Cattle Ticks and Risk Factors Related to Tick Infestation of Livestock in Periurban Farms in Southern Cote D'ivoire

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Abstract— *Tick-borne diseases are a global public health problem, particularly in sub-Saharan Africa, where most of the disease is caused by malaria and many other diseases of viral, parasitic or bacterial origin. This study aimed to identify the bovine tick's species in cattle farms and to determine possible risk factors related to tick infestation in Abidjan district and Azaguié commune. Thus, in July 2019, thirteen (13) herds distributed in these localities were visited for tick sampling and to conduct epidemiological investigations. At each visit, ticks were harvested from 15 cattle per herd. All the farms visited were infested with ticks. 96.92% of sampled animals had ticks. A total of 1796 ticks were collected of which 89.42% (1606) were adults, 10.41% (187) were pupae and 0.17% (3) was larvae. Two species of ticks have been identified, Amblyomma variegatum with 25% of the population and Rhipicephalus (Boophilus) microplus with 75%. 96% of the cattle were infested by ticks of the species R. (B.) microplus and 56% of the cattle were infested by ticks of the species A. variegatum. The co-infestation of cattle by the two identified species was 53%. The distribution of the sexes showed that in the species A. variegatum, males were more numerous (13.44% for males and 8.76% for females). However in the species R. (B.) microplus, females were more numerous (5.08% for males and 62.3% for females).The analysis of risk factors associated with tick infestation in cattle has shown that factors such as Undefined parks, Type of pasture, Training in the use of acaricides and Presence of wild animals contribute to major ectoparasite infestations in cattle. Tick samples collected from peri-urban farms in the district of Abidjan and the locality of Azaguié as part of this study, indicate that the relatively recent introduction of the species Rhipicephalus (Boophilus) microplus presents a threat to animal and human health.*

Keywords— Ticks, Rhipicephalus (Boophilus) microplus, Risk factors, Côte d'Ivoire.

I. INTRODUCTION

Among the potentially emerging diseases, those transmitted by arthropods, particularly ticks, are very numerous. Ticks pose a number of problems in human and veterinary health by their direct nuisance following their bites, but also by the infectious agents they are likely to transmit (Aubry & Gaüzère, 2016). These ectoparasites play a major role in human and animal epidemiology. Thus, they transmit a greater variety of pathogens than any other group of arthropods and are among the most important vectors capable of infecting both humans and domestic animals (Boyard, 2007).Tick-borne diseases cause enormous economic damage to livestock farmers and according to Guerrero *et al.,* (2014), the economic impact of ticks is major, especially in areas where cattle breeding is an important source of income. Also in terms of animal and human health, the consequences can be fatal and can even lead to death if the intervention is late or even leave physical and cognitive after-effects that can be very disabling if they are not treated early enough in humans.

To explain the spread of tick-borne diseases the study of the properties of the pathogen is therefore insufficient (Estrada-Peña*et al.,* 2015). And according to Brownstein *et al.* (2005) the notion of acarological risk must be taken into account, integrating both the notions of vector abundance in the environment and the prevalence of infection among the vector population. Given the central role of the vector in explaining cases of tick-borne diseases, knowledge of its lifestyle and distribution is an essential asset in the fight against these diseases. Tick-borne diseases pose real public health problems around the world and particularly in sub-Saharan Africa, where most diseases have very often been overlooked in favour of major viral or bacterial epizootics. In the district of Abidjan and its suburbs, there is strong demographic growth followed by galloping urbanisation. According to United Nation estimates, urban dwellers accounted for one third of the world's population in 1950, whereas they accounted for more than half in 2015 and will probably account for two thirds in 2050 (United Nations, 2014).In the face of this rapid urbanisation, previously isolated agricultural farms are now found close to the houses. This proximity can thus pose a threat to the population because the human-animal interface is much reduced. In the general context of assessing the infectious risk of tick-borne pathogen transmission, it is necessary to study the distribution of species present in an environment where human populations and farmed animals come into frequent contact. This study aims to identify bovine tick species in peri-urban cattle farms in Abidjan district and Azaguié commune and to determine possible risk factors related to ectoparasitic infestation.

II. MATERIAL AND METHODS

2.1 Study area

This study took place in the south of Côte d'Ivoire, precisely in the district of Abidjan and the locality of Azaguié. The district of Abidjan is bordered to the south by the Atlantic Ocean. It has a humid tropical climate with two dry seasons (from December to April, then in July and September) and two rainy seasons (from May to July, then in October and November) (Tapsoba, 1995).The temperature varies between 24 and 31°C. The district of Abidjan has a surface area of 2119 km², with a body of water representing about 15% of this surface. The district of Abidjan, the capital of Cote d'Ivoire, has a large part of forest vegetation in the image of its Banco National Park and protected areas. Four communes in the district of Abidjan (Cocody, Port-Bouet, Yopougon and Songon) and Azaguié commune were visited for sampling. In all these localities, thirteen (13) peri-urban cattle farms were visited. All farms were georeferenced using a Garmin Etrex 20 GPS (Figure 1).

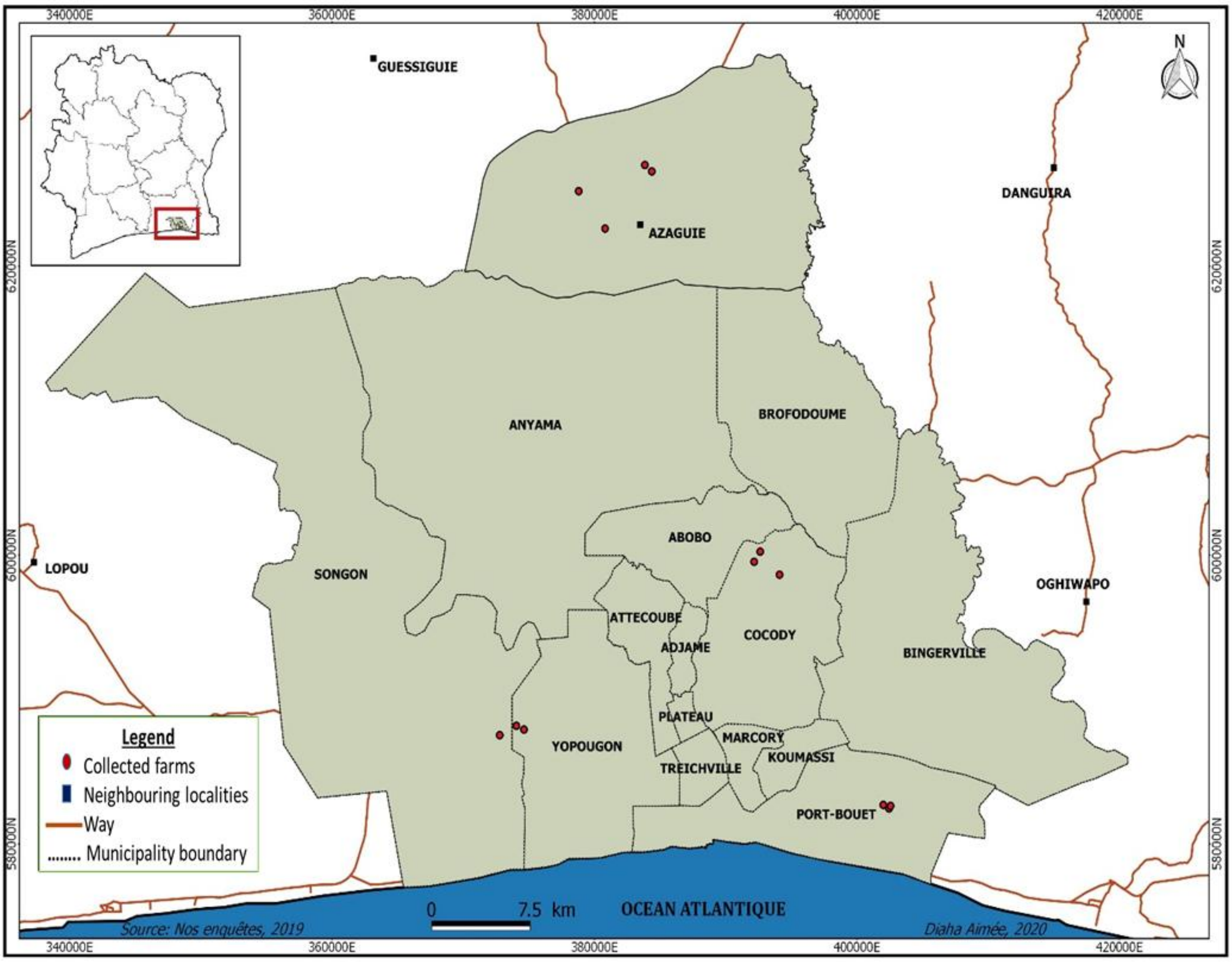

FIGURE 1: Location of farms

2.2 Sampling and conservation of ticks

In July 2019, thirteen (13) peri-urban cattle farms were visited. During each of these visits, for an average of 5 minutes per animal, ticks were collected from 15 animals over one year old. A questionnaire was also submitted to the manager of each farm in order to collect information on the farms and data that would allow us to characterize the different herds in our sample. For the collection of ticks, the animals were restrained in the restraint corridors for those farms that had them and on the ground for those that did not, with the support of farm workers. The ticks collected from each animal were placed in 10 ml collection tubes containing 70% ethyl alcohol for preservation. Each tube was subsequently identified with a tag indicating the location, date of collection, age, sex and identification number of the animal collected.

2.3 Collection of farm information

In order to describe the cattle tick population present on the farms visited and to establish the risk factors for cattle tick infestations, a questionnaire was developed. This questionnaire included information on epidemiological data on the cattle on the farm, and information on the environment. This questionnaire was completed at the time of tick harvesting and completed during interviews with each farm owner or manager. This questionnaire includes the following information: physical characteristics of cattle; overall health characteristics; habitat; feeding; geographical location by GPS; distance of farms from human habitations; type of farm construction; number of people caring for animals; level of education of the people caring for animals; health history of the farms; other domestic animals in vicinity of cattle; tick control; description of local ecology.

2.4 Ticks identification and conservation

After harvests, all samples were sent to laboratory of Institut Pasteur de Côte d'Ivoire (IPCI) for diagnosis. All adult specimens, nymphs and larvae were identified by microscopic examination to confirm species and sex using standard taxonomic keys. Thus identification was carried out according to stasis, genus and species. It was carried out using an OPTIKA binocular magnifier (G x 10 or G x 20) and identification keys (Walker *et al.*, 2003; Meddour-Bouderda & Meddour, 2006; Apanaskevich &Horak, 2007; 2009).

2.5 Statistical analysis

The data collected was entered using Microsoft Office Excel version 2013. Data processing was carried out using R software version 4.0.0 (multiplatform software: Windows, linux and Mac OS X downloadable at http://cran.r-project.org). The Student t-test was used to compare means of two sample groups.

III. RESULTS

3.1 Frequency of tick genera and stasis of collected ticks

In thirteen farms visited, ticks were sampled from 195 cattle. Of these, 189 were tick carriers, representing an infestation rate of 96.92%. The total number of ticks collected was 1796, of which 89.42% (1208) were adults, 10.41% (187) were nymphs and 0.17% (3) was larvae. The identification revealed the presence of two (2) distinct genera. These are the genus *Amblyomma* and the genus *Rhipicephalus*. All ticks of the genus *Rhipicephalus* belong to the subgenus *Rhipicephalus (Boophilus)*.

The distribution of different stasis in the genus *Amblyomma* and the subgenus *Rhipicephalus (Boophilus)* showed that in the genus *Amblyomma*, males were more numerous with 13.44% and 8.76% for females. On the other hand, in the subgenus *Rhipicephalus (Boophilus)*, females were more numerous with 62.3% and 5.08% for males (Figure 2).

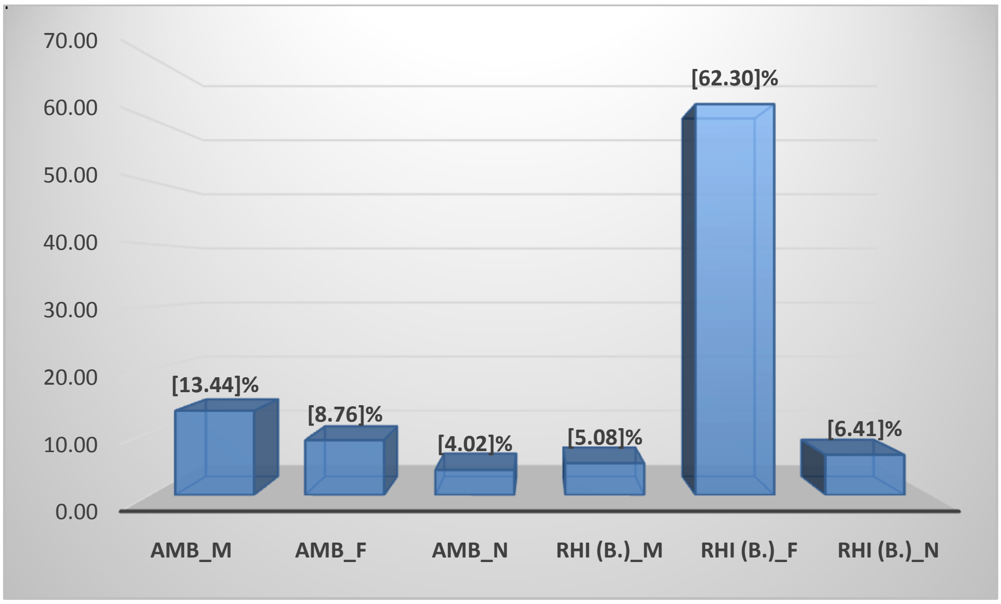

FIGURE 2: Frequency of Tick Stasis

AMB_M :male *Amblyomma*, AMB_F :female *Amblyomma*, AMB_N :nymph *Amblyomma*, RHI (B.)_M :male *Rhipicephalus (Boophilus)*, RHI (B.)_F :female *Rhipicephalus (Boophilus)*, RHI (B.)_N :nymph *Rhipicephalus (Boophilus)*

3.2 Tick species identified

After identification of ticks, the two genera obtained were represented by one species each. The infestation rates of animals by two tick species were 25% for *Amblyomma variegatum* (Fabricius, 1794) and 75% for *Rhipicephalus (Boophilus) microplus* (Canestrini, 1888) (Figure 3).

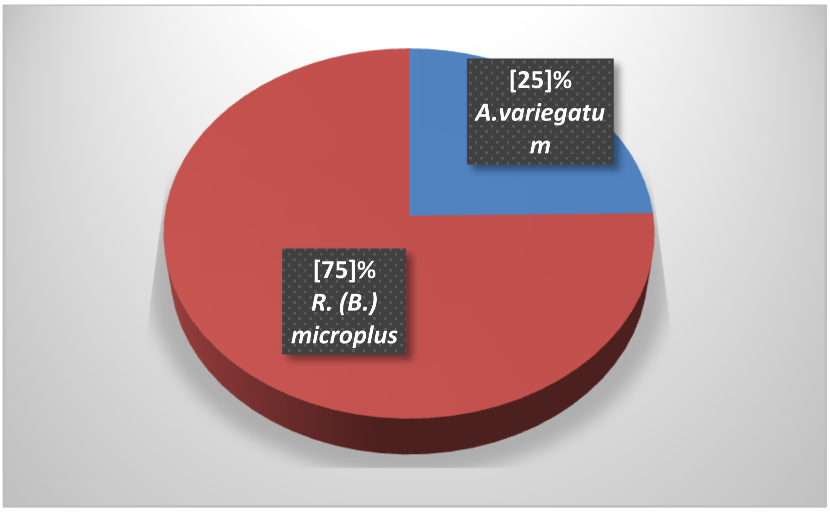

FIGURE 3: Proportion of Tick Species

3.3 Infestation of Cattle by Ticks

Of all animals sampled, 96.92% had ticks. All infested steers were parasitized by the species *Rhipicephalus (Boophilus) microplus* (96.92%) and 56% of beefs were infested by ticks of the species *Amblyomma variegatum*. The co-infestation of cattle by two identified species was 53%.

TABLE 1
PREVALENCE, INTENSITY AND ABUNDANCE OF TICK INFESTATION IN CATTLE

Ticks number	Moyenne (Ecartype)	Min	Med	Max	IQR (CV)
	138.2 (71.4)	60	127	348	51 (0.5)
Ticks species	**Prévalence %** [a]	**Mean intensity**[b]	**Mean abundance**[c]	**% of beef infested**	
Rhipicephalus (Boophilus) microplus	98,94	6,46	6,19	96,92	
Amblyomma variegatum	57,67	3,65	2,04	53	

a. Number of infested beefs by a tick species/number of infested beefs × 100
bNumber of collected tick species/number of infested buffaloes by a tick species
cTotal number of collected a tick species/total number of analyzed beefs

3.4 Analysis of the risk factors associated with cattle infestation by tick

Following the questionnaires submitted to each farm manager, a summary of the characteristics of farm, history of tick infestation and pasture management is carried out in order to determine risk factors associated with tick infestation in cattle for all farms. The student T-test applied to our data showed that four factors were significant. These were: undefined parks, type of pasture, training in the use of acaricides and presence of wild animals (Table 2).

TABLE 2
RISK FACTORS RELATED TO THE PRESENCE OF TICKS ON FARMS

Variable	Modality	Freqs (% of Valid)	Mean (sd)	P value
Location of farm	Dense vegetation	3 (23.1%)	149.3 (76.76)	0.469
	Clear vegetation	10 (76.9%)	101(36.75)	
Herd size	Large (more than 150 heads)	4 (30.8%)	97.75 (30.71)	0.079
	Small (less than 150 heads)	9 (69.2%)	156.11 (78.14)	
Type of pasture	Mixte	3 (23.1%)	93.67 (6.03)	0.049
	Native	10 (76.9%)	151.5 (76.97)	
Presence of wild animals	No	3 (23.1%)	88.67 (25.01)	0.047
	Yes	10 (76.9%)	153 (74.76)	
Training in the use of acaricides	No	12 (92.3%)	137.08 (74.42)	0.042
	Yes	1 (7.7%)	151 (NA)	
Effect of acaricides on ticks	Effective	0 (0%)	0 (NA)	NA
	Not effective	13 (100.0%)	138.15 (71.36)	
Type of speculation of breeding	Meat	9 (69.2%)	151.78 (79.53)	0.414
	Milk-meat	4 (30.8%)	107.50 (41.15)	
Delimited park	No	12 (92.3%)	144.67 (70.38)	0.042
	Yes	1 (7.7%)	60 (NA)	
Containment corridor	Absent	10 (76.9%)	149.3 (76.76)	0.174
	Present	3 (23.1%)	101.0 (36.76)	
Education	Cannot read or write	10 (76.9%)	149.3 (76.76)	0.174
	Can read and write	3 (23.1%)	101.0 (36.76)	
Tick treatment	Some of the animals	12 (92.3%)	145.00 (70.38)	0.154
	All animals	1 (7.7%)	60 (NA)	
Treatment method used	Manual sprayer	12 (92.3%)	145.00 (70.38)	0.154
	Pour-on	1 (7.7%)	60 (NA)	
Frequency of tick treatment	Upon observation of ticks	13 (100.0%)	138.15 (71.36)	NA
	Every week	0 (0%)	0 (NA)	

IV. DISCUSSION

Emerging diseases in humans are thought to be zoonoses in more than 60-70% of cases. Thus, faced with an increase in the incidence of tick-borne diseases, it would be better to know the species of ticks present in our environment in order to be able to control potential vector-borne diseases. This study on ticks in the district of Abidjan and the commune of Azaguié in the south of Côte d'Ivoire has shown the presence of two genera which are: *Amblyomma* and *Rhipicephalus*. In Côte d'Ivoire, these genera have also been highlighted in earlier work (Achi *et al.*, 2011; Diaha-Kouamé 2013; Amoia, 2015; Diaha-Kouamé 2017).In this study, the two genera obtained were represented by one species each, *Amblyomma variegatum* and *Rhipicephalus (Boophilus) microplus*. The latter was the predominant species with a proportion of 75%. The work carried out by Knopf *et al*. (1999) and Achi *et al.*, (2011) showed that *A. variegatum* was the predominant tick species in cattle farming. It should also be noted that in Côte d'Ivoire (CI), the species *R. (B.) microplus* was first identified in 2007 in Azaguié (Madder *et al.,* 2007). Since then, several studies have shown that this species is even in the majority in several large breeding areas of Côte d'Ivoire (Madder *et al.,* 2011; Touré *et al.,* 2012; Diaha-Kouamé 2013; Boka *et al.,* 2014, Amoia, 2015; Diaha-Kouamé, 2017).In this study we observed a decrease in the specific diversity of tick species. Indeed, previous studies carried out in these regions had recorded several other species. Among these species, we noted the presence of other species of subgenus *Rhipicephalus (Boophilus)* such as *Rhipicephalus (Boophilus) decoloratus* (Koch, 1844), *Rhipicephalus (Boophilus) geigyi* (Aeschlimann & Morel, 1965) and *Rhipicephalus (Boophilus) annulatus* (Say, 1821). The fact is that since the introduction of the species *R. (B.) microplus* in Côte d'Ivoire, these species have been identified in very small proportions or even non-existent in certain farms (Madder *et al.*, 2011; Touré *et al.*, 2014; Diaha-Kouamé, 2017).This has been observed in our study where we note a complete elimination of these species to the detriment of *R. (B.) microplus* which is the species newly introduced into Côte d'Ivoire. This study still shows the invasion capacity of *R. (B.) microplus*, as shown by Madder *et al.* (2011)in the Azaguié region and also by Diaha-Kouamé, (2017) on the transhumance corridor between Côte d'Ivoire and Burkina Faso where a small proportion of these species (0.02% for *R. (B.) decoloratus*, 0.49% for *R. (B.) annulatus* and 0.30% for *R. (B.) geigyi)* were obtained. The importance of ticks lies in particular in the fact that they can be vectors of disease. It is therefore important to be aware of their way of life, as well as the areas where animals are likely to become infested, in order to control and prevent diseases transmitted by these mites. Very little is known about the risk factors associated with the presence of ticks in cattle, particularly in the rapidly urbanising southern Côte d'Ivoire region.

In this study the analysis of risk factors associated with tick infestation in cattle showed that factors such as undefined parks, type of pasture, training in the use of acaricides and presence of wild animals would contribute to major ectoparasite infestations in these animals. The fact that the parks are not indefinite and the fact that the animals go to feed in the natural environment favour frequent contact between farmed and wild animals. The presence of wildlife is then very strong in most cases. And according to (Aubry & Gaüzère, 2016) the reservoir of several tick species is represented by wild rodents. According to these authors, risk areas should be avoided through the use of marked paths for leisure activities in the forest and contact with wild animals. It should also be noted that these increasing contacts between wild and domestic fauna and humans are progressively favouring exchanges of pathogens that may have harmful sanitary consequences on the three compartments. As is the case at the periphery of protected areas in southern Africa where these health risks are easily manifested in cases where livestock co-exist with wildlife species that have co-evolved with major livestock pathogens (Jori, 2017). There is therefore a growing interest in the health of populations around the world in relation to these wild animal species. According to (Wiethoelter *et al.*, 2015), this progressive interest is justified by the fact that, generally speaking, the global transformations of our planet have progressively favoured interactions between human and wild animals populations and are shaping what is known as the interface between wild and anthropised environments. It is an interface in which animals (wild and domestic) and humans interact and promote the circulation and transmission of their infectious agents. One such disease is African Swine Fever (ASF) transmitted by a double-stranded DNA virus of the Asfaviridae family. Its epidemiology and ecology includes both direct transmission between infected domestic pigs and/or wild boar and vector transmission (by soft tick bites) (Jori, 2017).Further research is therefore needed to better understand the association between the increasing environmental risk in the region and exposure to human disease and other emerging tick-borne infections (Kulkarni et *al.*, 2017). A study carried out in Brazil has shown that buffaloes reared in the municipality of Santarém have different levels of tick and lice infestation depending on the direct influence of the characteristics of the Amazonian ecosystem. Thus, the floodplain environment, which is widely used for buffalo breeding, contributed to minor ectoparasite infestations in these animals (Batista *et al.*, 2018).Measures to prevent tick-borne diseases include eliminating ticks by applying acaricide to animals and reducing the habitat of ticks in the environment. Livestock farmers generally control ticks because of the repugnance associated with heavy animal infestations but most are unaware that ticks can transmit diseases to animals and more often than not the animals are carriers of pathogens but are asymptomatic. In this study the lack of training in acaricide applications would contribute to the infestation of cattle. Indeed, the work of Furlong, (2004) showed that the appearance and then the evolution of tick resistance to acaricides are due to the inappropriate use of chemical acaricides in several regions. According to Aubry & Gaüzère, (2016) reducing and controlling tick populations is very difficult and that no single measure is therefore sufficient to completely prevent tick infestation in environments where ticks are present, whether in humans or animals. A study in livestock farms in northern Côte d'Ivoire showed that antibiotic doses and acaricide dilutions were not appropriate for the treatment of animals. Under dilution and overdoses of the drugs were therefore more observed (Yéo *et al* 2017). The lack of health monitoring in this type of livestock farming is frequent and represents a considerable and neglected health risk.

V. CONCLUSION

The identification of tick species and the knowledge of possible risk factors related to ectoparasitic infestation are very important in the framework of the fight against these parasites and the prevention of diseases that ticks can transmit. Two tick species were identified in this study, *Amblyomma variegatum* with 25% of the population and *Rhipicephalus (Boophilus) microplus* with 75%.The analysis of risk factors associated with tick infestation in cattle has shown that factors such as undefined parks, type of pasture, training in the use of acaricides, presence of wild animals contribute to major ectoparasite infestations in cattle. Entomological and microbiological monitoring is therefore necessary as it could help to anticipate an epidemic event. Vector surveillance and tick control measures should therefore be improved as part of a One Health approach. These initiatives will therefore need to be brought together in order to map the risk and distribution of ticks in Côte d'Ivoire, as well as the pathogens they carry. This knowledge will be used to guide prevention and control actions.

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