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Prevalence and Seasonal Survey of Tick Fauna (Acari: Ixodidae) of Domestic Ruminants in the Hauts-Bassins Region, Burkina Faso

Bamba Hubert Eloi Aboubacar Sidiki*[1,4], Tianhoun Denté Fidèle[2], Sawadogo Alizèta[3], Kaboré Adama[2], and Marichatou Hamani[4]

[1]*National Center for Scientific and Technological Research (CNRST)/Institute of the Environment and Agricultural Research (INERA)/Plant Production Department/Cotton Program, 01 BP 208 Bobo- Dioulasso 01, Burkina Faso*
[2]*National Center for Scientific and Technological Research (CNRST)/Institute of the Environment and Agricultural Research (INERA)/Animal Production Department, BP 10 Koudougou, Burkina Faso*
[3]*National Center for Scientific and Technological Research (CNRST)/Institute of the Environment and Agricultural Research (INERA)/Plant Production Department/Regional Center of Excellence in Fruits and Vegetables (CRE), 01 BP 910 Bobo- Dioulasso 01, Burkina Faso*
[4]*Abdou Moumouni University (UAM)/Regional Center of Excellence on Pastoral Productions (CERPP), BP 10960 Niamey, Niger*

*Corresponding author's Email: bheas2000@yahoo.fr

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ABSTRACT

As in other West African countries, ticks (Acari: Ixodidae) infesting domestic ruminants are a major constraint for livestock breeders in Burkina Faso. The present epidemiological survey study was conducted from October 2022 to September 2023 in two pastoral areas of the Hauts-Bassins region of Burkina Faso to inventory the tick genera and species present, and determine the prevalence and associated risk factors in infested ruminants, including host sex, age, and season. A total of 8,274 live ticks were collected from 800 ruminants randomly selected (300 cattle, 300 sheep, and 200 goats) across two pastoral zones (Sidéradougou and Saho pastoral zones) and three seasons (cold dry season, hot dry season, and rainy season) from the herds of 140 livestock farmers surveyed. Morphological identification identified six species within the genera *Amblyomma* (67.32%), *Hyalomma* (26.35%), and *Rhipicephalus* (*Boophilus*, 6.33%), with *Amblyomma variegatum* as the dominant species. The overall prevalence of tick infestation was 74.90%, including 37.25% in cattle, 23.50% in sheep, and 14.15% in goats, with an average infestation level of 10.34 ± 20.30 ticks per animal. Male ruminants (52.62%) were more infested than females (47.38%), and juveniles (41.37%) were more infested than adults (58.63%). Seasonal patterns revealed peak infestation during the rainy and cold dry seasons in both Pastoral zones, and ticks showed a predilection for the inguinal and pastern regions. These findings highlight the extensive tick burden in Hauts-Bassins region, Burkina Faso's pastoral systems, and underscore the need for targeted, season- and host-specific control strategies to mitigate tick-borne disease risks and improve livestock productivity.

Keywords: Pastoral area, Prevalence, Ruminant, Seasonal dynamic, Tick infestation

INTRODUCTION

In Burkina Faso, the livestock sector plays an important role in the national economy. It accounts for around 40% of agricultural value added and 30% of export earnings (Ouédraogo, 2021). With a numerically large and varied herd, this activity generates almost 20% of Gross Domestic Product (GDP) and is the third-largest source of foreign currency after gold and cotton in this country (FAO, 2019). It alone employs nearly 80% of the working population of Burkina Faso (MRA, 2011; FAO, 2019). This sector strengthens the food and nutritional security (animal protein intake) of rural and urban households, while also reducing poverty by providing them with appreciable income, especially the most vulnerable societies (MRA, 2010). Unfortunately, tick infestation and the diseases they transmit are a major constraint on livestock farming worldwide, especially in tropical locations. These zoonosis-carrying mites remain the main health problems limiting or restricting livestock productivity in Burkina Faso (Heylen et al., 2023). The skin lesions induced by direct physical damage from the tick's bite and attachment, the inflammatory and irritating effects of their saliva, allergic reactions in some individuals, and secondary infections due to skin damage from scratching (Biguezoton et al., 2016; Rodriguez-Vivas et al., 2018) can cause reduced production, weight losses, and livestock mortalities (Jongejan and Uilenberg, 2004; Ocaido et al., 2019). Indeed, these parasites are vectors of numerous pathogens responsible for many animal infections, such as babesiosis, theileriosis, anaplasmosis, and cowdriosis (CIRDES, 2014; Kasaija et al., 2021). Annual losses due to tick-borne diseases are estimated at $17.33 billion worldwide (Yéo et al., 2017; Balinandi et al., 2020; Ghafar et al., 2020).

Ecological control methods (Stachurski and Adakal, 2010; Nicaretta et al., 2020; Nava, 2024), genetic control (Shyma et al., 2015; Mandara and Maodzeka, 2023), anti-tick vaccination (Bonnet and Richardson, 2018; De la Fuente

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and Estrada-Peña, 2019; Muhanguzi et al., 2022; Pereira et al., 2022), the action of parasitoids (Gaye et al., 2019), and entomopathogenic agents (Ebani and Mancianti, 2021), the action of natural predators and biopesticides (Samish et al., 2004; Ojeda-Chi et al., 2010; Hüe et al., 2015; Dorla et al., 2019) can help reduce the incidence of ticks, but are difficult to implement. However, it must be acknowledged that chemical control is the conventional method advocated through the use of synthetic acaricides. However, to control ticks, chemical control is the conventional method advocated through the use of synthetic acaricides. Unfortunately, this method has shown its limitations with the emergence of resistance in recent years (Cossío Bayúgar et al., 2020; Heylen et al., 2024). Furthermore, the management of tick resistance to acaricides is becoming more problematic as global warming is accompanied by an increase in the number of annual generations of certain predators (Bouchard et al., 2019; Yessinou et al., 2022). It has been shown that 59% of 1,598 studied predator species (representative of different ecosystems in temperate and tropical zones belonging to many animal and plant taxa) already exhibit changes in their phenotypes and/or their distribution ranges due to climate change (Brodeur et al., 2013). Numerous studies (Yoda et al., 2015; Biguezoton et al., 2016; Adjou Moumouni et al., 2021; Ouédraogo et al., 2021; Compaoré et al., 2022; Heylen et al., 2023) have studied tick diversity and explored their prevalence in Burkina Faso. It is crucial to point out that these studies do not specifically target the Hauts-Bassins region in its entirety to evaluate the prevalence of infestations at all levels. The majority of these studies focus on particular tick or ruminant species, or indeed on distinct regions within Burkina Faso.

The present study aimed to fill this information gap by identifying the most prevalent tick genera and species in the study area, determining their frequency in the pastoral areas of the Hauts-Bassins region, estimating the prevalence of infestations in ruminants within this area, and analyzing the risk factors associated with these infestations.

MATERIALS AND METHODS

Ethical approval

The present study employed a simple protocol that is accessible and understandable to livestock farmers to ensure transparency and contribute to research aimed at applying knowledge in the field of zoonotic vector mites on domestic ruminants. Farmers from the two pastoral zones were informed and consulted regarding the use of the data, and gave their consent. By adhering to the ethical research standards, this approach promotes data-driven analyses that can improve animal care practices.

Study area

The epidemiological survey study was carried out in the Hauts-Bassins region of Western Burkina Faso, covering an area of 25,479 km² (geographical coordinates: 11° 15' North and 04° 30'). The region is subject to a tropical climate of the North Sudanian type, with average annual rainfall ranging from 800 mm to 1,100 mm, with high inter-annual variability and highly variable temperatures (25-30°C). It is characterized by two alternating seasons, including the long dry period (October to April) and the rainy period (May to September; MRA, 2010). The plant formations encountered are wooded savannahs characterized by woody and herbaceous strata (perennial and annual grasses) as well as gallery forests with a lowland herbaceous stratum and reconstituted natural areas such as fallow land (MRA, 2010). This region includes two pastoral zones where the study's epidemiological survey work took place, namely the Saho and Sidéradougou pastoral zones located in the Houet and Tuy provinces, respectively (Figure 1). These two areas were selected on the basis of their accessibility and the availability of breeders open to innovations in livestock production techniques. The resident population in these areas is essentially made up of Mossi, Dioula, Peulh, Bobo, Toussian, and Bwaba ethnic groups, who make their living from livestock farming and agriculture (Kéré et al., 2021; INSD, 2022).

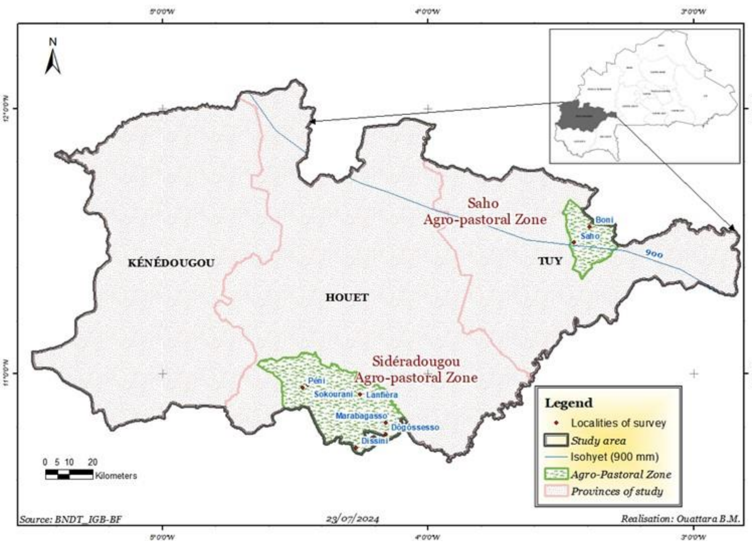

Figure 1. Geographical location of the two pastoral study areas in the Hauts-Bassins region of Burkina Faso

Sampling techniques and sample size

To select the ruminants for the study, a simple random sampling technique was employed. The necessary sample size, calculated using Thrusfield's equation (2018), was determined based on an expected prevalence (Pexp) of 90% (derived from a preliminary survey conducted in the study area and currently under publication), with a 95% confidence interval (corresponding to a Z of 1.96) and a desired absolute precision (d) of 5%. Thus, the following formula is used.

$$N = \frac{Z^2 Pexp(1-Pexp)}{d^2}$$

Applying these values, the sample size was determined to be N = 138. To enhance representativeness, 12 additional ruminants were added, bringing the total to 150 individuals, equally distributed among 50 cattle, 50 sheep, and 50 goats.

Design of the study

The study was carried out from October 2022 to September 2023, with tick samples taken from 800 domestic ruminants (300 cattle, 300 sheep, and 200 goats) randomly selected from the pastoral zones of Saho and Sidéradougou. For this purpose, the three seasons defined by Kaboré-Zoungrana et al. (2008) were considered with slight modifications, namely the rainy season (RS; June-September), the cold dry season (CDS; October-February), and the hot dry season (HDS; March-May). These ruminants, composed of both sexes (females and males), consisted of young animals (under 1 year for sheep and goats, and under 3 years for cattle) and adults (over 1 year for sheep and goats, and over 3 years for cattle). In each season, ticks were collected manually by simply pulling on the preferential tick attachment sites on the ruminant body (ears, dewlap, armpits, abdomen, inguinal region, perineal region, and pasterns) after restraining the animal. At the same time, individual information was collected on the rearing method, sex, breed, and age of the animals (with reference to the dentition of small ruminants, young - 1 year and adult + 1 year, and cattle: young - 3 years and adult + 3 years (Farougou et al., 2006). The vials used to collect the ticks were labelled with the date of collection, locality, and ruminant species.

Identification of the various tick species collected was carried out using an optical stereomicroscope (brand Olympus™ SFX - 31, Tokyo, Japan) at the entomology laboratory of the cotton program of the Institut de l'environnement et de recherches agricoles (INERA) in Bobo-Dioulasso. Ticks are immobilized by being mounted on a microscope slide in mounting medium (gelatin glycerin) and simply covered with a coverslip to facilitate their observation and identification. Ticks were identified by considering the morpho-anatomical characteristics described by Walker et al. (2003) and Barker and Walker (2014).

Statistical analysis

The data collected were used to calculate means, which were expressed as percentages and means ± standard deviation, before being subjected to descriptive and quantitative analyses. All statistical analyses were performed using R software (version 4.3.3), and graphs were produced using Excel. A Kruskal-Wallis or Wilcoxon test (5% significance level) was used to analyze variations in tick burden based on ruminant demographic characteristics, seasons, pastoral study area, and tick attachment sites on the animals' bodies. A P-value less than 0.05 was considered statistically significant.

RESULTS

Analysis of the data collected during the study reveals that the livestock farming system practised in the two pastoral zones is extensive. The animal breeds encountered were essentially Sahelian zebu peulh (286) and crossbreeds (14) in cattle, and Mossi (319), Sahelian (53), and Djallonke (128) small ruminants (goats and sheep).

Identification of tick species

A total of 8,274 ticks were collected from cattle (91.83%; n = 7598 ticks) and small ruminants (8.17%; n = 676 ticks), including goats (6.32%; n = 523 ticks) and sheep (1.85%; n = 153 ticks, Figure 2). Among the ticks collected, three genera were identified, namely *Amblyomma*, *Hyalomma*, and *Rhipicephalus* (*Boophilus*) with 67.32% (n = 5570), 26.35% (n = 2180), and 6.33% (n = 524) of individuals, respectively. These ticks were more frequently observed in the rainy season (RS; 51.81%) than in the hot dry season (HDS; 34.85%) and cold dry season (CDS; 13.34%; Figure 3). The *Amblyomma* genus was the most represented in the rainy and hot dry seasons, while the *Hyalomma* genus was dominant in the cold dry season. During the study (Figure 4), the tick development stasis observed was dominated by adults (75.70%), followed by nymphs (20.92%) and larvae (3.38%). *Amblyomma* sp. is the most represented (84.43%) among adults of all genera (n = 5570 individuals). With a total of 524 individuals, the genus *Rhipicephalus* (*Boophilus*) sp. is most represented under pupal stasis (50.57%). As for the *Hyalomma* sp. genus, it is represented with 3.12% of individuals in larval stasis out of a total of 2180 individuals identified. Regarding the Hyalomma sp. genus, it accounts for 3.12% of individuals in larval stasis from a total of 2,180 identified individuals.

Identification of the adult tick species collected revealed a total of six species, listed in Table 1, with the genus *Hyalomma* comprising three species, followed by the genus *Rhipicephalus* (*Boophilus*) with two species. Tick imagos (n = 7994 individuals) identified contained more females (50.60%) than males (49.40%) in the overall sample (Figure 5). However, only *Amblyomma variegatum* had more males (52.60%) than females (47.40%).

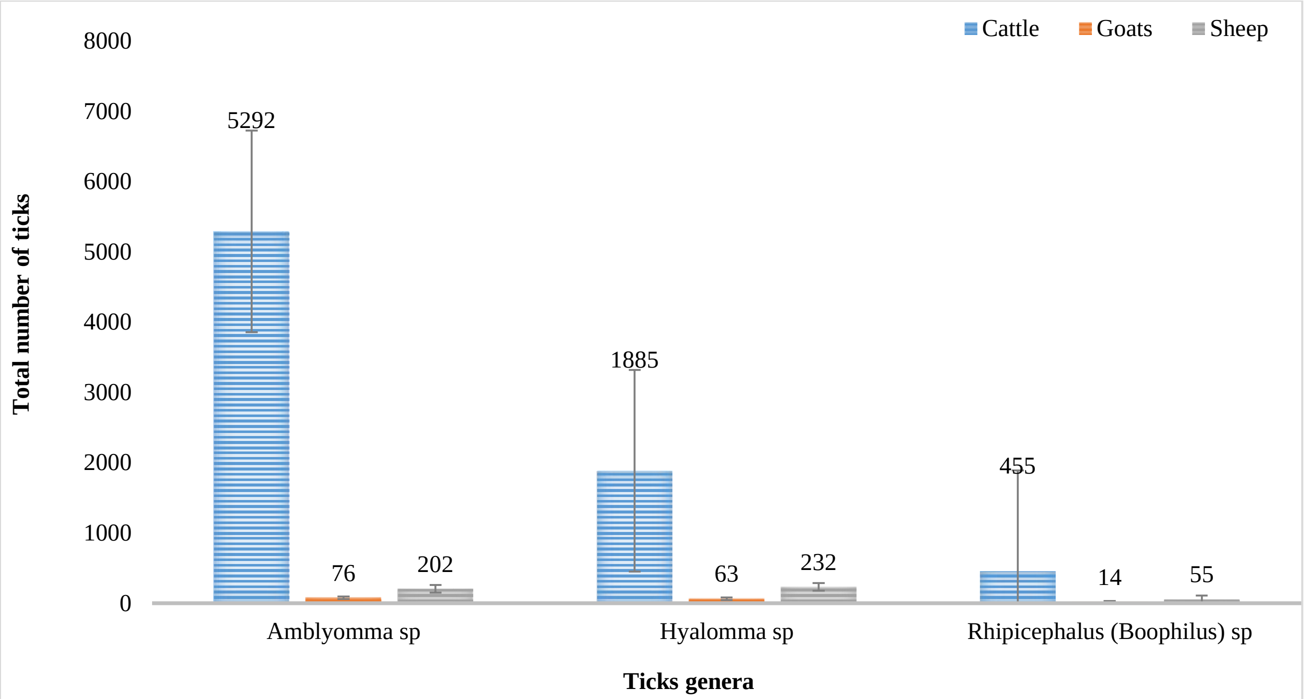

Figure 2. Tick genera encountered according to ruminant species surveyed in two pastoral areas in the Hauts-Bassins region of Burkina Faso during 2022-2023

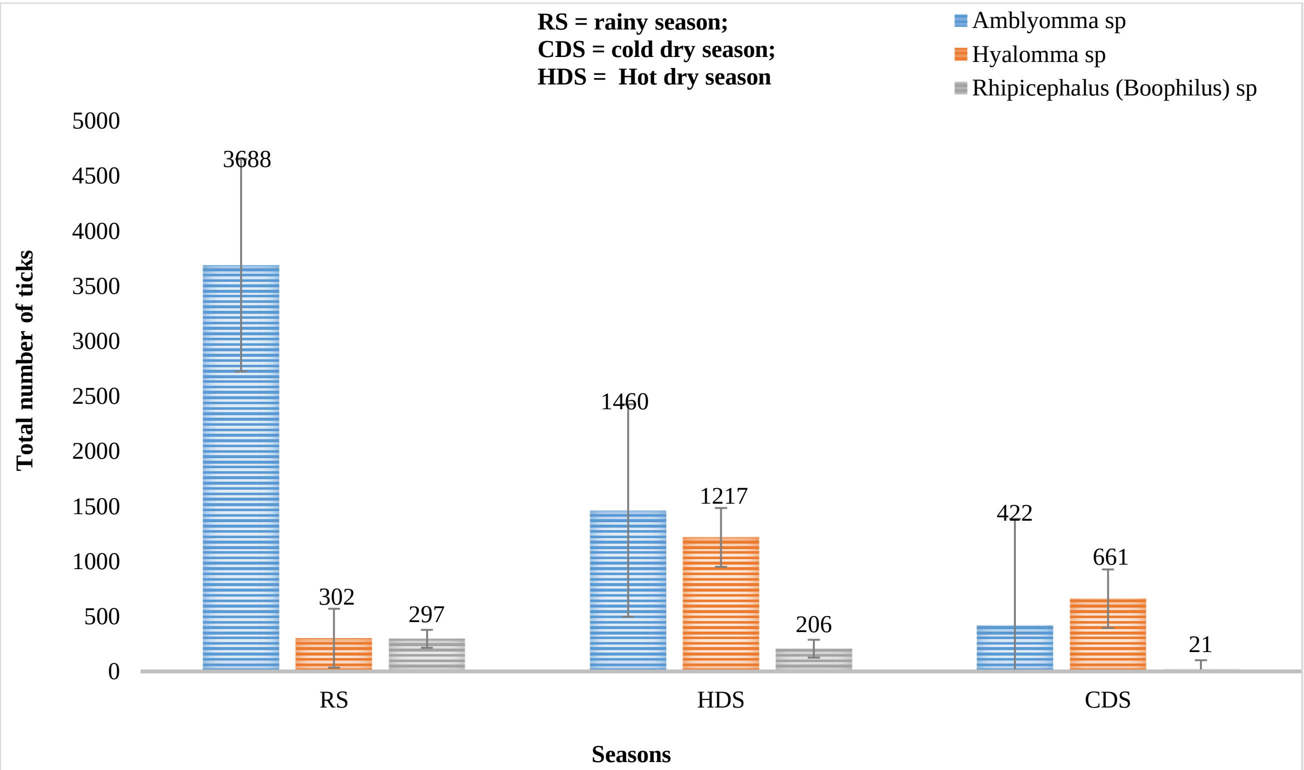

Figure 3. Seasonal distribution of tick genera in two pastoral areas in the Hauts-Bassins region of Burkina Faso during 2022-2023

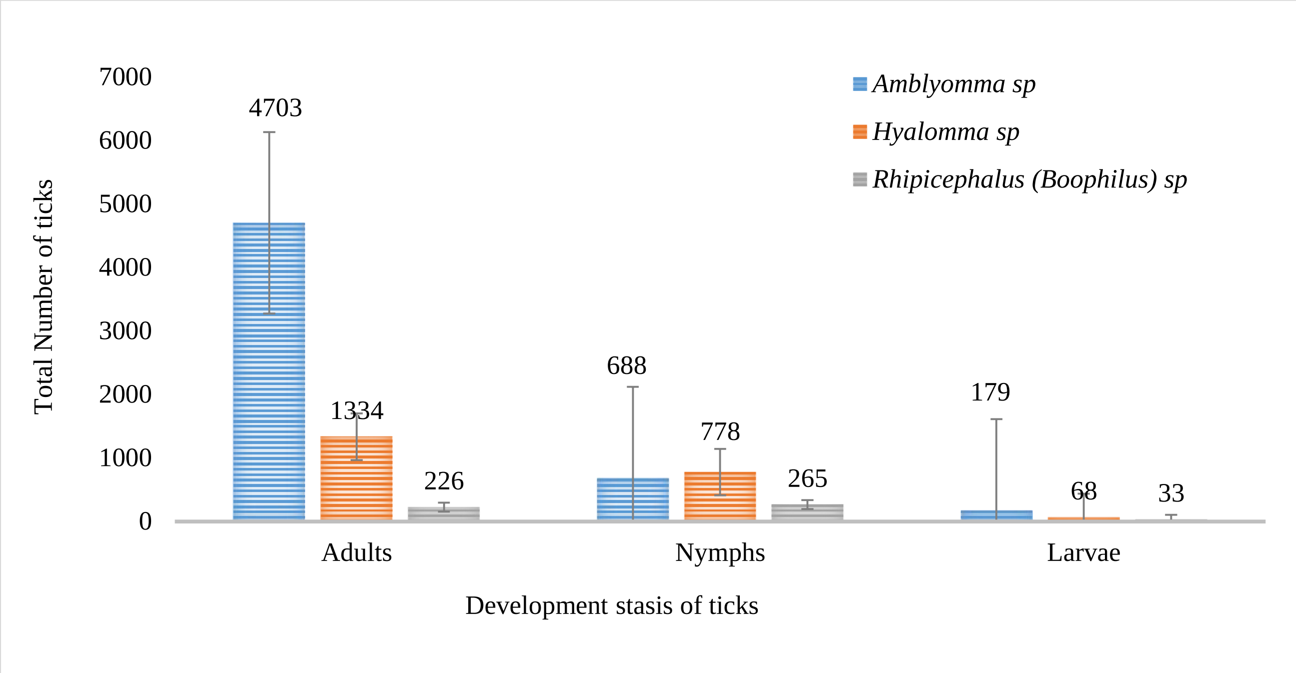

Figure 4. Development stasis of ticks according to tick genera encountered in two pastoral areas in the Hauts-Bassins region of Burkina Faso during 2022-2023

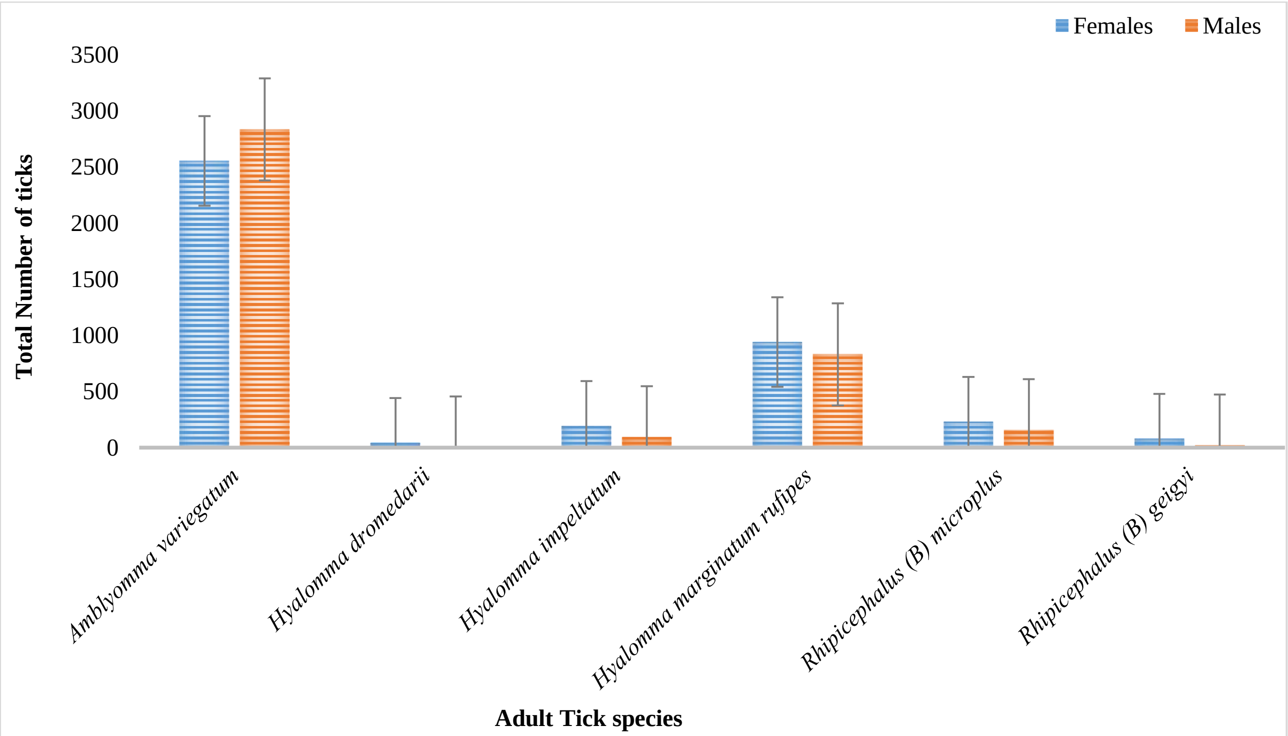

Figure 5. Tick species observed by sex during the study in two pastoral areas in the Hauts-Bassins region of Burkina Faso during 2022-2023

Table 1. Different tick species identified by tick genus in two pastoral areas in the Hauts-Bassins region of Burkina Faso during 2022-2023

Genus	Species
Hyalomma	*Hyalomma marginatum rufipes* *Hyalomma dromedarii* *Hyalomma impeltatum*
Amblyomma	*Amblyomma variegatum*
Rhipicephalus (Boophilus)	*Rhipicephalus (Boophilus) microplus* *Rhipicephalus (Boophilus) geigyi*

Prevalence and level of infestation

A total of 800 ruminants were sampled at the study sites (300 cattle, 300 sheep, and 200 goats). Of these, 52.62% (n = 421) were males and 47.38% (n = 379) females, comprising 41.37% juveniles (n = 331) and 58.63% (n = 469) adults.

For all the ruminants studied, the prevalence rate was 74.90% (n = 599), including 37.25% in cattle (n = 298), 23.50% in sheep (n = 188), and 14.15% in goats (n = 113). In the Saho pastoral zone, among all the surveyed ruminants, the overall prevalence rate was 37.40% (n = 299), with 18.75% of cattle (n = 150), 12% of sheep (n = 96), and 6.65% of goats (n = 53). In Sidéradougou, the obtained rate was 37.50% (n = 300), including 18.50% for cattle (n = 148), 11.50% for sheep (n = 92), and 7.50% for goats (n = 60).

For all ruminants surveyed, the average level of infestation was 10.34 ± 20.30 ticks per animal. By species, cattle (24.96 ± 1.57 ticks) were more infested than sheep (1.87 ± 0.17 ticks) and goats (1.11 ± 0.09 ticks). Depending on the season, the average infestation levels of the animals surveyed varied within the study area. In cattle, mean infestation levels ranged from 9.47 ± 0.87 to 40.09 ± 3.73 ticks/head, while in sheep and goats, they varied from 1.11 ± 0.19 to 2.93 ± 0.40 ticks/head and from 1.00 ± 0.14 to 1.23 ± 0.13 ticks/head, respectively. Cattle and sheep were more infested in the rainy season than goats, which were only infested in the hot dry season (HDS). Cattle were significantly more infested in the rainy season (RS, $p < 0.05$) than in the cold and hot dry seasons (CDS). In sheep, tick infestation showed no significant difference ($p > 0.05$) between the different seasons ($p = 0.07$). Similarly, in goats, the average level of infestation in the hot dry season (HDS) was not significantly higher ($p > 0.05$) than in the rainy season (RS). Comparative analysis of infestation levels between the two pastoral zones revealed no significant differences ($p > 0.05$). However, compared with the Sidéradougou pastoral zone, the Saho pastoral zone recorded a significant difference in the average infestation level ($p < 0.05$) for cattle ($p = 0.01$) and sheep ($p = 0.03$), in the cold dry season (CDS) and the rainy season (RS), respectively.

According to the sex of the animals, the average infestation level in males was significantly higher ($p < 0.05$) than in females. In goats and sheep, there was no variation in these infestation averages between the sexes. In cattle, on the other hand, the tick load in females was significantly higher ($p < 0.05$) than in males.

Concerning age, young ruminants (12.49 ± 21.34 ticks/head) were significantly more infested than adults (9.13 ± 19.61 ticks/head) overall ($p < 0.05$). However, no significant difference was observed between the two age groups for each of the three ruminant species surveyed ($p > 0.05$).

Infested anatomical regions

The preferential attachment sites of ticks on the ruminants surveyed, presented in Table 2, show that their average infestation levels varied according to the data collection periods corresponding to the three seasons of the study. Inguinal and pastern sites were the most significantly infested in ruminants surveyed during the study ($p < 0.05$).

Table 2. Average infestation levels of preferential tick attachment sites collected from surveyed ruminants according to season in two pastoral areas in the Hauts-Bassins region of Burkina Faso during 2022-2023

Seasons	Average infestation levels						
	Ears	**Dewlap**	**Armpits**	**Abdomen**	**Inguinal region**	**Perineal region**	**Pasterns**
CDS	0.43 ± 1.05 b	1.04 ± 2.59 b	0.25 ± 0.82 b	0.65 ± 1.92 b	1.45 ± 3.25 b	0.87 ± 1,72 b	0.58 ± 1.34 c
HDS	1.66 ± 2.83 a	1.17 ± 2.89 b	1.47 ± 3.54 b	1.01 ± 2.41 b	1.06 ± 2.53 b	1.26 ± 2.54 ab	1.75 ± 3.36 b
RS	0.75 ± 1.76 b	2.17 ± 6.11 a	1.90 ± 5.28 a	1.96 ± 5.31 a	3.45 ± 9.27 a	1.61 ± 4.16 a	2.84 ± 5.71a
Total	1.01 ± 2.17 C	1.51 ± 4.37 BC	1.32 ± 3.96 C	1.28 ± 3.73 C	2.05 ± 6.20 A	1.29 ± 3.12 C	1.87 ± 4.20 AB

Data are expressed as mean±SD; ^{a,b,c} Lower-case letters compare means between columns at 5%; ^{ABC} Upper-case letters compare means between rows at 5%; CDS: Cold dry season; HDS: Hot dry season; RS: Rainy season.

DISCUSSION

The results of this study indicated that the pastoral zones of Saho and Sidéradougou are exposed to infestations of parasitic ticks on ruminants, and consequently to the diseases they can transmit. Given the abundance of ticks and the high infestation of ruminants in these pastoral areas, it could be said that the Hauts-Bassins region of Burkina Faso offers highly favorable conditions for the development and spread of these mites. Indeed, the distribution, survival, and abundance of ticks in a given region are dependent on certain environmental and eco-climatic factors such as habitats, temperature, hygrometry, soil and atmospheric humidity, rainfall, and photoperiod (Sajid et al., 2017; Bouchard et al., 2019; Gray et al., 2021).

Of the 8274 ticks collected during the study, three main tick genera were identified, namely *Amblyomma*, which was the dominant genus, followed by *Hyalomma* and *Rhipicephalus* (Boophilus). Within these, six species were identified, namely *Amblyomma variegatum*, *Hyalomma marginatum rufipes*, *Hyalomma impeltatum*, *Hyalomma dromedarii*, *Rhipicephalus (Boophilus) microplus*, and *Rhipicephalus (Boophilus) geigyi*. According to ruminant host species, the most dominant tick genera by order were *Amblyomma* and *Hyalomma* in cattle and goats, versus *Hyalomma* and *Amblyomma* in sheep. The load of the genus *Rhipicephalus (Boophilus)* was lower in goats and higher in cattle. As in previous studies carried out in Burkina Faso, *Amblyomma* and *Hyalomma* genera encountered in the present work were also observed in cattle in the Sahelian and South Sudanian zones (Yao et al., 2020). The same findings have been observed in cattle in the northern Sudanian zone of Burkina Faso (Kaboré et al., 1998; Biguezoton et al., 2016; Ouédraogo et al., 2021) and in sheep by Farougou et al. (2006) in the Sudanian zone of Benin. However, the latter authors noted the predominance of *A. variegatum* followed by *Rhipicephalus (Boophilus) geigyi* in cattle in the North Sudanian region of Burkina Faso. This result contradicts the observations of the present study, which revealed a predominance of the *Hyalomma* genus followed by *Amblyomma* on small ruminants. In other countries, the predominance of the three-host tick *A. variegatum* has been reported in Cameroon, Ethiopia, Gambia, Ghana, Ivory Coast, Mali, Kenya, Nigeria, Senegal, Somalia, Tanzania, and Uganda (Jongejan et al., 2020; Tawana et al., 2022; Heylen et al., 2023; Girma et al., 2024).

Throughout this research, the overall prevalence rate of tick infestation on ruminants was 74.90% in the study area. The study of Heylen et al. (2023) reported prevalence rates of 37.60% in West Africa and 50.57% in East Africa. In Côte d'Ivoire, Yapi (2007) reported that the *A. variegatum* tick accounted for 69.5% of all ticks collected in Azaguié, Dabou, Sikensi, and Alépé (Brofodoume). In Benin, in Atacora and Donga, this tick species accounted for 69% of the ticks collected by Farougou et al. (2006). The prevalence of this tick species may be attributed to the semi-arid to warm climates of the studied pastoral zones. This aligns with findings by Walker et al. (2003) and Beati et al. (2012), who noted *A. variegatum*'s adaptability to diverse climates, including humid and hot conditions. In the study, all six tick species identified were observed in both pastoral zones and all seasons. The average infestation levels recorded were generally higher in the rainy season (RS) than in the cold and hot (HDS) dry seasons (HDS), inducing significant variability in the proportions and frequencies of occurrence of these tick species depending on the season. This result is consistent with the work of Kaboré et al. (1998) and Biguezoton et al. (2016) in Burkina Faso, who also reported a seasonal variation in tick infestation in cattle, with a predominance of ticks during the rainy season. Furthermore, as highlighted by these previous studies, the climatic conditions, notably the more favorable humidity and temperature during the rainy season, create an environment conducive to the survival and activity of ticks, thus explaining the observed increase in infestation levels. Also, these observations made during the study confirm that within a biogeographical zone, the distribution of a tick population depends on the availability of preferred hosts, the biotope, and bioclimatic conditions favourable to their survival (Estrada-Peña, 2003; Bouchard et al., 2019; Bregnard et al., 2020). The spatio-temporal distribution of the six tick species identified during the study in the Hauts-Bassins region could be explained by these factors. The two pastoral zones are characterized by a virtual absence of rainfall and high dry-season temperatures. Such conditions are unfavorable to the development and evolution of ticks, particularly immature stages, which exhibit greater sensitivity to drought compared to adults. This may account for the relatively low number of ticks collected during the study period.

Generally, all developmental stages (larvae, nymphs, and adults) of all identified tick genera infested the surveyed ruminants during the study. Similar observations on cattle in several countries were reported by Yessinou et al. (2022) and Onyiche and MacLeod (2023) in their comprehensive reviews of hard tick species and associated hosts. Furthermore, previous studies carried out in Burkina Faso reported that all developmental stages of *A. variegatum*, *H. marginatum rufipes*, and *R. Boophilus geigyi* species were collected from cattle, sheep, and goats (Adakal et al., 2013; Biguezoton et al., 2016; Ouédraogo et al., 2020). Among the ticks collected, the study recorded adults and immatures of *H. impeltatum* on all ruminants and also adults and immatures of *H. dromedarii* on cattle only. Rates of 4.34% of adult *H. impeltatum* were also recorded by Adakal (2009) in cattle and small ruminants in Bekuy, a peri-urban area of Bobo-Dioulasso in the Hauts-Bassins region of Burkina Faso. The stasis of all the species identified was dominated by adults, followed by nymphs and larvae. The same observations were made by Shuaib et al. (2020) on small ruminants in Sudan, with densities of nymphs and larvae considerably lower than those of adult ticks. This difference in densities observed between developmental stages could be explained by environmental conditions (high sensitivity of eggs and larvae to high temperatures and desiccation) and, above all, the probability of an immature stasis (larva and nymph) encountering a host. Jongejan et al. (2020), Wongnak et al. (2022), and Nimpaye et al. (2023) have also noted that tick larvae generally appear later in the season than nymphs and adults, given their differential sensitivity to environmental conditions. Clearly, temperature and desiccation influence the feeding activities and survival of ticks. Some species have an early cycle due to the fact that they live in high-temperature environments (warm climates), boosting their development processes and thus favoring an increase in their numbers (Agoulon et al., 2015).

In all three seasons, the presence of the genera *Amblyomma*, *Hyalomma*, and *Rhipicephalus (Boophilus)* in the study area denotes the perennial nature of their activities, and consequently, the potential danger they represent as perennial vectors propagating zoonoses. Reye et al. (2012) and Balinandi et al. (2020) reported that the greatest impact on the health of livestock and humans is caused by species belonging solely to these three genera. Indeed, *Amblyomma variegatum* imagos are vectors of the *Cowdriose ruminatum* parasite, the agent responsible for the greatest damage to hides and skins in cases of heavy infestation (Behailu, 2017). This tick also promotes dermatophilosis (*Dermatophilus congolensis*) in cattle (Kaufnann, 1989) and African fever (*Rickettsia africae*) in humans (Parola et al., 2002; Tomassone et al., 2018). Ticks of the genus *Hyalomma* also transmit pathogens affecting ruminant production (Jongejan and Uilenberg, 2004) and Crimean-Congo hemorrhagic fever (CCHF) virus (Gargili et al., 2017; Chitimia-Dobler et al., 2019). Ticks of the genus *Rhipicephalus (Boophilus)* are vectors of bovine babesiosis (Rodrigues and Leite, 2013) and zoonotic pathogens (Diarra et al., 2017; Ternovoi et al., 2020).

Depending on sex, infestations by females of all tick genera in the study were higher than those caused by males. Only the level of infestation by male ticks of the genus *Amblyomma* was higher than that of females. This result is contrary to that of Yoda et al. (2015), who recorded greater infestation by females of the genus *Boophilus* than by males. The high occurrence of infestations by *Amblyomma* males could be explained by the fact that fecundated females generally detach from their host after a blood meal, fall to the ground for digestion and oviposition. Grooming of the animal can also cause them to detach (Mooring et al., 2000; Mekonnen et al., 2001). Furthermore, male ticks of the *Amblyomma* genus feed on a limited quantity of blood and can remain attached to their hosts for several months. Females will only attach if a male is already attached, due to the aggregation-attachment pheromones produced only by males (Socolovschi et al., 2008).

Adult and immature stages of *H. dromedarii* and *H. impeltatum* species were collected for the first time from ruminants in the Saho and Sidéradougou pastoral zones of the Hauts-Bassins region of Burkina Faso. However, *Hyalomma dromedarii* is adapted to Sahelian and Sahelo-Saharan climates (Al-Deeb and Muzaffar, 2020; Perveen et al., 2021), while semi-arid biotopes and dry seasons are suitable for *H. impeltatum* (Yao-Acapovi et al., 2018). The authors of the current study results then show that these tick species are colonizing savannah areas characterized by woody, herbaceous (upright grasses), and gallery forest strata. The *Hyalomma impeltatum* tick has been recorded in Côte d'Ivoire and Togo (countries bordering Burkina Faso) on sheep, goats, and cattle (Yessinou et al., 2022; Onyiche and MacLeod, 2023). Also, the study of Abdullah et al. (2018) reported a reduced prevalence of infestations of the *Hyalomma dromedarii* tick in cattle, goats, and sheep, despite it being mainly camel-infested. In addition to the warm climate this biotope offers, living conditions are optimal for these ticks in the Hauts-Bassins region. These results are in line with those of Apanaskevich et al. (2009), who reported colonization by *H. impeltatum* in forests and grasslands on the Arabian Peninsula and in several Afro-tropical regions. Furthermore, in addition to the upsurge in livestock trade between African countries (Chand, 2020), the presence and dispersal of tick species in an area depend on other factors, including the movements of their hosts (Randolph et al., 2002). These movements of livestock by herders, due to conflicts (Zannou et al., 2021) and in addition to being a resilience strategy against harsh climates (Motta et al., 2018), are also the cause of the security crisis currently experienced by the Liptako gourma countries (including Burkina Faso) in West Africa. They are also potential phenomena for the exchange of ectoparasites between animals and the transmission of pathogens to animals by ticks (Diarra et al., 2023). These observations could explain the presence of these tick species in the current study region.

In domestic ruminants, the majority of ticks were collected from the ears in the hot dry season (HDS), but tick infestation was particularly high in the armpits, pasterns, and peri and ano-genital areas (tail, perineal, and inguinal areas) in the rainy season (RS). These observations are in line with those of Kaboré et al. (1998) in Burkina Faso, who reported that these areas are the preferred attachment sites for ticks at this time of year. According to some studies, the udder/scrotum of cattle has been identified as the main preferential attachment zone for *Amblyomma variegatum* in Ghana (Addo et al., 2023). Similar observations have also been made in Burkina Faso and Cameroon (Stachurski, 2000; 2006). Indeed, Hurtado and Giraldo-Ríos (2018) believe that ticks prefer areas of an animal's body with thin skin and abundant blood flow, such as the inguinal and external genital regions. The strong preference for these peri- and ano-genital regions could be due to their vascularization and moist nature, which enables ticks to prevent desiccation during feeding. The authors of the current study's point of view is in line with Addo et al. (2023), who believe that acquiring a blood meal in the anal region would be safer and more propitious for ticks. Similarly, Similarly, the authors of the current study, like Addo et al. (2023), believe that the animal's tail, which often covers the anus, protects these mites from the sun's rays and further conceals them from the view of animal trainers who sometimes remove them. These observations could also justify the high occurrence of ticks on ruminant ears in hot weather.

The present study also indicates that all age and sex categories of the ruminants surveyed are threatened by ticks. In addition, the results revealed a dependency between tick burden and the sex of the animal. A significantly higher tick infestation was noted in male ruminants than in females. In general, male animals, as opposed to females, are used extensively in agricultural activities. This could justify this result, in addition to the fact that male ruminants often move long distances to exploit pastures and watering points, consequently remaining more exposed to ticks (Opara and Ezeh, 2011; Musa et al., 2014). Nevertheless, gender is not a discriminating factor in infestation prevalence, considering the results obtained in the small ruminants (sheep and goats) in this study. This corroborates the study of Yoda et al. (2015), who found no link between tick infestation levels and ruminant sex; however, Shahid et al. (2022) found that female small ruminants (15.56%) were more infested than males (9.20%) in Pakistan. Riaz et al. (2017) also recorded a higher tick infestation rate among females (48.52%) than males (45.16%). Sajid et al. (2017) reported a prevalence of 66.44% in males and 80.33% in females of ovine and caprine species. However, the study revealed that female cattle, unlike females of small ruminants, were more prone to tick infestations than males, an observation that could be explained by the inhibitory and stimulatory effects of hormones such as estrogens and androgens on immune responses observed in females than in males (Hughes et al., 2001; Klein, 2004).

Seasonally, the study found tick infestation levels to be higher during the wet, rainy period than during the cold, dry season. These results are in line with the study of Bekele (2002) in Ethiopia, Farougou et al. (2007) in Benin, and Yoda et al. (2015) in Burkina Faso. This observation could be explained by the climatic meteorological data during the wintering season (humidity/hygrometry and ambient temperatures), which are more favorable to tick survival and proliferation.

Generally, the age of ruminants proved to be a discriminating factor, contrary to the results reported in the study of Yoda et al. (2015) and Biguezoton et al. (2016) carried out in the Centre region of Burkina Faso. Indeed, in the study, tick infestation presented a greater occurrence in young animals than in adults. These observations are in line with those made by Rehman et al. (2017). In contrast, Sajid et al. (2009) in Pakistan, Singh and Rath (2013) in India, Rahali et al. (2016) in Morocco, and Addo et al. (2023) in Ghana reported a higher prevalence of ticks in calves compared with young and adult cattle. The high tick burden in young ruminants could be explained by their high susceptibility to infection due to their limited immunity to these parasites. In addition, young ruminants generally receive less attention on smallholdings in farming environments (Burrow et al. 2019). Furthermore, Okello-Onen et al. (1999) and Lew-Tabor et al. (2017) reported that adult animals have acquired immunity through repeated exposure to ticks.

CONCLUSION

The results of the study indicated infestation by parasitic mites in all seasons in the study region, with a significant abundance in the rainy season (RS; 51.81%) than in the hot dry season (HDS; 34.85%) and cold dry season (CDS; 13.34%). Ruminant host factors such as age and sex significantly influenced tick infestation levels. A high occurrence of these parasites was found mainly in the inguinal region, and on the pasterns and dewlaps of ruminants. The tick species identified are known to cause significant damage to animal productivity, necessitating continuous monitoring of tick populations and the diseases they transmit in the region. In order to sustainably improve the productivity of the ruminants surveyed and protect farmers against possible diseases, the results obtained on the spatio-temporal and seasonal distribution of ticks could help to formulate appropriate control strategies in the study area. However, future studies should incorporate molecular identification techniques to clarify tick species diversity and genetic variability, investigate the presence and epidemiology of tick-borne pathogens affecting livestock, evaluate the effectiveness and resistance patterns of current and alternative tick control methods, assess the influence of environmental and climatic factors on tick population dynamics, and examine the socioeconomic impact of infestations alongside farmers' knowledge and practices to guide more effective and sustainable management strategies.

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Ethical considerations

The authors declare that all ethical aspects of the publication of an original article have been considered in the preparation of this article.

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Authors' contributions

All authors participated in the study. The protocol was developed by Bamba Hubert Eloi Aboubacar Sidiki, Kaboré Adama, and Marichatou Hamani. Data collection and trial execution were conducted by Bamba Hubert Eloi Aboubacar Sidiki, Tianhoun Denté Fidèle, and Sawadogo Alizèta. All authors contributed to data analysis. The first manuscript draft was written by Bamba Hubert Eloi Aboubacar Sidiki and revised by all co-authors. All authors approved the final manuscript.

Competing interests

The authors declare that no conflict of interest has been presented.

Availability of data and materials

The authors state that they will provide the related data of this study if requested.

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