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High Frequency and Activity of *Glossina* spp., Vectors of Human African Trypanosomiasis along a Secondary Forest-Man Made Transect in Makokou (North East-Gabon)

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AOJM, SSL, ZKCR, MF and JFM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors AOJM, SSL and MF managed the analyses of the study. Authors ZKCR, RMN, KAA, MF, AYGL, MB and SSL managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The abundance, species diversity and diurnal activity rhythm of hematophagous glossineswere evaluated by trapping using 15 Vavoua traps, during the rainy season (25th Sept-5th Oct to 21st Oct-9th Nov 2018), in two habitats: secondary forest and Anthropised milieu, in the biosphere reserve Ipassa-IRET Makokou in Gabon. In total, 489 glossines were caught with 245 collected from

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Village-Town site and regrouped under 4 species [*G.p.palpalis* (32.17%), *G. frezili* (36.23%), *G. nashi* (29.57%) and *G. f. fuscipes* (2.03%)] while 244 were collected from forest and regrouped under 3 species [*G.p.palpalis* (61.48%), *G. nashi* (28.69%) and *G. frezili (*0.84%)]. The abundance of glossines was higher in the Village-Town milieu (2.88 g/t/d) as compared to the forest (2.34 g/t/d) with no statistically significant difference (P>0.05). Glossines showed a unimodal diurnal activity rhythm with peak between 10h-12h in the two milieu and was dominated by females.

Keywords: Hematophagous flies; park; reserve; Vavoua traps; biotope; rainy season; Gabon.

1. INTRODUCTION

Human African Trypanosomiasis (HAT) or sleeping sickness is a disease caused by flagellated protozoans of the genus *Trypanosoma* [1] precisely members of the *Trypanosoma brucei* complex. It is spread by the bite of infected male and female dipterous insect of the genus *Glossina* Wiedemann, 1830 [1] during blood meal. The HAT affects 70 million people living in 1.55 million Km^2 of sub-Saharan Africa [2]. Sleeping sickness mostly affects people living in remote areas with highest exposure to tsetse bites [3,4,5].

In Gabon, inventories on the species composition, abundance and diversity of vectors of HAT in protected areas and its environs have been documented [6,7,8,9,10]. Little information exists on infection rates of glossines with human and bovine trypanosomes in Gabon [11,12,13].

According to Foil and Gorham [14]; Solano et al. [15]; Darchen [16], the main drivers responsible for the peak occurrence of tsetse flies in a milieu include ambient temperature (25°C), relative humidity and high host density. The diurnal activity trend of tsetse point toward showing the time of the day that tsetse is most abundant. This bionomic trait has been examined for some *Glossina* spp. in Gabon [17]. However, such reports did not consider sex of glossines in establishing daytime activity. The present survey aimed at determining the current abundance of glossines and their daily activity profile with respect to sex in a wildlife-human interface.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Makokou, located in the Ogooué-Ivindo province in North-East Gabon. Trapping was carried out at the Institute of Research for Tropical Ecology (IRET) of Ipassa (0°.51'N; 12° 79'E) and its environs (0°.52'N; 12° 82'E) (Fig. 1), elevated at an altitude of 500 m [18]. The climate is of the equatorial and humid type with alternating rainy and dry seasons. The mean annual rainfall is 1 600 to 1 800 mm while the mean annual temperatures are close to 24°C. The annual and daily thermal amplitudes are weak [19] and the main water body in the area is river Ivindo. The entomological prospection was carried out during the rainy season (25^{th} Sept-5^{th} Oct to 21^{st} Oct-9^{th} Nov 2018). The forest fauna of Gabon is rich and diversified and the Makokou region holds a significant share with one of the highest listed fauna in Gabon. It consists of 128 species of mammals, 424 species of birds, 65 species of reptiles, 47 species of amphibians among others [19].

2.2 Capture of Glossines

Trapping was carried out using 15 Vavoua traps [20]. The Vavoua traps have been reported to be efficient in the collection of glossines [5]. Traps were set along a transect of about 17 km, following the anthropogenic gradient from the secondary forest in the Ivindo National Park (non-anthropized environment), to village and Makokou town (highly anthropized environment). Trapping interval was three months (25^{th} Sept-5^{th} Oct to 21^{st} Oct-9^{th} Nov 2018). The 15 traps were divided into the two study areas, at a ratio of 7-8 traps per milieu. Trapping effort was: 15 traps × 30 days = 450 traps days. The traps were activated in the morning at 8 am and emptied at 6 pm. All trap cages were tagged with the trap number and date and returned to the laboratory. They were then placed in a freezer for 15 minutes to kill the insect prior identification. Identification was carried out using the dissecting microscope (LABOMED®, France) of the field station laboratory of IRET-Ipassa in Makokou.

2.3 Daily Activity Rhythm

The diurnal activity pattern of glossines in the study area was carried out for three days consecutively using three Vavoua traps pitched

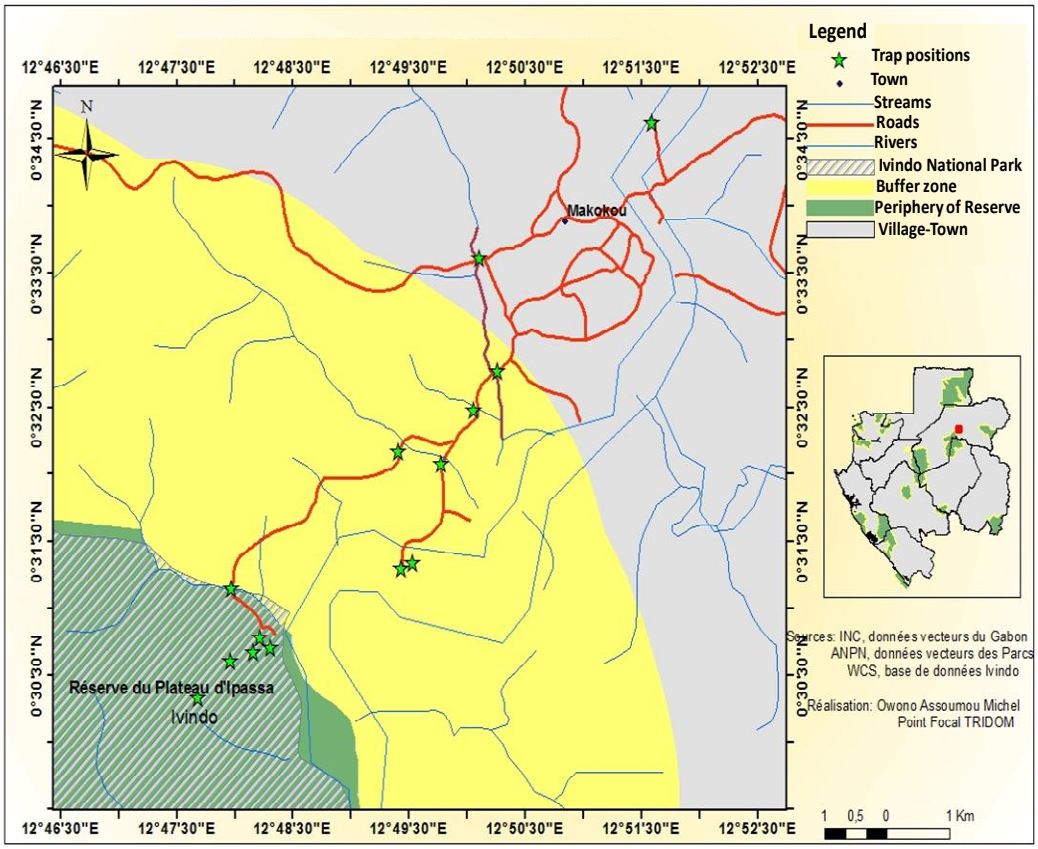

Fig. 1. Map of the study area showing trap positions (green stars)

in each of the two habitats during prospection days. The follow-up diurnal time ranges for this trial was 8-10H, 10-12H, 12-14H, 14-16H and 16-18H. Trap-tags consisted of date, location and time interval.

2.4 Fly Identification

Tsetse fly identification was carried out using the identification key of Pollock [21]. The sex of glossines was determined following the descriptions in the identification software by Brunhes et al. [22].

The abundance was defined by the Trap Apparent Density (ADT) known as the number of tsetse flies caught per trap and day:

$$\mathrm{ADT} = \frac{\text{Number of tsetse flies captured}}{\text{Number of traps} \times \text{Number of trapping days}}$$

2.5 Data Analysis

The statistical analysis was carried out using SPSS version 20. The one-way ANOVA on ranks was used to compare the ADT in the two prospection biotopes. The level significance was set at $P<0.05$.

3. RESTULTS

3.1 Species Composition of Glossines

In total, 589 glossines were caught with 345 collected in the Village-Town trapping sites and 244 at the INP trap-sites. Four species of tsetse flies were recorded in the Village-Town sites while three species were identified at the INP. The population of tsetse flies in the two habitats prospected was dominated by females (Table 1). *G. frezili* was the most dominant species in the Village-Town trap-sites while *G. palpalis palpalis* was rather most dominant in trap-sites of the INP (Table 1).

3.2 Trap Apparent Density of Glossines with Respect to Prospected Sites

At the Village-Town trap-sites, *Glossina frezili* (ADT=1.04) was the most abundant species, followed by *Glossina palpalis palpalis*

(ADT=0.93) and Glossina nashi (DAP = 0.85) (Fig. 2A). However, *Glossina fuscipes fuscipes* was rare with ADT less than 0.5. At the INP, *Glossina palpalis palpalis* was the most abundant species with ADT of 1.43. However, *Glossina nashi* and *Glossina frezili* were scantily caught with 0.69 and 023 ADTs respectively (Fig. 2B). However, the ADT of tsetse flies in Town-Village (ADT = 2.88) was slightly greater than that at the INP (ADT = 2.34) with no statistically significant difference (P>0.05) in ADT of tsetse flies between the two prospected sites.

Table 1. Species composition of *Glossina* with respect to site and sex

Biotope	Genus	Species	Male	Female	Number	%
Village-Town	*Glossina* (N=4)	*Glossina p. palpalis* (Robineau-Desvoidy, 1830)	30	81	111	32.17
		Glossina frezili (Gouteux, 1987)	27	98	125	36.23
		Glossina nashi (Potts 1955)	29	73	102	29.57
		G f. fuscipes (Newstead, 1911)	1	6	7	2.03
Total			**87**	**258**	**345**	**100**
INP	*Glossina* (N=3)	*Glossina p. palpalis* (Robineau-Desvoidy, 1830)	37	113	150	61.48
		Glossina nashi (Potts, 1955)	9	63	70	28.69
		Glossina frezili (Gouteux, 1987)	5	19	24	9.84
Total			**51**	**195**	**244**	**100**

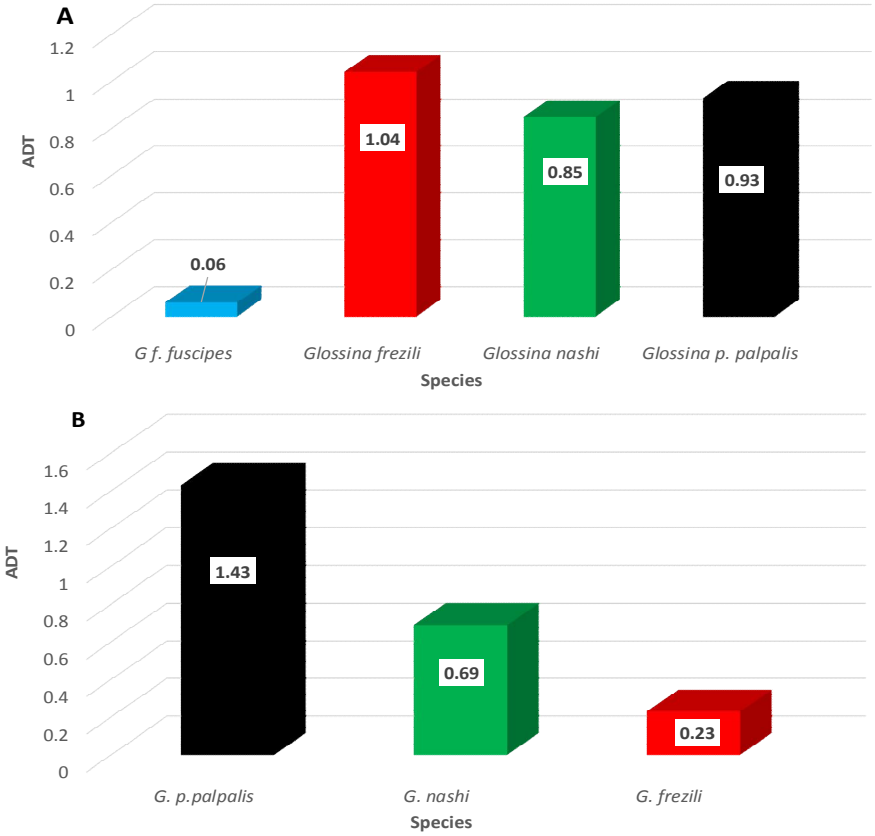

Fig. 2. Apparent density of the species of glossines
A: Village-Town; B: INP

3.3 Day Time Activity Rhythm of Glossines

In the Village-Town trap-sites, tsetse flies daily activity varied according to sex. Indeed, in *Glossina palpalis palpalis*, there were two peaks of activity, one between 8 and 10 h and a second between 10 and 12 h. However, in females of this same species, the daily activity presented a unimodal activity peak between 12 and 14 h (Fig. 3A). In *Glossina nashi* and *Glossina fuscipes fuscipes*, only females showed activity peaks between 8 to10 h and 10 to 12 h (Fig. 3A). In the forest, only the females of *Glossina palpalis palpalis* and *Glossina nashi* showed activity peaks observed between 12 to14 h and 10 to 12 h respectively (Fig. 3B).

4. DISCUSSION

The ADT of tsetse flies obtained in our study was barely greater than one. This ADT was higher than that obtained by Mbang Nguema et al. [23] and like that obtained by Batu et al. [24]. This difference in the ADTs in the different studies could be related to different periods or seasons of prospection. Indeed, the present study was carried out during the short rainy season (September to November), while the work of MbangNguema et al. [23] was in the rainy season (May 2015). Similarly, the study by Mamoudou et al. [25] showed that the ADT of glossines was higher in the early dry season but in the Soudano-Guinean climate.

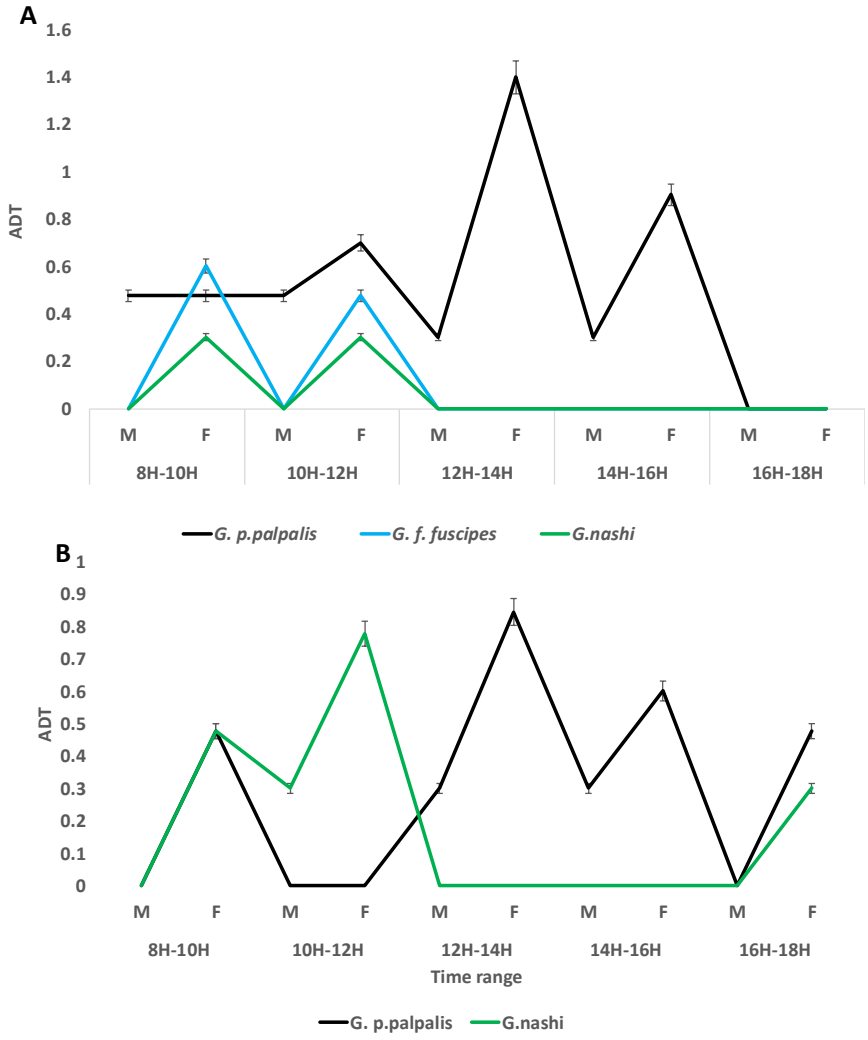

Fig. 3. Daily activity rhythm of glossines in the prospected sites
A: Village-Town; B: INP

The specific composition of glossines with respect to sex in the prospection sites showed that the females were highly caught than their male counterparts. This result corroborates with that of other authors [23,25].

According to Foil and Gorham [14]; Solamo et al. [15]; Darchen [16], high presence of glossines in a given environment is conditioned by an ambient temperature (250C), relative humidity and high vertebrate host density. These factors were present in both study sites since traps were set at the edges of streams which represented natural habitats of some species of glossines (*Glossina palpalis palpalis*, *Glossina tachinoides* etc). It was noticed that rivers were highly frequented by the locals for laundry, drinking, swimming etc. Similarly, wild animals were sometimes seen in adjacent villages especially around rivers. The high presence of vertebrate hosts at such points permits high tsetse-host contact. The high presence of glossines in the villages closest to the INP was contrary to the report of Zinga et al. [26] which showed that glossines were more abundant in the forest than in the man-made environment. This difference could be explained by different periods of prospection in the different studies as well as the high number of traps set in the Village sites as compared to the sites at the INP.

The abundance peaks of *Glossina palpalis palpalis* species (8-10 h) obtained in the present study was like that reported by Zinga et al. [26] at the Ivindo National Park (INP). This similitude in peak activity time period of glossines could be related to the optimal values of the meteorological variables (temperature and relative humidity) that favoured their activity and prevailed during this diurnal time range as compared to the other time ranges. However, in the present survey, female *Glossina palpalis palpalis* presented a unimodal activity between 8 and 10 h and was like that reported by Mounioko et al. [17] for glossines collected at the Moukalaba Doudou National Park.

5. CONCLUSION

Four *Glossina* spp. were caught at the Village-Town trap-sites and three out of the four were identified at the INP. *Glossina palpalis palpalis* and *G. frezili* were the most frequent tsetse flies in the prospected sites. At the Village-Town, peak activity of *G. palpalis palpalis* was unimodal and occurred between 12 to 14h while that of *G. fuscipes fuscipes* and *G. nashi* was bimodal and occurred between 8 to 10 h and 10-12 h. At the INP, *G. palpalis palpalis* (10-12 h) and *G. nashi* (12-14 h) presented a unimodal activity peak. All activity peaks of the tsetse species identified in the prospected habitats was dominated by females.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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