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# First Inventory of Non-Biting and Bitting Muscids of North Cameroon

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## Abstract

*Information about species-types, abundance, distribution and diversity of muscids in the Sora Mboum area of North Cameroon is lacking. This present survey seeks to determine species-types, abundance, distribution and diversity of biting and non-biting muscids in 03 ecological zones (Rao, Mbele (Vina) and Syrien Campsite) in this area in order to fill this gap. A line transect survey using unbaited Vavoua (N=15) and Biconical (N=15) traps, displayed in a 10x3 (i.e. 10 traps per each of the 3 sites) with 5:5 ratio of both traps in each plot. Traps were emptied every evening (5:30pm). Overall flies catch was 1609 and 1501 muscids were captured, identified and classified into the following taxonomic taxa i.e. two genera: Musca (non-biting) 783 (52.17%) and Stomoxys (biting) 718 (47.83%). At the species level, Musca domestica Linnaeaus 1758; 783 (52.17%) was the only Musca species identified and 04 Stomoxys species were identified in different proportions-Stomoxys calcitrans Linnaeaus, 1758; 372 (24.78%), S. niger niger Macquart, 1851; 193 (12.86%), S. niger bilineatus Grünberg, 1906; 109 (7.26%) and S. sitiens Rondani,* 1873; *44(2.93%) Musca domestica was highly distributed, followed by S. calcitrans and lastly by S. sitiens. Glossines (108) were also captured and identified into- Glossina tachinoides 87(80.56%) and Glossina morsitans submorsitans 21 (19.44%). Fly species were highly diversified and frequent in Mbele (Vina), followed by Syrien Campsite and rare in Rao. Vavoua was the trap of choice for the capture of most species than Biconical. Musca and Stomoxys caused the highest annoyance around farms in Sora Mboum of North Cameroon and their control efforts will reduce this direct effect and indirectly lead to the complete management of the diseases they transmit.*

**Keywords**: Muscids, identification, Abundance, Distribution, Diversity, Sora Mboum, North Cameroon.

## Introduction

Stomoxes or Stable flies are biting insects whose both sexes are bloodsucking[1,2]. They form a subfamily with well-defined morphological/behavioral characters[3,4]. Their body size measures between 3 to 10mm in length and resembles the house fly (*Musca domestica* Linnaeus, 1758) in appearance but possesses a buccal piece (proboscis) pointing forward in the axis of the body and is capable of piercing the skin of animals or humans. Their body is slightly hairy and dull in color and the abdomen is grey to yellowish with irregular dark spots[5].

This diptera is faced with the issue of interrupted blood meal where they change host during the same meal. This characteristic of blood sucking pests makes them potential vectors of pathogens with potentially serious epidemiological consequences for animals and humans[6,3]. Indeed, stable flies cause significant economic losses in stock farming, by their direct pathogenic effects (weight loss and milk production, reduced immune defenses), or their role in the transmission of pathogens (viruses, bacteria, protozoa and helminths), and because of the costs of the anti-stomoxes fight[7,8]. In the US, the economic losses inflicted by stable flies on livestock industry were evaluated between 100 and 400 million USD per year[9,10]. The indirect effect of these flies is the transmission of pathogens of medico-veterinary importance[11]. The importance of biting flies in the epidemiology of stock and human diseases is neglected but is a necessary subject if control interventions need to be efficient.

In Africa few studies have focused only on the following ecological aspects of muscids especially *Stomoxys* spp and includes-detailed identification of *Stomoxys* spp, blood meal sources[12] and population genetics[13]. Despite the importance of genus *Stomoxys*, no comprehensive work on this group has been done when we make references to the working systematic review of Zumpt[3]. However, most information relating to the biology of these insects comes from studies of *S. calcitrans* and

*S. niger niger* Macquart, 1851[2,14-18]. More recently, a preliminary study conducted by Masmeatathip[4] described the ecology of some species of *Stomoxys* of Thailand. In Gabon, the information on stomoxes comes from the work of Mavoungou[19] who reported that the presence of seven species and or subspecies: *S. inornatus*, *S. transvittatus*, *S. xanthomelas*, *S. omega*, *S. n. niger*, *S. niger bilineatus*, *S. calcitrans*[19,20]. In the Southern Kaduna state of Nigeria, Ahmed et al.[21] identified 2 species of *Stomoxys* (*S. calcitrans* Linnaeus and *S. niger niger* Macquart) with other bitting flies. In Cameroon, few reports have been documented about these vectors, but the report of Sieumeni[22] about *Stomoxys* of Dodeo of the Adamaoua Plateau, revealed two species (*S. calcitrans* and *S. niger niger*) and others which were unidentified. In addition, the study of Sevidzem et al.[23] was on the ecodiversity of this fly species and others in the livestock/ wildlife interface of Adamaoua plateau and identified stomoxes in the infected zone of Adamaoua plateau. Stomoxines exists in forests and natural parks[12,23, 24] and can have a significant impact on tourist industry. This has been best documented in North West Florida[25], where swarms of stable flies have led to complete evacuation of beaches and tourist resorts[26].

The present investigation of these flies was grounded in Sora Mboum in the North region of Cameroon, which is host to two Private natural reserves owned by Germans, and studies around this area in the past were focused on Onchocerchiasis and its vectors (*Simulium damnosum s.l.*) around the 80s. A recent report in this area was made on bovine trypanosomosis and its vector (*Glossina* spp) by Mamoudou et al.[27]. *Stomoxys* spp have been reported as mechanical vectors of important trypanosomes of cattle[11] and data about their ecology will be necessary for the complete management of this important disease of cattle in this area. House flies follow cattle/farmers and farm visitors because of poor sanitary conditions and odour released from their bodies such annoying attitudes of theirs is worsen by the fact that they mechanically transmit pathogens of both humans and animals[28,29]. They are equally responsible for secondary contamination of exposed wounds caused by other bitting flies.

The natural protected areas of north Cameroon are visited by several foreign tourists as well as cattle that roam around to graze on available fresh pasture. Recent complaints made by forest guards and herders to researchers on the nuisance of some flies motivated us to put forward this study. Also, lack of data on identified *Stomoxys spp* and its ecological diversity and distribution in Cameroon stimulated us to embark on such a study in order to update on their information. This present study aimed at identifying bitting and non-biting muscids in the Sora Mboum area of North Cameroon, in order to provide baseline information for their future control efforts in this area.

## Materials and Methods

**Study area:** This inventory was carried out in Sora Mboum in the Mayo Rey Division of North Cameroon. Geographically, the study area falls within Latitude N 07. 76400 and Longitude E 014.99208. The whole study area measures upto 20Km (Figure-1)[30]. This area is a host to two protected areas (one around Rao and the other around Syrien Campsite) and is a pasture area favoured by river Vina and Rao with drinking water available all season for sedentary and semi-sedentary cattle herds. Based on weather**;** March is warmest with an average temperature of 36.1°C at noon. January is coldest with an average temperature of 15.9°C at night. Sora Mboum has no distinct temperature seasons, the temperature is relatively constant during the year. Temperatures usually drop sharply at night. In winter there may be some days it freezes; overall winters are mild in temperature, with the coldest month most often being January. December is on average the month with most sunshine. The wet season has a rainfall peak around August; dry season is around the month of December. Sora Mboum has a humid (> 0.65 p/pet) climate. The landscape is mostly covered with closed to open shrub land, elevated at an altitude of 545 meters. The climate is classified as a tropical savanna (winter dry season), with a tropical dry forest biozone. The soil in the area is high in lixisols (lx), soil with clay-enriched lower horizon, low cec, and high saturation of bases.

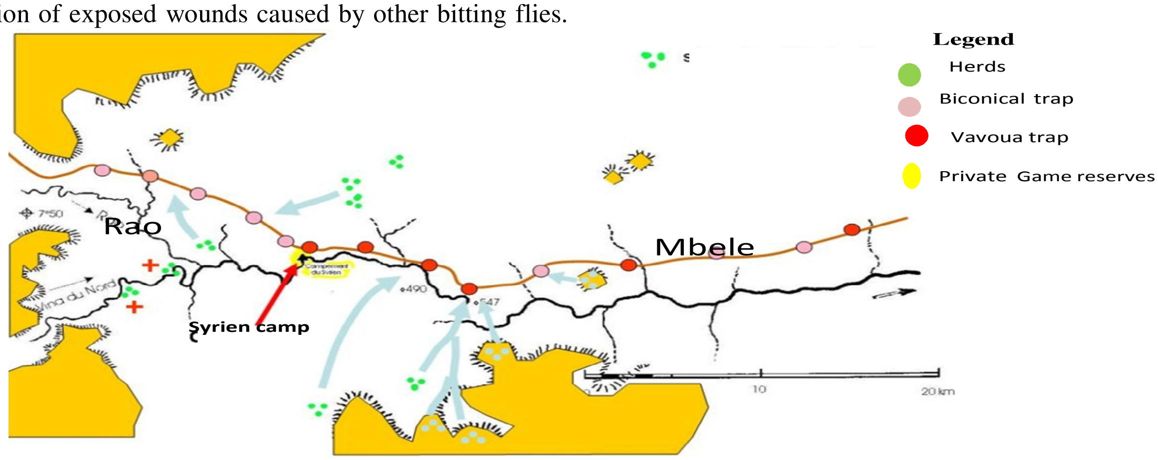


**Figure-1**
**Map of Sora Mboum, showing River Vina and Game reserves where traps were pitched for sampling, modified from Seidenfaden et al.[30]**

**Capture of flies:** A line transect survey was carried out around Syrien Campsite, on pasture along river Vina and Rao, using two trap-types Vavoua (N=15) and Biconical (N=15). The reason behind usage of more than one trap in a survey is that different traps may capture different numbers of individuals and species[31]. The most efficient traps for mechanical vectors are the Nzi (catches large numbers of tabanids and stomoxines), vavoua (catches tabanids and stomoxines in little numbers) and biconical traps for the capture of glossines[32]. It was important for us to appreciate the catches of various species using vavoua and biconical traps in order to confirm the acertion of Mihok et al.[31]. The line-trap-transect model was displayed to cover three sites namely Mbele, Rao and Syrien Camp, these sites are made up of savanna type vegetation, with tree shades around Rao, Mbele and not in Syrien Camp. The hydrographic network here in the study area is made up of Vina and Rao rivers, with confluence at the start of a Game reserve (Zone 27) located at Rao. The general topography of the area is plateau.

A mixture of the two traps in groups of tens was pitched on each site. All sites were closest to the private Game reserves. Traps in each site were maintained at 100-500m apart, based on the previous work of Mihok[33]. Traps were active in the morning from 8:00am till 5: 30pm when collection was made and the duration of capture was 7 days.

**Identification muscids and others:** *Stomoxys* were separated from *Musca domestica* using the aspect of presence of proboscis for *Stomoxys* and absence in *M. domestica*. Identification and differentiation of the various *Stomoxys* spp caught was according to the identification key developed by Zumpt[3] and to the new morphological criteria described by Garross et al.[16]. *Glossina* were also identified in the collection and this was identified upto species level based on habitat and morphological characteristics[34,35].

**Data Analysis:** Bar chats and line graph were constructed using Excel spread sheet program of Version Windows 2007. The condensed matrix was analysed by Correspondence Analysis (CA)[36] and completed by a Chi-square test to show the relationship between species and sampled sites/biotopes. Dendogram was used to classify the species captured in the study sites. All statistical tests were performed using Statictica 12.0 and R-statistical software of version 2.15.0 (R Development Core Team, 2012). The diversity index of muscids captured in each zone was computed using the diversity index of Margalef (I) as shown:

$$I = \frac{S-1}{\log N}$$

Where: "S" was the number of species and "N", the total number of individual's harvested [37] and "I" the diversity index.

## Results and Discussion

The present entomological prospection identified muscids (1501) in decreasing order of magnitude as such: genus *Musca* (N=1)-*Musca domestica* 783 (52.17%), genus *Stomoxys* (Geoffroy) (N=4) consisting of- *S. calcitrans* 372 (24.78%), *S. niger niger* 193 (12.86%) *S. niger bilineatus*109 (7.26), *S. sitiens* 44 (2.93). Others (108) identified in the collection were made up of *Glossina tachinoides* 87 (80.56%) and *Glossina morsitans submorsitans* 21(19.44%), resulting in the overall flies catch of 1609. Muscids were classified into non-biting 783 (52.17%) and biting 718 (47.83%) flies. *Musca domestica* was the only non-biting muscid identified while 04 *Stomoxys spp* were identified that stood for biting muscids (Table-1).

**Table-1**
**Non-biting and biting Muscids identified in the sampled sites**

| Muscids | Rao N (%) | Mbele N (%) | Camp Syrien N (%) | Total |
|---|---|---|---|---|
| Non-bitting<br>Genus : *Musca* | | | | |
| *Musca domestica* Linnaeaus, 1758 | 281 (18.72) | 271(18.05) | 231 (15.39) | 783(52.17) |
| Bitting<br>Genus : *Stomoxys* | | | | |
| *S. calcitrans* Linnaeaus, 1758 | 124 (8.26) | 105(6.99) | 143 (9.53) | 372 (24.78) |
| *S. niger niger*Macquart, 1851 | 84 (5.59) | 52 (3.46) | 57 (3.79) | 193 (12.86) |
| *S. niger bilineatus* Grünberg, 1906 | 45(2.99) | 39 (2.59) | 25 (1.67) | 109 (7.26) |
| *S. sitiens Rondani,* 1873 | 10 (0.67) | 12(0.79) | 22 (1.47) | 44(2.93) |
| Total | 544(36.24) | 479(31.74) | 478 (31.85) | 1501 (100) |

N, total number

Based on the mean fly numbers in the study area, all fly species showed significant mean differences in catches in the study area. *Musca domestica* recorded the highest number, followed by *S. calcitrans* and least was noticed with *S. sitiens* (Figure-2). The highest fly numbers with respect to site was recorded in decreasing order of magnitude as follows: Rao (579), Camp Syrien (524) and Mbele (506), while diversity of species according to the formula of Margalef in decreasing order of magnitude was recorded- Mbele (4.0), Camp Syrien (3.97) and Rao (3.86). It was observed that even though Mbele recorded the least number of species, species diversity here was highest and rare in Rao (Figure-3).

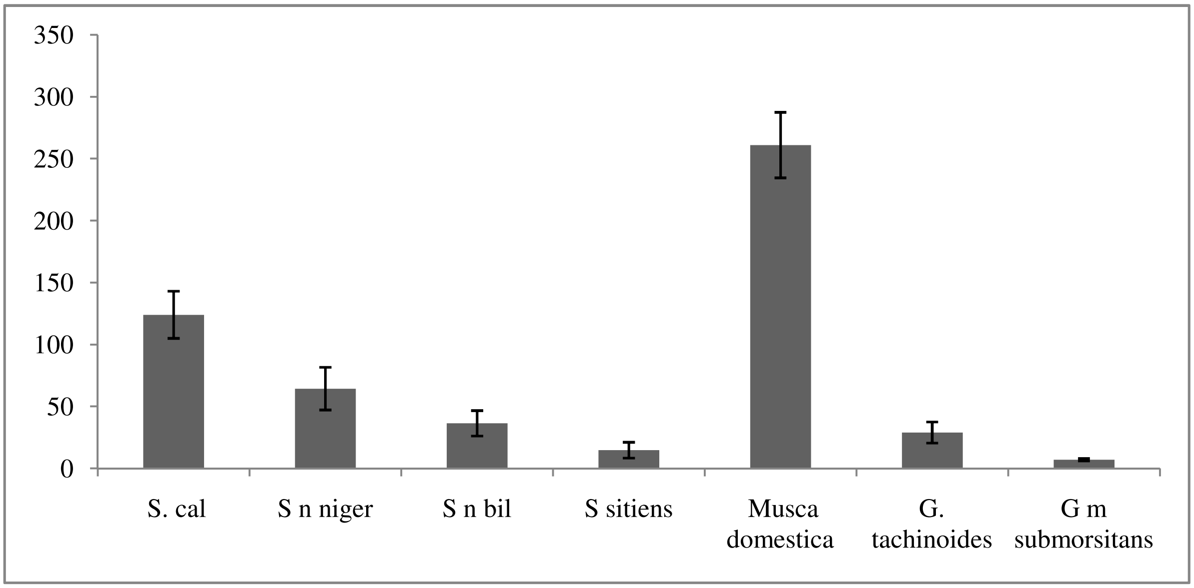


**Figure-2**
**Mean number of species captured in the study**

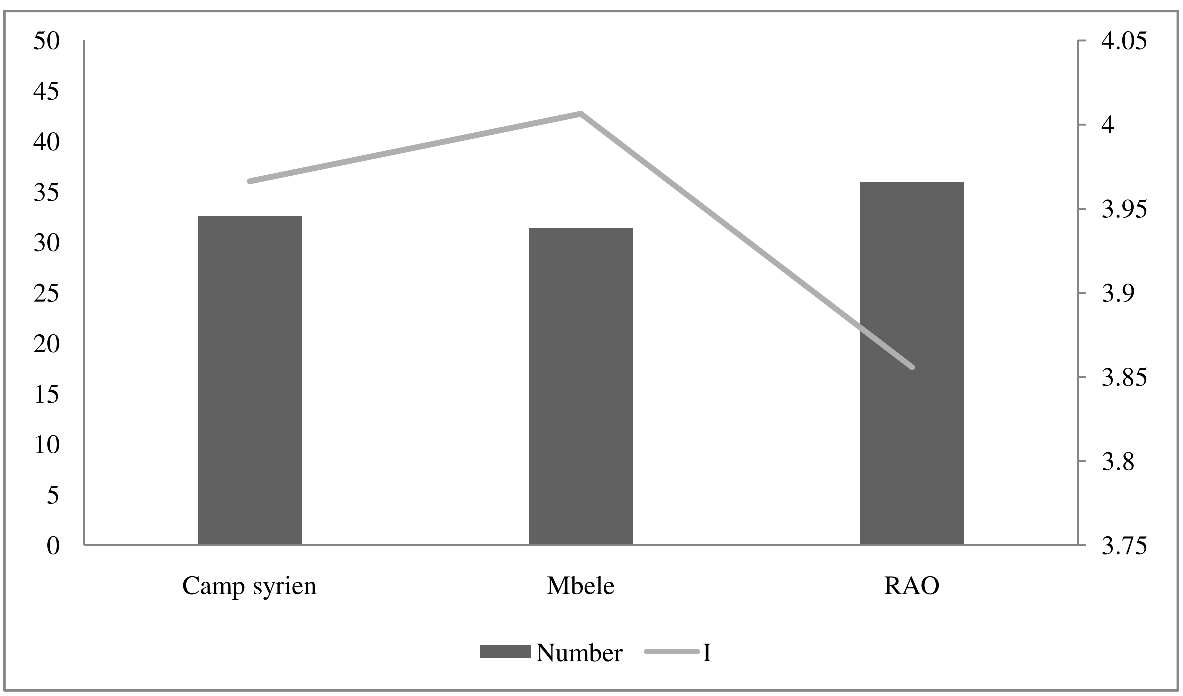


**Figure-3**
**Number and diversity of species captured, I, Index of Margalef**

The results of quantity of flies caught with respect to trap-type revealed that muscids and *Glossina tachinoides* were frequently collected with vavoua than biconical trap when trap catches were compared, but *Glossina morsitans submorsitans* recorded high catch with biconical trap and was the only (Figure-4).It was interesting to know from the same figure (Figure-4) that *S. niger bilineatus* recorded same catches with both traps.

**Hierarchical clustering:** The horizontal dendogram was constructed to classify species of flies caught according to different sites prospected and this resulted in two classes (Figure-5). Class 1 consisted of the following group-*S calcitrans*, *S. niger niger*, *S. niger bilineatus*, *S. sitiens*, *Glossina morsitans submorsitans* and *Glossina tachinoides* with an aggregation distance of 108. Class 2 consisted of *Musca domestica* and this second class joined with the first, resulting in an aggregation distance of 244.

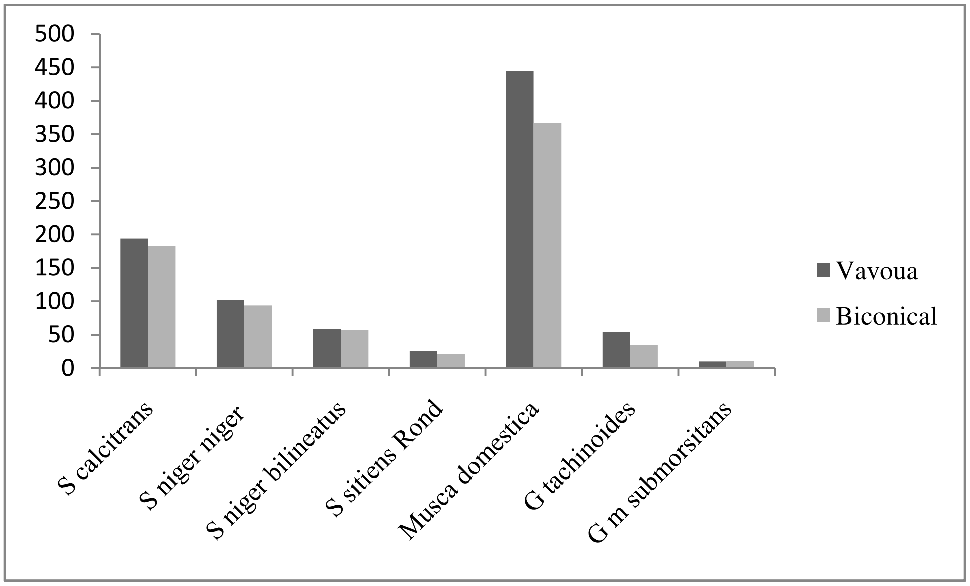


**Figure-4**
**Fly catches based on trap type**

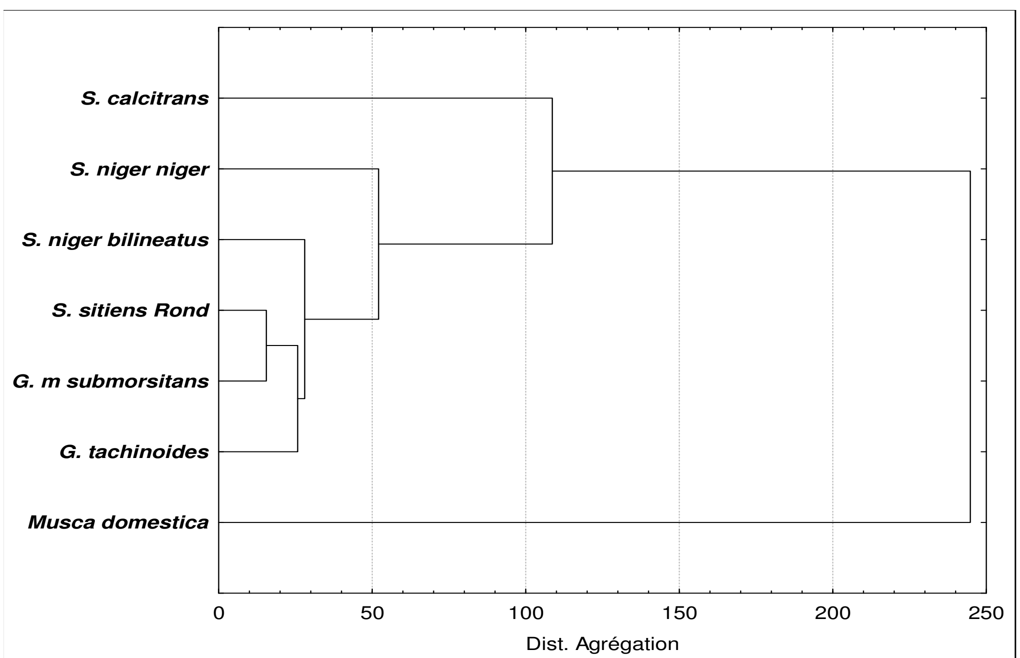


**Figure-5**
**Dendogram showing the classification of species based on aggregation distances**

**Correspondence analysis (CA) and Chi-square test:** A significant difference in the distribution of species of flies caught in the 3 sites prospected was observed ($X^2$=32.0095, dl=12, P=0.0014), factor correspondence analysis made with species locality matrices indicated that axis 1 expressed a high variability (axis 1=80.87%) while axis 2 expressed a low variability (axis 2=19.13%). The two axes were considered for analysis and interpretation of results (Figure-6). *Musca domestica* negatively correlated with axis 2 and was concentrated in Mbele; *Glossina morsitans submorsitans* and *S calcitrans* negatively correlated with axis 1 while *G tachinoides* negatively correlated with axis 2 and were found to be concentrated around the Syrien campsite. *S niger bilineatus* positively correlated with axis 1 while S *niger niger* correlated negatively with axis 2 and both species were concentrated around Rao.

**Discussion:** The results of this present preliminary entomological prospection in the north region of Cameroon was important than those obtained by Sevidzem et al.[23] in the Adamaoua plateau. Infact, a total of 1501 Muscidae were identified in the course of our study against the scanty record of 240 by Sevidzem et al.[23]. This difference can be due to the differences in landscape or biotopes prospected and by the number of trap number/types that were used in our study. Two types of traps were used consisting of 15 vavoua and 15 biconical traps against 10 biconical traps used by Sevidzem et al.[23] in Adamaoua. It is clear that high number and varieties of traps increase the chances of different fly-types-capture. From the results of quantity of flies caught with respect to trap-type, muscids and *Glossina tachinoides* were highly collected with vavoua than biconical trap when trap catches were compared, but *Glossina morsitans submorsitans* recorded highest catch with biconical trap and were the only. This finding is similar to that of Dia et al.[32] who reported that mechanical vectors such as tabanids and stomoxes are greatly captured by Nzi and vavoua as compared to biconical trap which is efficient for glossines. All stomoxines catches were high with vavoua trap; this is similar to the findings of Mihok et al.[31]; Gilles et al.[38] who reported that the vavoua trap was efficient in stomoxines capture. Also, this consensus agrees with the statement of Mihok et al.[31] that different traps may capture different numbers of individuals and species.

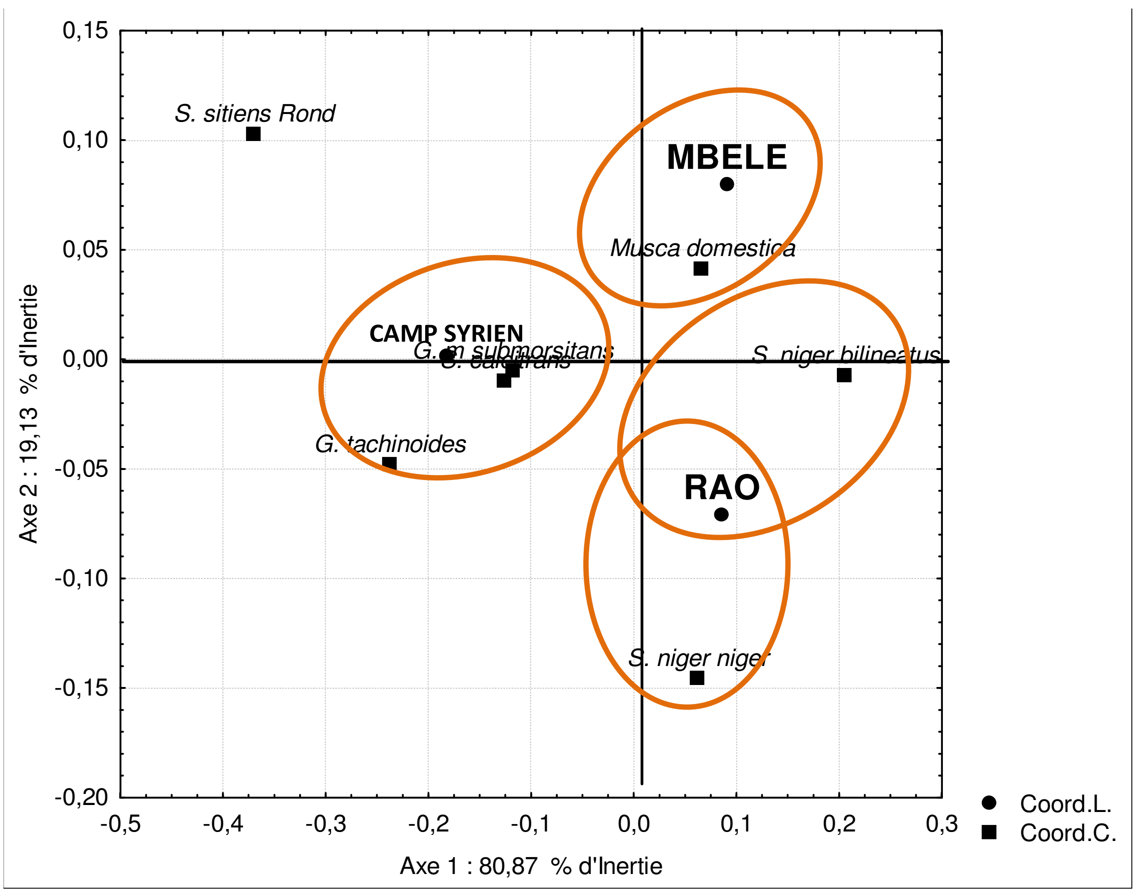


**Figure-6**
**Analysis of correspondence of species in each site of the study area**

The present survey recorded the following species of *Stomoxys* in the Soudano-sahelian zones of North Cameroon- *Stomoxys calcitrans, S. niger niger*, *S. niger bilineatus* and *S. sitiens,* reported for the first time in Cameroon, but most of them have already been reported in Gabon by Mavoungou et al.[12]. Zinga-koumba et al.[20] except *S. sitiens* which do not figure-out in their list. Indeed, *Stomoxys* spp from the ancient world includes 18 common species. While *Stomoxys calcitrans* (Linnaeus, 1758) is a cosmopolitan species, the other 17 are distributed in African and Asian regions. Indeed, four of them are of oriental origin that is-*S. indicus*, *S. Uruma*, *S. bengalensis, S. pullus* but *S. sitiens* is found in Africa and Asia. The other species are all African and includes: *S.varipes*, S. *chrosomus*, *S. inornatus*, *S. boueti*, *S. transvittatus*, *S. pallidus*, *S. luteolus*, *S. xanthomelas*, *S. omega*, *S. stigma*, *S. taeniata* and *S. niger*. In a large part of Africa, *S. n. niger* is the most common *Stomoxys* species in the Afrotropical Region[3], Uganda[39] and Tanzania[15]. It was introduced from Africa, Madagascar, La Réunion and Mauritius Island[3]. The variation in *Stomoxys* spp fauna in the various bio-geographical settings might be due to changes in ecological settings as we move from one country to the next, which is usually accompanied by the uneven repartition of species. Non-biting flies dominated in the present collection, when their proportions were compared with that of their bitting counter parts. This finding contradicts with that of Njila et al. [40] in a forest in Nigeria, who reported that bitting flies were more abundant than non-biting flies; this difference might be due to different ecological settings. This is because the study in Nigeria was realised in the forest while this present one was conducted in the savanna beside protected reserves and river courses. Muscids are anthropophilic and are seen beside animals and humans, it is known that bovidae constitutes a major preference for these flies especially *Musca domestica* which use cow droppings as breeding environments, but forest biting muscid and other species dominates in the forest because of their preference in biting wild animals as well as breed in their droppings. *Stomoxys calcitrans* was the most abundant and diversified of *Stomoxys* spp, this finding is in consonance with the report of Roungthip et al.[41]. Njila et al.[40] reported high abundance of this fly in their collection. This is because *Stomoxys calcitrans* is highly proliferative and is also a cosmopolitan species. Also, trap types and season/climatic conditions during the period of capture, favoured their high collection than other *Stomoxys* spp. *Musca domestica* commonly known as housefly dominated in the present collection and this is in consonance with the report of Howard[42] who identified highest number of this fly in his survey. This is because house flies breed in various types of excrement of different animals as well as in house foods. In addition to this report, Townsend[43] reported that adult house flies feed on all types of filth hence their ability to survive and maintain their populations in any given environment. The paucity of records about house flies from Western and African countries can be interpreted as owing to lack of collecting of this common domestic pest. The high collection of *Glossina tachinoides* than *Glossina morsitans submorsitans* in this present investigation was not unexpectant because this area is made of a network of rivers such as Rao and Vina in Mbele which are perfect breeding grounds for riverine (*Glossina tachinoides*) than savanna (*Glossina morsitans*) species even though trapping was not biased and number of traps distributed equally across riverine and savanna biotopes. This shows the high distribution of *Glossina tachinoides* and their implication in the transmission of diseases such as bovine trypanosomosis in Mayo Rey Division[27].

The analysis of correspondence supplemented with chi-square test, enabled the identification of some defined associations. However, it can be deduced that *G morsitans submorsitans*, *Glossina tachinoides* and *Stomoxys calcitrans* were specifically associated with Syrien Camp; S *n niger* and *S n bilineatus* were associated with Rao and *Musca domestica* was specifically associated with Mbele. *Stomoxys sitiens* did not show any specific association with site. However, it is known that *Stomoxys calcitrans* and *Musca domestica* were abundant and common in all sites and this can be likened to the fact that they are cosmopolitan species and develop in all environments. This site-species-correspondence was due to climatic conditions as well as biotope-type that favoured the differential repartition of various fly species in the three prospection sites.

Classification of flies based on dendogram, revealed that flies of this study area were classified into two classes namely class 1 which constituted of species of the genera *Stomoxys* and *Glossina* and class 2 was made up of only *Musca domestica*. From the above classification, only stomoxes were closer to glossines as compared to *Musca domestica* which is also a muscid like stomoxes, when their aggregation distances were considered. In addition, it can be highlighted from the analysis that biotopes of stomoxes and glossines overlap or they exist in sympatry as compared to *Musca domestica* whose biotopes were distant. This ecological aspect is important for their control. Based on species diversity with study sites, it was observed that species were diversed in Mbele and rare in Rao. Mbele is host to a private reserve and this protected area harbours wild beasts which are preferred hosts to the different haematophagous flies captured. In addition to preferred host, during sampling, cattle were always present around this area to drink water and graze on fresh pasture and these visits permitted flies to feed on them. Also, this area is made up of savanna vegetation and a river which act as biotopes to these flies. This shows that Mbele harbored rich muscids and glossines niches than other sites. The above characteristics of Mbele can also be applied to Rao except the fact that during the survey no cattle was found in Rao, reducing the flies around this area since there was no cattle to bite and feed on their blood by the flies. The Syrien Camp shared most of the environmental characteristics with Rao but for the fact that a lot of human activities take place here like farming, hunting and fishing and as the name depicts, it is a Camp where visitors stay. This man-made disturbance contributed to the escape of species to nearby protected reserves like zone 26 and 27 which served as safe haven for the flies hence reducing their populations around Camp Syrien.

## Conclusion

The species of muscids captured and identified for the first time in Cameroon include: non-biting group of genus *Musca*, with *Musca domestic* as the only species. *Stomoxys* spp (biting) were identified into - *Stomoxys calcitrans, S. niger niger*, *S. niger bilineatus* and *S. sitiens.* Biting flies were less represented in the present collection than non-biting flies. Mbele (Vina) represented the highest fly's diversity and annoyance zone in terms of highest record of biting and non-biting flies than other zones. Vavoua was the trap of choice in muscids catch than biconical trap which rather caught highest number of *Glossina morsitans submorsitans.* This annoyance is a potential nuisance for tourists, herders, stocks and farmers who visit private protected reserves as well as farm around this area. Control of these fly-populations to reduce their burden will indirectly reduce the prevalence of diseases transmitted by these flies to both animals and humans.

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