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CONTROL OF DIPTERIDS IN A FEEDLOT UNDER CONSTRUCTION IN A FOREST AREA OF CENTER REGION OF CAMEROON

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ABSTRACT

The forest agro-ecological zone of Cameroon is heavily infested with biting dipterids, but no control is ongoing in this part of the country. In the rainy season (May 2022) in a feedlot under construction in Ndogbea village, eight days entomological study consisting of (i) baseline fly collection using five vavoua traps set in all the sides of a one hectare feedlot yard for four days and (ii) installation of deltamethrin impregnated screens set at 1m from trap and their spraying at frequency of two days in four days. About 1368 biting and non-biting dipterids were collected and classified under five important genera namely *Musca*, *Stomoxys*, *Tabanus*, *Chrysops,* and *Glossina. Musca* spp. Were more frequent than other species. Only one *Glossina fuscipes fuscipes* was identified. The vavoua trap (VT4) facing the forest with canopy trees had the highest fly catches. The apparent density (ADT) of all the fly genera dropped from pre-screen installation phase (ADT=86.8flies/trap/day (f/t/d)) to screen installation phase (ADT= 38.2 f/t/d) with overall fly population density reduction rate of 55.99%. However, there was no statistically significant difference (X^2=35.000; df =30; P=0.243) in population density reduction rates of the various fly-groups. In conclusion, five dipterid groups of veterinary and zoonotic importance constituted the fly-vector fauna of Ndogbea village. The presence of deltamethrin impregnated screens contributed to the fly population density reduction rate of 55.99%. An integrated approach including: animal spraying, herd hygiene, use of traps and screens is needed to maintain low fly numbers in this feedlot.

Keywords: Dipterids, Feedlot, Fly-vector, Forest, Parasite.

INTRODUCTION

Dipterans are common pests of cattle in feedlots in the tropics (Shety et al., 2022; Walker, 2022). Apart from the transmission of some dangerous diseases during blood meals, their irritating painful bites stress the animals leading to behaviour change that result in poor body condition, low milk production and overall poor performance of the farm. Naturally, cattle uses several defensive mechanisms to drive landing insects and some of them include foot stamping, head tossing, tail switching, skin twitching and general aggregation to dilute the frequency of attack (Lendzele et al., 2019). A study conducted in Thailand reported a significant loss in live body weight gain of cattle exposed to insects, estimated at 8.0±1.5 Kg/month (Boonsaen et al., 2021). They also reported that dipterans were responsible for 10-11% loss of live body weight during the main grazing season of feeder-cattle.

Apart from tsetse flies, little is known about other stable dipterous insects in the Center forest region of Cameroon. However, in a rangeland in Yoko, the presence of *Stomoxys* spp. and *Tabanus* spp. alongside tsetse flies have already been reported (Simo et al., 2020). The reverse is true for the Guinean/Sudano-saheian savannas of the Northern regions where these flies have been well studied (Sevidzem et al., 2016; Lendzele et al., 2017; Lendzele et al., 2019). Some common dipterous insect pests of livestock already identified in rangelands of Cameroon include *Musca*, *Glossina*, *Tabanus*, *Haematopota*, *Haematopota*, *Haematobia*, *Stomoxys*, *Culex*, *Anopheles*, *Simulium*, and *Culicoides* (Hiol et al., 2019; Sevidzem et al., 2019).

The control of biting insect pests remains problematic to farmers in developing and developed countries. The frequent use of insecticides in farms has contributed to increase selection of resistant genes in fly populations against some commonly used families of insecticides as already reported in Europe and USA (Olafson et al., 2019). Despite the

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recent reports on the increase resistance of some stable flies population against insecticides, there is no doubt that the use of insecticides remains an important component of control strategies of vector-borne diseases of man and animals (Gratz and Jany, 1994). Several approaches have been devised to control stable flies and a review on some of them have already been published (Cook, 2020). In the Northern region of Cameroon, screens and traps were reported to effectively reduce the population of tsetse flies and improve the body condition score of cattle (Mamoudou et al., 2017). Also, in the tsetse free zone of Ngaoundere, screens and traps were reported to reduce the population of biting flies (Sevidzem et al., 2019). In the Democratic Republic of Congo, the use of tiny screens or targets impregnated with insecticides resulted in a >85% tsetse reduction rate (Tirados et al., 2020).

There is need to test the effectiveness of this control tool against forest biting flies in the Center forest region. To improve farm performance for small scale farmers and ranchers in the Center region, there is need to free their environment from tsetse flies and other mechanical vectors.

The current study aimed to set a control mechanism to reduce the population of biting flies in a cattle fattening pen.

MATERIALS AND METHODS

Description of study area

An entomological survey in the rainy season from 19 to 26 of May 2022 was conducted in Ndogbea village found in the Nyong and Kelle division of the Center region. This village falls within latitude 03.74231 north and longitude 011.23158 east. It is a fast growing village with several ongoing agricultural projects such as cocoa (Figure 1 A), palm oil (Figure 1 A) and cassava plantations (Figure 1 B) as well as livestock projects such as aquaculture and cattle rearing. The study site was a 1 hectare feedlot under construction (Figure 1C), located beside >40 hectares of palm oil and cocoa plantation. This agricultural and livestock site had about 20 workers staying in wooden houses beside the farm (Figure 1D). The vegetation of this site is entirely forest as this area falls within the mosaic-forest agro-ecological zone of Cameroon. A river network, palm trees and forest canopies provide favourable breeding grounds for fly-vectors. During the study month, the average climatic variables were: mean temperature of 30^{o}C, precipitation of 39.3mm, humidity of 85%, and wind speed of 4 km/hr. The four sides of the feedlot yard were ecologically heterogenous and traps were set facing the different sides. The characteristics of the different trap-sites are described in table 1.

Figure 1 - Images of study site. Palm tree and cocoa mix farm (A); cassava farm (B); feedlot under construction (C) and house of workers (D).

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Table 1 - Characteristics of trap-points.				
Trap code	Site	North	East	Altitude (m)
VT1	Entrance of ranch facing open grass vegetation	03.74216	011.23115	722
VT2	Side of ranch facing resident of palm oil and cocoa plantation workers	03.74237	011.23155	731
VT3	Side of ranch facing resident of palm oil and cocoa plantation workers	03.74224	011.23184	720
VT4	Side of ranch facing the forest with canopy trees	03.74173	011.23200	725
VT5	Side of ranch facing the palm oil plantation	03.74174	011.23142	720

VT: Vavoua trap

Entomological survey

The entomological study comprised of two phases notably (i) pre-intervention and (ii) intervention.

Phase I-Pre-intervention

Baseline data collection on biting dipterids

This phase consisted of collecting biting flies in the feedlot using a blue-black cloth trap known as the Vavoua that has been shown to be effective in the collection of biting and non-biting dipterids in a rangeland in North Cameroon (Sevidzem et al., 2016). Five vavoua traps were set around the fence of the feedlot at an average distance of 40m from each other. All the five Vavoua traps were coded as VT1, VT2, VT3, VT4, and VT5. The emptying of traps was made after every 24hrs for consecutively four days. During each collection session, the following information was documented : date, GPS coordinates and trap code.

Phase II-Intervention

The activities of this phase included the preparation of screens, manual treatment of screens with insecticide and installation in the 1 hectare feedlot yard.

Sewing of screens

Blue-black polyester fabrics were purchased from Ngaoundere main market. The blue fabric (100% polyester, Vestergaard Frandsen, Denmark) had reflectance of around 460 nm. Screens of 150 cm length × 50 cm width in size were prepared by sewing two pieces of 50 cm × 50 cm blue to one piece of 50 cm × 50 cm black (Figure 2).

Figure 2 - A 150 cm length × 50 cm width screen.

Manual treatment of screens with deltamethrin

The insecticide used for the treatment of screens was deltamethrin (DECTROL EC 50; MEDIVET). In the field, the insecticide solution was prepared by diluting 5ml of insecticide in 10L of H_2O as instructed by the manufacturer (Figure 3A). The screens were soaked in the insecticide solution for at least 30 minutes to allow maximum absorption of the product.

Installation of screens

The screens were set atleast 1 m from the vavoua traps (Figure 3B). Flies were collected from traps every 24hours with the screens in place for consecutively four days. Additional 15 screens were set in riverine areas and rangeland beside the pen. Since the study was conducted during the rainy season that was characterised by heavy rains, they were sprayed (Figure 3C) after two days post-installation.

Figure 2 - Preparation, installation and replenishment of screens and traps. A) dilution of insecticides to soak screens; B) installation of screens 100 cm from traps ; and C) spraying of screens after two days post-installation.

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Fly identification

The genus *Chrysops* was identified using the published taxonomic keys of Oldroyd (1957). The *Musca* genus was identified using the morphological key of Gregor et al. (2002). *Stomoxys* spp. were identified using the identification key of Zumpt (1973) and a local color key referring to the landmarks on their abdomen (Sevidzem et al., 2016). The identification of *Glossina* species was carried out using the morphological key prepared by CIRDES (2001).

Data analysis

The abundance of flies was defined as the number of flies per trap per day (f/t/d) from Sevidzem et al. (2022b) as follows:

$$\mathrm{ADT} = \frac{\mathrm{NTC}}{\mathrm{NT\ x\ NTD}}$$

Where, ADT: Apparent density; NTC: Number of tabanids captured; NT: Number of traps; NTD: Number of trapping days

The fly density reduction rate (FDRR) was calculated using the formula from Sevidzem et al. (2019) as follows:

$$\mathrm{FDRR} = \frac{\mathrm{ADTi} - \mathrm{ADTf}}{\mathrm{ADTi}}$$

Where, ADTi: initial apparent density; ADTf: final apparent density

The FDRR of the different fly-groups was compared using the Chi-square test. Data was analysed using the JASP 0.13.0.0 statistical software.

RESULTS

Genus composition

The study led to the collection of 1368 dipterans belonging to five genera (*Musca*, *Stomoxys*, *Tabanus*, *Chrysops*, and *Glossina*) of biting insects of medical, veterinary and zoonotic importance (Figure 4). Concerning the five important genera identified in the current study, the population of *Stomoxys* and *Musca* was five times that of *Tabanus*. *Chrysops* and *Glossina* were rarely caught by the vavoua during the study period.

Mean catches of dipterids by trap and period

High catches were made with the VT4 that was set facing the forest with canopy trees. Tsetse fly was only collected by VT1 that was set at the entrance of the ranch facing open grass. For the five important genera, their population dropped post-installation of screens.

Trend of fly catches

For most fly-groups, their population dwindled after the application of a booster spray on screens at day 6 except for *S. omega* that had a delay in their population reduction (day 8).

Fly density

The non-biting muscids *Musca* spp. had highest density, followed by *S. omega, T. fasciatus* but that with lowest density was *G. fuscipes fuscipes*. The densities of the different fly-species dropped tremendously post-screen installation (Table 2).

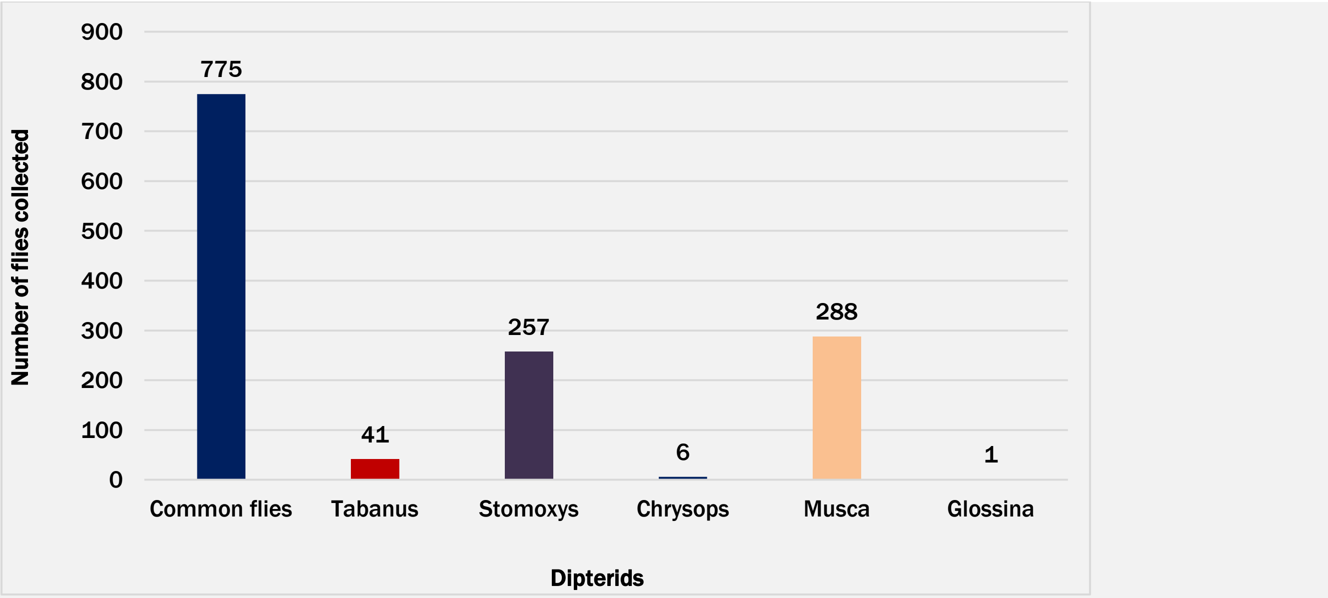

Figure 3 - Composition of dipterids.

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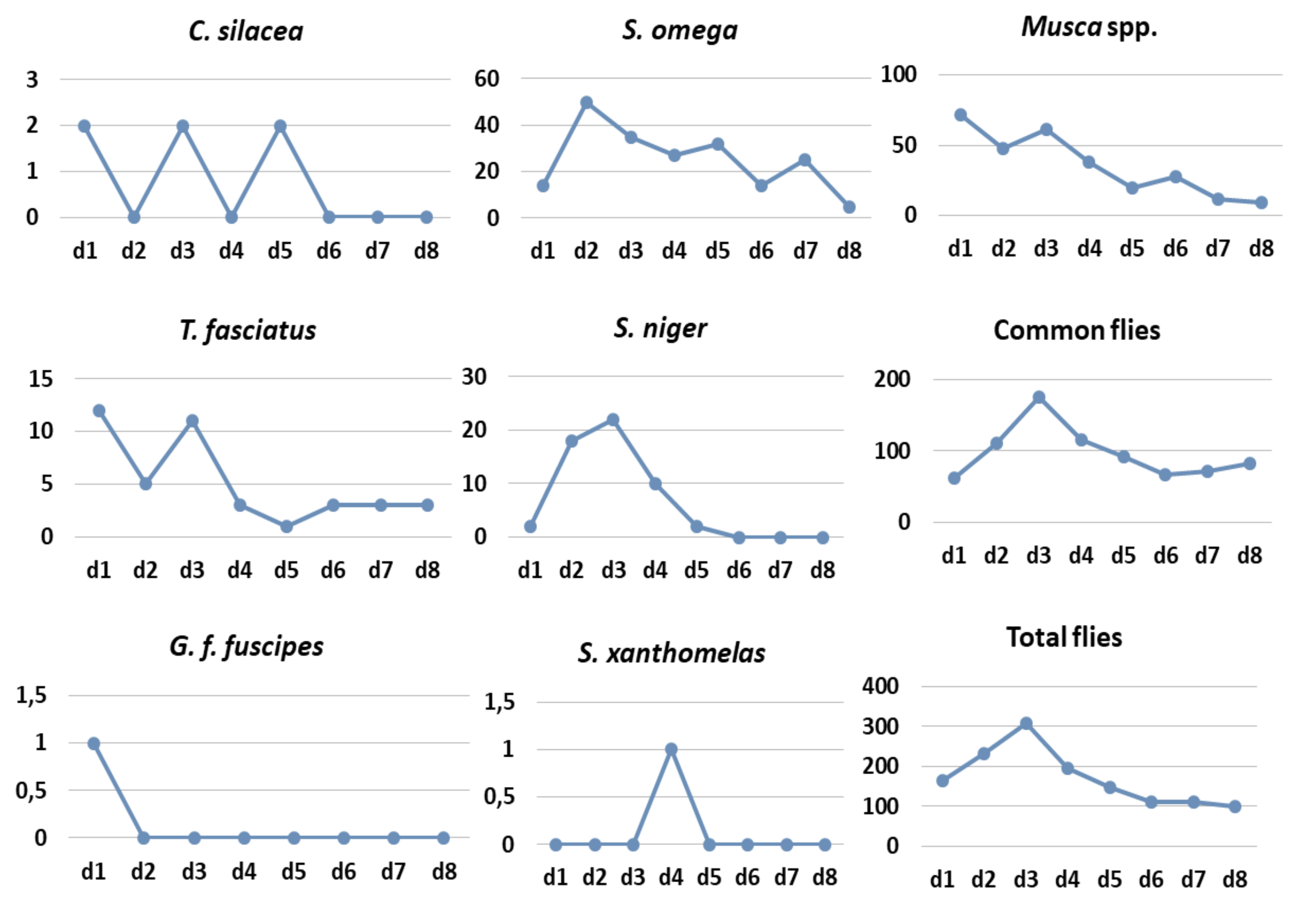

Figure 4 - Trend of fly catches during study period.

Table 2 - The density of dipterids by collection phases.

Phase	*T. fasciatus*	*S. xanthomelas*	*S. omega*	*S. niger*	*S. silacea*	*G. f. fuscipes*	*Musca spp.*
	n (ADT)	n (ADT)	n (ADT)	n (ADT)	n (ADT)	n (ADT)	n (ADT)
Pre-installation of screens	12(2.4)	0	14(2.8)	2(0.4)	2(0.4)	1(0.2)	72 (14.4)
	5(1.0)	0	50(10)	18(3.6)	0	0	48(9.6)
	11(2.2)	0	35(7)	22(4.4)	2(0.4)	0	61(12.2)
	3(0.6)	1(0.2)	27(5.4)	10(2)	0	0	38(7.6)
	21(6.2)	1(0.2)	126(25.2)	52(10.4)	4(0.8)	1(0.2)	219(43.8)
Post-installation of screens	1(0.2)	0	32(6.4)	2(0.4)	2(0.4)	0	20(4)
	3(0.6)	0	14(2.8)	0	0	0	28(5.6)
	3(0.6)	0	25(5)	0	0	0	12(2.4)
	3(0.6)	0	5(1)	0	0	0	9(8.2)
	10(2)	0	76(15.2)	2(0.4)	2(0.4)	0	69(20.2)

n: number of fly catches; ADT: trap apparent density

Table 3 - Density reduction rates for fly species.

Species	ADTi	ADTf	%RR
	X^2=35.000; df =30; P=0.243		
T. fasciatus	6.2	2	67.74[a]
S. xanthomelas	0.2	0	100[a]
S. omega	25.2	15.2	39.68[b]
S. niger	10.4	0.4	96.15[a]
C. silacea	0.8	0.4	50 [b]
G. f. fuscipes	0.2	0	100 [a]
Musca spp.	43.8	20.2	53.88[b]
Total	86.8	38.2	55.99

ADTi: initial apparent density; ADTf: final apparent density; RR : reduction rate. %RRs with similar superscript letters are not statistically significantly different (P>0.05) and %RRs with different superscript letters are statistically significantly different (P<0.05).

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DISCUSSION

The present study with aim to set a mechanism to control biting insects, vectors of dangerous diseases of animals and humans in a 1 hectare feedlot yard under construction in the forest Center region of Cameroon, led to the identification of five dipterid genera notably- *Tabanus*, *Stomoxys*, *Chrysops*, *Musca* and *Glossina*. The different biting fly-groups identified in this study have already been reported in the forest area of Sanaga Maritime of Cameroon by Hiol et al. (2019) and in Peninsular Malaysia (Ola-Fadunsin et al., 2020). Non-biting muscid *Musca* spp. were highly frequent than other fly-groups and this could be linked to favourable conditions for their reproduction and survival during the study period. Non-biting muscids have already been reported to be most abundant in rangelands of the sahel savanna of the North region of Cameroon (Sevidzem et al., 2016). It has been reported that these nuisible dipterids represents biological and mechanical vectors of major cattle diseases in Cameroon (Sevidzem et al., 2021; 2022 a,b). Apart from being vectors of animal diseases, some species like *C. silacea* and *G. f. fuscipes* are biological vectors of *Loa loa* filariasis and *T. brucei gambiense* respectively. During trapping, *C. dimidiata* was observed biting researchers and workers but were never caught by the stationary Vavoua traps. This could possibly be due to their less attractiveness to this trap type and limited trapping days. Similarly, we experienced mosquito bites and observed *Anopheles* temporary breeding sites (stagnant water in tracks created by tires of trucks), but never had a trap to collect and identify adults. Mosquitoes have already been observed biting cattle at night time in a semi-extensive cattle farm in Ngaoundere of Cameroon (Lendzele et al., 2019) and in feedlots in Thailand where they were reported as frequent nocturnal dipterids (Boonsaen et al., 2021). According to Boonsaen et al. (2021), the significant loss in live body weight gain of cattle exposed to these insects was estimated at 8.0±1.5 Kg/month.

The density of fly-groups reduced after the installation of screens with an overall reduction rate of 55.99%. The percentage density reduction rate for *S. xanthomelas* and *G. f. fuscipes* was 100%. This could be due to the low population of the two species during the study period as in the case of *G. f. fuscipes* that was only caught by one trap at day 1 during the pre-screen installation phase. However, in the Democratic Republic of Congo, tiny targets impregnated with insecticide resulted in >85% tsetse reduction rate (Tirados et al., 2020). Similarly, ZeroFly® screen significantly reduced tsetse population in Tanzania (Nagagi et al., 2017). It is important to know that screens or targets were developed to control tsetse flies in Africa and have been reported to be effective in clearing stable flies in farms in USA. Furthermore, the effective treatment frequency of 2 to 3 times insecticide spray per week is required to control tabanids and *Stomoxys* (Bruce and Decker, 1951; Mullens et al., 2006). However, an integrated control approach is most preferred for the control of stable flies (Cook, 2020). Although the current study was only conducted for eight days in the rainy season in one location, there is need to conduct a seasonal, diurnal/nocturnal study in different feedlots to know the fauna of all the biting fly-groups as well as evaluate their economic impact.

CONCLUSIONS AND RECOMMENDATIONS

1368 dipterids were collected and classified under five important genera namely *Musca*, *Stomoxys*, *Tabanus*, *Chrysops,* and *Glossina.* The presence of deltamethrin impregnated screens contributed in fly population density reduction rate of 55.99%. There is need for a seasonal entomological study in this area to understand the population dynamics of these important genera. An integrated approach including animal spraying, herd hygiene, use of traps and screens is needed to maintain low fly numbers in the feedlot. Fly control authorities of Cameroon should extend their control activities to the forest part of the country to enable safe and productive feedlot husbandry practices in this agroecological zone.

DECLARATIONS

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Authors' contribution

S.S. Lendzele performed conceptualization, project administration, data collection, data analysis and preparation of initial draft. K.A. Burinyuy – Data collection, R. Mintsa Nguema – preparation of initial draft, J.F. Mavoungou –finalization of the draft. All authors read and approved the final draft.

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Conflict of interest

None

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