

ARTICLE

# Apparent Densities of *Stomoxys* Species (Diptera, Muscidae) of Different Physiological Ages Caught with Vavoua Trap Differ With Landscape and Trapping Period

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ABSTRACT

Stable flies (*Stomoxys* spp.) are common pests of livestock in the peri-urban rangelands of Vina Division of the Adamawa Plateau. No documented information is available on their diurnal dynamics in relation to physiological age and landscape. The main aim of this study was to determine the trap apparent density (ADT) of *Stomoxys* and associate it to their diurnal activity rhythm and landscape. Vavoua traps (n=12) were used for *Stomoxys* collection. Trapping was carried out for seven days *i.e.* three days consecutively in August and four days consecutively in October, 2016. Three traps were pitched in each of the three biotopes (river, cattle corral and gallery forest) of the four study sites (Galim, Mbidjoro, Velambai and Soukourwo). All female *Stomoxys* captured underwent ovarian dissection for the determination of their physiological ages (parous or nulliparous). A total of 218 *Stomoxys* were caught and identified into four species (*S. niger niger*, *S. omega*, *S. calcitrans*, and *S. xanthomelas*) with an overall ADT of 2.59 flies per trap per day and *Stomoxys niger niger* (1.13 *s.n.n.* per trap per day) recorded the highest ADT. Species richness was study site dependent. Higher catches of females 113 (51.83%) were made than that of their male 105 (48.17%) counterparts. Galim recorded the highest *Stomoxys* apparent density (4.90) as compared to other sites with a statistically significant difference ( $P < 0.05$ ). The proportion of parous 87 (59.30%) was higher than that of their nulliparous 46 (40.71%) counterparts. Parity differed with landscape and capture periods. *S. n. niger* was the most frequent in all biotopes and Galim recorded the highest ADT. The population of female flies was made up of adults (parous) with a bimodal diurnal activity rhythm whereas males had a unimodal activity rhythm.

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## 1. Introduction

Stable flies (*Stomoxys* spp.) are symbiotic pests of economic importance in sub-Saharan Africa [1-3]. They are biting muscoids whose cosmopolitan nature is imparted by their ability to breed in different substrates [4,5]. Another special life trait of this group is that male and female are haematophagous with major blood meal hosts being domestic and wild counterparts [6], but occasionally attack humans. Their high densities in rangelands [7-11] do not only cause irritation and production losses but transmit several dangerous diseases [11,12] to their hosts. The report of Charlwood and Lopes [13] showed that male and nulliparous *S. calcitrans* had an M-shape diurnal bimodal activity pattern as compared to parous female whose activity was dominant in the late afternoon.

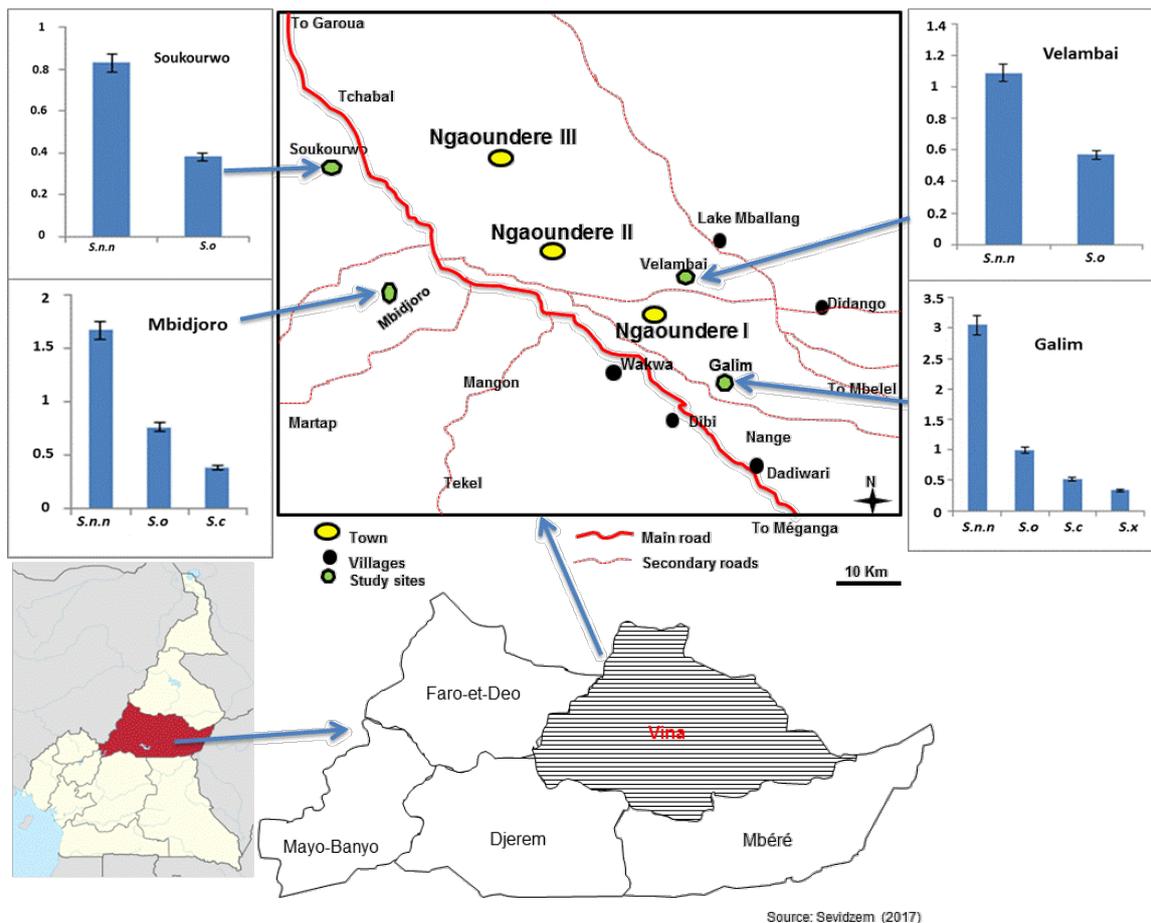
Till present, little knowledge exists on the correlation of age structure of stable flies to landscape and their diurnal biting activity pattern. However, the study of Charlwood and Sama [14], Charlwood and Lopes [13] only

focused on the correlation of sex with time ranges and ovarian developmental stages of *S. calcitrans* and *S. n. niger*. The present study was designed to determine the apparent densities of *Stomoxys* species of different physiological ages and correlate it with landscape and day time ranges.

## 2. Materials and Methods

### 2.1 Study Area

The present study was carried out in the Vina Division of the Adamawa plateau of Cameroon in August and October, 2016. The study sites consisted of Galim (07° 11, 971' north and 013° 34, 951' east), Mbidjoro (07° 21 378' north, 013° 32 695' east), Velambai (07° 18 457' north, 013° 41 934' east) and Soukourwo (07° 31 282' north, 013° 26 549' east) (Figure 1). The study sites were away from the town of Ngaoundere as such: Soukourwo (49km), Mbidjoro (15 km), Velambai (13Km) and Galim (25km) and the distance between sampling sites was approxi-



**Figure 1.** Map of the study area indicating the apparent densities (number of flies per trap per day) (ADT) of the *Stomoxys* species trapped in each study site (marked in green). S.n.n : *S. niger niger*; S.o: *S. omega*, S. c: *S. calcitrans*, S.x: *S. xanthomelas*

mately 50km. The area has a typical Soudano-Guinean climate. The vegetation of this region consists of gallery forests and savanna grasses used for grazing by livestock. Some of these grazing areas harbor natural niches of biting insects. Cattle are the most domesticated livestock in the region and are mostly kept under traditional extensive farming system.

## 2.2 Stomoxys Collection and Identification

Stomoxys were collected using Vavoua traps (n=12) [6]. Three traps were set in each biotope (river, gallery forest and animal corral) of the study sites and collection was made from 8 a.m to 6 p.m in two hours intervals (8:00-10:00, 10:00-12:00, 13:00-15:00, 16:00-18:00) for three days consecutively in August 2016 and four days consecutively in October 2016.

Stomoxys identification was carried out using the identification key of Zumpt [15]. Sex determination was carried out using the Frontal Index (FI) [16].

**Frontal Index = (Interocular space)/(Ocular length)**

Measurements made to estimate the FI were conducted using full fly on the dorsal side with the aid of a binocular microscope with magnification of 12.5 (Stemi 2000-C or Wild M5). The measured values were compared with those from four populations of Stomoxys by Garros *et al.* [17] and Masmeatathip *et al.* [16] as such: 0.37-0.4 (male) and 0.5-0.6 (female).

The trap apparent density (ADT) is defined as the number of Stomoxys caught per trap per day and presented mathematically as follows:

$$\text{Trap apparent density} = \frac{\text{Number of Stomoxys flies captured}}{\text{Number of traps} \times \text{Number of trapping days}}$$

## 2.3 Ovarian Dissection of Stomoxys for Physiological Age Determination

Females were placed in well labeled eppendorf tubes and kept frozen at -20°C prior to dissection. The tubes were labeled with date, time interval and biotope. Flies were dissected in Ringer's saline, the ovaries were examined, and their physiological age determined according to Scholl [18]. Scholl's method is based on whether follicular relics can be seen in stained (neutral red stain) or unstained ovaries: nulliparous (fly has not oviposited), follicular relics cannot be seen in either the unstained or stained ovary; for uniparous (fly has oviposited once), follicular relics cannot be seen in the unstained ovary, but can be seen in the stained ovary; while for biparous (fly has oviposited twice or more), follicular relics can be seen in the unstained ovary. The unstained approach was used to separate the nulliparous females from the parous.

## 2.4 Data Analysis

Data was analysed using the R statistical software (R version 3.4.0). The non-parametric Kruskal Wallis rank sum test was used to compare the number of Stomoxys collected with sites and sex. The same test was used to compare ADTs of *Stomoxys* spp. of different physiological ages with biotope. All the statistical tests were kept at  $P < 0.05$  significant level.

## 3. Results

The overall Vavoua trap apparent density was 2.59 Stomoxys per trap per day. The ADTs of the different species with site were as follows: Galim [*S. n. niger* (3.1), *S. omega* (0.9), *S. calcitrans* (0.4) and *S. xanthomelas* (0.2)]; Mbidjoro [*S. n. niger* (1.6), *S. omega* (1.0), *S. calcitrans* (0.3)]; Velambai [*S. n. niger* (1.0), *S. omega* (0.5)] and Soukourwo [*S. n. niger* (1.0), *S. omega* (0.4)] (Figure 1). Galim recorded highest ADT as compared to other prospected sites with a statistically significant difference ( $P < 0.05$ ). Higher numbers of male *S. n. niger* and *S. omega* were recorded that their female counterparts whereas higher numbers of female *S. calcitrans* and *S. xanthomelas* were rather trapped than males (Figure 2).

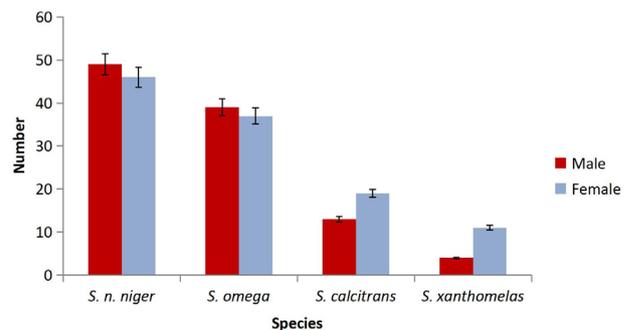


Figure 2. *Stomoxys* spp. collected with sex

The proportion of parous 87 (59.30%) was greater than nulliparous 46 (40.71%) and this disproportions were observed across sampled biotopes (Figure 3).

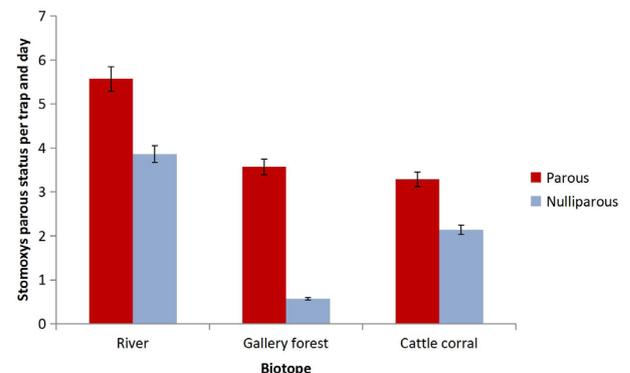
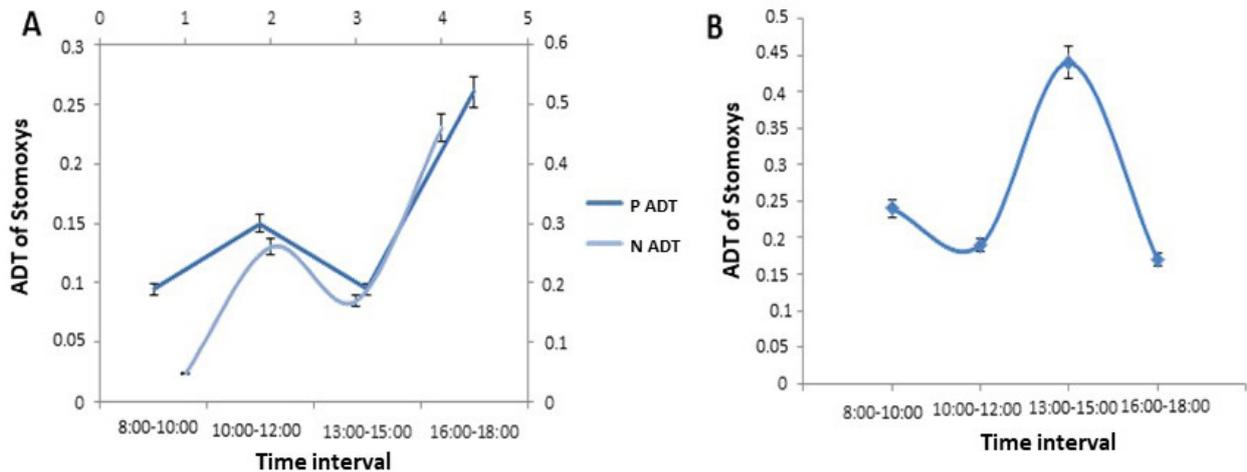


Figure 3. Composition of parous and nulliparous females with sampled biotopes



**Figure 4.** Stomoxys diurnal activity rhythm of female (A) [parous (P) and nulliparous (N)] and male (B)

From the plot of ADTs of the female of different ovarian status with time ranges, it was noticed that both parous and nulliparous females had a bimodal diurnal activity pattern occurring between 10:00-12:00 and 16:00-18:00 (Figure 4A). We rather observed a unimodal diurnal activity rhythm for males with peak occurring between 13:00-15:00 (Figure 4B).

#### 4. Discussion

The overall scanty catch of 218 Stomoxys was due to the limited number of trapping days as compared to the trapping duration in the previous studies. The vavoua trap is an efficient trap for collection of Stomoxys as revealed by other authors [6,7, 9,11,19,20].

The high ADT of Stomoxys in Galim was not surprising as the pasture area of this site is not regularly sprayed with insecticides to control flies but in the other sites, farmers frequently sprayed their animals with insecticides and anti-parasitic drugs [8]. *S. n. niger* was most abundant in all the prospected sites and this is similar to the finding of other authors [1,6, 9,10,11,19,21,22], but different from that of Mameatathip *et al.* [16] who rather reported *S. calcitrans* to be the most abundant in their collection in Thailand as well as that of Hiol *et al.* [20] in the forest of Littoral area of Cameroon with rather highest numbers of *S. omega*. From our past surveys in central African forests particularly in Cameroon and Gabon, we noticed highest numbers of *S. omega* compared to other species, whereas in savanna and anthropized environments, *S. n. niger* is rather dominant [9, 10, 11, 19, 21].

The highest frequency of *S. n. niger* in the present collection could be due to favourable environmental conditions, availability blood meal hosts, and low population of pests [23] for this species in the study area during our

prospection period. According to Zumpt [15], *S. n. niger* is the most widespread species in the savanna and humid tropical rainforests.

Higher number of female Stomoxys were parous as compared to their nulliparous counterparts. This implies that the area was infested by adult females. This finding is contrary to that of Gustave *et al.* [24] who rather recorded more nulliparous Stomoxys than parous. The present finding is similar to that of Taylor and Berkebile [25] who reported that blue/black cloth traps mostly caught older stable flies than nulliparous. Stable flies require blood for successful mating and ovarian development, but also require nectar as a supplementary energy source for flight activity and successful blood-feeding [26]. Müller *et al.* [27] conducted studies on the diurnal feeding behavior of three *Stomoxys* spp. in Mali and noticed a bimodal blood-feeding and unimodal sugar-feeding activity periods. Charlwood and Sama [14] reported a bimodal activity pattern for both male and female *S. n. niger* in Tanzania but our study obtained a bimodal activity pattern for parous and nulliparous females and unimodal peak for males. This discrepancy can be accounted for by the differences in the geographical settings where the different prospections were carried out as well as the trapping methods and duration.

The higher number of parous females in the different biotopes sampled indicates that the population of Stomoxys was made of adults (with high infection probability) than young. Also, it could be deduced from this observation that prospection sites did not harbor several newly emerged young flies as compared to adults (which were either from taking their first or second blood meal). The highest number of female Stomoxys of all physiological ages was made in pastures along rivers. This highest trapping of females along rivers was not strange because

rivers are used for drinking by livestock and such areas guarantee them of locating their blood meal hosts <sup>[2, 28, 29]</sup>. Further studies are required in this study area to examine freshly engorged male and female flies for parasites and blood meal source.

## 5. Conclusion

Four *Stomoxys* species were trapped with an overall ADT of 2.59 *Stomoxys* per vavoua trap per day. Galim was heavily infested than other prospected sites. A higher population of females was made up of adults. Highest number of *Stomoxys* females of both physiological ages was made along river Vina in Galim. The activity rhythm of nulliparous and parous females was bimodal while that of males was unimodal.

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