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Epidemiological evaluation of animal trypanosomosis in the special economic zone SiKoBo (Comoé and Léraba provinces) in Burkina Faso

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ABSTRACT

In Sub-Saharan countries infested with tsetse flies, African animal trypanosomosis is considered the main pathological constraint in bovine farming. The objective of this study was to assess the epidemiological risk of trypanosomosis in four departments of the Special Economic Zone in Burkina Faso, namely Loumana, Niankorodougou, Ouéléni and Niangoloko. The study combined parasitological and entomological investigations. In the parasitological aspect, 704 animals were sampled, and examination using the Buffy-coat method revealed 49 positive cases, with a prevalence of 6.96%. Analysis between departments showed the highest prevalence in Loumana (11.60%), which was significantly different from the other three departments ($p<0.03$). Two species of trypanosomes were responsible for the infections, namely *Trypanosoma congolense* and *T. vivax*, with a predominance of *T. congolense* (6.68%). In the entomological aspect, surveys captured a total of 135 tsetse flies, with an overall apparent density of 0.79 flies/trap/day, and *Glossina palpalis gambiense* was the only species encountered. Mechanical vectors were also captured at a low density, with 0.32 flies/trap/day. This study demonstrates that landscape fragmentation is associated with a reduction in the diversity of tsetse fly species but the trypanosomiasis risk remains present, given the high prevalence in animals.

Keywords: African animal trypanosomosis, Tsetse flies, Parasitological prevalence, Apparent density

INTRODUCTION

In Sub-Saharan Africa, an area with an agricultural and pastoral focus, livestock serves not only as a source of animal protein but also plays an indispensable role in agriculture, including animal traction, transportation, and animal manure for soil fertilization. Livestock also holds economic and social significance. Livestock diseases persist in this region, posing not only a significant constraint to the development of livestock but also hindering a substantial improvement in the production of the agricultural sector. Among these diseases, African Animal Trypanosomosis (AAT), whose parasite is primarily biologically transmitted by tsetse flies, is considered the most significant. AAT is a parasitic disease caused by trypanosomes, protozoan parasites of the genus *Trypanosoma*. The main trypanosomes responsible for these pathologies include *Trypanosoma congolense*, *T. vivax*, *T. brucei brucei*.

In Sub-Saharan Africa, nearly 10 million square kilometers of land, the most fertile for forage and agricultural production, are infested with tsetse flies, thereby limiting initiatives for the development of sustainable agriculture (Hursey et al., 1995). Indeed, AAT annually results in the death of over 3 million head of cattle, the loss of 500,000 tons of meat and 1 million tons of milk, a 10% reduction in animal traction and fertility, and induces abortions in pregnant cows. The potential losses in animal and plant production due to AAT are estimated to exceed 4,750 million USD per year. In Burkina Faso, trypanosomosis is presumed to be endemic throughout the Sudano-Sahelian zone (located between isohyets 1,300 and 1,000 mm) (Bengaly et al., 2001). Faced with the significant damage caused by AAT for decades, various integrated control approaches have been employed, including chemotherapy, chemoprophylaxis, vector control, etc. However, these approaches seem to be insufficient. A more recent integrated control approach, utilizing chemical techniques upstream of the Sterile Insect Technique (SIT), would be more effective, especially in Burkina Faso against *Glossina tachinoides*, *G. palpalis gambiensis*, and *G. morsitans submorsitans* (Politzar et al., 1984) and in Zanzibar against *G. austeni* (Vreysen et al., 2000).

However, without a good understanding of the epidemiology of the disease, effective control measures cannot be implemented. In the West African context where ruminant farming is primarily based on mobility, the Regional Animal Health Center (CRSA) in Bamako has provided the community space with a regional strategy for the control of AAT and Tick-Borne diseases, validated by all ministries responsible for livestock in the 15 Member States of the Economic Community of West African States (ECOWAS). During the development of this strategy, the assessment of the situation of these diseases in the MS revealed that the available data were mostly very outdated. The objective of this study was to update the situation of AAT by assessing the epidemiological risk in the provinces of Comoé and Léraba in Burkina Faso.

MATERIALS AND METHODS

Study Area

The study area covers the national Comoé River Basin, which is a transboundary basin located in the southwest of Burkina Faso, primarily shared between Côte d'Ivoire (80%) and Burkina Faso (18%), and to a much lesser extent, Ghana (2%) and Mali (less than 1%). The Special Economic Zone–Sikasso–Korogo–Bobo-Dioulasso (ZES-SiKoBo) was created within the framework of cooperation and sub-regional integration by the Governments of the Republic of Burkina Faso, the Republic of Côte d'Ivoire, and the Republic of Mali covering the towns of Sikasso (Mali), Korhogo (Côte d'Ivoire) and Bobo-Dioulasso (Burkina Faso). The main economic activities in this zone are agriculture and livestock farming. The selection of the provinces of Comoé and Léraba was influenced by their affiliation with the ZES-SiKoBo, characterized by a pastoral livestock farming system with an estimated bovine herd of nearly 684,849 head for Comoé and 47,292 for Léraba. The data were collected in the departments of Loumana (in the villages of Tamassari, Lera, Loumana, Yetelo/Koko, and Baguera), Niankorodougou (Djondougou, Kagbora, and Fourkoura), and Oueleni (Sarkadjalan, Khobada, and Oueleni) for the province of Léraba. In the province of Comoé, data collection were collected in the departments of Niangoloko (Diagora, Koutoura, and campement) (Figure 1).

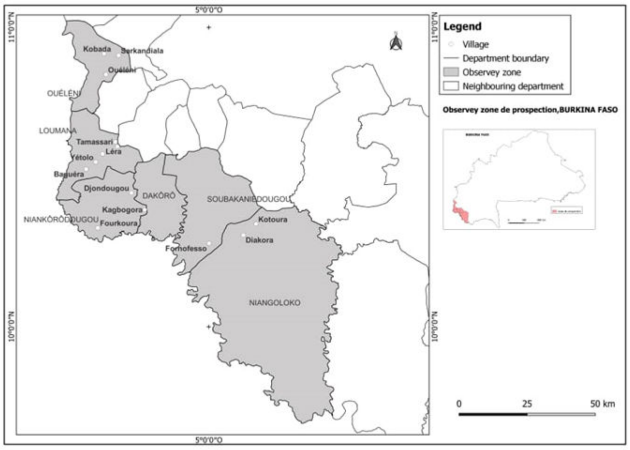

Figure 1: Map showing the locations surveyed.

Parasitological Survey

A total of 704 cattle distributed across the four departments were sampled. The majority of the sampled animals were Fulani Zebus and half-bre between Fulani Zebus × “Baoulé” taurines. In each locality, cattle were randomly selected without criteria regarding age, sex, or breed. The physical parameters of the animals were determined at the time of or after blood sampling. Thus, sex and body condition were determined through direct visual examination, and the age of the animal was provided by the livestock keeper.

The date of the last treatment against AAT and the type of trypanocide used were recorded. Blood samples were collected from the jugular vein using a vacutainer needle mounted on a tube containing EDTA. The blood analysis began with the determination of hematocrit, and it helps characterize the degree of anemia. Hematocrit was determined after centrifugation at 12,000 revolutions per minute for 10 minutes of capillary tubes filled to 4/5th of their volume with blood. Hematocrit values were directly read using a SIGMA™ reading chart (Murray et al., 1977).

The "Buffy-Coat" method was used for the parasitological examination. After reading the hematocrit, the capillary tube was cut using a diamond tip at approximately 1 mm below the red blood cell-plasma layer (Buffy-Coat). The red cell/plasma interface was then placed on a slide, covered with a cover slip, and observed under a microscope at 40X magnification. Parasitemia was then expressed as the number of parasites per microscopic field after examining a total of 40 fields for each sample. These values were then converted to the number of trypanosomes per milliliter of blood using a corresponding conversion table (Paris et al., 1982).

Entomological Survey

The entomological survey aimed to determine the density of tsetse flies and mechanical vectors of AAT in the study sites. In each village, two tsetse sites were selected, either along watercourses or, in their absence, along water points used as watering points for livestock, and were approximately 1 kilometer apart from each other (Figure 2). In each site, two standard biconical traps were set at intervals of 100 meters. For each trap, geographic coordinates were recorded using a GPS and an Android application (Qfield). An entomological form was used to document the vegetation, deposition and collection times for each trap, as well as the different mechanical vectors and various species of tsetse flies captured, including their number and sex. Each trap was collected 72 hours after placement. The captured insects were identified, counted, and preserved in alcohol for further analysis.

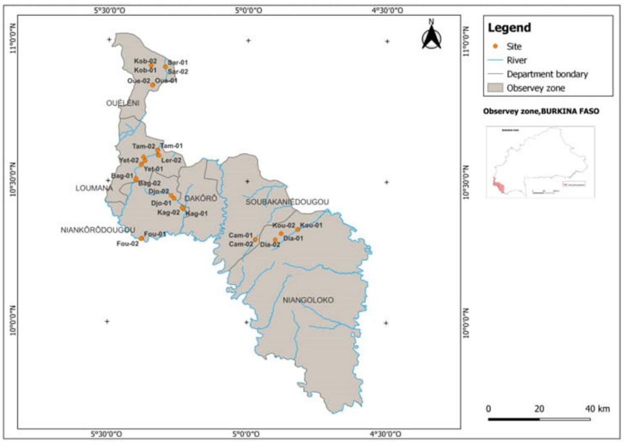

Figure 2: Map showing the different sites in the survey area.

Data Analysis

The evaluation of the prevalence of trypanosomal infection in animals and the Apparent Density per Trap (ADT) of captured insects were performed using Microsoft Excel software based on the following formulas:

Prevalence=(No. of animals diagnosed as positive/Total number of animals sampled) × 100

ADT=The number of individuals captured/(no. of traps × no. of capture days)

The R software version 4.2.2 was used to perform the statistical analyses. The Shapiro test was used to check for data normality, and the Tukey test was applied. For parasitological and entomological data, the generalized linear mixed-effects model was used to analyze bovine infection rates (with a binomial distribution) and the ADT of tsetse flies and mechanical vectors (with a Gaussian distribution), with the department considered as a fixed variable. For the hematocrit, the same linear model was used (with a Gaussian distribution), incorporating department, sex, and parasitemia as fixed variables. R software was also utilized for constructing the graphs.

RESULTS

Parasitological Survey

A total of 704 cattle were sampled from 14 villages across 4 departments, namely Ouéléni, Niankorodougou, Niangoloko, and Loumana. The parasitological examination using the buffy coat method revealed 47 positive cases, resulting in an overall prevalence of 6.96%. Parasitological prevalence varied significantly between departments (χ^2=16.86; df=3; p<0.001). Further analysis between departments indicated that the prevalence was significantly higher in the Loumana department (11.60%, n=250) compared to the Niangoloko (p=0.003, n=155) and Ouéléni departments (p=0.008, n=155), and marginally higher compared to the Niankorodougou department (p=0.09, n=144). No significant differences were observed among these three departments (p>0.05) (Figure 3).

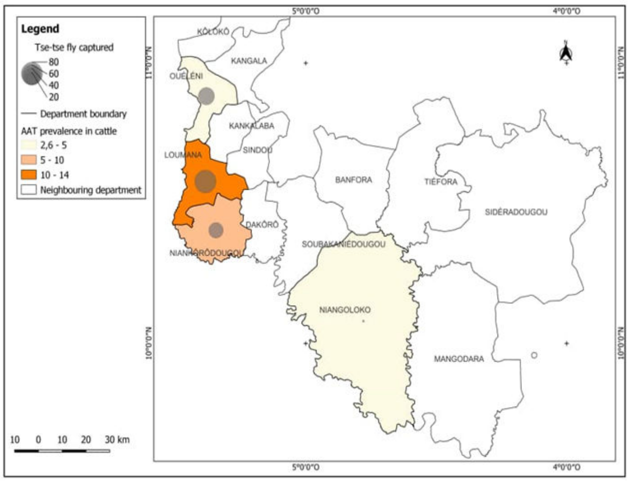

Figure 3: Map of the prevalence of AAT according to the departments surveyed.

Trypanosoma spp. infections involved two species of trypanosomes (Table 1). These are *T. congolense* (6.39%) and *T. vivax* (0.28%), with a predominance of *T. congolense* in all departments. *T. vivax* was only observed in the Niankorodougou department. The prevalence of *T. congolense* was significantly higher in the Loumana department compared to the other three departments (Niangoloko, Ouéléni, and Niankorodougou), which were similar to each other (Table 1). No mixed infections were observed during the parasitological examinations. Additionally, no cases of active infection by *T. brucei* brucei were identified in any of the localities.

Table 1: Parasitological prevalence by trypanosome species and by department.

Department	Animals sampled	Positive to *Tsp* (prevalence (%))	Positive to *Tc* (prevalence (%))	Positive to *Tv* (prevalence (%))
Loumana	250	29 (11.60)[a]	29 (11.60)[a]	0 (0)[a]
Niangoloko	155	4 (2.58)[b]	4 (2.58)[b]	0 (0)[a]
Niankorodougou	144	9 (6.25)[ab]	7 (4.86)[b]	2 (1.39)[a]
Oueleni	155	5 (3.23)[b]	5 (3.23)[b]	0 (0)[a]
All departments	704	47 (6.68)	45 (6.39)	2 (0.28)

Note: *Tc*: *T. congolense*; *Tv*: *T. vivax* ; *Tsp*: All species of trypanosomes combined

[a-b]Values in the same column that have a common letter are not significantly different (p>0.05).

In the entire study area, the mean hematocrit was not influenced by either the department (χ^2=1.90, df=3, p=0.59), sex (χ^2=0.01, df=1, p=0.94), or parasitemia (χ^2=0.27, df=1, p=0.60). The analysis by department and according to parasitemia showed that the mean hematocrit was 30.46% and 31.83% in Loumana, 30.85% and 29.44% in Niankorodougou, 31.06% and 34.20% in Ouéléni, and 31.18% and 30.25% in Niangoloko, respectively, for animals negative and positive for Buffy coat (Figure 4).

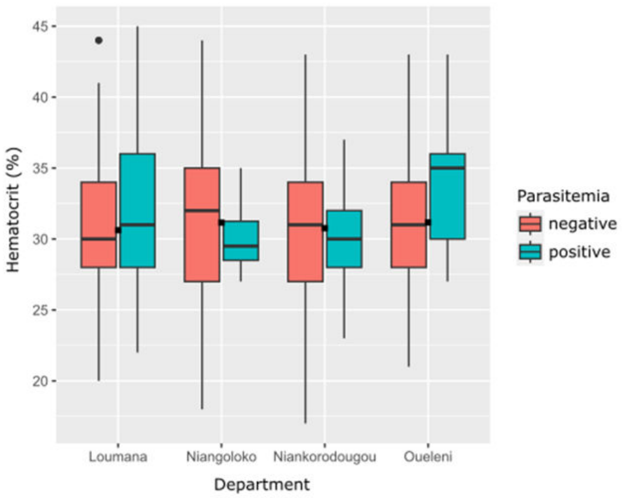

Figure 4: Average hematocrit based on department and parasitemia.

Entomological Survey

Fifty-six (56) traps were deployed and captured a total of 135 tsetse flies, resulting in an overall ADT of 0.79 tsetse flies/trap/day for the whole visited area. Morphological examination revealed that all captured tsetse flies belonged to the species *G. palpalis gambiensis* with a sex ratio (M/F) favored males (0.77). Tsetse fly density (ADT) varied across departments (χ^2=14.46, df=3, p=0.003). No tsetse flies were captured in the department of Niangoloko, while the ADT was 1 tsetse fly/trap/day in Loumana, 0.91 in Niankorodougou, and 1.1 in Ouéleni (Figure 5). The difference in density was not significant among the three departments where captures were made (Loumana, Niankorodougou, and Ouéleni). The observed zero density in Niangoloko was significantly different from those in Loumana and Ouéleni (p=0.02) and marginally different from that in Niankorodougou (p=0.06).

During the entomological survey, in addition to tsetse flies, mechanical vectors were captured with an overall low ADT of 0.32 flies/trap/day. The identification of these insects showed that they included Stomoxes with 0.27 flies/trap/day and Tabanids with 0.047 flies/trap/day for the whole study area. The highest density was observed in Niangoloko at 0.64 (Figure 5). However, these densities were not statistically different between departments (χ^2=5.66, p=0.13).

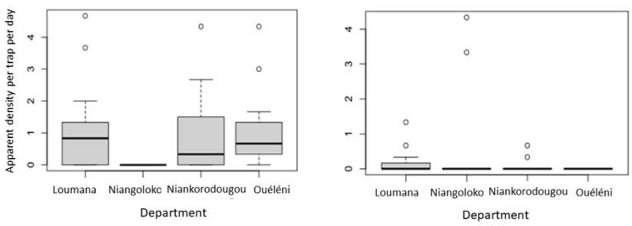

Figure 5: Distribution of tsetse fly and mechanical vector densities by department.

DISCUSSION

The present study obtained an overall parasitological prevalence of 6.96%, which was low compared to that observed in the study by Pagabeleguem et al., conducted in Folonzo, which was 19.79%. This high prevalence in previous study suggests the importance of contact between animals and savannah tsetse flies known as effective vectors of *T. congolense* (Reifenberg et al., 1997). Indeed, *G. morsitans* submorsitans had been captured in high density of 10.56 ± 15.23 flies/trap/day (Pagabeleguem et al., 2012) while this species was not captured in the present study; only *G. palpalis* gambiensis was encountered.

Considering the surveyed localities, the parasitological prevalence varied from one area to another, demonstrating spatial heterogeneity of infections in our study area. The department of Loumana recorded the highest prevalence (11.60%), and Niangoloko the lowest (2.58%). A parasitological study in the same area had shown a relatively similar prevalence in Loumana of 9.2% and significantly higher in Niangoloko of 7.7% (Bengaly et al., 1998). Despite anthropogenic pressure on plant and animal resources leading to the disappearance of tsetse fly habitats and wild hosts (Courtin et al., 2010), these comparative results attest to the maintenance of the same level of trypanosomosis risk in the area 30 years later. While *G. morsitans submorsitans* seems very susceptible to these environmental variations, leading to its disappearance (Rouamba et al., 2009) or significant decline (Rayaisse et al., 2009), riverine flies, on the other hand, appear more resilient due to opportunistic feeding behavior associated with learning abilities (Bouyer et al., 2007) and linear dispersion along watercourses (Bouyer et al., 2009) which maintain the trypanosomosis risk.

The average apparent density of tsetse flies was 0, 1.16, 1.3, and 1.5 tsetse flies/trap/day in the departments of Niangoloko, Ouéléni, Loumana, and Niankorodougou, respectively. These densities are relatively low according to (Tazé et al., 1978). This low density could be explained, on the one hand, by habitat disturbance due to anthropogenic acceleration and modification of climatic factors. On the other hand, by the survey period, which may not be favorable because in the study area, most watercourses, which are tributaries, experience a significant decrease or drying up in the dry season, leading to the retreat of flies towards permanent watercourses. Despite this low tsetse density, the mobility of animals linked to the livestock system could have effects on parasitological prevalence considering the high prevalence observed in the animals. Due to insecurity in the field, some watercourses that could be permanent were not able to be surveyed.

Two species of trypanosomes, namely *T. congolense* and *T. vivax*, were responsible for infections, with a predominance of *T. congolense*. This predominance of *T. congolense* in cattle in the administrative province of Comoé had been observed in previous studies, notably in a site near Folonzo (Dayo et al., 2010) and in Folonzo. However, in the Boucle du Mouhoun region, previous studies had observed a predominance of *T. vivax* over *T. congolense*. This contrasting situation could be explained by the difference in the hydrographic network. Indeed, in our study area, most watercourses dry up during the dry season, while in the Boucle du Mouhoun region, cattle remain concentrated along the last water points, which is the Mouhoun River, and experience a high intensity of contact with riverine tsetse flies that are good vectors of *T. vivax*. Furthermore, the presence of mechanical vectors could relay this transmission seasonally as they are particularly abundant at the end of the rainy season and during the cold dry season in the Boucle du Mouhoun zone (Koné et al., 2011). Furthermore, the age of the animals could be a factor, as age seems to have an influence on the type of trypanosome infection and the level of receptivity and sensitivity of the animals. Young animals are more susceptible to *T. vivax* than *T. congolense* due to their lower receptivity and sensitivity (Murray et al., 1982). However, in our study, the sampled animals in the study area had a relatively high age (average age of 4.5 years).

The absence of *T. brucei brucei* in cattle confirms the trends observed in previous parasitological studies conducted in Burkina Faso (Bouyer et al., 2009; van den Bossche et al., 2011). Moreover, this trypanosome is localized in tissues rather than in blood vessels, reducing the likelihood of finding it in peripheral blood through microscopic examination.

The parasitized and non-parasitized animals showed similarities in hematocrit levels. These results could be explained by the fact that it is an area of trypanosomosis endemicity, and farmers frequently treat animals with trypanocides, ensuring good general health. Additionally, crossbreeding between taurine and zebu breeds in the area also could confer a certain tolerance to animals regarding trypanosomosis.

CONCLUSION

This study demonstrates that landscape fragmentation is associated with a reduction in the diversity of tsetse fly species and the parasites transmitted to animals. The documented situation here only partially contributes to characterizing the epidemiology of AAT in this special zone of Burkina Faso. A similar study could be conducted after this period of insecurity, with a follow-up on the incidence of the disease and vector dynamics.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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