs) were physically examined for tick infestation, of which 383 were goats and 321 sheep aged 5 months to 7 years. Of the 704 animals examined, 651 were found positive with one or more ticks giving an overall prevalence of 92.5%. The highest prevalence was recorded in sheep (99.4%) while 86.7% was recorded in goats. There was a significant difference ($p<0.05$) in the prevalence and intensity of tick infestation of these ruminants in the study area. The overall intensity of infestation or tick burden was 1302 with the highest intensity observed in *Boophilus geygei* (416). Six species of ticks were identified which were *Boophilus geygei, Boophilus annulatus, Boophilus decoloratus, Rhipicephalus sanguineus, Hyalomma truncatum and Haemophysalis laechi* with a high prevalence recorded for *Boophilus geygei* (29.5%) and the least recorded for *Haemophysalis laechi (*8.4%). Adults and females were the most infested compared to young stock and male animals. Concerning the various management techniques, the prevalence of tick infestation was higher in tethered animals (97.8%), followed by free-range grazing animals (89.8%). Animals confined in paddocks had the least prevalence (71.6%). This study provides an important step to reduce animal infestation and minimize economic losses in sheep and goats by providing information that will help farmers of these areas to use strategic treatment methods and medicinal plants to reduce parasite infestations on the animals and also to practice the right traditional management techniques.

Keywords: Bui, Cameroon, Donga-Mantung Divisions, prevalence, ruminants, tick infestation.

INTRODUCTION

Ticks rank first among vectors of diseases affecting livestock globally (de la Fuente et al., 2008) and Cameroon in particular. Their direct effects on the hosts include anemia and excessive grooming, stress, toxicosis and immunosuppression, which often lead to diminished productivity (Scholtz et al., 1991). Ticks also transmit a great variety of pathogenic microorganisms that cause disease in both humans and livestock (Jongejan and Uilenberg, 2004). Data on the economic impact of ticks and tick-borne diseases (TBDs) are scarce but it has been estimated that, globally, about 20 to 30 billion US dollars are lost annually due to tick-borne diseases (Lew-Tabor and Valle, 2016). In a study conducted in Cameroon in 1982, approximately 63% of animal mortality in the Wakwa research station situated in the principal cattle rearing region was attributed to tick-borne diseases (Mbah, 1982). This situation has seriously constrained attempts to rear high performing exotic dairy cattle breeds which are highly susceptible to tick-borne diseases including babesiosis, ehrlichiosis and dermatophilosis (Bayemi et al., 2005). Increased demand for animal food products in West and Central Africa due to rapid population growth has accelerated trans boundary livestock movements for trade across the region. Consequently, there is an increased risk

of animal disease transmission (Volkova et al., 2010; Fèvre et al., 2006). In addition, animal movements in sub-Saharan Africa are also linked to transnational transhumance (Motta et al., 2018). This regular movement of herders and their livestock across national boundaries to exploit the seasonal availability of pastures is a sociocultural phenomenon (Lesse et al., 2015). It represents the transhumant communities' key resilience strategy to combat fluctuations and long term change in climate. Unfortunately, disease surveillance at the borders of most sub-Saharan African countries is limited or altogether lacking (Motta et al., 2017). This has created a situation that allows the importation of exotic tick species and their pathogens into many countries.

The recent findings of sheep and goat tick *Rhipicephalus (Boophilus) microplus* in West African countries such as Ivory coast, Burkina Faso, Mali, Togo, Benin and Nigeria is worrisome because this tick species is an efficient vector of Babesia bovis which causes a virulent form of babesiosis, the most important tick-transmitted disease of sheep and goats globally (Madder et al., 2012; Adakal et al., 2013; Kamani et al., 2017). It is widely believed that *Rhipicephalus microplus* was introduced into West Africa, seemingly through livestock imported from Brazil and has rapidly spread across the sub-region through transboundary cattle movements (Madder et al., 2012; [12; Madder et al., 2007). Small-scale livestock keepers play an important role in the livestock industry in developing countries, contributing greatly to food security and rural development (McDermott et al., 2010). Most small scale livestock farmers (sheep and goat owners) cannot afford regular tick control with acaricides, relying on labor intensive manual control of ticks, combined with limited chemical treatment, particularly during the rainy seasons (Achukwi et al., 2001).

The few studies undertaken on ticks infesting livestock especially sheep and goats in Cameroon have been limited to the principal livestock rearing areas, namely the Far North, North, Adamawa and North West regions (Awa et al., 2015; Silatsa et al., 2019). Areas with low animal densities, including the eastern region bordering Central African Republic (C.A.R.) are understudied, yet this area has been the focus of very extensive livestock movements (Seignobos, 2008). Such animal movement can contribute to a shift in the tick 'population landscape' (Nyangiwe et al., 2018). Additionally, it has been demonstrated that the distribution of many species of ticks will expand or contract as a consequence to global warming and climate change (Dantas-Torres, 2015). Despite the high impact of tick infestation on the global economy, there is a lack of reliable data since data on the incidence and prevalence of tick infestations and the distribution map of many tick vectors is either not available for many African countries or are outdated. It is therefore urgent to accurately identify and update the distribution of ticks in order to predict the risk of emergence or re-emergence of tick-borne diseases in the study area and country in particular.

Based on these findings and reports from a significant number of scientific publications demonstrating a high prevalence and intensity of tick infestation and their effects on the health status of sheep and goats (Kumsa et al., 2012; Mohammed and Gashaw, 2013; Mamoudou et al., 2016), the objective of this study was conceived to detail the identification of ticks to species level as well as their infestation in sheep and goats of Bui and Donga-Mantung Divisions in Cameroon.

MATERIALS AND METHODS

Area of study

The study was conducted in two divisions, Bui and Donga Mantung Divisions with Kumbo and Nkambe as headquarters respectively in the North West Region of Cameroon. The climate of this region is characterized by a long rainy season from Mid-March to October, with annual average rainfall ranging from 1,500 to 2,000 mm and an altitude of about 1,100 m above sea level (Bamenda Urban Council, 2014). Bui Division has a total population of 322,877 inhabitants, located between latitude 6.2542^0N and longitude 10.7549^0E with 2.297 km^2 while Donga-Mantung has a total population of 337,533 inhabitants located between latitude 6.400^0N and longitude 10.496^0E with 4.279 km^2 (North West Region Census, 2001). The dry season stretches from November to Mid-March, with monthly average temperatures in June reaching a maximum of about 21°C. The rainy season and the beginning of the dry season corresponds to the period of activity of adults and nymphs of many tick species previously identified in Cameroon (*Amblyomma spp*, *Aponomma spp*, *Dermacentor spp*, *Boophilus spp*, *Hyalomma spp*, *Rhipicephalus spp*). These species, found in Cameroon play an essential role in the transmission of many blood parasites (Mamoudou et al., 2016). Hence, the choice of the period of the rainy season and the beginning of the dry season to conduct this study.

Selection of study sites and farms

The study sites (Figure 1) were selected on the basis of having a higher concentration of livestock. The sites included the following twelve villages: Tobin, Kikaikom, Mbah, Nkar, Shukai, Oku, Jakiri, Shisong, Ndu, Nkambe centre, Tabiken and Bom.

Criteria for choosing study subjects

A total of 704 animals consisting of 342 males and 362 females were examined for the presence of ticks. Of this number, 383 were goats and 321 sheep (463 adults and 241 kids/lambs). For animals to be qualified as subjects,

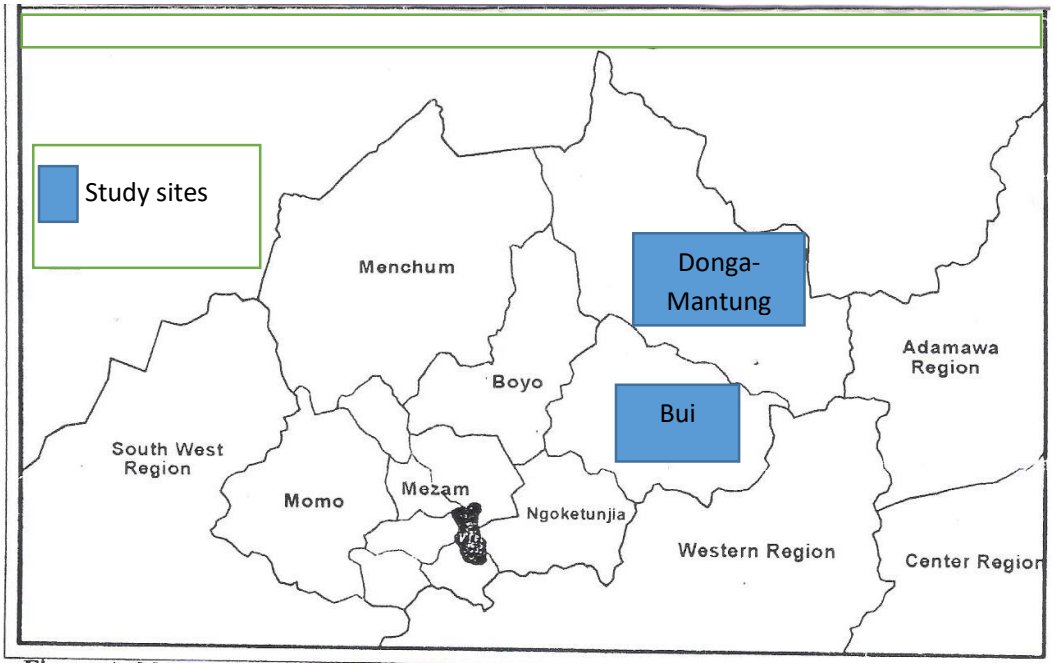

Figure 1. Map of the North West Region showing the location of Bui and Donga-Mantung ivisions.

the sheep and goats must have lived in the study area and or its environs for the past three months. The ages of the animals were determined from interviews with the farmers and using the dental formula. Animal ages ranging from 0-11 months were classified as young stock (lambs for sheep, kids for goats) while those from 12 months and above were categorized as adults. A larger number of sheep and goats were sampled because of their predominance in the area. Sample size was determined using the equation on parameters of study. The expected prevalence was estimated at 80% in the study area. The physical examination of animals was done by close inspection and collection of ticks after proper restraining.

Study design

A preliminary survey was carried out prior to sample collection to sensitize interested farmers on the objectives of the study. Questionnaires were administered to some of the farmers whose animals were to be examined. It included information on the age/sex/breed of the animal, farm management practices and health status of the animals.

Identification and collection of ticks

A cross sectional study was conducted in animals present in twelve villages in Bui and Donga Mantung Divisions. Animals were selected and examined for the presence of ticks and skin lesions. Prior to examination, each animal selected was categorized based on its sex, age and species. The age of animals was determined using the following Dental formula on parameters of study. When lambs and kids were less than 1 year of age, they were considered as young and animals from 1 year and above were included in the adult age group as already mentioned above. A good number of ticks species encountered were identified based on their morphology, color, size.

Ticks were collected from 704 sheep and goats in the two Divisions. In each Division, a good number of ruminants were examined for the presence of ticks. The animals were restrained and kept standing and half of the body of the animal was examined. Only visible adult ticks were collected. The parasite load per animal (intensity) was obtained by multiplying the number of ticks counted by two. All visible ticks (regardless of the stage) were collected by hand-picking, where the base of the rostrum (capitulum) was targeted and by rotating while pulling gently, so as not to lose the clips of the tick in the skin of the animal. They were then transferred to a tube containing 70% ethanol, immediately labeled with information about the host (age, sex, ID number and Division). The morphological identification of tick species was made using a stereo-microscope with a magnification of up to 100× following published work on taxonomy (Morel and Mouchet, 2008; Walker et al., 2003).

Parameters of study

Prevalence (P): The prevalence of was calculated generally and for each parasite using the formula:

$$P = \frac{\text{Number of infested animals}}{\text{Total number of animals examined}} x100$$

Where P is the prevalence of infestation.

Intensity(I) of infestation: The intensity of infestation was calculated using the formula below:

$$\text{The intensity of infestation} = \frac{\text{Number of ticks}}{\text{Number of infested animals}}$$

Abundance: The abundance of ticks was calculated using the formula below:

$$\text{Abundance} = \frac{\text{Number of ticks}}{\text{Total number of animals}}$$

Determination of sample size: The sample size was determined by using the formula below:

$$n = \frac{1.96^2\ pq}{L^2}$$

Where: n = sample size, p = expected prevalence, q = 1–p, L = limits of error on the prevalence (absolute precision at 95% confidence interval).

The expected prevalence was estimated at 80% in the study area (Thrusfield, 2005).

Determination of age of the animals: The age of animals was determined using the following Dental formula:

2(I 0/4; P 3/3; M 3/3) = 20

Where; I = Incisors, P = Premolars and M = Molars

The first number = sets of teeth in the upper jaw; The second number = sets of teeth in the lower jaw (Rahman et al., 2014)

Statistical analysis

The data obtained was stored in a Microsoft Excel spread, cleaned by checking for errors or missing variables and then exported to SPSS (Statistical Package for Social Science, Version 20) Software for analysis. Summary statistics were generated using the same software. For the purpose of modeling these data, explanatory variables were first explored for associations between parasites using Chi-square ($\chi 2$) test. The Chi-square test was also used to examine the effects of the various risk factors. The non-parametric test of Kruskal Wallis was used to compare prevalence between age group and locality, prevalence with animal gender, management systems and state of health. The Chi-square test ($\chi 2$) was equally used to analyze data collected and differences were considered as significant when p-value was less than 0.05.

Ethical approval and consents to participate

All authors hereby declare that "Principles of Laboratory Animal Care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

RESULTS

Overall prevalence of tick infestations for sheep and goats in the study area

A total of 704 small ruminants, 383 goats and 321 sheep were examined for the presence of ticks in Bui and Donga Mantung Divisions. Out of this number, 651 ruminants were infested with one or more ticks, giving an overall prevalence of 92.5%. Sheep recorded the highest prevalence (99.4%) while goats recorded a prevalence of 86.7%. There with no significant difference ($p>0.05$) in the prevalence of tick infestation of these ruminants in the study area (Figure 2).

Prevalence and intensity of tick species encountered in sheep and goats

Microscopic examination of collected ticks led to the identification of 6 species of ticks based on their morphology: *Rhipicephalus (Boophilus) geygei*, *Rhipicephalus (Boophilus) annulatus*, *Rhipicephalus (Boophilus) decoloratus, Rhipicephalus sanguineus Hyalomma truncatum and Haemophysalis laechi,* which gives the results of species/sub species-types and their frequency *Boophilus geygei* recorded the highest prevalence (29.5%) and intensity while *Haemophysalis laechi* recorded the lowest prevalence (8.4%). A significant difference existed between the prevalence of tick species encountered ($p<0.05$) (Table 1).

Age related prevalence of tick infestation in sheep and goats in the study area

A total of 463 adult ruminants and 241 young (kids/lambs) were examined during the study. Out of these, adult sheep recorded the highest prevalence of tick infestation (100%) (Figure 3), followed by the young sheep (98.2%). On the other hand, the least prevalence of 72.3% was observed in young goats (kids). It was generally noticed that adult sheep and goats had the highest prevalence (96.7%) while young goats (kids) and young sheep (lambs) recorded a prevalence of 84.2% (Figure 4). However, Chi square value revealed no significant difference among the different age groups ($p>0.05$).

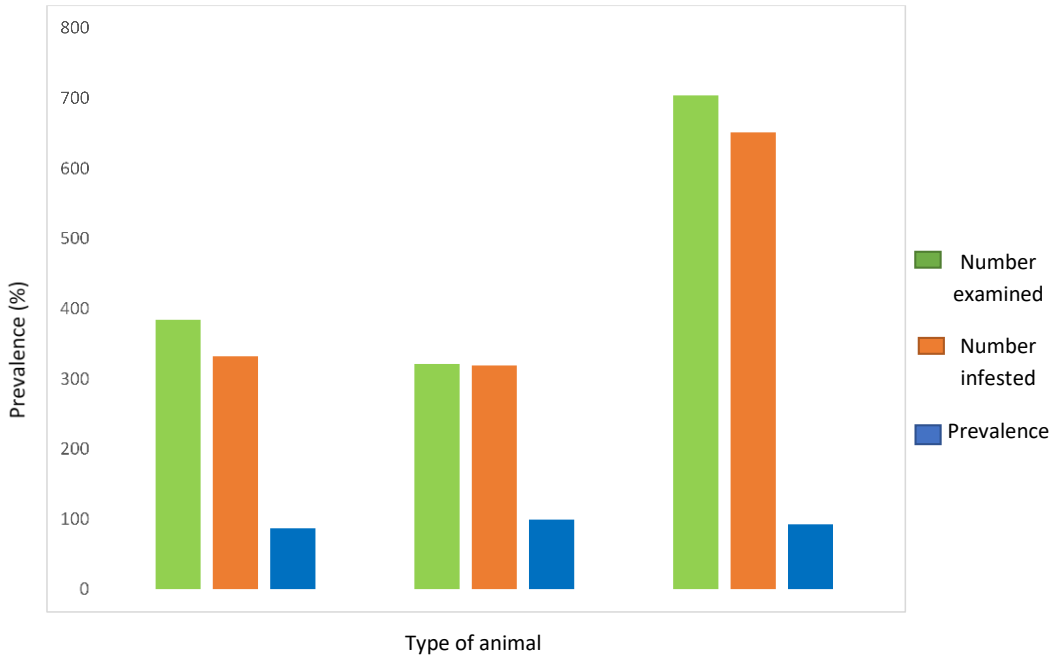

Figure 2. Overall prevalence of tick infestation in sheep and goats in the study area.

Table 1. Prevalence and intensity of infestation by various tick species encountered

Tick species	Infested sheep	Infested goats	Total	Prevalence (%)	Intensity	P Value
Boophilus geygei	143	65	208	29.5	416	<0.05
Boophilus annulatus	45	70	115	16.3	230	
Boophilus decoloratus	54	38	92	13.1	184	
Rhipicephalus sanguineus	50	40	90	12.8	180	
Hyalomma truncatum	41	46	87	12.3	174	
Haemophysalis laechi	28	31	59	8.4	118	<0.05
Total	361	290	651	92.5	1302	

Sex related prevalence of tick infestation in sheep and goats in the study area

A total of 362 females (168 sheep and 194 goats) and 342 males (153 sheep and 189 goats) were examined during the study. Out of these, female sheep and goats recorded the highest prevalence of tick infestation (100%), followed by male sheep (98.7%), and the least prevalence of 86.2% was observed in male goats. However, the overall prevalence of tick infestation in the different sexes showed that generally, female animals were the most infected with the highest overall prevalence of 93.1% while the male animals recorded an overall prevalence of 91.8% (Table 2). The Chi-square value however revealed no significant difference among the different age groups ($p>0.05$).

Prevalence and intensity of tick infestation in sheep and goats based on management systems

The present study also revealed details on the prevalence of tick infestation in animals kept under different traditional management systems. It was found that, animals confined in paddocks recorded lower prevalence of 71.6% compared to free range grazers with highest prevalence (89.8%) and tethered animals (97.8%). Sheep and goats that were grazed in confined paddocks had prevalence of 95.8 and 55.5%, respectively, with sheep recording the highest prevalence. For both sheep and goats, tethered animals had highest infection rates of 100 and 95.8%, respectively with all tethered sheep infested. Free range grazers had prevalence of 100 and 83.3% for sheep and goats, respectively with sheep still recording the highest prevalence. A significant difference in prevalence was observed in both sheep and goats grazed under different grazing systems and also in confined animals (Table 3).

DISCUSSION

Ticks posed a major health problem to ruminants in the study area. Some farmers from whose animals' f aecal

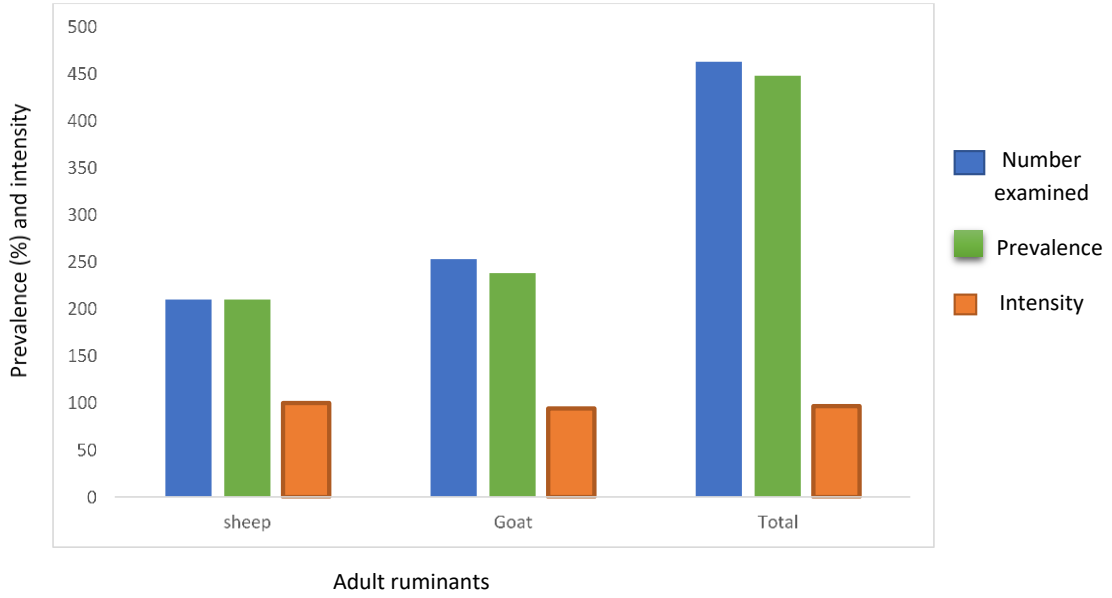

Figure 3. Age related Prevalence and intensity of tick infestation in adult sheep and goats.

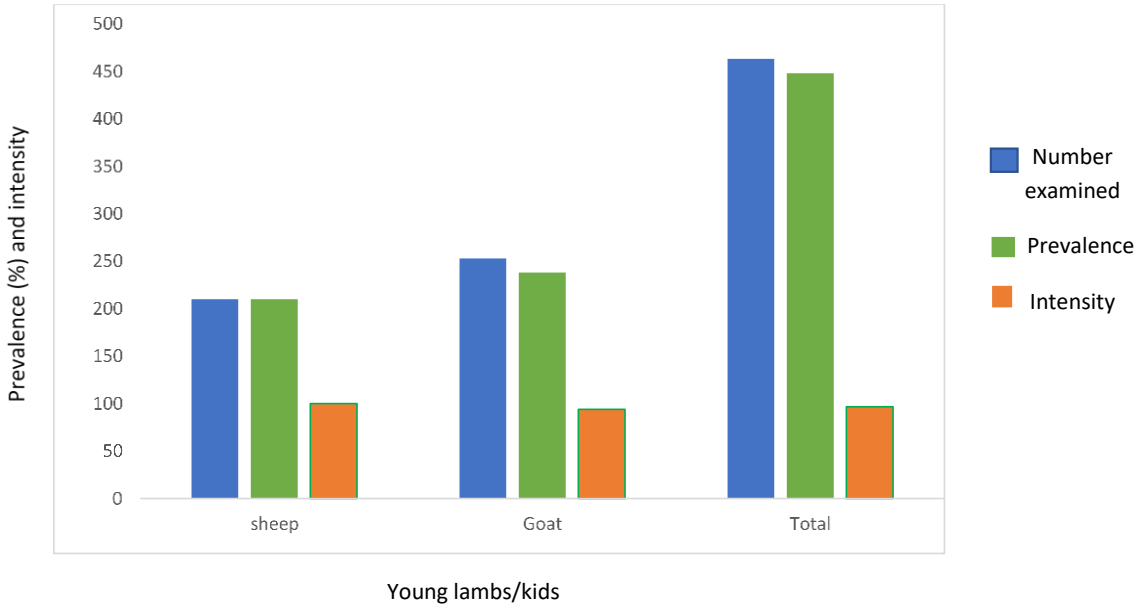

Figure 4. Age related Prevalence and intensity of tick infestation in young sheep and goats.

samples were collected complained of their animals passing out blood tinged urine which is a sign of babesiosis; a tick-borne infection. Under such conditions, gastrointestinal parasites thrive best due to reduced immunity in the ruminants. This led to increased mortality rates in ruminants prior to the study.

Concerning tick infestation, results of this study revealed an overall prevalence of 92.5%. The higher prevalence of ticks could be due to various factors including the fact that ticks are easier to find compared to other ectoparasites that frequently jump. The high prevalence in this is most probably due to several important factors including inadequate management problems, conducive environment, malnutrition and poor husbandry systems, poor awareness of farmers, inadequate veterinary services (Wall and Shearer, 2001) and inefficiency of the ongoing control campaign against ectoparasites in the study area, absence of animals movement policy from one

Table 2. Sex related prevalence of Tick infestation in sheep and goats.

Ruminant	Sex	No Examined	No Infested	Prevalence (%)	P-Value
	Females	168	168	100	
Sheep	Males	153	151	98.7	
	Total	321	319	99.4	>0.05
	Females	194	169	87.1	
Goats	Males	189	163	86.2	
	Total	383	332	86.7	>0.05

Table 3. Prevalence and intensity of tick infestation in ruminants based on management systems.

Management type	Ruminants	No. Examined	No (%) Infected	Intensity	P-value
	Sheep	48	46 (95.8)	92	-- --
Paddocks	Goats	72	40 (55.5)	80	-- --
	Total	120	86 (71.6)	172	<0.05
	Sheep	242	242 (100)	484	-- --
Tethered	Goats	263	252 (95.8)	504	-- --
	Total	505	494 (97.8)	988	>0.05
	Sheep	31	31 (100)	62	-- --
Free range	Goats	48	40 (83.3)	80	-- --
	Total	79	71 (89.8)	142	<0.05

place to the other as well as lack of knowledge by farmers about quarantine of newly introduced animals that could easily get access to ectoparasites uninfected areas (Tolossa, 2014). Other factors which might have contributed to high prevalence of tick infestation in the study area were methods of application of acaricides (spray). During spraying, the formulated liquid acaricide might not reach the base of the skin and all other hidden parts might not be covered or reached by acaricides. A higher prevalence might have also been due to higher temperatures mostly in dry season, relative humidity and prolonged sunlight which favor survival and reproduction of ticks, as had been suggested in other parts of the world (Kumsa et al., 2012). Also, ticks are most often common in ruminants from newly arriving infested animals, this could have been one of the reasons for the high prevalence of ticks in the sheep and goats as reported in other studies (Kufman et al., 2012).

The present study noticed that the prevalence of ticks was slightly higher in sheep (99.4%) than in goats (86.7%). This may have been due to differences in the feeding behavior of sheep and goats where goats usually browse and have pronounced grooming behavior which could reduce the chances of infection and help to detach more ticks from the body. These results corroborate with those of Abunna et al. (2009) who also reported a higher prevalence of tick infestation in sheep than goat in Miesso district, Ethiopia.

The dominant species of ticks was *Boophilus geygei* with a prevalence of 29.5% and the least species *Rhipicephalus (Boophilus) decoloratus* with a prevalence of 3.26%. This trend seems to be different from the report of Awa et al. (2015) who found a prevalence of dominant *Rhipicephalus (Boophilus) decoloratus* (62.2%) in the North West Region of Cameroon, and 41.4% by Lorusso et al. (2013) in neighboring Nigeria. This fact is explained by the differences in the ecological niches of these ticks. Indeed, the combined actions of temperature and rainfall have a selector action on ticks of this region, as well as many other physical factors (Awa et al., 2015). According to, other factors such as the phylogenetic relationships of ticks are also important to explain their geographic distribution (Silatsa et al., 2019).

Ticks tend to occupy the available space and avoid interactions with species of the same lineage; the abundance of some species of ticks in a given area would be more. A good number of adult animals were infested with ticks (96.7%) while the young showed 84.2% prevalence rate. It is worth noting that in the present study, no significant difference for tick infestation between young and adult animals was evidenced in the sheep and goat populations. This discrepancy would be related to a poor access of young animals to pasture and to the unfavorable climate to tick development during the study period. These

results contradict those of Kufman et al. (2012) who reported a particular susceptibility of females to tick attacks.

The prevalence of tick infestation in female sheep (100%) was higher than in males (98.7%). There was equally a slight difference in prevalence of female (87.1%) and male goats (86.2%) with no significant difference. This finding is probably due to several important factors such as; females being kept by the farmer for long periods of time for breeding purposes compared to males that are sold before they are two years of age, hence the treated females might be exposed to infestation as they stay on the same farms for long. In addition, during the breeding season, females are in close contact with many rams for a long time which might increase the risk of being infested with ticks from infested rams. This result could also be due to the weakness of pregnant and lactating females which could not efficiently get rid of ticks from their bodies (McDermott et al., 2010). Clinically affected and carrier animals are the source of infestation (Silatsa et al., 2019). Females might also acquire ectoparasites during nursing from infested lambs which were born after control campaign. Also, some species of ticks spend more time off the host and can exist for a very long period of time without feeding due to no more application of environmental treatment females, therefore, those kept for breeding after control campaign might get infested.

The present study also revealed details on the prevalence of tick infestations in animals kept under different traditional management systems. It was found that, tethered animals recorded the highest prevalence (97.8%) compared to free range grazers (89.8%) and animals confined in paddocks (71.6%). Concerning animal type, sheep and goats grazed in confined paddocks had the highest prevalence (95.8%) compared to a low prevalence (55.5%) in goats. The high prevalence of tick infestation recorded in sheep compared to goats grazed under different management systems might have been because of the grazing habits of sheep (grazing closer to the earth soil and in groups) warrants these animal species to be more infested than goats. These findings are in agreement with the report of other authors (Kanyari et al., 2009). In the present survey, the difference in philosophy with the previous findings may be because majority of the studied animals are kept under poor veterinary infrastructure and medication which leads to a high rate of infestations.

Conclusion

It is worth noting that the overall prevalence of tick infestations evaluated for the concerned sample was relatively high, (92.5%). The six species of ticks identified in this study were *Boophilus geygei, Boophilus annulatus, Boophilus decoloratus, Rhipicephalus sanguineus, Hyalomma truncatum and Haemophysalis laechi* with a high prevalence recorded for *Boophilus geygei* (29.5%) and a low prevalence (8.4%) recorded for *Haemophysalis laechi.* Adult animals were more infested with ticks (96.7%) than the young (84.2%). Concerning animals kept under different traditional management systems, it was found that, tethered animals recorded the highest prevalence (97.8%) compared to free range grazers (89.8%) and animals confined in paddocks (71.6%). For animal type, sheep and goats grazed in confined paddocks had the highest prevalence (95.8%) of tick infestation compared to a low prevalence (55.5%) in goats.

The study clearly indicates that control measures should make use of the variations in tick prevalence and intensity among management systems, age, sex and groups to achieve rational use of acaricides for ticks. Also, tethered animals should not be allowed to graze on a particular spot continuously for several weeks. Grazing spots should be rotated to reduce the chances of ruminants being re-infected from contaminated pastures.

In view of the findings of the present study, it is possible to conclude that several species of ticks represent common health and productivity problems of sheep and goats. Age, sex and management systems were noted as risk factors of tick infestation in the current study. The problem is still very serious and there are still animals suffering from tick infestation in ectoparasite control campaign areas in the region and the country as a whole, thus threatening the national economy, sheep and goat population and tanning industries. Lack of proper awareness creation, absence of control on animal movement and poor quarantine policy could have been the reason for high rates of infestation due to limited control campaigns. This threat of ticks on overall sheep/goat productivity and tanning industry in the North West Region of Cameroon as a whole warrants urgent strategic control intervention based on peculiar characteristic of each agro-ecology.

The results suggested that field veterinarians should assist farmers in treating their animals with effective acaricides used at the beginning and after the end of the rainy season. Traditional medicines should equally be introduced to the farmers of this community in order to fight against these infestations in the ruminants. Also, anti-tick vaccines that use species-specific epitopes to have efficient and innovative practical field applications should be produced to fight these parasites in ruminants. Finally, farmers should be educated on the importance of using dry season feed reserves as means to ensure safe feed for zero-grazed ruminants.

COMPETING INTEREST

The authors declared that they have no competing interest.

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