Vol. 14(3), pp. 58-68, July-September 2023
DOI: 10.5897/IJLP2023.0826
Article Number: 6754D9E71277
ISSN 2141-2448

http://www.academicjournals.org/IJLP

ACADEMIC JOURNALS
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International Journal of Livestock Production

Full Length Research Paper

Entomological inventory of bovine trypanosome vectors in the locality of Logone Birni, Far North Cameroon

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Received 14 June, 2023; Accepted 7 August, 2023

In order to identify the vectors of bovine trypanosomiasis in the locality of Logone Birni, inventories were carried out from March to June 2020 in six sites. The purpose of this work is to contribute to the evaluation of the seroprevalence of bovine trypanosomiasis, to identify trypanosome vectors and to inventory the vector control methods already implemented in this area. Forty cattle were sampled for parasite analysis using the Rapid Diagnostic Test (RDT) method. Insect captures were made using Vavoua traps at a frequency of three successive days per week during the two months of investigations. Surveys and interviews were also conducted with thirty people (traditional leaders, livestock farmers and shepherds) about local control methods. The analysis results show that, of the 40 cattle tested, *Trypanosoma vivax* and *Trypanosoma congolense* are the most frequent parasites with a seroprevalence rate of 30 and 05%, respectively. A total of 12,482 Stomoxes and 494 Tabanids were captured with an average of Apparent Population Density (APD) of 173.36 Stomoxes/Trap/Day and 6.86 Tabanids/Trap/Day, respectively. In short, trypanosome seroprevalence is very high compared to the diversity of mechanical vectors (Stomoxes and Tabanids) and the absence of biological vectors (*Glossina* species). According to breeders, control methods reduce the pressure of insect vectors on cattle and make pastures more accessible, hence the need to deepen by diversifying control methods against the mechanical vectors listed.

Key words: Seroprevalence, vector, trypanosome, trypanosomiasis, vector control, apparent density, Stomoxes, Tabanids.

INTRODUCTION

Livestock is one of the main sources of protein in the human diet worldwide (FAO, 2012). This sector accounts for 40% of global agricultural production and contributes to the livelihoods and food security of around one billion people (FAO, 2009). According to the FAO (2009), the economy of the population of rural areas is essentially

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based on the agro-pastoral sectors (agriculture, livestock) of which 80% of households are undernourished. Nowadays, livestock farming is a key to the Cameroonian economy, it contributes nearly 165 billion CFA francs to the GDP and provides income for nearly 30% of the rural population (Fernand et al., 2013). The Cameroonian cattle herd is estimated at six million head. Eighty-three percent of this herd is found in the North, Far North and Adamaoua regions; the remaining 17% being distributed in the West, North-West, South-West, and East regions (Messomo, 2006).

In addition, livestock farming is part of the economic activities of the Far North region, which comes second after Adamawa region in terms of cattle herd (Messomo, 2006). In the Far North of the country, this activity remains subject to numerous constraints, including the scarcity of pasture, the lack of water as well as the resurgence of several vector-borne zoonoses (PAPE, 2018). In this region, some rich pastures in flooded areas remain inaccessible during the rainy season, during the day, due to the high presence of haematophagous insects (Tompaloumla et al., 2020). In addition, some pastures in the Far North region and surrounding areas are rich in good quality fodder and with high yields; unfortunately, these host countless insect vectors that inoculate animals with pathogens (Mouchet et al., 1961). Some of these insect pests include external parasites of livestock.

Even if they have very different morphological and biological characters, these insects have one thing in common, that of being a real nuisance for animals as well as for humans (Badelon, 2016).

They sometimes exert strong pressure on livestock and cause high bovine mortality linked to parasitic diseases such as African Animal Trypanosomiasis or AAT (Mounioko et al., 2017). Repeated despoiling of blood, painful bites and the resulting stress are detrimental to the good health of livestock (Badelon, 2016). In Cameroon in general, trypanosomiasis reduces meat and milk sales by at least 50% as well as the efficiency of oxen traction for agriculture (PATTEC, 2010). The losses in meat, milk and the costs of the vector control programmed are estimated at around 1200 million US dollars (or 660 billion CFA francs) per year throughout the world.

In the locality of Logone Birni and its surroundings, the problem of AAT vectors has given rise to the realization of several studies being carried out on the attempt to eradicate tsetse flies considered to be active biological vectors of this pathology (Mouchet et al., 1961). An experimental campaign to control *Glossina tachinoides* had already been carried out in this locality by Mouchet et al. (1961). Despite the application of chemoprophylactic measures based on the half-yearly administration of lomidine on the population and the systematic screening of new patients, the endemic persists until today except for the apparent absence of tsetse flies. However, knowledge of mechanical vectors in this area remains lacking. Furthermore, the relative role of mechanical vectors in the transmission of animal trypanosomiases in Africa needs to be studied (Mounioko et al., 2017). Indeed, the elimination of glossina seems not to be sufficient to eradicate trypanosomiases in sectors where mechanical transmission could be ensured by this type of vector (Desquesnes and Dia, 2004). It is in this context that a cross-sectional study based on a preliminary inventory of the entomofauna of potential AAT vectors was carried out in the commune of Logone Birni, 59 years after the work of Mouchet et al. (1961) in this locality and its surroundings.

Therefore, the objectives of this research were: (i) detect the real presence of trypanosomiasis in Logone Birni; (ii) inventory and characterize the entomofauna of potential AAT vectors and (iii) identify vector control techniques already implemented by farmers to contribute to the inventory of haematophagous insects, potential vectors of AAT, with a view to the optimal management of the expected results within the framework of the establishment of an efficient vector control program in the locality of Logone Birni, this in a context of efficient and sustainable breeding.

MATERIALS AND METHODS

Study area

The municipality of Logone Birni is located in the Far North Region, division of Logone and Chari, subdivision of Logone Birni. With an area of 3.809 km^2, it is limited to the north by the Kousseri municipality; to the south by the Zina municipality; to the east by the Logone River; and to the west by the Waza and Makary municipalities.

Sampling

Stratified and random sampling techniques were those chosen for this study. They are applied at the level of trapping sites, sampling herds, villages, livestock farmers, agro-pastoralist and transhumant pastoralists.

At the level of the sites for setting traps, the choice was made on environments that seem to be breeding grounds for insects and animal frequentation (Badelon, 2016). According to the characteristics of the biotope, the traps were installed in three different places: at the level of the water points, close to the camps, and along the cattle track in the Yaéré.

For the choice of herds and the subjects of sampling, they were chosen randomly by the volunteer livestock farmers.

For the surveys, the choice was directed towards people who are involved in the practice of livestock farming (livestock farmers, shepherds, and transhumant). While walking in the pastures and at the cattle market in Zimado, any random herder encountered was investigated. The study was carried out on a sample of 35 people, surveyed in the municipality of Logone Birni. The data collected concerned: the socio-economic characterisation of the respondents, the farming method and practice, knowledge of the different vectors, the control methods used and their effectiveness, and the most affected areas and pasture areas. The choice of persons to be surveyed was made randomly.

(a) Sampling (b) Blood deposit on the card (c) Buffer addition (d) Reading the result

Figure 1. Steps of the RDT.

After the surveys, a total of forty cattle were sampled from four herds, that is, ten cattle per herd belonging to cattle farmers who voluntarily submitted to our evaluation. The choice of animals whose blood was taken from the different ranches to estimate trypanosomiasis seroprevalence was made at random by the owner.

Determination of trypanosomiasis seroprevalence by the rapid test

Procedure of the test

For each animal in the sample, blood was collected from the left or right ear vein using a syringe and an aspirating pipette. The breed, sex, age and owners of the cattle were recorded.

A drop of blood obtained after sampling was deposited in the cassette using the pipette. This drop of blood is supposed to contain the AAT antigens. Each cassette is numbered on the back for identification. A drop of buffer is added to the well of the cassette, taking care not to pour anything into the reading window. After adding the buffer, 10 to 15 min later, the result was read (Figure 1).

Interpretation of the test

The seroprevalence was sought and identified using the rapid screening test which is done on a card, to confirm or by the cases of trypanosomiases in the locality of study. The map is read according to the indications of Find et al. (2011). The test is positive if one line is visible in the "C" window and one or two visible or faintly visible lines in the "Tv" or "Tc" window; in this case, the animal is suspected of AAT (presence of antibodies directed against AAT antigens). The test is negative if a line is visible in the "C" window and no line is visible in the "Tv" or "Tc" windows; in this case, the animal is free of TAA (Absence of antibodies directed against TAA antigens). The result is invalid when there is no line in the "C" window and one or no line in the "Tv" window or in the "Tc" window making the TDR invalid.

The prevalence of each haemoparasite was calculated using the following formula developed by Thrusfield (2007), where P represents the prevalence of a haemoparasite; d the number of animals that tested positive for this haemoparasite on the rapid test; N represents the total number of animals sampled. The proportions of trypanosome species diagnosed were calculated. Similarly, the prevalence was estimated for each species of trypanosome according to the sex of the animals, the breed and the age of the cattle sampled.

Inventory of fly vectors of trypanosomes

Laying capture traps

The capture of potential trypanosome vectors was done using 6 Vavoua traps, geo-referenced (GPS) at 100 m intervals from each other. With the help of a hammer, an iron bar serving as a support for the net was fixed. Attached to the iron rod, the cone and the mosquito net were also mounted. The trap was placed at a height of approximately 50 cm from the ground as pre-registered by Badelon (2016). This Vavoua trap is made up of three screens sewn at 120°. The spacing between the screens is in two parts, namely: the outer band (75 × 30 cm) phthalogen blue and the central band (75 × 15 cm) black. These screens are held in place by a mosquito net tulle cone held at its base by a wire circle approximately 80 cm in diameter. The device carries at the top a point of no return and a box for collecting trapped insects. The trap was then fixed to the ground by a stake with the condition that the bottom of the trap is not more than 50 cm from the ground (Laveissière and Penchenier, 2005 cited by Badelon, 2016) because Stomoxes fly between 30 cm and 1 m from the ground (Hansens, 2012). Each trap was placed in the sun so that the reflectance of the blue color was optimal. The traps were placed in three different biotopes: water points used as drink for cattle, camps and cattle tracks or "Yaérés".

Insects collection

Insect collections were performed once a day for three consecutive days during one month. Captured insects were collected every 24 h after trapping. Each insect collection box from each identified trap was dismantled and taken to the Logone Fishing Center Laboratory for sorting, identification and quantification of insect morphotypes by taxonomic affinity.

Identification and quantification of haematophagous insects

The different species of vector insects collected were identified under a binocular magnifying glass using identification keys

Table 1. Relative abundance of the listed entomological types.

Insects	Number	Relative abundance (%)
Stomoxes	12 482	93.91
Tabanids	501	3.77
Glossina spp	0	00
Others	309	2.32
Total	13 292	100

described by Zumpt (1973) and Taufflie (1988) according to their morphological characters (head , thorax, abdomen, wings and legs) under a binocular magnifying glass and their number was quantified by counting.

Entomological characterization

The characteristics of the dipterofauna vector of AATs were based on the evaluation of the following parameters:

Diversity of the insects listed: This consisted of determining the number of morpho-species identified in the entomofauna vector of trypanosomes in the study locality. Only haematophagous insects, can play a trypanosomes in the locality of the study. Only haematophagous insects, which can play an important role in the transmission of parasitosis, were taken into consideration. The in-depth identifications will make it possible to determine within each morpho-species, the different species captured.

Relative abundance of the dipterofauna vector Zaime of trypanosomes: The relative abundance for a given group of insects is the ratio of the number of individuals of the insects taken into consideration to the total number of individuals constituting the total listed entomological fauna (Zaime and Gautier, 1989). It is estimated by the following formula: R.A (%) = [(ni/N) × 100], where R.A (%) is the relative abundance or centesimal frequency, ni the number of individuals of the insects taken into consideration and N the total number of individuals of all insects combined. As a whole, the different insects and the values of their relative abundance will make it possible to better appreciate the compositional diversity of the entomofauna responsible for the transmission of the trypanosome to livestock in the study site locality.

Apparent density: The values of the different apparent densities per group of insects (APD) were calculated by the formula:

$$APD = \frac{\text{number of Insectes captured by morpho} - \text{Species}}{\text{number of traps x number of days}}$$

Grouping of captured insects into types of Vectors: This involved classifying the fly species listed according to their status in the transmission dynamics AATs. Thus, the biological vectors in which develop part of the biological cycle of the parasite will be distinguished from the mechanical vectors.

Frequency of occurrence of morpho-species captured: The frequency of occurrence (C) or frequency of appearance is the degree of frequency with which the morpho-species listed were encountered in the sortings from the different traps (Dajoz, 2006). The frequency of occurrence is the percentage between the number of samples containing the morpho-species considered (Pi) and the total number of samples made (P); the general formula is: C (%)= [(Pi/P) × 100] (Dajoz, 2006). Bigot and Bodot (1973) classified the frequencies of occurrence into four categories according to variations in the value of C: sporadic species (C < 10%), accidental species (10% ≤ C ≤ 24%); accessory species (25% ≤ C ≤ 49), and constant species (C ≥ 50%).

Statistical analysis

For the analysis of the data itself, these were subjected to descriptive statistics. We used the Chi-square test of independence (or Fisher's t test when the expected frequencies were less than 5). SPSS software version 19 was used for this purpose; the significance threshold has been set at 5%.

RESULTS

Characterisation of the entomofauna of potential vectors of parasitosis

Overall relative abundance of the entomofauna vector of trypanosomes

Table 1 shows the different groups of insects listed in the study site locality, classified according to their relative abundance.

It was noticed that, the group Stomoxes were the most represented with a relative abundance or centesimal frequence of 93.91%. They are followed by Tabanids from afar, which occupy a centesimal frequency of 3.77%. The various other insects constitute a relative abundance of 2.32% of the listed local entomofauna. The striking fact in this study is the total absence of tsetse flies in the various trapping sites in the commune of Logone Birni. The recrudescence of stomoxes in our study locality can be attributed to the fact of the high humidity in the Yaeres which is favorable to the development of stomoxes. Furthermore, stomoxes are considered stable flies.

Monthly relative abundance of the entomofauna vector of trypanosomes

The results in Table 2 show the different variations in the relative abundance of the insects listed according to the different months of the study. Overall numbers vary from

Table 2. Monthly relative abundance of the entomological fauna according to the month.

Insects	Period May Number	May Abundance (%)	June Number	June Abundance (%)	Total Number	Total Abundance (%)
Stomoxes	5911	94.61	6571	93.29	12482	93.91
Tabanids	195	3.12	306	4.34	501	3.77
Glossina spp	0	00	0	00	0	00
Others	142	2.27	167	2.37	309	2.32
Total	6248	100	7044	100	13292	100

Table 3. Variation in the relative abundance of insects according to the survey sites.

Insects	Site: Camp Number	Camp Abundance (%)	Cattle track (Yaere) Number	Cattle track (Yaere) Abundance (%)	Water point Number	Water point Abundance (%)	Total Number	Total Abundance (%)
Stomoxes	4392	95.04	3158	94.47	4932	92.57	12482	93.91
Tabanids	156	3.38	116	3.47	229	4.30	501	3.77
Glossina spp	0	0.00	0	0,00	0	0.00	0	0.00
Others	73	1.58	69	2,06	167	3.13	309	2.32
Total	4621	100	3343	100	5328	100	13292	100

6248 individuals in May 2020 to 7044 individuals sampled in June 2020. The differences in monthly relative abundances are not at all significant between the two months with regard to Stomoxes and Tabanids ($P > 0.05$). This non-significant difference reveals the similarity of the biotic parameters between the two months, the rains having been somewhat delayed in the month of June 2020.

Distribution of insects according to biotopes

The relative abundance of vectors varies from one site to another. Table 3 presents the relative abundance of vectors according to capture sites.

The results recorded in Table 3 present the different variations in the relative abundance of the insects listed according to the different study sites. Overall numbers vary from 4,621 individuals at the camp level, 3,343 at the cattle track and 5,328 near the water point. Overall, there is a significant difference between the three sites ($\chi 2 = 27269.38$ ddl=1, $P < 0.001$), this difference would be related to the difference in biotic variation in the three sites.

The differences in monthly relative abundances are not at all significant between the three sites with regard to Stomoxes and Tabanids ($P > 0.05$). Stomoxes are the most abundant in the three capture sites followed by Tabanids. Stomoxes are densest at the animal encampment level, why they called stable flies. The total absence of tsetse flies would be linked to the effect of the control campaign carried out by the LCBC in the locality or either the period during which the work was carried out is not conducive to the development of tsetse flies.

General apparent density of insects

Two major groups of insects belonging to the order Diptera were recorded during our investigations; these are the Tabanids and Stomoxes. In addition, other individuals belonging to the orders Lepidoptera, Coleoptera and Orthoptera were also captured. Table 4 shows the values of the general apparent population density (APD) of the different groups of insects from the different Vavoua traps set or APDs of 347 S/D/P, respectively; 14 T/D/P and 0.00 G/D/P. The other non-haematophagous insects combined presented a APD equivalent to 09 I/D/P. Stomoxes and Tabanids are the most interesting insects for our study because they feed on the blood of animals and are very present in the study site environment. In addition, the Stomoxes present a very important daily pullulation compared to the Tabanids. This predominance is explained by the ecological conditions of the locality which seem to be favorable for their multiplication. Overall, the total absence of tsetse flies during the study period is undoubtedly linked to the effectiveness of the control campaign implemented by the Lake Chad Basin Commission in 1961, which was able to eradicate tsetse

Table 4. General apparent density.

Cash	Stomoxes	Tabanids	*Glossina* spp	others	Total
Number	12482	494	0	309	13292
AP D (I/P/J)	347	14	-	9	369

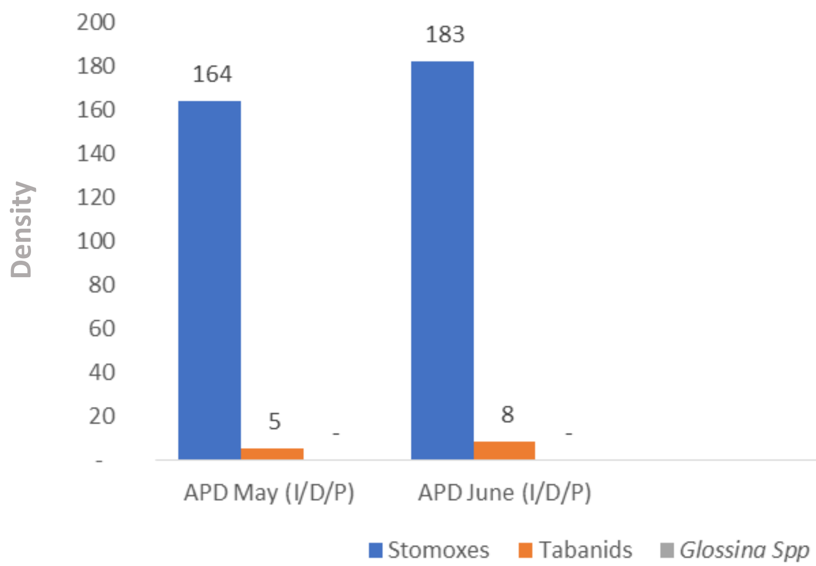

Figure 2. Monthly evolution of apparent density of insects.

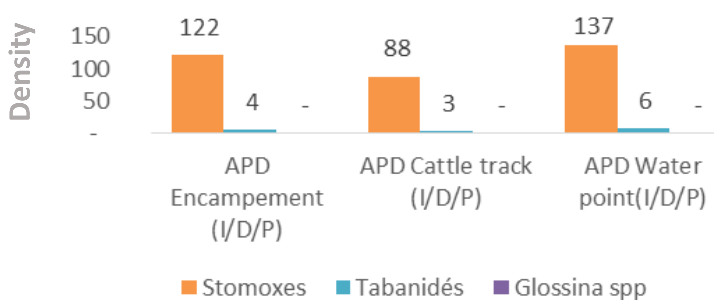

Figure 3. Apparent density of insects according to sites.

flies in the locality and its surroundings.

Monthly evolution of the apparent density of insect populations

Figure 2 shows the monthly evolution of apparent density of insects. From Figure 2, the vectors are more abundant in June. Stomoxys are the most densely represented in June with an APD of 183 S/D/P against 164 S/D/P in May. As for Tabanids, they are denser in the traps in June with an APD of 8 T/D/P while there is a density of 5 T/D/P in May. No *Glossina* was caught during the two months of the 0 G/D/P study (May and June). In general, the high density recorded in June could be explained by the season: June marks the start of the rainy season, a period coinciding with the multiplication of insects.

Apparent density (APD) of insects according to prospecting sites

The calculation of the apparent densities of the different haematophagous insects according to the sites of installation of the Vavoua traps made it possible to obtain the results presented in Figure 3.

Table 5. Frequency of occurrence of blood-sucking insects.

Entomological groups	Haematophagous Insects	*C* (%)
Constant Insects	Stomoxes	100
	Taons	100
Sporadic Insects	*Glossina* spp	0

Table 6. Seroprevalence rate of trypanosomes in the cattle studied.

Animal		Number infested	Seroprevalence (%)
Infested animals	*Tv*	12	30
	Tc	02	05
Non-infested		26	/
Total		40	35

According to Figure 3, the insects are denser at the level of the water points. The Stomoxes come first with 137 S/J/P followed by encampment (122 S/J/P). In Figure 3, we retain that Tabanids are more abundant at the level of the water points with a DAP of 6 then 4 T/D/P. The humid conditions generally around the water points can explain the abundance of insects in this area. At camp level, abundance would be linked to the fact that Stomoxes are stable flies.

Frequency of occurrence of the various listed insects

The results recorded in Table 5 provide information on the values of the frequency of occurrence of blood-sucking insects collected in the various Vavoua traps during all the survey days. This table shows that Stomoxes and Tabanids were collected during all six days of investigation, that is, an occurrence frequency of 100%. As a result, these two groups of insects are qualified as constant insects in the entomofauna vector of trypanosomes in the study site locality. The *Glossina* spp. absent here (C = 0%) belong to the group of so-called sporadic insects. Finally, the other non-haematophagous insects (Coleoptera, Lepidoptera and Orthoptera) although collected in the traps were not taken into consideration in this classification because they play no role in the dynamics of transmission of trypanosomes to animals.

Typology of insect vectors

The results relating to the type of vectors inventoried, show that the biological vectors like *Glossina* spp. are totally absent from the study site: they are therefore grouped in the class of so-called very accidental or sporadic insects. On the other hand, the Stomoxes and Tabanids which are very well represented in the locality of Logone Birni constitute the so-called constant insects and therefore can play an important role in the transmission of the mechanical type of trypanosomes. In short, the manifestation and persistence of AAT in the locality of Logone Birni are certainly maintained by the presence of mechanical vectors such as Stomoxes and Horseflies.

Serological analysis of trypanosomiases in the locality of study

Seroprevalence of trypanosomiasis

The application of rapid screening test (RDT) revealed the infestation of animals by two main species of Trypanosomes: *Trypanosoma congolense* and *Trypanosoma vivax*. The seroprevalence rate of trypanosomes is summarized in Table 6.

The general seroprevalence of trypanosomiasis in cattle sampled in the locality of Logone Birni is 30% of *T. vivax* and 05% of *T. congolense*, that is, a general seroprevalence of 35%. This prevalence would be linked to the presence of potential haematophagous insect vectors of parasitosis in the pastures of the locality.

Influence of sex on seroprevalence of trypanosomiasis

Thirteen out of thirty-four females and one out of six males tested positive for trypanosomiasis. Table 7 highlights the influence of the sex factor on trypanosome seroprevalence in cattle in the study locality.

The prevalence of trypanosomiasis is higher in females (32.5%) than in males (2.5%) with a significant difference ($\chi2$ = 19.69; dof=1; P < 0.001). These results are explained by the fact that females last longer in production farms than males. In slaughter houses, more

Table 7. Influence of the sex factor on the Seroprevalence of the parasite responsible trypanosome.

Sex	Results			Total	Seroprevalence (%)
	Negative	*Tv*	*Tc*		
Masculine	5	1	0	6	2.5
Feminine	21	11	2	34	32.5
Total	26	12	2	40	35

Tc: *T. congolense*, Tv: *T. vivax*; seroprevalence (%) = [(number of seropositives/40) × 100]

Table 8. Seroprevalence of trypanosomiasis according to cattle breed.

Breed	Results			Total	Seroprevalence (%)
	Negative	*Tv*	*Tc*		
RF	17	7	1	25	20
WF	5	5	1	11	15
Crossbreed	4	0	0	4	0
Total	26	12	2	40	35

Tc: *T. congolense*, Tv: *T. vivax*; RF: Red foulani or red Zebu Mbororo; WF: White Foulani or White Mbororo Zebus; seroprevalence (%) = [(number of seropositives/40) × 100].

males are slaughtered than females, as the latter are generally kept for reproduction and milk production.

Influence of breed on seroprevalence of trypanosomiases

RDT results reveal that trypanosomes were found in all breeds with varying prevalences; however, a significant difference is recorded between races ($\chi 2 = 70.12$; dof= 2, $P < 0.001$). Table 8 shows the seroprevalence of trypanosomiasis according to cattle breed.

The variation in the prevalence of trypanosomiasis according to breed remains perceptible with a significant difference ($\chi 2 = 70.12$). Animals of the "White Foulani" breed were the most infected (15.00%) while the "Red Foulani" were infested at a prevalence of 20%. No half-breed tested positive out of the 04, that is, a prevalence of 0%. These results are explained by the fact that the color white is the preferred color of flies related to visibility.

Influence of age on seroprevalence of trypanosomiasis

Trypanosomes have been found in animals of all ages, both young and adult. Table 9 shows seroprevalence of trypanosomiasis according to age group.

The highest prevalence was observed in animals considered to be adults in the age group greater than 3 years (22.5%). It is low in young people aged less than 3 years (12.5%), but the difference between the prevalence obtained in adults and that of young people is not significant ($\chi 2 = 1.23$; dof = 1, $P > 0.05$). However, adults seem to be more affected because the longer the animal lasts in the herd, the more it comes into contact with vectors on pasture.

DISCUSSION

Serological analysis of AAT

The general seroprevalence of trypanosomiasis in cattle surveyed in the locality of Logone Birni was 35%. This result is greater than that of 8.12% obtained for the same parasitosis in the Adamaoua plateau in 2010 (Mpouam et al., 2011), than that of 18% in the locality of Petté in 2018 (Tompaloumla et al., 2020) and 26.31% in the department of Mayo Rey in 2013 (Mamoudou et al., 2015). Also, this prevalence rate is less than that of 40.7% obtained in 2010 in the department of Faro and Deo (Tanenbe et al., 2010). The relatively high seroprevalence in Logone Birni is linked to the fact that this locality is especially an area with high transhumance activity. Moreover, the results of the variation in the seroprevalence of trypanosomiasis according to the cattle breed (Oluwafemi, 2009; Girma et al., 2014; Mamoudou et al., 2016; Tompaloumla et al.,2020), animal sex (Tanenbe et al., 2010; Mpouam et al., 2011; Seyoum and Abera, 2016; Mamoudou et al., 2015) as well as the age of bovids (Abenga et al., 2004; Feyissa et al., 2011; Seyoum and Abera, 2016; Tompaloumla et al., 2020) have already been clearly elucidated both in Cameroon and elsewhere. All the previous results are illustrative of the actual presence and persistence of trypanosomiases in the locality of study to justify our research on the

Table 9. Seroprevalence of trypanosomiasis according to age group.

Age	Results			Total	Prevalence (%)
	Negative	*Tv*	*Tc*		
Adult	15	7	2	24	22.5
Youth	11	5	0	16	12.5
Total	26	12	2	40	35

Seroprevalence (%) = [(number of seropositives/40)×100]; Tc: *T. congolense*, Tv: *T. vivax.*

potential vectors of this pathology. Indeed, the symptoms of trypanosomal animals are generally similar to those of certain other animal pathologies of a bacterial, viral, parasitic or mycelial nature (Arijo, 1997). This is particularly the case for babesiosis or bovine piroplasmosis, anaplasmosis and anthrax, which are also prevalent in the locality. It was therefore necessary to eliminate the doubt about the presence of parasitosis in Logone Birni by using the appropriate tests. This precaution made it possible to consolidate our study on the inventory of potential entomological vectors of trypanosomes listed in the Logone Birni municipality.

Inventory of haematophagous insects, potential vectors of AAT

The results of insect captures revealed a resurgence of Diptera or flies as the main haematophagous insects and therefore potential vectors of AATs in the locality of Logone Birni. Insects belonging to the order Diptera are recognized as being for the most part the vector agents of animal and human pathologies including AATs (Chiodini et al., 2001).

The striking fact in our study is the total absence of tsetse flies (*Glossina* spp) in our inventory despite the use in the field of Vavoua traps which are more suitable for their capture (Koumba et al., 2018). This absence of tsetse flies in our sampling may be linked to the existence in the field of several works aimed at eradicating the tsetse fly (Mouchet et al., 1961) and programs for the control of clean vectors or biological vectors of trypanosomes in Cameroon sometimes including the Central African sub-region.

Several other previous works report the absence of *Glossina* spp. in several study sites in Cameroon (Mounioko et al., 2017; Tompaloumla et al., 2020). In addition, tsetse fly control campaigns are maintained in the field by the Lake Chad Basin Commission, the main objective of which is the eradication of biological vectors of trypanosomes.

Despite the absence of biological vectors, *Glossina* species, in our experiment, it is worth noting the presence of trypanosomal animals in the Logone Birni locality. There is reason to think that this persistence of AAT in this municipality is maintained by other haematophagous insects responsible for the transmission of this parasite. From this study, it appears that Stomoxes and Tabanids play an essential role in the dynamics of trypanosome transmission in Logone Birni in the absence of tsetse flies. Among these two groups of insects, the most important part goes to the Stomoxes. Indeed, compared to the Tabanids, the Stomoxes stand out in particular by the high value of their relative abundance and their Apparent Population Density (APD). The results obtained confirm the effectiveness of Vavoua traps for the capture of stomoxys as already demonstrated by Amsler and Filledier (1994).

Several other works have noted the proliferation of Stomoxys and Tabanids in the absence of *Glosina* spp. in Petté (Tompaloumla et al., 2020) and Campo (Mounioko et al., 2017). Mechanical vectors of trypanosomes, in this case, Stomoxes and Tabanids play an extremely important role in human and animal health (Mavoungou et al., 2008). Responsible for several diseases such as animal trypanosomes and humans, they constitute a vectorial transmission link for many pathogens. In addition, because of their haematophagy, these insects represent a problem for human and animal populations, in particular because of their direct nuisance such as harassment and predation (Desquesnes et al., 2005).

The APD values per trap and per day obtained in the Logone Birni municipality which are respectively 347 S/P/D for Stomoxes and 14 T/P/D for Tabanids are very high compared to those obtained in Campo by Mounioko et al. (2017) which are respectively 0.98 S/P/D and 0.093 T/P/D. The difference between these values in both Stomoxes and Tabanids suggests that the entomological pressure of the mechanical vectors listed may vary from one region to another, given the prevailing climatic conditions. It is indeed known that the locality of Campo undergoes an equatorial climate of the Guinean type, whereas Logone Birni is under a Sudano-Sahelian climate. These differences are also perceptible within the same region from one locality to another; this is why Petté's results, which are 98.8 S/P/D and 15.5 T/P/D, are different from the current ones. These last variations between Petté and Logone Birni may also suggest that the entomological pressure of mechanical vectors is characteristic of each locality within the same agro-ecological zone. According to the work of Desquesnes et al. (2005), certain abiotic and biotope factors influence the abundance of entomofauna in a given environment. This is why we observe a variation in the values of the

APDs when passing from the camps to the cattle tracks, passing through the water points.

The different morpho-species of Stomoxes and Tabanids captured during our experiment are being determined by a sworn taxonomist. This precaution makes it possible to avoid an ambiguous identification of the different insects to guarantee a better knowledge of the species of mechanical vectors specific to the Far North region, of which no taxonomic study has yet been made up to the taxon of the species. However, several species of Stomoxes, namely: *Stomoxys niger niger, S. omega, Stomoxys xanthomelas, Stomoxys calcitrans* and *Stomoxys niger bilineatus* as well as several species of Tabanids including *Chrysops silacea*, *Chrysops distinctipennis,* and *Tabanus taeniola* have already been identified in the forest region of Cameroon as being responsible for the mechanical transmission of AATs.

Overall, this study constitutes a preliminary database relating to the mechanical vectors listed in the locality of Logone Birni. This database could serve as a reference for additional studies aimed at setting up an efficient vector control program in this municipality.

Conclusion

This study, entitled entomological inventory of the vectors of Bovine trypanosomiasis in the locality of Logone Birni (Far North, Cameroon) allowed us to confirm the effectiveness of AAT in this locality. Indeed, through serological tests by TDR, two species of Trypanosomes, namely *T. vivax* and *T. congolensis* were diagnosed with a prevalence of 35%. The presence of trypanosomal animals in the study locality therefore attests the existence of vector agents responsible for the transmission and persistence of this parasitosis. If the biological vectors that are *Glossina* spp. were not listed in our study, the existence of other haematophagous insects which are responsible for the mechanical transmission of TAA in cattle in Logone Birni should be noted. Among these mechanical vectors, the Stomoxes and Tabanids have been mentioned here; this underlies the pressure of the mechanical vectors that infest the herds in these pastures. Among the two groups of insects, the Stomoxys clearly stands out from the horseflies by their relative abundance and their Apparent Population Density (APD) and would therefore play an important role in the dynamics of AAT transmission in Logone Birni. Moreover, these different insects swarm in camps, at water points and along cattle tracks. Unfortunately, the implemented control techniques are archaic and remain far from effective.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

ACKNOWLEDGEMENT

The authors appreciate the support from the Livestock Development Project (PRODEL) in Cameroon for provision of essential research material during the investigations.

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