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Contribution to the knowledge of ecodiversity and density of tsetse (Glossinidae) and other biting flies (Tabanidae and Stomoxyinae) in the fly controlled-infested livestock/wild life interface of the Adamawa plateau-Cameroon

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Abstract
This present study seeks to contribute to knowledge of eco diversity and density of trypanosomiasis vectors in Adamawa Plateau of Cameroon. Ten Laveissiére traps were pitched in Alme and Faro Game Reserve and checked 24 hours every 4 days from December 2014 to June 2015. An overall scanty catch of 240 flies were recorded due to presence of impregnated Deltamethrin screens. Based on interview of herders, they were aware of fly dense areas such as Faro Game Reserve. Flies mean densities and Shannon-Weaver indices were: *Glossina morsitans submorsitans* (0.55f/t and 0.23) with bimodal peaks in January and May, *Glossina tachinoides* (0.13f/t and 0.10), with bimodal peaks in January and March, *Tabanus* spp. (0.51f/t and 0.18) with a unimodal peak in June and *Stomoxys* spp (0.10f/t and 0.03) with a unimodal peak in the month of May. Fly infestation of formerly controlled areas is increasing, with major re-invasion sources from protected areas.

Keywords: Tsetse, Re-Invasion, Eco diversity, Density, Adamawa, Cameroon

Introduction
In terms of conservation of biological diversity, tsetse flies have the same intrinsic value as other species. Tsetse flies are unique elements of biological diversity because they have an unusual combination of life history traits (strictly haematophagous, viviparous and low reproduction). Therefore countries which have signed an international Convention on biological diversity (http://www.cbd.int/convention/parties/list/) should not accept eradication of tsetse flies in protected areas (Game reserves and national parks). Tsetse invasion of Cameroon began in the 1950s, with the arrival of *Glossina morsitans submorsitans* to the Adamawa Plateau. This same year was characterized by the appearance of trypanosomiasis in this same region [1, 2]. Since then two additional species, *Glossina fuscipes* and *Glossina tachinoides* have been reported. Implying that tsetse invasion brought about trypanosomiasis appearance in this region.

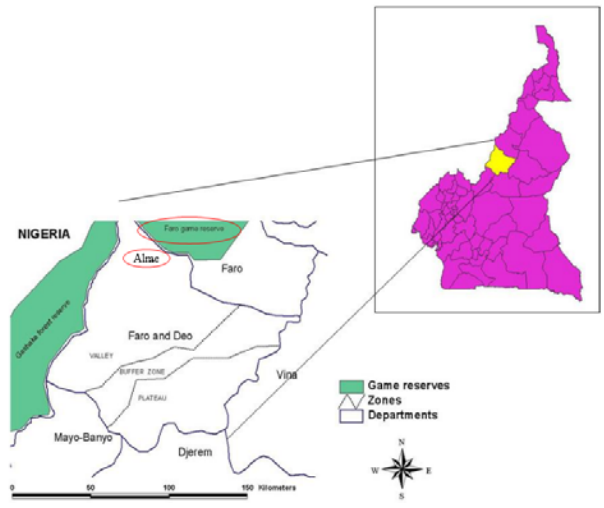
The invasion of tsetse in Cameroon led to decrease fertility, birth rate, weight gain, milk production [3]. This made the Cameroon Government to join the crew in the fight against tsetse and diseases they vector. In 1994, insecticide treatment of cattle was most frequent in tsetse fly control [4, 5] highlighted factors which were a milestone to re-invasion barriers following the 1994 Eradication Campaign (EC) such as: Assess difficulties of some areas, resistance of insecticides used, movement of cattle herds between infested and cleared areas and tsetse invasion through roads. Tsetse densities remained high in the Gashaga Forest Reserve and the Faro Game Reserve as a result of absence of effective tsetse control activities in these areas [4]. Preliminary findings 10years after the 1994 EC reported that vector density was still in a rise [6, 7] reported an elevated density of *Glossina morsitans submorsitans* value which was higher than the index of apparent abundance (IAA) [6]. Presently, the presence of Deltamethrin-impregnated screens in this area for control has played a role in significant fly-reduction. An overall 94.9% fly reduction using such screens has been achieved in Ethiopia as reported by [8]. Other biting flies such as Tabaninae of the genus *Haematopota* and *Stomoxys* have just been mentioned in some literature but little has been known about their population dynamics and their consequences to livestock and human health. Three species of tabanids have so far been

identified in the Adamawa Plateau- Cameroon (Dodeo): *T.taeniola*, *T. biguttatus* and *T. gratus* as well as two *Stomoxys spp: Stomoxys nigra and Stomoxys calcitrans* [9]. Our present study seeks to bring evidence on the effect of season on the eco-distribution and density of haematophagous dipteran-vectors of bovine trypanosomiasis in the controlled-infested livestock/wild life agro-ecological interface of the Adamawa plateau of Cameroon. This is to determine a major re-invasion source in the infested zone of Faro and Deo division of Adamawa Plateau.

Materials and Methods

Description of study area

This present entomological survey was carried out from December 2014 to June 2015 in two seasons (dry and rainy seasons). Alme Village was considered as an infested and formerly controlled (control effected with the use of Deltamethrin impregnated screens and treatment of cattle) area during the 1994 EC. It is a Village in the infested zone of Faro and Deo division of Adamawa. This Village is surrounded by a forest area where the flies have never been cleared. This forest surrounds the tsetse infested Faro game reserve (FGR)in the North and to the West by Gashaga forest reserve (GFR) in Nigeria. Transhumance herds of "Mbororo" pastoralists is seasonal in this area that is, they arrive at the beginning of dry season and retire at beginning of rainy season. This village falls between Latitude 7◦N and Longitude 8◦E (Figure 1). Influx of wildlife (such as antelopes, hyenas, monkeys, lion and bush pigs) from Faro Game Reserve into Alme allow these wild animals to mingle with cattle during grazing periods and this phenomenon occurred on daily basis. The choice of this area was because it is surrounded by these important protected areas (FGR and GFR). It was noticed that Deltamethrin impregnated screens were deployed in the area as barriers to tsetse flies.



⬭ : Encircled zones in red shows flies trapping points

Fig 1: Map of Cameroon showing Faro and Deo division and Alme bordered by Gashaga and Faro reserve [5]

Interview of herders

Herders were visited in two rounds as follows: round 1 in December and round 2 in May in the dry and rainy seasons respectively. The aim of this interview was to assess their knowledge on these biting flies and "dangerous" areas (where rich biting fly niches can be found) and the extent to which they control and abstain from such vector zones while practicing their local husbandry technique in the area.

Entomological surveillance

A point transect survey was conducted. Blue biconical Laveissière trap [10] baited with acetone and three weeks cow urine (applied on it in order to boost its odour attracting effect) [11]. Traps were deployed in two areas namely: Alme Village (formerly controlled but infested) (n=5) and FGR (non-eradicated and protected) (n=5) at intervals of 300m^2 and flies harvested every 24 hours for four days, every month in a total of 7 months in two seasons. Flies were captured and conserved in a solution of 70% methanol prior identification. Fly specimens which were not identified in the field were transported to Vector Borne Infectious Disease Unit (VBID) of the Laboratory of Biology and Applied Ecology (LABEA) of the University of Dschang in Cameroon for identification. Tsetse flies were identified to species level and the other biting flies to genus level [12, 13].

Data analysis

The density of each hematophagous fly was calculated using the formula as shown [14]:

$$TAD = \frac{NFC}{NTs \times TDs}$$

Where,
NFC=Number of flies captured
NTs=Number of traps
TDs= Number of trapping days
Biodiversity index of Shannon-Weaver permitted us to quantify the heterogeneity of the biodiversity of the milieu and was computed using the following formula [14]:

$$H' = -\sum_{i=1}^{s} pi.\log 2pi$$

H': biodiversity index of Shannon-Weaver
i: species in the study milieu
pi: proportion of species (i) with respect to total number of species (S) in the study area
Graphical as well as histogram presentation of results was achieved using Excel of Microsoft office 2007 in order to bring out a simple seasonal or monthly trend of density/biodiversity index of Shannon-Weaver of various flies captured.

Results

Interview of herders revealed that all of the herd heads could identify flies that gave their animals painful bites. They were aware of such areas around the forest of Faro Game Reserve. Herders release their animals in the morning with little or no follow up, unless they don't return. Negligence on the part of herders led to their animals visiting such "danger" flies zones. Every 6pm, fire was being burnt by herders at a particular spot around the pen where animals usually gather. This local husbandry practice of evening fires acted as anti-fly for herders and their animals as an organ for the control of fly nuisance. Tsetse flies were identified to species level and sex with two species recorded in the following proportions: *Glossina morsitans submorsitans* (male=57.79% and female=47.20%), *Glossina tachinoides* (male=75.55% and female=41.44%), while the other biting flies were identified to genus level (*Tabanus*=92.8% and *Stomoxys*=7.2%). Flies mean density and Shannon-Weaver indices were as follows: *Glossina morsitans submorsitans* (0.55f/t and 0.23), *Glossina*

tachinoides (0.13f/t and 0.10), *Tabanus* (0.51f/t and 0.18) *Stomoxys* (0.10 f/t and 0.03). Based on density/biodiversity with season the following trend in the capture of hematophagous flies was observed: *Glossina morsitans submorsitans* had peak diversity and density at the beginning of rainy season (March and April) (Figure 2). *Glossina tachinoides* was highly distributed and dense at the end of dry season (January) (Figure 3) and declined during heavy rains (May and June). Tabanids had a steady trend in the majority of trapping periods with sharp peaks witnessed during the rainy season (June) (Figure 4). Stable fly (*Stomoxys*) were not captured in a majority of months but peak values were noticed in May in the capture sites (Figure 5).

Based on monthly frequency of flies, it was observed that most of them were most frequent in the month of June and least frequent in the month of December. The most encountered fly-type as revealed by identification was as follows: *Tabanus* >>>>> *Glossina morsitans submorsitans* male >>>> *Glossina morsitans submorsitans* female >>> *Glossina tachinoides* male >> *Stomoxys* > *Glossina tachinoides* female (Figure 6). It was noticed with the glossines that more males were caught than females. Based on habitat distribution, *Glossina* of *morsitans submorsitans* group (savannah-habitat) was frequent than *tachinoides* group (riverine-habitat).

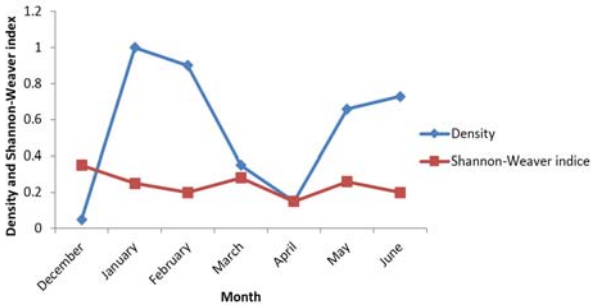


Fig 2: Monthly (year 2014-2015) density and Shannon-Weaver indices of *G. morsitans submorsitans*

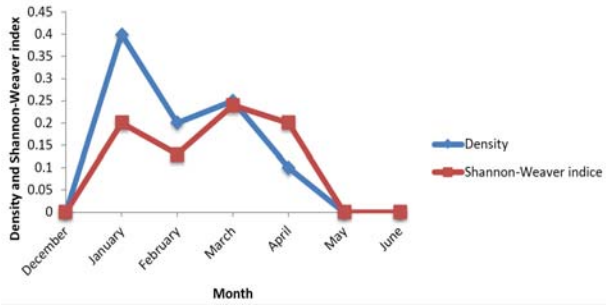


Fig 3: Monthly (year 2014-2015) density and Shannon-Weaver indices of *G. tachinoides*

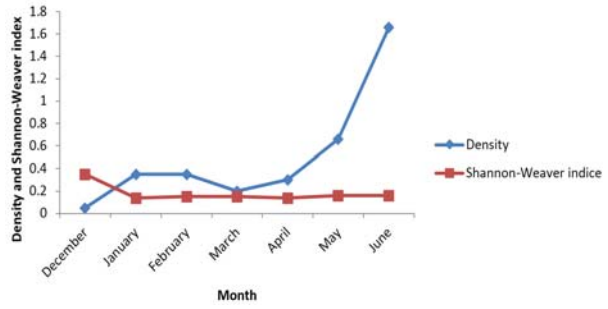


Fig 4: Monthly (year 2014-2015) density and Shannon-Weaver indices of *Tabanus* spp.

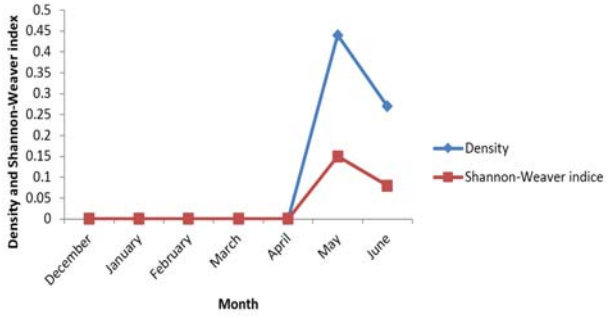
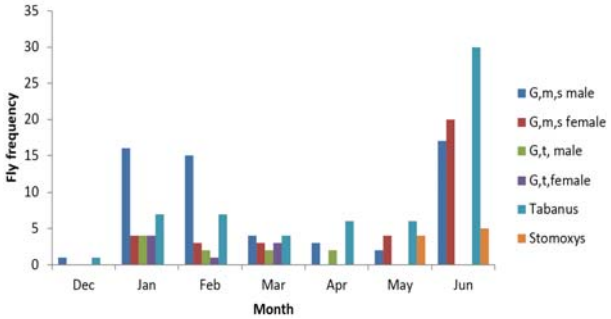


Fig 5: Monthly (year 2014-2015) density and Shannon-Weaver indices of *Stomoxys* spp.



G, m, s: *Glossina morsitans submorsitans*, G, t: *Glossina tachinoides*

Fig 6: Monthly (year 2014-2015) Frequency of flies in the livestock/wildlife agro ecological interface-Alme

Discussion

The abundance of species varies according to season and more importantly, according to habitat-type [15]. However, the monthly ecodiversity and density of *Glossina* spp. was bimodal for this species as follows: *Glossina morsitans submorsitans* with peaks at the end of the dry season (January) and beginning of rainy season (May). Also, *Glossina tachinoides* had a bimodal pattern with peak at end of dry season (January) and beginning of rainy season (March). This result corroborates with that of [6] in the same study area. This was due to conducive climatic conditions and a suitable habitat for the flies in the months of January, March and May. Also high peaks of *Glossina* spp during the dry season could also be explained by the permanent presence of wild animals in the course of this season which contribute a source of blood meal [16] around the Alme zone. Moreover, scanty *Glossina morsitans* of 58 flies during the present survey is less than 1007 recorded by [6]. Also, scanty catch of *Glossina tachinoides* of 39 in our present study was greater than 23 for this species reported by same author in preliminary study in this same study area. The prominent less *Glossina morsitans submorsitans* catch in our present survey as compared to preliminary data is due to presence of control barriers (Deltamethrin impregnated screens and increase knowledge of pour-on formulation application) introduced densely into this area. Also trap number (n=10) and type (Laveissière) in the present study was small as compared to 23 traps used in the preliminary study. In addition, present human encroachment into this area has led to habitat destruction of these potential vectors of trypanosomiasis hence leading to a huge reduction in their population density.

Based on monthly distribution of flies captured in the livestock/wildlife interface of Adamawa, flies were most frequent in the month of June and least frequent in the month of December. This result corroborates with that of [17] who recorded high frequency/percentage of tabanids in June/July in

the Texas Rolling Plains. In addition, sex frequency of *Glossina* revealed that female was more frequent in the collection than males. This finding agrees with that of [18] but disagrees with that of [19] who recorded rather a high number of females than males in his collection. This can be justified by the fact that males were more attracted to the blue biconical Laveissière trap than females, since Laveissière trap was the only censor-tool used. The diversity and density of genus *Tabanus* was also season-dependent. Their monthly distribution pattern was unimodal with peak in the month of June that is in the rainy season. This result is in consonance with that obtained by the following authors- [20] and [21] who reported that in tropics, fly populations often reach a peak towards the beginning of the rainy season with decrease in population witnessed in the dry season but not often completely disappearing. This peak is suggested to be partly due to rainfall. This peak can also be due to erratic behavior of this species in search of a nutritive host [22]. This genus *Tabanus* was the most abundant. This result is similar to that obtained by [23]; [15] and [14], but disagrees with that of [24] who rather recorded highest fly catch with genus *Stomoxys* in their purposive survey for *Tabanids* and *Stomoxys* using the Nzi trap.

Considering *Stomoxys* (Stable fly), the abundance and diversity of this species varied with season with a unimodal pattern. Basically, high populations of this fly-type was recorded during the rainy season (May). High abundance observed in the rainy season corroborates with results of the following authors: [14] and [25] who reported that this species have a strong affinity for humid zones. This result was again similar to that obtained by [26] and [27] who showed that *Stomoxys* are usually abundant during the rainy season.

Highest diversity and density of *Tabanus* in our present study is of medico-veterinary importance. Tabanids are mechanical and biological vectors of certain haemo-parasitic diseases such as trypanosomiasis and filariasis especially *Chrysops* spp which is a vector of loaloa filariasis [28]. Their presence as vectors in high numbers is of public health concern. This is a problem because no study has been carried out in this region in order to assess the risk of transmission of loasis and other diseases by this fly.

Conclusion

We recall that diversity is a concept that describes the composition of a community in terms of the number of species present and some factor that weight the relative evenness of distribution of each species. Only two species of *Glossina* were caught that is G. *morsitans submorsitans* and G. *tachinoides.* Seasonal/monthly distribution of *Glossina morsitans submorsitans* and *Glossina tachinoides* were bimodal with peak population densities recorded in the months of January, March and May. Other biting flies caught were of the genus *Tabanus* and *Stomoxys*. *Tabanus* was the most abundant of all flies in the whole survey. *Tabanus* and *Stomoxys* showing a unimodal distribution pattern across seasons with high population density peaks in the rainy season (June and May respectively). Fly diversity and density in the controlled-Alme village is in a rise to levels which are threatening to reach the diversity index in the Faro Game Reserve (uncontrolled area). This is due to diurnal visits of cattle from Alme village in FGR in search of pasture and end up carrying the vectors back home (confirmed by many cattle herders upon interview). Also the diversity index of other biting flies (*Stomoxys* and *Tabanus*) in Alme is alarming and should be a call for public health concern. Bio-control approaches such as Sterile Insect Technique (S.I.T.) is needed to bring fly density in Faro Game Reserve and around (Alme) to a bay. A high density of screens, replenished at high concentrations in the rainy season (June) should be broadcasted between the uncontrolled and formerly controlled infested interface. Herders in Alme should not allow their cattle to graze and browse around Faro Game Reserve.

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