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Distribution and Seasonal Dynamics of Tick Species Infesting Cattle in Nocturnal and Daytime Systems of Livestock in the Far North Region, Cameroon

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Abstract: Diseases transmitted by ticks constitute a threat to cattle in Cameroon, Far North Region. The objective of this study was to identify ticks and to determine the structure and seasonal variation of tick communities infesting cattle in two types of farming in the Far North Region of Cameroon. Investigation on cattle were conducted from August 2018 to July 2019. Thus, ticks were collected monthly from 108 cattle in three districts (Bogo, Pétté, Kalfou). A total of 13151 adult ticks were collected. Identification revealed the presence of six tick species belonging to three genera whose relative abundance varied according to the different tick species: *Amblyomma variegatum* (39.88%), *Hyalomma marginatum rufipes* (33.43%), *Hyalomma truncatum* (14.70%); *Hyalomma impeltatum* (9.88%); *Boophilus decoloratus* (1.58%); *Rhipicephalus sanguineus* (0.51%). Ticks were most abundant at the beginning of the rainy season (June-July) and least abundant during the dry season (October-April). There was no significant difference between the abundance of different tick species in the two farming systems. Older animals and females were the most infested with ticks. The most infested parts by ticks were udders and testicles (40.08%), anal region (18.04%), legs and armpits (13.27%) and chest (13.96%). This study can help in improving of appropriate strategies for the control of ticks infestation in cattle.

Keywords: Ticks, Distribution, Seasonal Dynamic, Cattle, Far North Region, Cameroon

1. Introduction

Livestock plays an important socio-economic role in human life. In Cameroon, livestock contributes more than 226.8 billion CFA francs to the GDP, i.e., a growth rate of 4.9%. In the rural sector, it constitutes a source of income for more than 60% of the active population and is one of the most remunerative traditional activities in this region [18]. In addition, products derived from livestock provide food self-sufficiency to the population [28]. The national cattle herd in

Cameroon is estimated at more than 7456123, 38% of which is in the Far North region. Livestock production is dominated by cattle, sheep, pigs and poultry [18]. Unfortunately livestock production is threatened by various factors. Numerous studies revealed that livestock conditions predispose to parasite infestations such as ticks. In the Far North Region, livestock is raised in the traditional way [33]. Tick infestation leads to direct and indirect impacts such as weight loss, reproductive disorders, irritation, decreased milk production, skin lesions, blood spoliation, paralysis, high mortality and morbidity [19]. Economically, the loss of weight per bovine is estimated at more than twenty kilograms, or an estimated loss of fifty thousand CFA francs per cattle [28]. The fight against ticks and the vector-borne diseases they transmit is therefore becoming an imperative and must begin with systematic tick control [12]. In recent years we have witnessed a modification of pastoral ecosystems due to climate change which influences the transmission of vector-borne diseases [31]. Current trends imply a new distribution of ticks as well as variation in the level of infestation and abundance of different tick species [15]. In Cameroon, some basic data on ticks have already been obtained (host, geographical distributions, biology and systematics) [29]. However, the seasonal dynamics of the different tick species in the Far North Region are not yet documented. The objective of this study was to identify ticks and to determine the structure and seasonal variation of tick communities infesting cattle in two types of farming in Far North Region of Cameroon.

2. Material and Methods

2.1. Presentation of the Study Area

The work took place in the Bogo, Pette and Kalfou (figure 1) Districts located in the Far North Region of Cameroon with the following geographical coordinates: Bogo (x=14°34'26"E and y=10°22'0.0"N), Petté (y=10°50'08"N and x=14°32'12.0"E), Kalfou (x=15°02'2.0"E and y=10°22'0"N). It covers an area of nearly 34,263 km². It is the second most populated Region with a population estimated in 2010 at 3480414 inhabitants in Cameroon. This region shows a diversity of landscapes, economic activities and livestock systems related to cultural, climatic and relief contrasts [26].

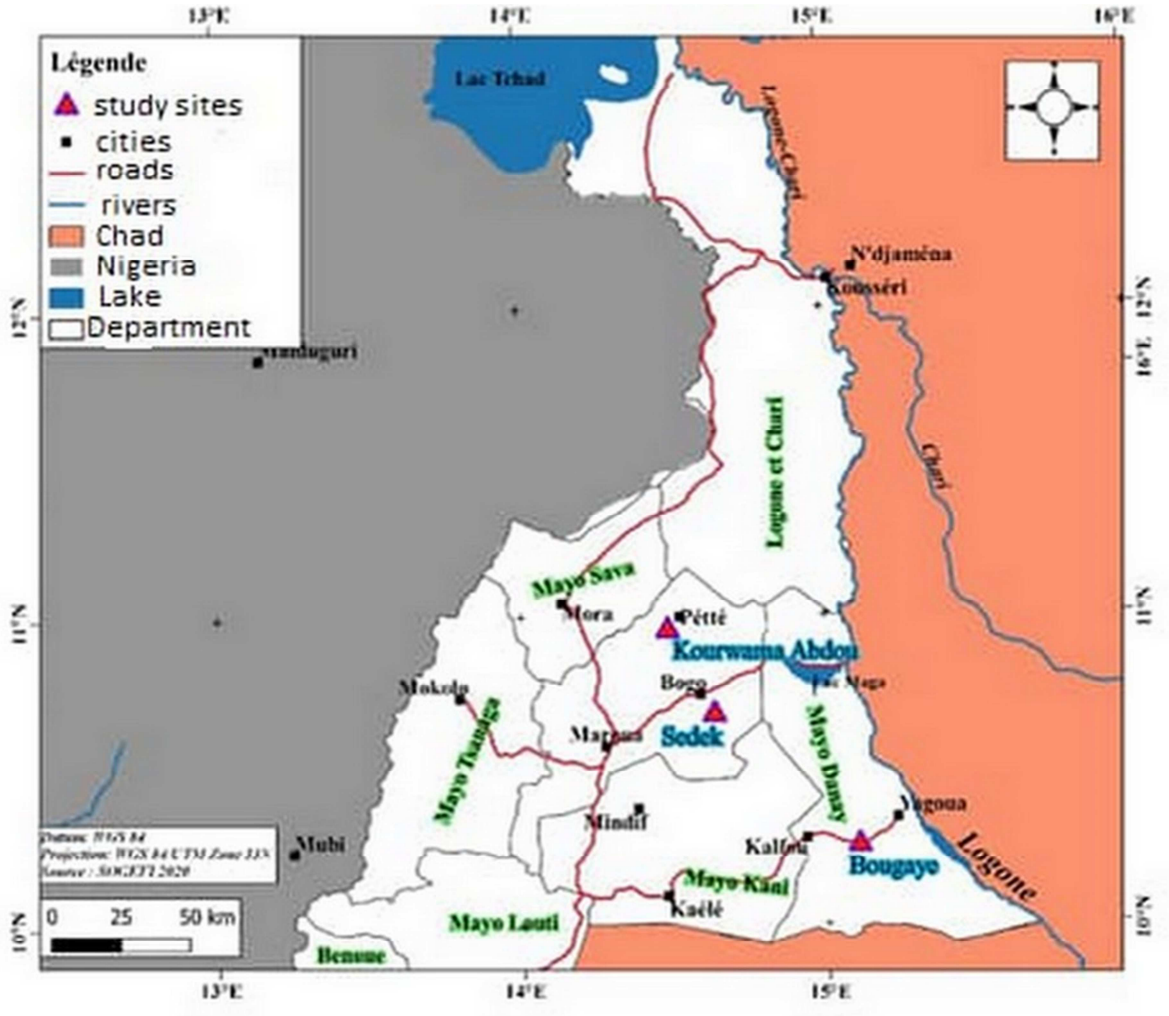

Figure 1. *Map showing the location of the Study area.*

2.2. Climate

The Far North Region climate is of the Sudano-Sahelian type. This climate is characterized by the alternance of dry season from October to April and rainy season from May to September, with two months, July and August, accounting for 2/3 of the total annual rainfall. Rainfall is low and irregular. Annual rainfall varies between 600 and 1000 mm with an average of 800 mm. The average annual temperature is 34°C, with March, April and May as the hottest months and December, January and February as the coldest. In addition, there is an annual temperature range of 28°C with a minimum of 23°C and a maximum of 45°C as extreme temperatures. The hygrometry is very low, especially in the dry season. This climate influences the availability and distribution of water resources, necessary for the development of various agricultural and pastoral activities [33, 34].

2.3. Relief

Four sets of landforms can be identified in the Far North, creating different ecological zones, namely:

1) the Lake Chad delta which is the area between Kousseri and Lake Chad. Its lands are arid and therefore constitute an obstacle to the promotion of human activities such as agriculture, livestock and fishing;
2) The "Yaerés" describe the area along the eastern border with Chad as far as the town of Kousseri. It is a land in the process of drying up because of the Maga dam, which stops the flow of water from the Logone and the Mandara Mountains;
3) The Mandara Mountains, whose peaks reach an altitude of 600 to 1,200 meters, constitute an arid area devoid of vegetation cover due to intensive agricultural and pastoral activities;
4) The Diamaré Plains, which form the eastern foot of the Mandara Mountains, offer favorable conditions for agriculture and livestock production [30].

2.4. Vegetation

The vegetation is composed mainly of herbaceous steppe and shrubby savannah, but there are also a few isolated, stunted and thorny trees with striated bark, characteristic of the traces of accelerated anthropization. These plant formations are predominantly herbaceous and dotted with woody species on the slopes and ridges of the mountains. The dominant herbaceous families are grasses. Most of these plants are used for livestock feed [33].

2.5. Animal

We chose two parks per study site based on the daytime and nighttime grazing system. On the one hand, the animals are confined to the huts during the day and released into the pastures at night, and on the other hand, a system where the animals go out to graze accompanied by the herders during the day and in the evening the herd spends the night in the open enclosures (Waldé). Each herd consisted of 40 to 50 Sahelian Zebu (Bos indicus) cattle. A total of 108 animals were selected from the three study sites, or 36 animals per localities. The 36 animals were distributed as follows: 18 for the daytime system and 18 for the nighttime system. We selected the animals according to sex, age and dress. The age ranged from 1 to 10 years and the coat variations were red, white, red spotted, white spotted. The least aggressive animals were retained for further study. During the whole study the sample was the same as the 36 animals chosen were marked per herd and de-tagged once a month for twelve months [33].

2.6. Tick Collection

Ticks were collected from the animals using surgical forceps after the animal was restrained by the herders and wearing protective bands. Restraint of the animal facilitated the removal of the ticks and limited the time lost, and also prevented the rostrum of the tick from remaining attached to the animal. The forceps were therefore placed as close as possible to the animal's skin. Tick removal was done once a month per study site, per park, and per site of attachment (legs, ears, head, armpits, udders, chest, tail and the rest of the body) of the ticks on the cattle. Tick sampling on each cattle was done for 10 minutes taking into account the tick attachment sites on the animals [37].

2.7. Identification of Ticks

Ticks were identified on the basis of morphological and anatomical characteristics using the identification keys for Ixodidae. Identification was done under a binocular magnifying glass at LANAVET (National Vétérinairy Laboratory) in Garoua, Cameroon. Identification consisted of determining the genus and species of the ticks [16, 37].

2.8. Determination of Some Epidemiological Indices

2.8.1. Prevalence of Infestation

The prevalence of infestation (Pi) is the percentage ratio of the number of hosts infested (N) by a tick species to the number of hosts examined

$$\text{(H). } Pi = N/H \times 100$$

It expresses the percentage of cattle infested by a tick species compared to other tick species.

2.8.2. Tick Species Abundance

The infestation abundance of a tick species (Ai) corresponds to the ratio of the total number of individuals of the latter to the number of hosts examined (H). $Ai = ni/H$

It allowed to determine among the tick species, the most important numerically during the whole sampling period

2.8.3. Average Parasite Intensity of Tick Species

Average parasite intensity of a species is the ratio of the

total number of individuals of a tick species (ni) in a sample of hosts to the number of infested hosts (N) in the sample.

$$Ip=ni/N$$

2.8.4. Statistical Analysis of the Data

The number of ticks collected was recorded by month, anatomical regions, sex, age, parks and for all locations. Excel software was used to determine monthly averages of tick abundance, averages were calculated by month by species, and by anatomical region. Pairwise comparison of means and analysis of variance was performed by Tukey's t-test using R software. Sigmaplot 10.1 and Excel software were used to produce the graphs.

3. Results

3.1. Data on Ticks Collected

3.1.1. Abundance of Different Tick Species by Locality

Figure 2 presents the abundance of the different tick species according to the localities studied. It appears from this analysis that in the localities of Bogo, Petté and Kalfou we identified six species of ticks in each locality, including *Amblyomma variegatum*; *Hyalomma marginatum rufipes*; *Hyalomma truncatum*; *Hyalomma impeltatum*; *Boophilus decoloratus* and *Boophilus sanguineus*. These species are grouped in three genera namely *Amblyomma* (39.88%), *Hyalomma* (58.02%) and *Boophilus* (2.19%). Overall, the species *Amblyomma variegatum* (39.88%) is the most abundant numerically, followed by the species *Hyalomma marginatum rufipes* (33.43%), then *Hyalomma truncatum* (14.70%) then *Hyalomma impeltatum* (9.88%), *Boophilus decoloratus* (1.5%) and finally *Rhipicephalus sanguineus* (0.51%). The abundance of the different tick species varies significantly within the same locality. There was a significant difference between the abundance of *Amblyomma variegatum* and *Hyalomma impeltatum*, *Hyalomma truncatum*, *Boophilus decoloratus* and *Rhipicephalus sanguineus* at $P<0.05$ in all locations. There is not a significant difference between the abundance of *Amblyomma variegatum* and *Hyalomma marginatum rufipes* species, between *Hyalomma impeltatum* and *Hyalomma truncatum* species, between *Boophilus decoloratus* and *Rhipicephalus sanguineus* at $P<0.05$. But there is not a significant difference when going from one study site to another.

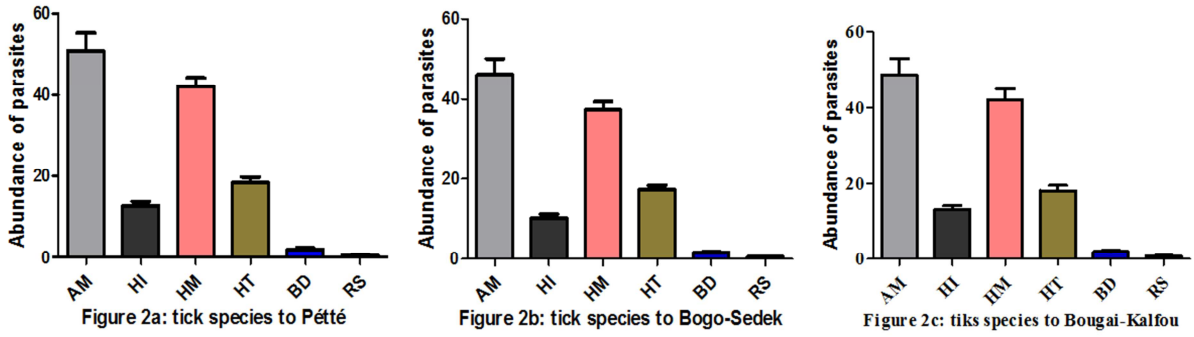

Figure 2. *Abundance of different tick species by locality.*

Legende: AM=*Amblyomma variegatum*, HI=*Hyalomma impeltatum*, HM=*Hyalomma marginatum rufipes*, HT=*Hyalomma truncatum,* RS=*Rhipicephalus sanguineus*, BD=Boophilus decoloratus

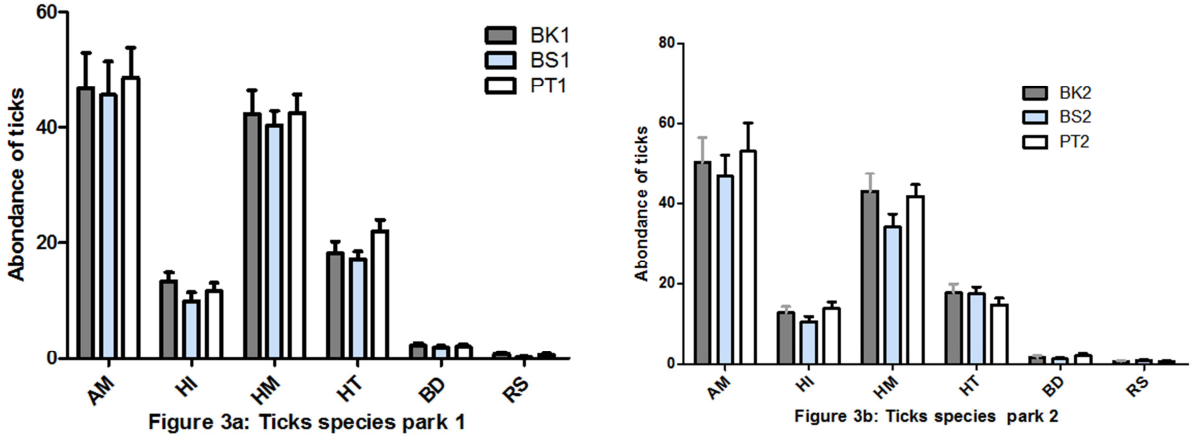

Figure 3. *Abundance of different tick species according to parks.*

Legende: AM=*Amblyomma variegatum*, HI=*Hyalomma impeltatum*, HM=*Hyalomma marginatum rufipes*, HT=*Hyalomma truncatum*, RS=*Rhipicephalus sanguineus*, BD=*Boophilus decoloratus*

3.1.2. Abundance of Different Tick Species According to Parks

Figure 3 shows the distribution of tick species according to the farming systems. The analysis of these graphs shows that in park 1 and park 2 the same tick species are found but with varying densities. In park 1, where the animals are kept in stalls all day in huts surrounded by mosquito nets and released at night into the vegetation, ticks are less abundant. In contrast, in Park 2, the animals are free during the day and locked up at night in open pens far from the houses (Walde), and ticks are more abundant on the animals. However, there is no significant difference (P >0.05) between the abundance of different tick species in the two farming systems. The system seems to protect the cattle from flies and mosquitoes and not from ticks.

3.1.3. Influence of Age and Sex on Tick Density

Figure 4 present influence of age and sex on tick density. Figure 4a shows the influence of age on tick density. Animals were grouped into three groups: Young (0-2), adult (3-5), old (6 and above). The analysis of figure 4a shows that there is a very significant difference between the density of different ticks species according to the age groups (P-value <0.0001). Young animals are less infested than adults and old animals. The intensity of infestation increases with age. *Amblyomma variegatum* and *Hyalomma marginatum rufipes* ticks infested more old animals than young ones. The following figure 4b shows the influence of the sex of the animals on their parasite load. The analysis of figure 4b shows that there is a very significant difference between the infestation of males and females (P-value=0.001). Females are more infested than males.

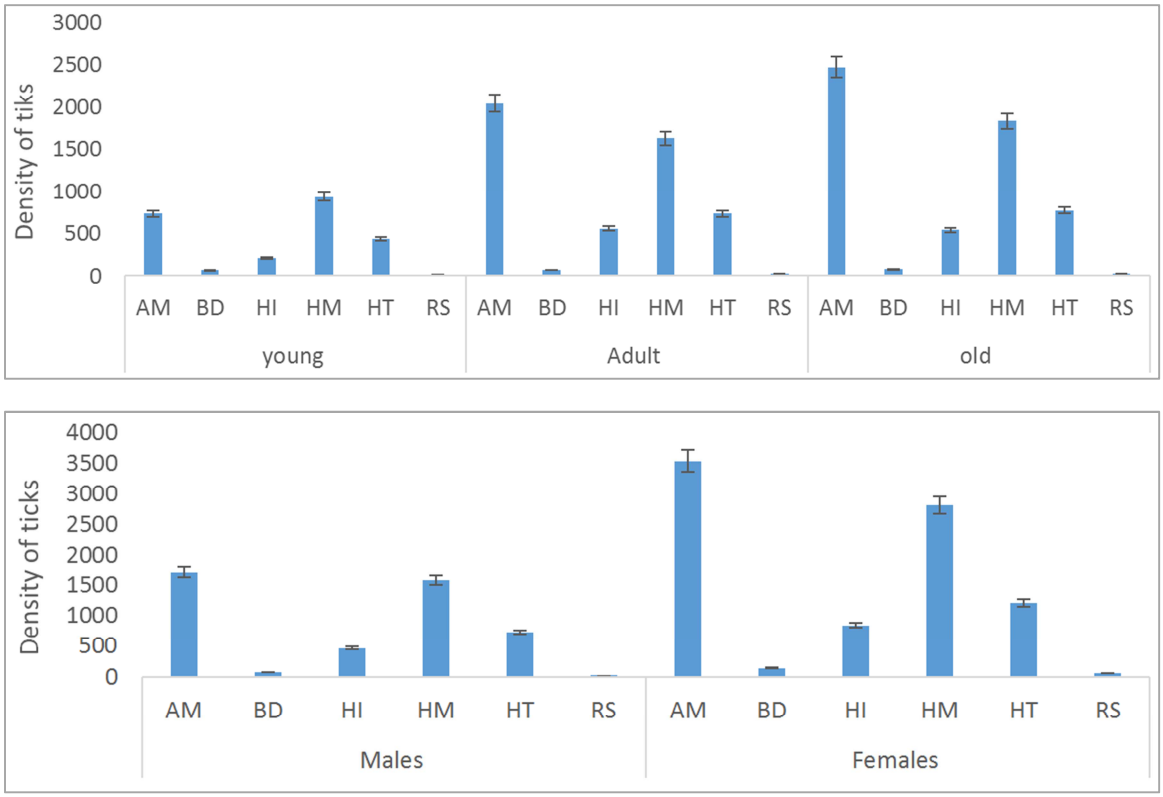

Figure 4. *Influence of age and sex on tick density.*

Legende: AM=*Amblyomma variegatum*, HI=*Hyalomma impeltatum*, HM=*Hyalomma marginatum rufipes*, HT=*Hyalomma truncatum*, RS=*Rhipicephalus sanguineus*, BD=*Boophilus decoloratus*

3.2. Seasonal Variation of Different Tick Species

Figure 5 shows the seasonal variation in the densities of the different tick species according to the months of the year. The analysis of the different curves shows that all the tick species have a period of high infestation and the period of temporary disappearance on the animals. There is a significant difference between the density of the different tick species according to the months (P<0.05). In figure 5, *Amblyomma variegatum* shows high infestation between June and August. The parasite load drops from August to March. *Amblyomma variegatum* disappears in April. Figure 5 also shows the seasonal variation in the abundance of *Hyalomma marginatum rufipes* on cattle during the year. From this figure 5, this tick is present on cattle almost year round. *Hyalomma marginatum rufipes* infested more cattle in June. The lowest density is recorded in April followed by a reappearance in May. The density of *Hyalomma impeltatum* is low throughout the year with a peak in July. As for *Hyalomma truncatum* its density is high during the months of June and September.

It also disappears in April and reappears in June. *Boophilius decoloratus* and *Rhipicephalus sanguineus* present a low density throughout the year. The most important species by their level of infestation are *Amblyomma variegatum* (June-August) and *Hyalomma marginatum rufipes* (June and September).

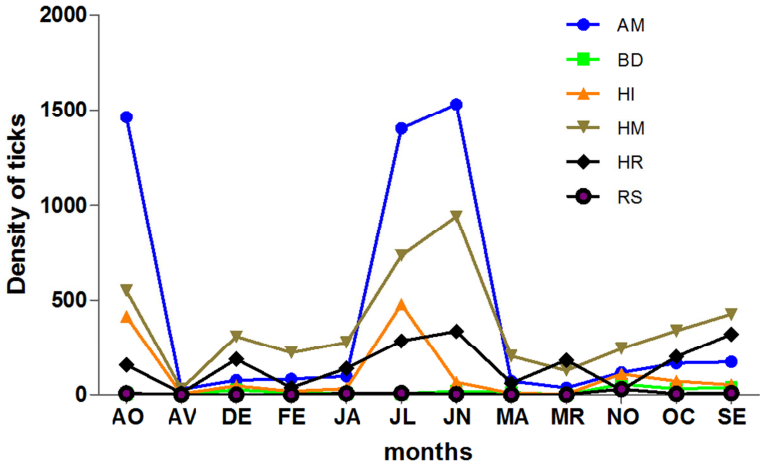

Figure 5. *Seasonal variation of different tick species (August 2018 – July 2019).*

Legende: AM=*Amblyomma variegatum*, HI=*Hyalomma impeltatum*, HM=*Hyalomma marginatum rufipes*, HT=*Hyalomma truncatum*, RS=*Rhipicephalus sanguineus*, BD=*Boophilus decoloratus* AO=August, SE=September, OC=October, NO=November, DE=December, JA=January, FE=February, MR=March, AV=April, MA=May, JN=June, JL=July,

3.3. Tick Attachment to Parts of the Animal

Figure 6 shows us that cattle ticks, in their search for pasture, expose certain parts of their bodies to tick infestations. Thus, ticks attach themselves weakly to the head (0.66%), ears (1.69%), tail and the rest of the body (3.1%). On the other hand, the parts with thin skin and in contact with vegetation are the most infested by these mites. In particular the testicles and udders (40.08%), anal region (18.04%), chest (13.96%), legs and armpits (13.27%), and flank (9.15%). Thus, at the level of the head, ears and the rest of the body have a low fixation of the different species of ticks. On the other hand, the testicles and udders, the anal region, the armpits and legs, and the chest showed a significant fixation of the different tick species. There is a significant difference between the abundance of the different tick species for each anatomical part of the animal ($p < 0.05$).

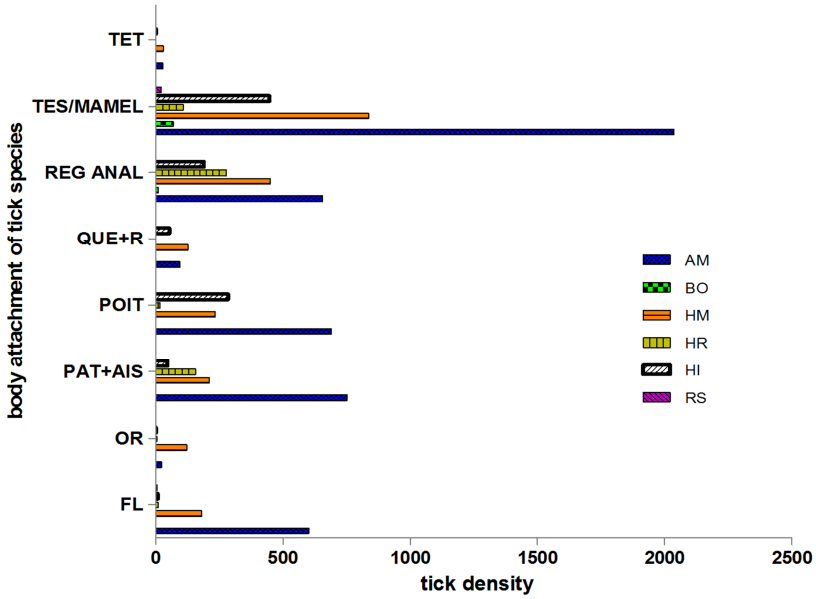

Figure 6. *Tick attachment to parts of the animal.*

Legende: AM=*Amblyomma variegatum*, HI=*Hyalomma impeltatum*, HM=*Hyalomma marginatum rufipes*, HT=*Hyalomma truncatum*, RS=*Rhipicephalus sanguineus*, BD=*Boophilus decoloratus*, TET=head, TES/MAMEL=testicles or udders, reg anal=anale region, que+R=tail and the rest of body, poit=chest, pat+ais=legs and armpits, Or=ears, Fl=flank

3.4. Prevalence, Parasite Intensity of Different Tick Species

Table 1. *Prevalence (P %) of different tick species.*

months	P (%)					
	AM	**HI**	**HM**	**HT**	**BD**	**RS**
AO	94.44	79.62	86.11	41.16	5.55	6.48
SEP	75.92	34.25	86.11	80.55	29.62	7.4
OC	62.03	38.88	73.14	73.14	021	3.7
NO	50	50.92	75.92	17.59	0.21	15.74
DE	45.37	18.51	69.44	55.55	24.07	6.48
JA	53.7	23.14	42.59	80.55	5.55	0
FE	43.51	9.25	49.07	23.14	9.2	0
MR	23.14	2.7	40.74	18.51	0	0
AV	12.96	0	14.81	4.62	0	0
MA	38.88	43.51	48.14	74.07	9.2	0
JN	97.22	46.29	92.59	80.55	14.81	2.77
JL	90.74	79.62	83.33	66.66	6.48	7.4

Legende: AM=*Amblyomma variegatum*, HI=*Hyalomma impeltatum*, HM=*Hyalomma marginatum rufipes*, HT=*Hyalomma truncatum*, RS=*Rhipicephalus sanguineus*, BD=*Boophilus decoloratus*: AO=August, SE=September, OC=October, NO=November, DE=December, JA=January, FE=February, MR=March, AV=April, MA=May, JN=June, JL=July

Table 2. *Parasite Intensity (PI) of different tick species.*

months	PI					
	AM	**HI**	**HM**	**HT**	**BD**	**RS**
AO	14.93	2.48	5.89	3.48	1	1
SEP	2.1	4.27	4.58	3.66	1.21	1.12
OC	2.49	3.38	4.27	1.51	1.34	1.25
NO	2.16	0.78	2.97	9.63	2.43	1.7
DE	1.55	1.1	2.9	2.43	1	1
JA	1.67	1.44	3.82	1.59	1	0
FE	1.76	1.1	4.03	1.48	0.6	0
MR	1.44	1	2.9	1.2	0	0
AV	2	0	1.93	1.6	0	0
MA	1.69	1.65	3.28	2.28	1.1	0
JN	15.62	6.16	9.4	3.83	1	2.33
JL	12.79	331	10.7	3.94	0.85	1

Legende: AM=*Amblyomma variegatum*, HI=*Hyalomma impeltatum*, HM=*Hyalomma marginatum rufipes*, HT=*Hyalomma truncatum*, RS=*Rhipicephalus sanguineus*, BD=*Boophilus decoloratus*: AO=August, SE=September, OC=October, NO=November, DE=December, JA=January, FE=February, MR=March, AV=April, MA=May, JN=June, JL=July

Tables 1 and 2 show the variations of the prevalence and the parasite intensity of the different tick species according to the months. Indeed, it appears from table 1 that the prevalence and the parasitic intensity of the different tick species varies during the year. Regarding the species *Amblyomma variegatum*, the highest prevalence (97.22%) is observed in June and the lowest prevalence (12.967%) is observed in April. The lowest parasite intensity (1.12) of *Amblyomma* was observed in April and the highest parasite intensity (15.62) was observed in June. There is a significant difference between parasite intensity and tick prevalence between wet and dry seasons ($p < 0.05$). During the month of June, lots of cattle were parasitized by this species. However, onwards October, the prevalence of *Amblyomma variegatum* starts to drop until April. Tables 1 and 2 show the variations of the prevalence and the parasite intensity of *Hyalomma impeltatum* ticks according to the months. Indeed, it appears from table 1 that the highest prevalence (79.62%) is observed in August and July and the lowest in April (0%). The lowest infestation intensity (0) is observed in April and the highest infestation intensity (6.16) is observed in June. There is a significant difference between the prevalence and the intensity of infestation of *Hyalomma impeltatum* during the months of the rainy season and the dry season. Concerning the variations of prevalence and intensity of *Hyalomma marginatum rufipes* according to the months, it appears from table 1 that the highest prevalence (92.59%) of *Hyalomma marginatum rufipes* is observed in July and the lowest prevalence (14. 81%) is observed in April. The lowest infestation intensity (1.93) is observed in April and the highest (10.7) in July. There is a significant difference in the distribution of tick densities by month in June, July and August with the other months of the year at $p < 0.05$. As for the variations of the prevalence and the parasite intensity of *Hyalomma truncatum* species ticks, we notice that the highest infestation intensity of *Hyalomma truncatum* is observed in June (3.83%) and the lowest prevalence is observed in March (1.2%). Concerning the variations of prevalence and intensity of *Boophilus decoloratus* according to the months, it appears from table 1 that the highest prevalence (14.81%) of *Boophilus decoloratus* is observed in June and the lowest prevalence (0 %) is observed in April. The lowest infestation intensity (0) is observed in April and the highest (2.43) in June. Concerning the variations of prevalence and intensity of *Rhipicephalus sanguneus* according to the months, it appears from table 1 that the highest prevalence (15.74%), of *Rhipicephalus sanguneus* is observed in June and the lowest prevalence (0%) is observed in April, January, february, and march. The lowest infestation intensity (0) is observed in April and the highest (2.33) in June.

4. Discussion

At the end of our investigation, a total of 13151 adult ticks were collected from 108 cattle in three localities (Bogo, Pette and Kalfou). Six species of ticks were identified and were grouped into three genera: *Hyalomma* (58.02%), *Amblyomma* (39.88%), and *Boophilus* (2.19%). These ticks comprised: *Amblyomma variegatum*; *Hyalomma marginatum rufipes*; *Hyalomma truncatum*; *Hyalomma impeltatum*; *Boophilus decoloratus* and *Boophilus sanguineus*. This multitude of tick species parasitizing cattle would be due to the traditional breeding system which consists in leading the animals to graze in the bush. In the rainy season, the animals feed on grasses around the houses and in the dry season, they feed on the remains of leaves and stems and some dried grasses in the millet fields of the *Sorghum* spp. These results show that when the animals go out to pasture, they are infested with ticks. In addition, farmers do not use acaricides to control ticks and manual tick removal remains the only method of tick control. In livestock systems where people use acaricides to control ticks, there is a reduced species diversity. We can already see that specific diversity varies according to the habits of the farmers (use of acaricides or not), and the types of traditional, extensive or intensive breeding [1, 24].

Comparing our result with previous studies on ticks infesting cattle in Cameroon, show that cattle in the peri-urban area of Ngaoundere are infested by 7 species of ticks such as *Rhipicephalus (Boophilus*) *geigyi, Rhipicephalus (Boophilus) annulatus*, *Rhipicephalus (Boophilus) decoloratus, Hyalomma truncatum, Hyalomma Marginatum rufipes, Rhipicephalus sanguineus* and *Haemophysalys* [24]. Cattle infection with Babesiosis and Anaplasmosis like other Tick Borne Diseases (TBDs) is common in this region of Cameroon [22]. In the western highlands of Cameroon Merlin reveals the presence of three tick genera such as *Amblyomma, Boophilus,* and *Hyalomma* with 10 different species. However, the North of Cameroon shows the total absence of *Boophilus decoloratus*, even though they are present in the Adamaoua zone and in the Far North of Cameroon [3, 4-24]. The Zebu cattle breed is resistant to ticks, especially ticks of the genus *Boophilus* [2].

When we compare the results of our work with those carried out in the Sudanosahelian zone of Benin, we note that ten species of ticks belonging to the genera *Amblyomma, Boophilus, Hyalomma* and *Rhipicephalus* were identified [13]. The specific diversity of tick species in this area is higher than that identified in the Sudanosahelian zone of Cameroon. We note here that the specific diversity of the different tick species also varies from one country to another. These differences can be explained by the ecological and climatic conditions that vary from country to country, depending on the year and the period of tick collection [10]. Indeed, within a country, climatic variations observed during successive years will favor or disfavor the evolution of the tick population.

It is noted that in the nocturnal rearing systems the animals were slightly less infected by *Amblyomma variegatum* than in the diurnal rearing systems. *Amblyomma variegatum,* the African bont tick*,* is a tick that stalks vegetation at the end of a blade of grass and is found in so-called open biotopes [16]. This tick was ubiquitous and was the main vector of *Ehrlichia ruminantium, protozaans, Theileria mutans,* dermatophilosis *and T. velifera* [32]. In general, it can be noted that whether animals are taken to pasture during the day or night does not have much influence on their infestation. Pastures are the places of massive infestation of animals [9]. Numerous studies done on the comparison of tick parasite loads on stray and confined dogs reveal that dogs that go out in wooded or brushy areas are more infected than those that are tethered [16].

Amblyomma variegatum (39.88%) was the most abundant species, followed by *Hyalomma marginatum rufipes* (33.43%), then *Hyalomma truncatum* (14.70%), then *Hyalomma impeltatum* (9.88%), *Boophilus decoloratus* (1.5%) and finally *Rhipicephalus sanguineus* (0.51%). These abundances did not vary from one locality to another because these three localities have the same ecological situations and the herders also have the same habits. The high abundance of Amblyomma variegatum, *Hyalomma marginatum rufipes*, *Hyalomma truncatum, Hyalomma impeltatum species is thought to be due* to their parasite specificity for cattle, and can also be justified by the high number of eggs laid by the females (10-15,000) [5]. The genius *Hyalomma* is involved in the transmission of diseases such as Crimean Congo hemorrhagic fever (CCHF) in humans and Bartonellosis. The low abundance of *Boophilus decoloratus* and *Rhipicephalus sanguineus* ticks may be due to the natural resistance of Zebu cattle to these ticks. In addition, *Rhipicephalus sanguineus* is a dog-specific tick. We also collected it on cattle because they share and exploit the same pastures. Thus, accidents in the search for the host or behavioral adaptations can lead ticks to parasitize other animals of which they are not specific. In the work of [25] in Adamaoua we note the dominance of *Amblyomma variegatum* with a relative abundance of (65.18%), followed by Boophilus microplus with a relative abundance of (24.11%) and finally *Rhipicephalus appendiculatus* (10.71%). The abundance of *A. variegatum* (65.18%) in Adamaoua is higher than the relative abundance of this same tick in the Far North Region of Cameroon (39.88%). In Benin, abundances of 33.85% and 32.66% were noted for *Amblyomma variegatum* and *Boophilus geigyi* respectively [13]. We also note here a relative abundance of *Amblyomma variegatum* lower than the one we obtained. These differences found would be due to the geographical location of the different study areas [8].

The present survey reveals a relatively high abundance (33.43%) of *Hyalomma marginatum rufipes*. This tick was identified in the highlands of western Cameroon in the work of Merlin but with a very low relative abundance. In Algeria this species was identified on cattle by Mohamed with a relative abundance of (11%) [27]. This species was identified in Benin with a relative abundance of (4.36%) [13]. In Morocco the prevalence of this species is (1.11%) [19]. These abundances are lower than those obtained in our work. These differences can be explained by the different farming systems. This tick is involved in the transmission of diseases such as Crimean Congo hemorrhagic fever (CCHF) in humans [32]. The abundance of *Boophilus decoloratus* (1.5%) and *Boophilus sanguineus* (0.5%) is very low in our study area. These ticks were identified in Adamaoua and in the center in the work of Bahemi [6, 24]. In these two works the relative abundances were not determined. These two ticks are responsible for the transmission of *Anaplasma marginale,* and *Babesia occultans* to cattle and Rickettsioses to humans [22, 32].

The parasite intensity and prevalence of the different tick species studied varies with the different months of the year. Thus the species *Amblyomma variegatum* is more abundant during the months of June, and August. We note that the parasite intensity and prevalence are higher during these months. This would be due to the climatic conditions (temperature and humidity) favorable to the hatching of eggs and the good development of this species of tick. The drop of the parasite intensity is due to the unfavorable conditions excessive rainfall, very high temperature and low humidity. Regarding the seasonal variation of *Hyalomma marginatum rufipes*, *Hyalomma truncatum* and *Hyalomma impeltatum* species, it was found that the intensity and prevalence are higher during the months of June, August, September and October. The genus *Boophilus* presents a low occurrence and low variation throughout the year. The comparison of our

results with those of Kamto [20] carried out in Nigeria reveals that for all tick species combined, the months of August and September show a very high abundance of the different tick species and the dry season shows a low abundance of the different tick species. Indeed, the first moderate rains favor the hatching of tick eggs and the abundant rains lead to the progressive disappearance of ticks [11, 21].

The distribution of the different species of ticks shows that they attach themselves in a preferential way on the parts of the animal. Ticks attach themselves to the testicles and udders (40.08%), anal region (18.04%), tail and rest of the body (3.1%), chest (13.96%), leg and armpit (13.27%), flank (9.15%), ear (1.69%), head (0.66%). The parts most infested by all the ticks were: testicles, udder and anal region. These results do not totally corroborate those observed by Farougou et al who rather found ticks in the anogenital region, abdominal region, legs and ears. *Amblyomma variegatum* is more abundant in the testicles and udders, anal region, legs and armpits. Work in Nigeria on dogs shows that ticks generally attach to the ears, perineum, abdominal region, and scrotal with a prevalence of 85%, 65%, 3.1% respectively on the perineum, ears, abdominal region and scrotal. Other studies show that cattle ticks preferentially attach themselves to the ears, the ano-genital region and the abdomen scrotal region are the most infested [13, 21]. The parts most infested by ticks are those that are in direct contact with vegetation. The ticks then migrate to the thin-skinned and highly vascularized parts of the animal to better attach themselves and begin their blood meal.

Young cattle were the least infected and older cattle the most infested. Females were also more parasitized than males. This may be explained by the fact that individuals born at the beginning of the rainy season are kept in park and do not follow their mothers to pasture. Thus the young are not in contact with the different species of ticks. At the end of the rainy season, the young follow the adults and collect ticks in the pastures, hence their high infestation.

5. Conclusion

This study showed that in the Far North Region of Cameroon, the night and day rearing systems do not have much influence on the abundance of different tick species. Thus, a total of 6 (six) tick species belonging to three genera were identified on cattle. *Amblyomma variegatum* was the most abundant tick, followed by *Hyalomma marginatum rufipes*, then *Boophilus decoloratus,* then *Hyalomma truncatum*, and finally *Rhipicephalus sanguineus*. The two most abundant species are *Amblyomma variegatum* and *Hyalomma marginatum rufipes*. Their abundance and parasite intensity increase with the arrival of the rains and decrease progressively with the departure of the rains i.e. during the dry season. The prevalence of parasitized cattle is high in the rainy season and low in the dry season. The animals are parasitized in specific areas in contact with the vegetation during grazing. The most parasitized animals are the older ones and the females. These different species of ticks are involved in the transmission of several livestock diseases. The tick *Amblyomma variegatum* is involved in the transmission of Cowdriosis and dermatophilosis, *Hyalomma truncatum, Hyalomma marginatum rufipes* are responsible for the transmission of Crimean Congo hemorrhagic fever and Bartonellosis. Cattle are animals consumed by humans. The presence of different species of ticks in these animals used for human consumption poses several problems: the decrease of yields, exposed professionals and possible contaminating of the meat, milk and their derivatives. This increases the risk of various zoonosis. It is therefore essential to implement a strategy to fight against ticks and the diseases they transmit.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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