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Abundance and Seasonal Distribution of Tsetse Flies (*Glossina* Species) In Three Divisions of Adamaoua Region, Cameroon

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Abstract: *Tsetse flies constitute one of the major constraints for livestock and agricultural production in sub-Saharan Africa because of their ability to transmit trypanosomosis to human beings and animals. Within the framework to plan suitable and sustainable measures for trypanosomosis control and prevention, a study on abundance and seasonal distribution of tsetse flies was conducted from October 2014 to September 2015 in three divisions of the Adamaoua region. The survey of Glossina species was carried out through biconical traps setting and the captured insects were identified using binocular optical microscope. In results, 6 tsetse fly species including Glossina fuscipes congolense, G. f. fuscipes, G. fusca, G. m. morsitans, G. p. palpalis and G. tachinoides were identified in Faro & Deo division with high APD in Dodeo locality for G. f. congolense (22.01 flies/trap/day and G. m. morsitans (20.8 flies/trap/day), while only 3 fly species were collected in each division Djerem (Glossina. f. congolense, G. fusca and G. tabaniformis) and Vina (G. m. morsitans, G. p. palpalis and G. tachinoides). In the 3 divisions, the majority of tsetse flies caught were male compared to female. All tsetse flies captured were abundantly during the rainy season (from April to October) compared to dry season (from November to March). Thus, this present study raises alarm for intervention within the framework to reduce density of Glossina species in these 3 important cattle breeding zones of the region through trypanosomosis and vectors control programmes.*

Keywords*: Glossina species, Vectors, Seasonal distribution, Cattle, Adamaoua region*

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I. Introduction

From their earliest days, insects have annoyed human and animals with their bites and sickness through the parasites they transmitted to them. The vectors of AAT including tsetse flies and other biting flies (Tabanids and Stomoxes) constitute a big constraint of the livestock production in sub-Saharan of Africa [1]. These blood-sucking insects cause major economic losses in agriculture both by direct damage to livestock and as a result of the veterinary diseases, such as the various trypanosomiases, that they transmit. In 37 Sub-Saharan African countries, the biological vectors tsetse flies infested about 10 million km^2 area in which about 47 million cattle are at risk to contract the disease [2][3]. The economic losses due to the vectors and trypanosomes in infested African regions are estimated up to 1.3 billion dollar annually [3]. In addition, US$30 million losses as expenditure on about 35 million doses of trypanocides per year are recorded [4].

To face the problem, the government of Cameroon created in 1974, a specialized Special Mission for the Eradication of Tsetse (SMET) for Adamaoua and North regions of the country and charged for tsetse vector suppression by spraying lands with DDT (dichloro-diphenyl-trichlorethane) [5]. However, despite the control efforts, tsetse-cleared areas of the regions continued to be reinvade with *Glossina* species and others biting insects [6]. From the reinfection land established, effective control of tsetse flies through two aerial spraying campaigns (in 1991–1992 and 1994) were conducted and accompanied with a barrier consisting of targets and traps set [7]. Besides, targets and traps are destroyed by bush fires and replaced by a programme of insecticide treatments of cattle. Preliminary investigation of the tsetse control activities in the Adamaoua region showed that the eradication campaign was not completely effective since *Glossina* species such as *G. m. submorsitans* and *G. f. fuscipes* had survived [7]. As evidenced by a tsetse survey in 1988, re-infestation of previously cleared fly areas occurs regularly [8]. Previous studies carried out in the 3 Divisions of the Adamaoua region indicated a low trypanosomiasis prevalence and incidence [8][9][10][11]. But, the maintaining of that cattle disease could be linked to the presence of whether to mechanical vectors or both biological and mechanical vectors. Although several investigation on AAT parasite prevalence and its vectors tsetse flies were reported

[12][13][14][15][16][17][18], but, there is a lack of knowledge on the effective distribution of tsetse flies in several breeding areas, which constitutes an obstacle for animal production in the region. The distribution of tsetse flies and the risk evaluation of the trypanosomose in Cameroon are not yet totally established. The present investigation aimed to determine tsetse flies distribution in the Djerem, Vina and Faro & Deo Division of the Adamaoua region of Cameroon.

II. Materials and Methods

2.1 Study area

Located in the northern part of Cameroon, Adamaoua region covers more than 72,000 km^2 with an altitude of 1000-1100 m above sea level and an average rainfall of 1800 mm. The region is a savannah covered with more than 90% of *Lophira lanceolate* and *Daniellia olivera* plant species [19]. Intensive cattle breeding is very suitable in the environment rearing and the zebu cattle (white-red Fulani and Goudali) are kept under traditional extensive and communal husbandry systems. Transhumance is frequent in the dry season and many cattle herds move from the tsetse-free zones to the tsetse infested areas. The present study was conducted from October 2014 to September 2015 in 3 Divisions of Adamaoua region of Cameroon including Djerem, Faro & Deo and Vina Divisions (Figure 1). In each Division, 3 localities were selected based on the density of cattle and the complaining of farmers about the AAT vectors.

The Faro & Deo division, which covers 10,435 km^2, counts 74,559 head of cattle and has 67,000 inhabitants in 2005 [20]. Djerem division is an area about 13 284 Km^2 located in the southern part of the region. The soudano-guinean climate has two seasons with an annual rainfall of 1600 mm. Animal breeding is significant in the zone and the cattle population is estimated about 100,000 heads for a population of 100,000 people [21]. Vina division covers 4000 km^2 including Centre and north-East of Adamaoua region. The bovine breeding constitutes the main activity with cattle population in this area estimated around 70 000 heads for a population de 30 000 inhabitants [21].

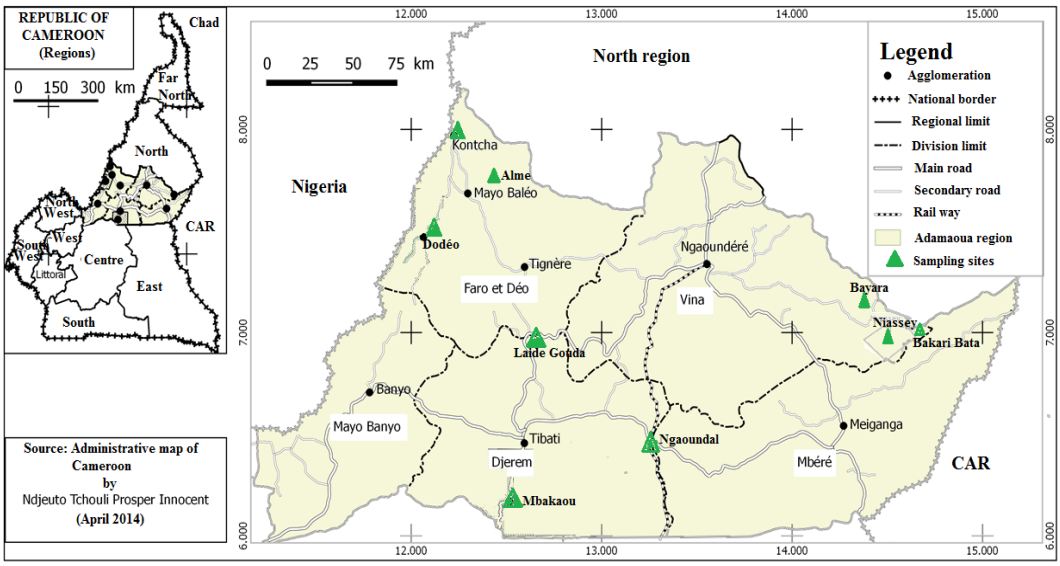


Figure 1. Map of the Adamaoua region showing the study sites

2.2 Entomological monitoring of tsetse flies

The vectors of AAT were captured using 54 biconical traps (Figure 2A) [22] geo-referenced 100 m interval [23]. Indeed in each Division, 18 biconical traps were set with 6 in each of 3 localities selected in the Division. Every day of the 5 consecutive days, flies were collected from the traps [22]. Insects collected were identified (Figure 2B) in the laboratory of Special Mission for Tsetse fly Eradication in Ngaoundéré (Cameroon) using optical microscope following the identification keys described by CIRDES [24]. The different apparent densities (APD) were calculated using following formula:

$$APD = \frac{\text{number } of \text{ insects captured}}{\text{number of traps} \times \text{number of days}}$$

Figure 2. Setting of biconical trap (A) and identification of flies under optical microscope (B)

2.3 Statistical analysis

Data were organized and APD were calculated using Microsoft Excel 10. Statistical Package for the Social Sciences (SPSS) Version 16.0 software was used to determine frequencies and Chi-square test was applied to compare proportions. Results were appreciated significant at $P<0.05$. Graphs were designed using Microsoft Excel 10 software.

III. Results

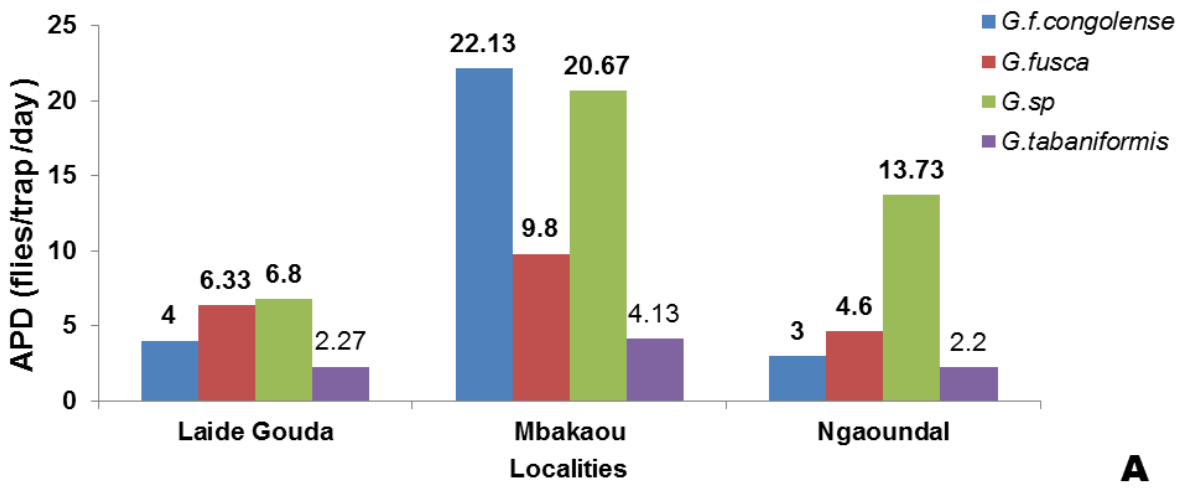
3.1 Distribution of tsetse flies in different localities of each division of the Adamaoua region

Figure 4 presents the diversity and abundance of tsetse flies captured in the localities of each division of Adamaoua region of Cameroon during period from October 2014 to September 2015. During twelve months of study, 4718 tsetse flies were captured with 45 biconical traps set in different localities of each division of the region. The abundance of tsetse flies species significantly varied between Djerem, Vina and Faro & Deo divisions and within localities of each division.

In the Djerem division, 1495 tsetse flies were collected and identified. Different *Glossina* species after identification included *Glossina. f. congolense, G. fusca, G. tabaniformis* and others *G. sp* not identified. In the localities of the division, The area of Mbakaou was the most populated with *Glossina* species and *G. f. congolense* (APD=22.13 fly/trap/day) and *G. sp* (APD=20.67 fly/trap/day) were the most abundant compared to other tsetse fly species captured. Laide Gouda and Ngaoundal localities of the division are also abundantly populated with other unidentified *G. sp* representing APD of 6.8 and 22.13 flies/trap/day, respectively.

In the Vina division, tsetse fly species caught and identified were *G. m. morsitans, G. p. palpalis*, *G. tachinoides* and other unidentified *G. sp*. In this division, Bakari Bata and Nyassey localities were the most infested with tsetse fly species and *G. m. morsitans* was the most present representing APD of 14.4 and 19.6 flies/trap/day, respectively.

In the Faro & Deo division, the population of tsetse fly was largely diversified in species. In this division, 6 tsetse fly species including *Glossina fuscipes congolense, G. f. fuscipes, G. fusca, G. m. morsitans, G. p. palpalis* and *G. tachinoides* were indentified. These *Glossina* species were most populated in Dodeo area compared to other localities. In this locality (Dodeo), tsetse fly species *G. f. congolense* and *G. m. morsitans* were densely represented with APD of 22.01 and 20.8 flies/trap/day, respectively.



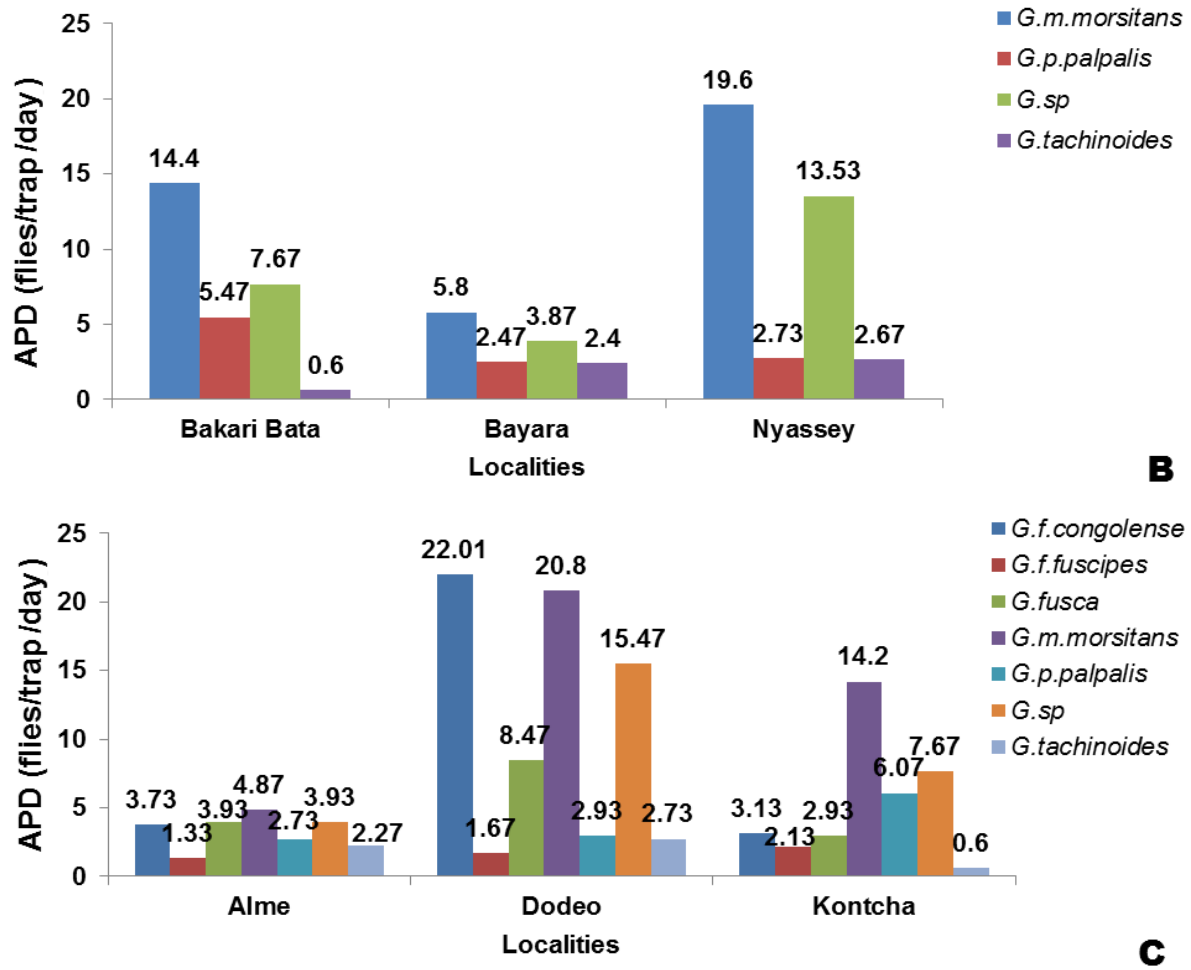


Figure 4. Apparent densities (APD) of tsetse flies captured in the localities of each division of Adamaoua region. A= Djerem division; B= Vina division and C= Faro & Deo division.

3.2 Distribution of tsetse flies per sex in each division of the Adamaoua region

Table 1 presents the distribution and abundance of tsetse flies species per sex captured during 12 months using biconical traps in Djerem, Faro & Deo and Vina divisions of the Adamaoua region of Cameroon. During the 12 months of study in the region and in each division, the majority of tsetse flies caught were male compared to female. Within the 1495 *Glossina* species captured in the Djerem division, 904 (60.5%) were male while 591(39.7%) were females. In the Faro & Deo, among 2005 tsetse flies caught, up to 59.3% (1188 flies) were males compared to 40.7% (817 flies) females collected. Among 1218 *Glossina* species captured during the study in the Vina division, the population of tsetse flies caught was dominated with males (60.4%) while females represent 39.6% of *Glossina* species collected during the study period.

The tsetse fly species *Glossina morsitans morsitans* was the most abundant in the Faro & Deo (598 tsetse flies) and Vina divisions (597 tsetse flies) in which males represent 356(59.5%) and 364(61%), respectively. Apart *Glossina* sp, tsetse species *Glossina fuscipes congolense* (437 flies) was the most abundant and males of that species represent 59.3% compared to females (40.7%).

Table 1. Abundance of tsetse flies species per sex captured in the three divisions of Adamaoua region.

Divsions	Tsetse species	Sexe		Total flies
		Female	Male	
Djerem	*Glossina fuscipes congolense*	178(40.70%)	259(59.3%)	437
	Glossina fusca	122(39.2%)	189(60.8%)	311
	Glossina sp	254(41.1%)	364(58.9%)	618
	Glossina tabaniformis	37(28.7%)	92(71.3%)	129
	Total flies	**591(39.5%)**	**904(60.5%)**	**1495**
Faro & Deo	*Glossina fuscipes congolense*	178(41%)	256(59%)	434
	Glossina fuscipes fuscipes	35(45.5%)	42(54.5%)	77
	Glossina fusca	94(40.9%)	136(59.1%)	230
	Glossina morsitans morsitans	242(40.5%)	356(59.5%)	598

	Glossina palpalis palpalis	71(40.3%)	105(59.7%)	176
	Glossina sp	164(40.4%)	242(59.6%)	406
	Glossina tachinoides	33(39.3%)	51(60.7%)	84
	Total flies	**817(40.7%)**	**1188(59.3%)**	**2005**
Vina	*Glossina morsitans morsitans*	233(39%)	364(61%)	597
	Glossina palpalis palpalis	64(40%)	96(60%)	160
	G.sp	157(41.8%)	219(58.2%)	376
	Glossina tachinoides	28(32.9%)	57(67.1%)	85
	Total flies	**482(39.6%)**	**736(60.4%)**	**1218**

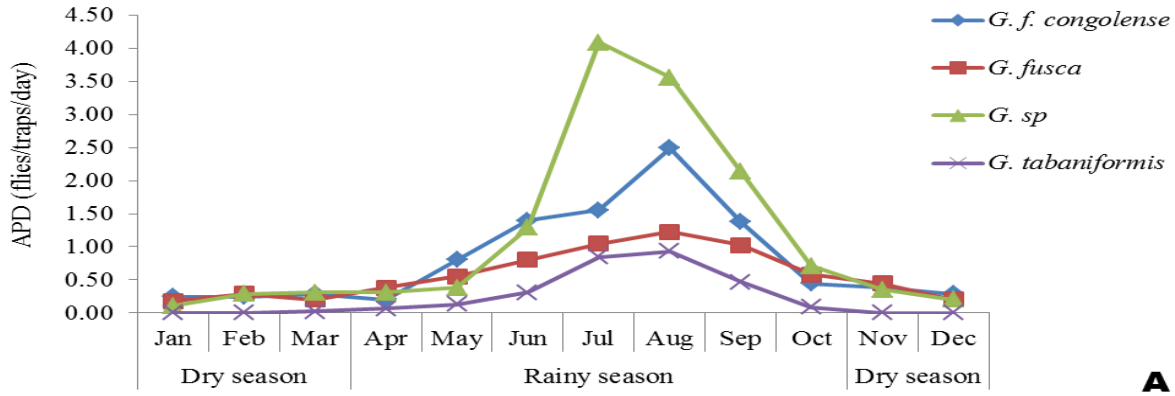
3.2 Distribution of tsetse flies per month (season) in each division of the Adamaoua region

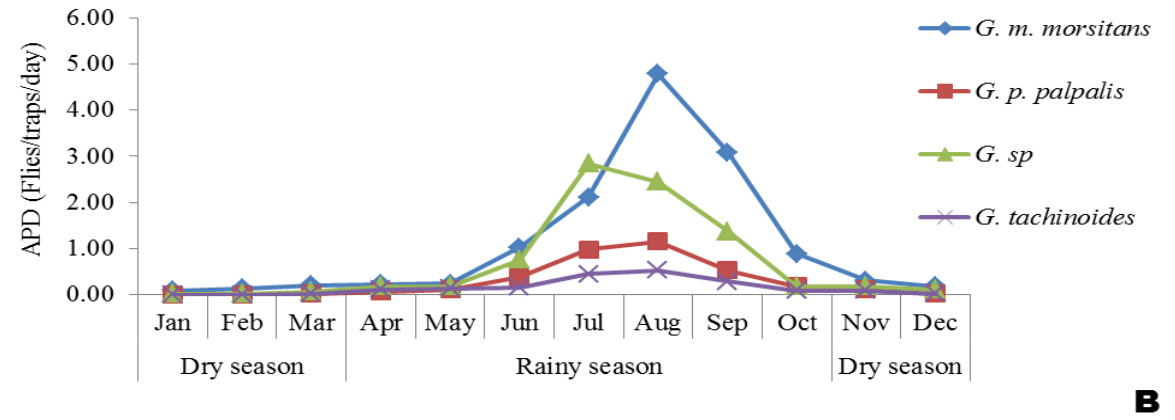
Figure 5 presents the monthly distribution and abundance of tsetse flies captured in the Djerem, Vina and Faro & Deo Divisions of Adamaoua region from October 2014 to September 2015. Globally, the population of tsetse flies significantly varied alongside the year study. All tsetse flies captured were abundantly during the rainy (from April to October) season compared to dry season (from November to March).

In the Djerem Division, tsetse fly species significantly (χ^2=120.87; df=33; P<0.00001) varied within months. During the rainy season, *G. f. congolense* was the most populated followed by *G. fusca* and *G. tabaniformis* with a maximum APD of 2.49, 1.22 and 0.93 flies/traps/day, respectively recorded during the month of August. In that Division, the apparent density of the unidentified tsetse fly species (APD=4.09 flies/traps/day) was also high in the month of July.

In the Vina Division, tsetse fly species significantly (χ^2=82.20; df=33; P<0.0001) varied within months. *G. m. morsitans* tsetse fly species was the most populated (APD=4.78 flies/traps/day) in the month of August followed by *G. p. palpalis* (APD=1.16 fly/traps/day) and *G. tachinoides* (APD=0.53 flies/traps/day). The APD of the unidentified *Glossina* species (APD=2.44 flies/traps/day) was also significant in the month of July.

The Faro & Deo Division was the richest in term of tsetse fly species (6 species identified) and these fly species were significantly (χ^2=183.76; df=66; P<0.00001) present in the rainy season. In this Division and especially in the month of August, *G. m. morsitans* (APD=4.96 flies/traps/day) was the most populated followed by *G. f. congolense* (APD=2.89 flies/traps/day), *G. p. palpalis* (APD=1.49 fly/traps/day), *G. fusca* (APD=1.36 fly/traps/day) *G. f. fuscipes* (APD=0.56 fly/traps/day) and *G. tachinoides* (APD=0.53 flies/traps/day). The unidentified tsetse fly species (APD=3.22 flies/traps/day) were also densely present but in the month of July.





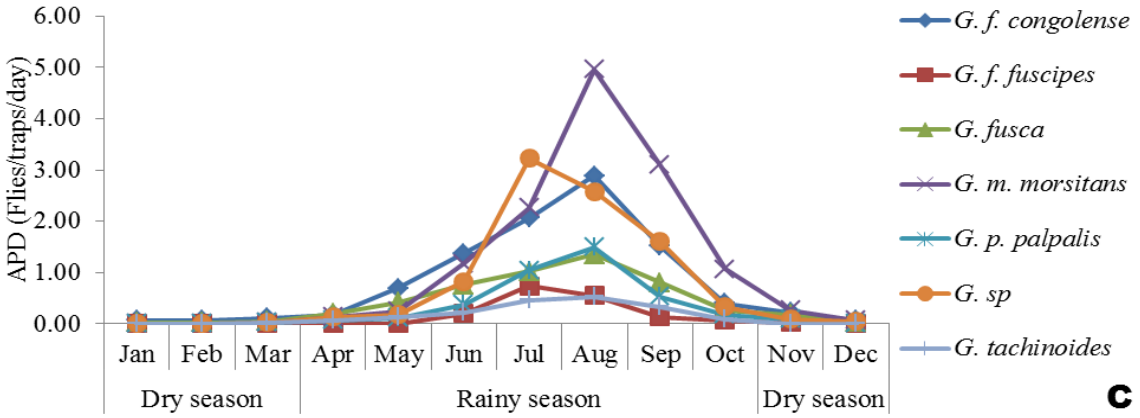


Figure 5. Distribution of tsetse flies captured per month in the localities of each division of Adamaoua region. A= Djerem division; B= Vina division and C= Faro & Deo division.

IV. Discussion

Results from this present investigation showed a significant diversity on tsetse fly species, a variation in flies' sex and on a seasonal abundance of *Glossina* species within localities of each Division of Adamaoua region of Cameroon. In this study, tsetse fly species varied significantly between localities and Dodeo in the Faro & Deo Division was the most invaded with the flies. Study conducted from November 2014 to July 2016 in three localities around the Mbam and Djerem National Park presented a significant difference in the distribution of *Glossina palpalis* spp species between Betare-Oya and Yoko localities [25]

Variation on diversity and abundance of tsetse fly species within the localities in each Division may be explained by the structure and landscape able to create to these insects, a favorable particular microhabitat. This variation may also be linked to the combination of miscellaneous factors such as climate, vegetable density and the presence of hosts for blood feeding [26][27]. Previous studies highlighted also that the combination of many factors such as vegetation density and the presence of nutrient hosts could explain the high density of tsetse flies in any specific area [26][27] [28].

In this present investigation, the majority of tsetse flies caught were male. Similarly in Nigeria, male tsetse fly catches (309, 61.6%) were significantly ($P<0.05$) higher than females (193, 38.4%) [29]. Among 6161 adults of *G. f. fuscipes* captured in the study conducted in South Sudan, 3394 (55.09%) were females and 2767 (44.91%) were males [30]. A seasonal variation in the monthly sex ratio with higher proportions of females during the wet season (April to October) than in the dry season (November to March) was reported from Nigeria by Madubunyi [31]. The high percentage of male than the females in trap catches observed in this present study may be attributed to high fly activity for searching food and mating partner.

In the Adamaoua region of Cameroon, apparent density of tsetse flies was reported higher during the wet season instead of dry season [32]. From the middle of rainy season (August), Tongue et al. [33] observed a high abundance of *Glossina fuscipes fuscipes, G. morsitans submorsitans* and *G. fusca* in Dodeo basin. Similarly, study conducted in Tanzania by Nnko et al. [34] on tsetse fly species showed monthly changes in abundance with most of the flies (G. *swynnertoni* and *G. m. morsitans*) collected in July. In Zambia, the index of apparent density of tsetse fly (*G. m. morsitans*) increased in the beginning of the rainy season in November to reach peak at the end of that wet season in April in Miombo [35]. In contrary to this present result, Lukaw et al. [30] reported a significantly high catches of flies in dry season than that of the wet season in South Sudan. In Kogo (Equatorial Guinea), the apparent density of *G. p. palpalis* clearly fell from 1.23 fly/trap/day in July (rainy season) to 0.27 in December (dry season) [36]. This variation in seasonal abundance of tsetse flies population could be linked to the effect of optimum temperature on the normal physiological activity of tsetse flies during seasons in each agro-ecological zone.

V. Conclusion

In this present study, 6 tsetse fly species including *Glossina fuscipes congolense, G. f. fuscipes, G. fusca, G. m. morsitans, G. p. palpalis* and *G. tachinoides* were identified in Faro & Deo division with high APD in Dodeo locality for *G. f. congolense* (22.01 flies/trap/day) and *G. m. morsitans* (20.8 flies/trap/day), while only 3 tsetse fly species were collected in each division including Djerem (*Glossina. f. congolense, G. fusca* and *G. tabaniformis*) and Vina (*G. m. morsitans, G. p. palpalis* and *G. tachinoides*). Overall, the majority of tsetse flies caught were male compared to female. All tsetse flies were significantly captured in high proportion during the rainy (from April to October) season compared to dry season (from November to March). Thus, the reduction of

Glossina species density in these 3 important zones of cattle breeding of the region is required through suitable and sustainable trypanosomosis and vectors control programmes.

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