International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

Inventory of Ticks in the Savannah Ecosystem of the Ferkessédougou Sugarcane Zone in Northern Côte d'Ivoire

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Abstract: ***A prospecting study on 200 cattle and 166 wild animals was conducted in the sugarcane area of Ferkessédougou (Côte d'Ivoire) to better comprehend the tick species in the Savannah District. Manual tick extraction resulted in a total of 2, 290 ticks. Nine tick species were identified, four of which were Cattle-specific (Hyalommatruncatum, Rhipicephalus (Boophilus) annulatus, Rhipicephalus (Boophilus) geigyi, and Rhipicephalus (Boophilus) microplus) and four of which were wild-animal specific (Haemaphysalislaechi, Rhipicephalus sanguineus, Rhipicephalus simpsoni, and Ixodes aulacodi) with Amblyomma variegatum common to both animal groups. These tick species are classified into two (2) families, with eight (8) belonging to the Amblyommidae family and only one (I. aulacodi) belonging to the Ixodidae family. R. (B) microplus was the most infectious tick species in cattle, with infection rates ranging from 78% in the Zebu breed to 90% in the Baoulé breed. With infestation prevalence ranging from 48 % in the Baoulé breed to 64 % in the N'Dama breed, A. variegatum was the second most infectious tick species. In contrast, R. sanguineus ticks affected the majority of wild animals, with infestation rates ranging from 40% in rats (Rattus rattus) to 95.3 % in rabbits (Oryctolagus sp). Cattle and wild animals share a single tick species (A. variegatum) of which only juvenile forms (nymphs and larvae) have been detected in wild animals which could be reservoirs for this species.***

Keywords: tick species, cattle, wild animals, Côte d'Ivoire

1. Introduction

Agriculture continues to be the foundation of the Ivorian economy, accounting for more than 21% of the country's Gross Domestic Product (GDP). Livestock, fisheries, and aquaculture account for just over 10% of agricultural GDP [1]. Despite efforts by the government of Côte d'Ivoire to increase animal protein output, livestock's contribution to agricultural GDP (4.5 %) has remained stable [2]. The socio-political crises of 2002 and 2010 aggravated the issue. Cattle looting, epizootics, and inaccessible inputs all contributed to herd degradation, notably in the central, northern, and western zones [3]. In this setting, animal protein and dairy products are in short supply to meet the needs of a fast-rising population (4.5 %). As a result, imports are made to meet the population's immediate needs. Since 2012, a Strategic Plan for the Development of Livestock, Fisheries, and Aquaculture (PSDEPA) has been included in the National Agricultural Investment Plan to overcome this restriction. Controlling the environment and diseases is critical to achieving this goal. Ticks are hematophagous ectoparasites that feed on the blood of their hosts. They carry a wide range of diseases, including bacteria, viruses, and parasites. Babesiosis, theileriosis, anaplasmosis, ehrlichiosis, and rickettsiosis are all diseases caused by these pathogens [4, 5]. These diseases cause growth failure, abortions, anemia, and high mortality (50 %) in livestock, resulting in significant economic losses [6, 7, 8, 9]. The general goal of this research is to learn more about the bio-ecology of ticks to better understand the epidemiology of transmitted diseases and contribute to food security. It will identify the host species of ticks found in wild animals; (ii) inventory tick species; and (iii) determine tick distribution by bovine and wild animal species.

2. Materials and Methods

2.1 Study environment

The research was conducted out in Côte d'Ivoire's ruminant-rich Savannah District, particularly in the Ferkessédougou sugarcane zone (Tchologo region), which is located between 9°30' North latitude and 5°20' West longitude (Figure 1). The climate has two distinct seasons: a dry season from November to March and a wet season from April to October. The annual rainfall averages 1200 mm [10]. The Bandama River and its various woodland galleries go through this sugarcane zone on the west.

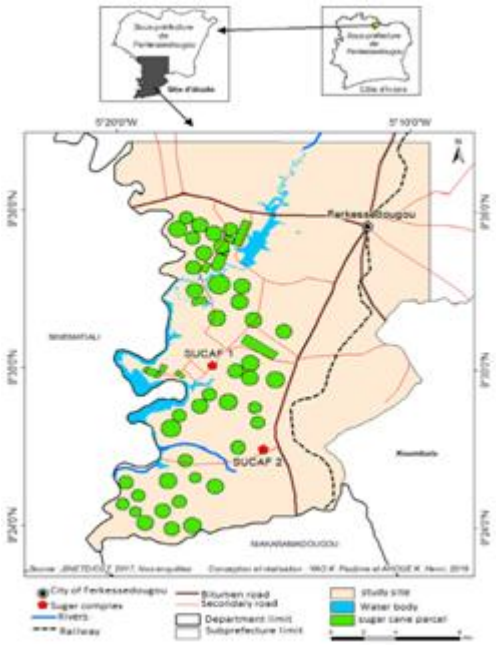

Figure 1: Ferkessédougou sugarcane zone

Large sugarcane fields totaling 14, 600 ha [11] are found in this woodland savannah area, which is expected to be home to a variety of wild species.

2.2 Biological material

Ticks from cattle and wild animals in the Ferkessédougou sugarcane zone make up most of the biological material.

2.3 Methods

2.3.1 Sampling

During the rainy season, from April to October 2018, sampling occurred in 20 sedentary cattle farms, which were chosen depending on the amount of the farmers, by utilizing the study area and selecting workers' wild animal habitation sites. During the same period, ten (10) cattle of various sexes and ages were randomly selected from each of the farms chosen for the study, as well as wild animals captured or freshly killed by the residents of the study region.

2.3.2 Tick collections

Ticks were obtained from wild animal entire bodies (coat, anogenital, head, and ears). Ticks were found mainly in predilection zones in cattle, such as the urogenital area, ears, interdigital spaces, and udders [12]. Ticks were removed using surgical forceps but a simple traction method that did not damage the rostrum [13]. Ticks were collected and preserved in 70 % ethanol-filled pillboxes (depending on their origin) before being forwarded to the laboratory for identification.

2.3.3. Identification of ticks

Tick samples were examined in the lab using an optical microscope (VWR-BI500) or a digital microscope (USB PCE-MM200) that was connected to a computer. The identification keys of Walker *et al.* [13], Meddour *et al.* [14], and the dichotomous key of Bouattour [15] were used to identify the ticks found. Following the identification of the tick species, they were counted according to their species and developmental status.

2.3.5 Expression of results

The following formulae were used to calculate the frequency, prevalence of infection, and abundance of ticks in the animals studied:

$$Frequency = \frac{Number\ of\ one\ animal\ examined}{Total\ number\ of\ animals\ examined} * 100 \quad (1)$$

$$Abundance = \frac{Number\ of\ ticks\ of\ a\ species}{Total\ number\ of ticks\ collected} * 100 \quad (2)$$

$$Prevalence = \frac{Number\ of\ infected\ animals\ of\ species}{Number\ of\ animals\ examined} * 100 \quad (3)$$

2.3.6 Statistical analysis

For proportion comparisons, R software (version 3.1.3) was used, and the Pearson Chi-square (χ^2) test was used. When the p-value is less than 0.05, the difference is considered significant.

3. Results

3.1 Tick host species

3.1.1 Cattle cheptel

The ticks were found on 200 bovine sheep, which included bull breeds (N'Dama, Baoulé), Zebu, and Metis breeds. Table 1 shows the distribution of cattle by breed and genetic type. Metis breeds are the most common, accounting for 50% of the total, followed by Zebu (25.5 %) and local breeds (Table 1).

3.1.2 Wild fauna

There was a total of 166 wild animals found. These wild animals included *Civettictiscivetta* (Civetta), *Xerus erythropus* (Palm Rat), *Thryonomys swinderianus* (Aulacode), *Oryctolagus sp* (Rabbit), *Sciunussp* (Squirrel), *Rattus rattus* (Rat), *Varanus sp* (Varanus), *Canis aureus* (Jackal), *Perdix sp* (Partridge), *Cervidae sp* (Hind) and *Vulpes sp* (Fox). The species *Oryctolagus sp* (Rabbit) is the most common, with a frequency of 38.6%, followed by *Xerus erythropus* (Palm rat) with a frequency of 14.5 % (Table 2).

Table 1: Species of cattle

Races	Number	Frequencies (%)
Baoulé	21	10, 5
N'Dama	28	14
Zébu	51	25, 5
Métis	100	50
Total	200	100

Table 2: Wild animals

Species	Number	Frequencies (%)
Civettictiscivetta (Civetta)	19	11, 4
Xerus erythropus (Palm rat)	25	15, 1
Thryonomys swinderianus (Aulacode)	23	13, 9
Oryctolagus sp (Rabbit)	64	38, 6
Sciunussp (Squirrel)	24	14, 5
Rattus rattus (Rat)	5	3, 0
Varanus sp (Varanus)	1	0, 6
Canis aureus (Jackal)	1	0, 6

Perdix sp (Partridge)	2	1, 2
Cervidae sp (Hind)	1	0, 6
Vulpes sp (Fox)	1	0, 6
Total	**166**	**100**

3.2 Tick inventory

3.2.1. Qualitative inventory

During the research, a total of 2290 ticks were collected. The tick inventories conducted resulted in the discovery of nine (9) tick species from two families (Amblyommidae and Ixodidae). The Amblyommidae family contained eight species (88.89 %) compared to the Ixodidae family, which had only one species (11.11 %) (Table III).

We were able to identify five tick species in cattle (55.55 %) and wild animals (55.55 %) based on the distribution of species per fauna type. Four species are particular to cattle (*A. variegatum, H. truncatum, R (B). annulatus, R (B). geigyi, R (B). microplus*) and four others are specific to wild animals *(H. laechi, R. sanguineus, R. simpsoni*, and *I. aulacodi*). Furthermore, the Amblyommidae family remained the most well-represented in cattle (100 %) and wild animals (75 %) (Table 3).

Table 3: According to the type of fauna, an inventory of tick species was made.

Family	Genere	Species	Cattles	Wild Animals
Amblyommidae	Amblyomma	*Amblyomma variegatum*	+	+
	Haemaphysalis	*Haemaphysalis Laechi*		+
	Hyalomma	*Hyalomma truncatum*	+	
	Rhipicephalus (Boophilus)	*Rhipicephalus (B) annulatus*	+	
		Rhipicephalus (B) geigyi	+	
		Rhipicephalus (B) microplus	+	
	Rhipicephalus	*Rhipicephalus sanguineus*		+
		Rhipicephalus simpsoni		+
Ixodidae	Ixodes	*Ixodes aulacodi*		+
Total			5	5

3.2.1.1 Distribution of fauna infestation rates

3.2.1.1.1. Cattle

Figure 2 describes the distribution of cattle breed infestation rates according to tick species. *A. variegatum* infestation rates were highest in the N'Dama (64 %) and Métis (59 %) breeds, medium in the Zebu (55 %), and low in the Baoulé breed (48 %) breeds (Figure 2). The Baoulé (29 %), Zebu (27 %), and Metis (26 %) breeds had the highest prevalence of *H. truncatum* infestations, while the N'Dama breed had the lowest frequency (7 %). The Baoulé breed had the highest infestation rate (29%) for the species *R. (B) annulatus*, whereas the Métis (22%) and Zebu breeds had low infestation rates, respectively, and the N'Dama breed had the lowest infestation level (7 %). Infestation rates for *R. (B) geigyi* were found to be particularly high in the Métis (11%) and Baoulé (10) races (Figure 2). While Zebu and N'Dama had relatively modest infection levels (6 %-4 %). In Baoulé cattle, the species *R. (B) microplus* (Figure 4) was most common (90 %). The remaining breeds' average prevalence (78 and 79 %) was also reported (Figure 2).

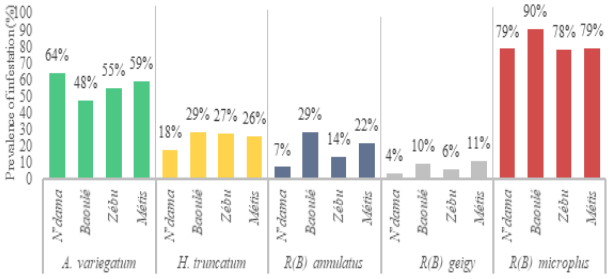

Figure 2: Prevalence of infestation of tick species in several cattle breeds

3.2.1.1.2 Wild animals

Figure 3 illustrates the prevalence of wild animal infestations. The tick *R. sangineus* was found in the highest number of species, including *Civettictiscivetta, Xeruserythropus*, and *Oryctolagus sp* (76 %-95.3 %). *H. Raechi* (14-28%) and *A. variegatum* (5 %-11 %) were moderately and weakly represented, respectively (Figure 3). *R. simpsoni* and *R. sangineus* were the most important tick species in *Thryonomys swinderianus* (52 %-57 %). The species *I. aulacodis* and *A. vareigatum* were both underrepresented (9 % and 4%, respectively) (Figure 3).

I. aulacodi was the most common species in *Ratturattus* (60 %). The other species were underrepresented (between 20% and 40%) (Figure 3).

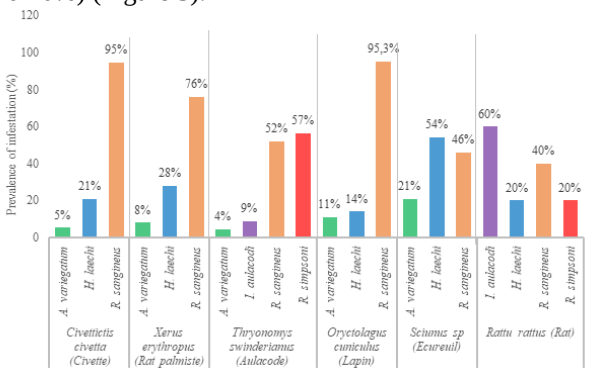

Figure 3: Prevalence of infestation of tick species in wild animals.

3.2.2. Quantitative inventory of ticks

3.2.2.1. Abundance of ticks in cattle breed

Three (3) genera (Rhipicephalus (Boophilus), Amblyomma, and Hyalomma) were identified in the Amblyommidae family, with 70.8 %, 21.4 %, and 7.8 % abundance rates on cattle, respectively. As a result, at the 5% criterion, the genus Rhipicephalus (Boophilus) was shown to be the most prevalent (Table 4).

Table 4 shows the many tick species found on cattle, as well as their abundances. With a 62.8 % abundance, the species *R. (B) microplus* (Figure 4) was the most frequent. Adult ticks, on the other hand, were more numerous (92.6%) than young ticks (nymphs and larvae) (7.4%). (Table 4). There

was a highly significant difference in tick abundance in cattle (p 0.05).

Table 4: Abundance of ticks collected from cattle by gender

	Number of ticks collected	Abundance (%)	Khi^2	P
Genere				
Amblyomma	343	21.4	67.1	0.001
Rhipicephalus (Boophilus)	1133	70.8		
Hyalomma	125	7.8		
Species				
A. variegatum	343	21.4	106.8	0.001
R. (B) annulatus	81	5.1		
R. . (B) geigyi	46	2.9		
R. (B) microplus	1006	62.8		
H. truncatum	125	7.8		
Stage				
Adults	1482	92.6	85.9	0.001
Immatures (nymph et larvae)	119	7.4		

3.4 Abundance of ticks in wild animals

Three (3) genera (Rhipicephalus, Haemaphysalis, and Amblyomma) were found on wild animals with abundances of 78.4 %, 15.2 %, and 4.6 %, respectively, within the Amblyommidae family. At the 5 % threshold, the genus Rhipicephalus was the most prevalent genus (Table 5). Only the species *I. aulacodi* of the genus Ixodes was obtained from rodents in the family Ixodidae, with 1.3 % abundance (*Thryonomys swinderianus*, *Rattus rattus*).

R. sanguineus was the most common species in wild animals (72.4 %), with *H. laechi*, *R. simpsoni*, *A. variegatum*, and *I. aulacodi* being the least common. Adult ticks (nymphs and larvae) were more common (94%) than juvenile ticks (nymphs and larvae) in the same way they were in cattle (6 %). Tick abundance was significantly different in wild animals (p 0.05).

Table 5: Abundance of ticks collected from wild animals by gender

	Number of ticks collected	Abundance (%)	Khi^2	P
Genere				
Amblyomma	32	4.6	141.8	0.001
Ixodes	9	1.3		
Hyalomma	105	15.2		
Rhipicephalus	543	78.4		
Species				
A. variegatum	32	4.6	144.1	0.001
I. Aulacodi	9	11.3		
H. laechi	105	15.2		
R. sanuineus	502	72.4		
R. simpsoni	41	5.9		
Stage				
Adults	648	94	93.2	0.001
Immatures (nymph et larvae)	41	6		

3.3. Prevalence of infestation in cattle

All the animals in this investigation were parasitized. With an infestation rate of 80%, the tick species *R. (B) microplus* was the most common, followed by A. variegatum (57.5 %). *R. (B) annulatus*, *R. (B) geigyi*, and *H. truncatum*, on the other hand, were only discovered on a small %age of cattle, with a prevalence of 18.5 %, 8.5 %, and 25.5 %, respectively.

R. (Boophilus) microplus was the most infesting among the cattle breeds studied. It was found in 78 % of Zebu cattle and 90 % of Baoulé cattle. With frequency ranging from 48 % in the Baoulé breed to 64 % in the N'Dama breed, *A. variegatum* was the second most infested tick species (Figure 4). The other tick species found in the study were less common and infested less.

Figure 4: Tick species common to cattle and wild animals (X 20)

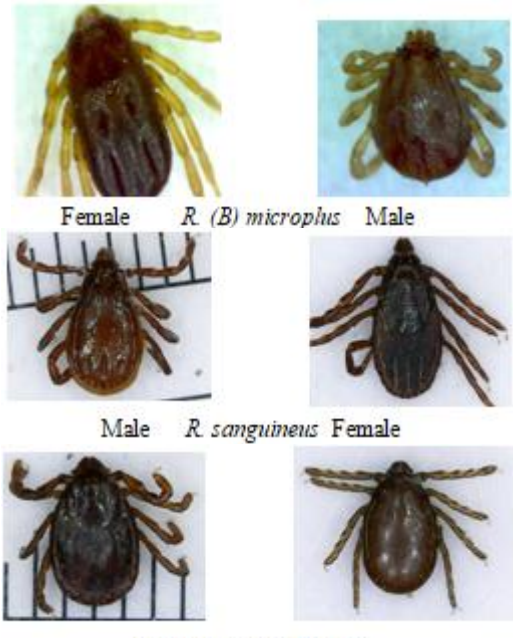

Figure 5: Tick species most representative in abundance in the study area (X 20)

3.4 Prevalence of infestation in wild animals

All wild animals investigated, like cattle, have at least one tick species parasitizing them. However, with a frequency of 75.4 %, the tick species *R. sanguineus* (Figure 5) was the most infested. *H. laechi*, *A. variegatum*, *R. simpsoni*, *and I. aulacodi* were low infesting species on these wild animals, with a prevalence of 21.6 %, 10.8%, 8.4%, and 3%, respectively.

With a prevalence of 95.3 %, 95 %, and 76 % on *Oryctolagus sp* (Rabbit), *Civettictiscivetta* (Civet cat), and *Xerus erythropus* (Palmetto rat), *R. sanguineus* was the most infesting species. *R. simpsoni*on *Thryonomys swinderianus* (Aulacode), *H. laechi* on *Sciunussp* (Squirrel), and *I. aulacodi* on *Rattus rattus* (Rat) were the most infested tick species, with the prevalence of 57 %, 54 %, and 60 %, respectively. Other tick species were the least infested, with modest infection prevalence.

3.5 Tick species common to cattle and wild animals

Among the nine (9) tick species observed in the research region, only one common to both groups of animals, *A. variegatum* (Figure 4), was recognized. Adult and immature (nymph and larva) cattle have a higher population of this tick. Only the juvenile stages of this species (nymph and larva) were detected in high quantity in wild animals (Figure 6).

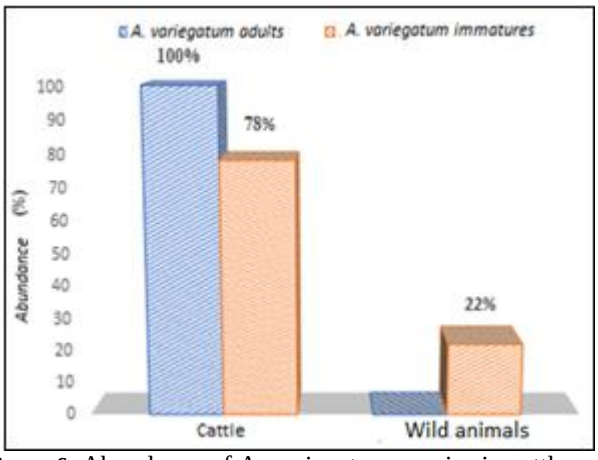

Figure 6: Abundance of A. variegatum species in cattle and wild animals

4. Discussion

The tick inventory in the study area identified nine (9) tick species. Only one was common to both types of animals (cattle and wild animals). Four (4) were specific to each of the two types (cattle and wild animals). This suggests that the infestation of these two types of animals by ticks remains independent of each other. These results confirm those obtained by Morel [16]and Walker *et al.* [13] who revealed that *H. truncatum*, *R. (Boophilus) annulatus*, *R. (Boophilus) geigyi*, and *R. (Boophilus) microplus* would be species with a wide preference of domestic herbivore hosts.
The present study showed a high abundance of the species *R. (Boophilus) microplus* (62.8%) followed by *A. variegatum* (21.4%) in cattle as reported by Touré *et al.* [17]. However, Tuo [18] in an earlier study showed a dominance of *A. variegatum* in cattle in the savannah district. This rearrangement of the dominant tick species in the district could be explained by the invasion of the *R. (Boophilus) microplus tick*. It was discovered in 2007 in the south-east of Côte d'Ivoire in the town of Azaguié [19]. This accidentally imported exotic tick, which is very harmful to livestock, was first identified in the department of Korhogo in 2014 by Touré *et al.* [17]. According to Madder *et al.* [19] and Boka *et al.* [20], *R. (Boophilus) microplus* is highly prolific and suppresses other indigenous tick species of the same genus including *R. (B) geigyi* and *R. (B) annulatus*. This situation would explain the low presence of *R. (B) geigyi (2.9%)* and *R. (B) annulatus* (5.1%) in the present study. According to Baffi*et al.* [21], the acquired resistance of *R. (Boophilus) microplus* compared to other acaricides encountered would favor the replacement of Rhipicephalus (Boophilus) species. The high infestation of cattle by *R. (Boophilus) microplus* (80%) could explain the low presence of other tick species in the present study. The tick species identified in wild animals are specific to this group of animals. This result could be explained by the choice of infestation hosts. Walker *et al.* [13] revealed in a study in Africa that *R. sanguineus* and *H. laechi* are broad-spectrum host species (wild carnivores, rodents, and lagomorphs). The lack of direct and permanent contact between wild animals and cattle could also explain this specificity of infestation. The tick species *R. simpsoni* and *I. aulacodi* are rodent-specific parasites. These results agree with those of Zouh Bi *et al.* [22] who showed that *R. simpsoni* and *I. aulacodi* are tick species-specific to aulacodes. However, they could also parasitize other small rodents such as Rattus rattus observed in the present study.

The high abundance of the *R. sanguineus* tick (72.4%) observed in wild animals could be explained by its adaptive preference to the warm semi-arid climate [23], which is like that of the study area. Indeed, the low rainfall (1000 to 1200 mm/year) and high heat (38°C) conditions of the sugar zone could constitute a favorable environment for the evolution of this tick. Besides *R. sanguineus*, *H. laechi* was the second most abundant tick (15.2%) on these wild animals in the study area which may also be related to climatic conditions [13]. On the other hand, the ticks *I. aulacodi*and *R. simpsoni* were only found in rodents, namely the aulacod (*Thryonomys swinderianus*) and the rat (*Rattus rattus*). The same observations were made in the same wild animals by Tuo [24].

The tick species *A. variegatum* was the only tick common to both cattle and wild animals in the study area. Unlike other ticks specific to wild animals, only immature forms (nymphs and larvae) of A. variegatum species were found in wild animals. This tick was more abundant in cattle than in wild animals. This could be explained by its wide host range and ubiquity [25-26].

5. Conclusion

Several diseases are caused by parasitic ticks in cattle and wild animals, either directly by their growth or toxic effect, or indirectly through pathogen transmission.

This study on ectoparasitic ticks of cattle and Wild animals in the Ferkessédougou sugarcane zone identified nine (9) species (*A. variegatum*, *R. (Boophilus) annulatus*, *R. (Boophilus) microplus*, *R. (Boophilus) geigyi*, *H. truncatum*, *H. laechi*, *R. sanguineus*, *R. simpsoni* and *I. aulacodi*), *belonging* to six (6) genera (Amblyomma, Haemaphysalis, Hyalomma, Rhipicephalus (Boophilus), Rhipicephalus and Ixodes) and two (2) families (Amblyommidae and Ixodidae). Of these species, four (4) were specific to cattle with an abundance of the species *R. (Boophilus) microplus*

and four (4) species were also specific to wild animals with an abundance of *R. sanguineus* species. Only the species *A. variegatum* was common to both types of animals encountered and abundant in cattle. Wild species appear to be reservoirs for this tick species in the study area.

6. Acknowledge

YAO Kouadio Pacôme, Yapi-Gnaore Chia Valentine

References

[1] PNIA.2017. Programme National d'Investissement Agricole De Deuxième Génération. Rapport Final.2017. Côte d'Ivoire 157p, http://extwprlegs1. fao.org/docs/pdf/IVC176030.pdf

[2] MIRAH.2014. Plan stratégique pour le développement de l'élevage, la pêche et de l'aquaculture en Côte d'Ivoire (PSDEPA 2014-2020). Tome 1: Diagnostic-Stratégie de Développement-Orientations. Ministère des Ressources Animale et Halieutique, Abidjan, Côte d'Ivoire, 102 p. http://extwprlegs1. fao.org/docs/pdf/ivc146471.pdf

[3] BAKAYOKO VameKonabe, 2016, « Revue des filières betail/viande & lait et des politiques qui les influencent en Côte d'Ivoire », Abidjan, FAO et CEDEAO, 114 p. https://www.fao.org/3/i5266f/i5266f.pdf

[4] **Mccoy, Karen D., and Nathalie Boulanger,** eds. *Tiques et maladies à tiques: biologie, écologie évolutive, épidémiologie*. IRD Éditions, 2017. https://horizon. documentation. ird. fr/exl-doc/pleins_textes/divers19-06/010066505.pdf

[5] **Rakotomanga M. N., Goodman S. M., Soarimalala V., Boyer S., Apanaskevich D., 2017**. Les tiques dures (Acari: Ixodidae) ectoparasites de micromammifères non-volants dans la forêt d'Ambohitantely, Madagascar. *Malagasy Nature, 12: 59-67.* http://www.vahatra. mg/volume12/MN12_06_Rakotomanga.pdf

[6] **Minjauw B., McLeod A., 2003**. Tick-borne diseases and poverty. The impact of ticks and tick-borne diseases on the livelihood and marginal livestock owners in India and Eastern and Southern Africa. *Research report, DFID Animal Health Programme, Centre of Tropical Veterinary Medicine, University of Edinburgh, U K: 59-60. https://www.researchgate. net/publication/303141086*

[7] **Farougou S., Tassou A. W., Tchabode D. M., Kpodekon M., Boko C., Youssao A. K. I., 2007**. Tiques et hémoparasites du bétail dans le nord-Bénin. *Revue Méd. Vét., 158: 463-467. https://bec. uac. bj/uploads/publication/126b1b004c5d23709d2df3b2bf7 ff082.pdf*

[8] **Achi Y. L., Koné P., Stachurski F., Zinsstag J. et Betschart B., 2012**. Impact des tiques sur des bovins métissés dans le Nord de la Côte d'Ivoire. *Bull. Anim. Hlth. Prod. Afr. Vol.60, N°2, pp: 109-118. https://www.ajol. info/index. php/bahpa/article/view/81734*

[9] **McCoy, K., & Boulanger, N. (2015).** Tiques et maladies à tiques. IRD Éditions, 89-98.

[10] Bigot S., Yao T. B., Oszwald J. et A. Diedhiou.2005. Facteur de variabilité pluviométrique en Côte d'Ivoire et relations avec certaines modifications environnementales. Sécher.16 (1): 5-13. https://www.jle.com/fr/revues

[11] Marnotte P. Rapport de mission de malherbologie à la SUCAF-CI Ferkéssédougou (Côte d'ivoire).2015. Unité de Recherche AÏDA – Cirad.34p. https://agritrop. cirad. fr/578873/

[12] Horak, Ivan Gerard, Habib Golezardy, and André Charles Uys. "Ticks associated with the three largest wild ruminant species in southern Africa. " *Onderstepoort Journal of Veterinary Research* 74.3 (2007): 231-242. https://ojvr.org/index. php/ojvr/article/view/126/121

[13] **Walker A. R., Bouattour A., Camicas J. L., Estradas P. E. N. A., Latif A. A., Pregram R. G. et Preston P. M., 2003**. Ticks of domestic animal in Africa: *A guide to identification of Species. Biosciences reports, Edinburgh EH105QR, Scotland, U. K., 221p.* https://www.researchgate. net/publication/265412942

[14] **Meddour K., Bouderda., Meddour A., 2006**. Clé d'identification des Ixodina (Acarina) d'Algérie. *Revue de science et technologie, Université Badji Mokhtar Annaba, Algérie; Faculté des Sciences, Département de Biologie, Laboratoire de Parasitologie, 24, 32-42p.* Doi=10.1.1.903.2248

[15] **Baouttour A., 2002**. Clé dichotomique et identification des tiques (Acari: Ixodidae) parasites du bétail au Maghreb. *Arch. Inst. Pasteur, Tunis, 79: 43-50.* https://www.researchgate. net/publication/292753151

[16] **Morel P. C., 1958.** Les tiques des animaux domestiques de l'Afrique Occidentale Française. *Rév. Elev. Méd. Vét pays Trop, 111/ 1153-189p.* https://doi.org/10.19182/remvt.7033

[17] **Touré A., Diaha C. A., Sylla I. et Kouakou K., 2014**. Récente recomposition des populations de tiques prévalent en Côte d'Ivoire. *Int. J. Biol. Chem. Sci.8 (2): 566-578.* https://www.ajol. info/index. php/ijbcs/article/view/107076

[18] **Tuo Z., 2013**. Identification des tiques parasites de bovins dans le district des savanes de Côte d'Ivoire. *Mémoire de Maitrise de Biologie et Productions Animales, Université Nangui Abrogoua, Unité de Formation et de Recherche en Sciences de la Nature, 44p. http://www.afriquescience. net/PDF/18/3/8.pdf*

[19] **Madder M., Thys E., Geysen D., Baudoux C., Horak I., 2007**. *Boophilusmicroplus* ticks found in West Africa. *Exp ApplAcarol.43: 233–234. https://www.proquest.com/openview/341297ff943cddb5 3c4ae72b4d56f26e/1?pq-origsite=gscholar&cbl=33748*

[20] **Boka O. M., Madder M., Achi Y. L., Kaboret Y. Y. etBerkvens D., 2014**. Modélisation du remplacement de *Rhipicephalus (Boophilus) decoloratus* par *Rhipicephalus (Boophilus) microplus*, une tique émergente en Côte d'Ivoire. *European Scientific Journal.10 (30): 1857-7881. http://193.190.239.98/bitstream/handle/10390/8440/20 14esjo0120.pdf?sequence=1*

[21] **Baffi M. A., De Souza G. R., De Souza C. S., Ceron C. R., Bonetti A. M., 2008**. Esterase enzymes involved in pyrethroid and organophosphate resistance in a Brazilian population of *Riphicephalus* (*Boophilus*) *microplus* (Acari, Ixodidae). *Mol. Biochem. Parasitol,*

160: 70–73. https://doi.org/10.1016/j. molbiopara.2008.03.009

[22] **ZOUH BI ZahouliFaustin, BIGUEZOTON Abel S., TOURE Alassane, OKA KOMOIN Clarisse, ADAKAL Hassane, KARAMOKO Yahaya, YAPI-GNAORE Valentine C., FANTODJI Agathe**. Invasion de l'Afrique de l'Ouest par Rhipicephalus (Boophilus) microplus: les aulacodes (Thryonomysswinderianus) sauvages, potentiels réservoirs favorables à la dissémination.*2018.* Fiche technique N°58. Santé animale en Afrique de l'Ouest

[23] **Dantas-Torres F., 2010**. Biology and ecology of the brown dog tick, *Rhipicephalus sanguineus. Parasit. Vectors3, 26p. https://parasitesandvectors. biomedcentral.com/articles/10.1186/1756-3305-3-26*

[24] **Tuo Z., 2014**. Identification des tiques chez les bovins et chez les aulacodes dans le district des savanes de Côte d'Ivoire. *Mémoire de Master II de Biologie et Productions Animales, Université Nangui Abrogoua, Unité de Formation et de Recherche en Sciences de la Nature, 20p.*

[25] **Ouédraogo A. M., 1975.** Les tiques des animaux domestiques de Haute-Volta. *Thèse de doctorat vétérinaire, Université de Dakar, Ecole Inter-états des Sciences et Médecine Vétérinaires, 128p.*

[26] **Lafia Sacca., 1982**. Tiques (Amblyommides) parasites des bovins en république populaire de bénin. *Thèse pour le Doctorat Vétérinaire n°9, Université de Dakar, Ecole Inter-états des Sciences et Médecine Vétérinaires, 18-19, 91p.*