Chapter

Ecological Aspects of Tabanids (Diptera: Tabanidae) in a Gabonese Cattle Ranch

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Abstract

To embark on an anti-vectorial fight against mechanical vectors of animal trypanosomosis, investigations were undertaken in order to determine the abundance, species diversity and daily activity of tabanids in a cattle ranch in Gabon. The nzi and vavoua traps were used to catch tabanids in three divisions of this ranch. In this study, 616 tabanids were captured: 349 (56.66%) in Division 1, 226 (36.69%) in Division 2 and 41 (6.66%) in Division 3. In the first Division, *T. taeniola* was the most abundant species with an Apparent Density (ADT) of 2.2, followed by *H. pluvialis* (ADT = 1.05). In the second Division, *H. pluvialis* was most abundant with ADT of 1.6, followed by *T. taeniola* (ADT = 0.38). In the last Division, the most abundant species was *H. pluvialis* (ADT = 0.15). Comparing the relative abundance of catches with sites (Divisions), we realized that there was no statistically significant difference in catches with trapping sites. It was noticed that Division 3 recorded the highest diversity index values. We realized that the nzi trap recorded higher tabanid catches than the vavoua trap. The diurnal activity rhythm of the most frequent species encountered slightly differed with prospection sites.

Keywords: tabanids, ecology, abundance, activity, diversity, ranch, Gabon

1. Introduction

Insects are necessary creatures to the living world [1, 2]. Indeed, they are involved in many processes and mechanisms essential for the functioning of ecosystems [3] for example, honey bees, domestic flies and butterflies pollinate our crops [4–6]. Other groups of insects play the role of predators of certain species such as wasps and ladybugs that attack caterpillars and aphids that destroy plants [7]. Similarly, beetles and flies guarantee the decomposition of organic matter, playing a major role in the recycling of essential nutrients to primary producers [7].

However, there are also insect species, including hematophagous dipterans such as tabanids that play a role in the transmission of several pathogens responsible for many diseases [8]. In fact, tabanids are known to be mechanical vectors of trypanosomes including *Trypanosoma vivax*, responsible for African Animal Trypanosomosis (AAT) or Nagana [9, 10]. These insects are capable of colonizing any type of environment including livestock farms [11–15]. Additionally, these insects have negative impacts on the growth and development of livestock [16].

Presently, there are approximately 4400 known species of tabanids [17, 18]. In Gabon, knowledge on tabanids in livestock farms is lacking. However, previous studies conducted by Mavoungou et al. [11] and Zinga et al. [19, 20] at the Ivindo National Park showed that several tabanid species co-existed in sympatry in the different biotopes prospected. In addition, the report of Obame et al. [21] in traditional livestock farms in north Gabon highlighted the presence of blood-feeding flies in this region. Regarding the weakly documented information on tabanids in livestock farms in Gabon, an entomological prospection to determine the abundance and species diversity is indispensible if control operations are to be conducted in this part of the country [22].

In the Nyanga ranch (located in southern Gabon), trypanosomosis is the most common disease of livestock. This disease causes fever, anemia and death in infected animals [23]. In order to establish effective control strategies against tabanids, mechanical vectors of animal trypanosomosis, an entomological study was undertaken to determine their abundance, species diversity and daily activity in the Nyanga cattle ranch.

2. Materials and methods

2.1 Study zone

This study was conducted in the Nyanga Ranch. It is a cattle farm located in the Nyanga province in the south-west of Gabon (**Figure 1**).

The ranch covers an area of 100,000 ha and was created for the breeding of more than 6000 cattle heads [23]. It is made up of three divisions, each of which has its own individual characteristics.

Division 1 has an area of 30,000 ha. It consists of six (6) sections: Bibonga, Galla, Mibamba, Upper Douki, Nyanga and Lower Douki. About 851 animals are reared in this division. In addition, the vegetation of this site is savanna-like.

Division 2 covers nearly 30,000 ha. It is dedicated for breeding, selection and fattening of males. It receives all males (bulls and oxen) after the weaning stage. This division is subdivided into three sections: Kouri, Moukenlengui and Povo. A total of 1754 animals are present in this division. The vegetation of this division consists of savannas and forest galleries.

Division 3 covers an area of 40,000 ha and includes four (4) sections: Yaba, Douli, Voungou and Douxila. This division is used for cattle breeding. Here, there are cows, heifers and calves that are kept until weaning. More than 2500 animals are reared in this division and the vegetation of this division is savanna and forest.

In general, the vegetation of the Nyanga Ranch area is made up of savannas and forest galleries colonized by many plant families including members of the subfamily Gramineae. The area has a rich and diverse fauna including elephants (*Loxodonta africana cyclotis*), buffalos (*Syncerus caffer nanus*), duikers (*Cephalophus* sp.) and bovines (*Bos taurus*, *Bos indicus)* [24]. The Nyanga Ranch has a dense hydrographic network of numerous swamps and rivers such as Nyanga, Douki, Kouri, Mibamba and Douli.

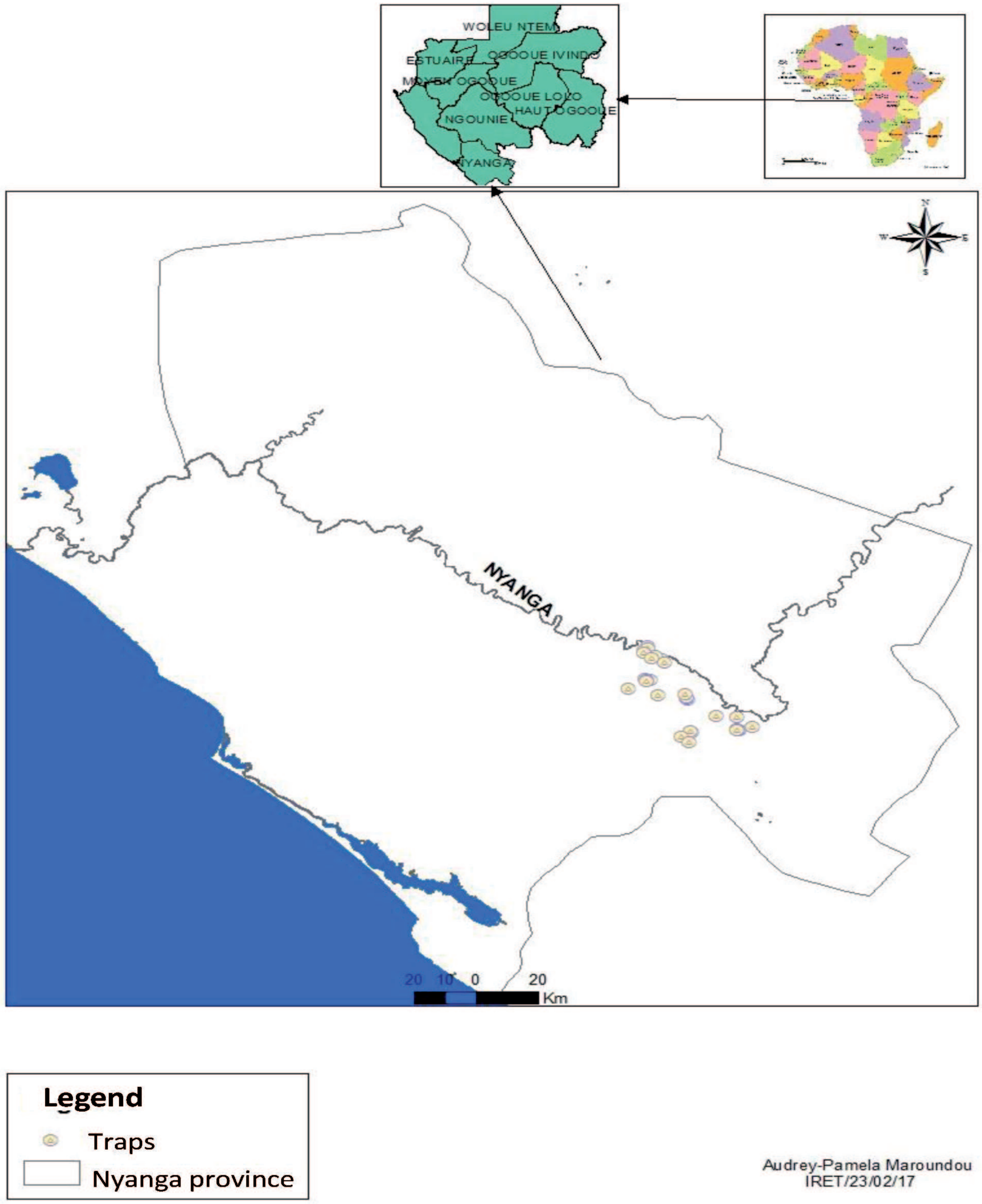

Figure 1.
Map showing the study site and trap positions.

The Nyanga Ranch region has an equatorial climate marked by alternating rainy and dry seasons. The rainy season spans from October to April, while the dry season occurs from May to September [25]. The average annual rainfall is 2000 mm in the North and 1600 mm in the South.

2.2 Capture and identification of tabanids

Tabanids were captured using the vavoua (constructed by Laveissière & Grébau [26] and nzi (constructed by Mihok [27] (**Figure 2a** and **b**) traps. A total of 10 traps were set in each division of the Nyanga Ranch, including 5 traps of each type, spaced approximately 30 m apart. Each of the two traps constituted a capture point in the trapping sites. Flies were collected daily. Trapping was conducted from 9th October to 14th December 2016 with total trapping duration of 60 days.

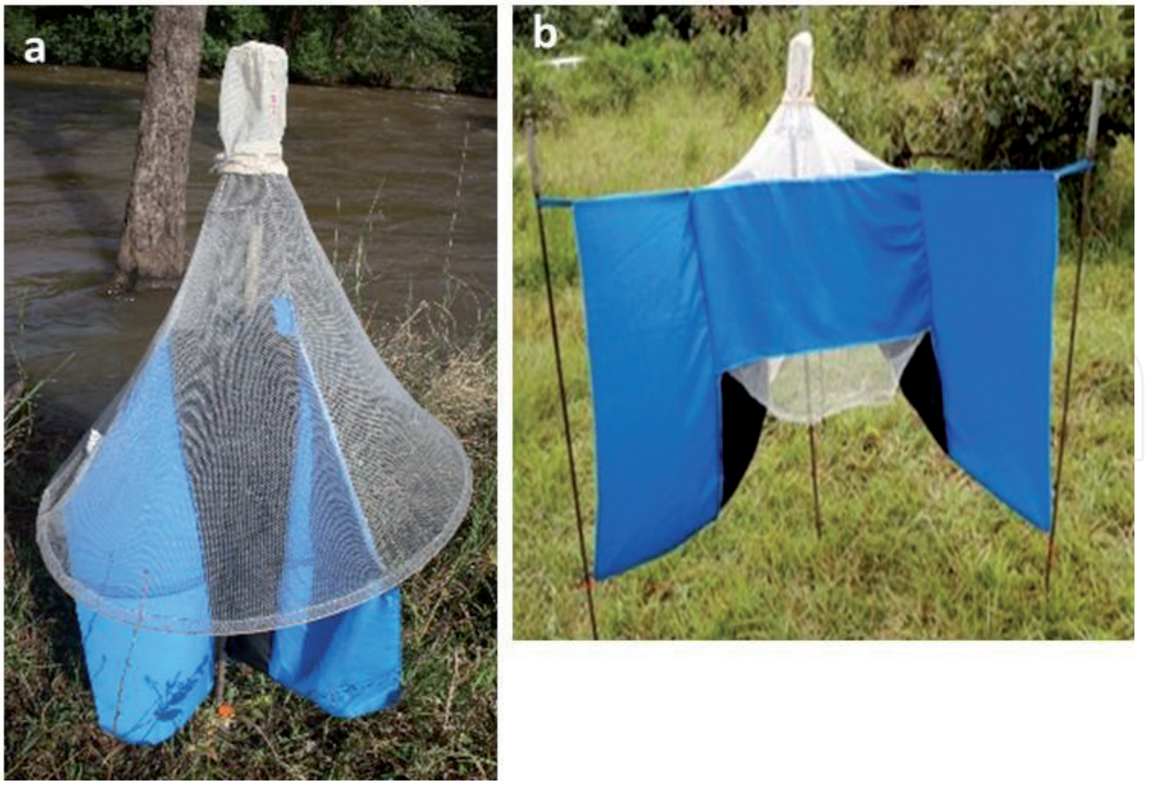

Figure 2.
Trap types a) vavoua trap, b) nzi trap (photos by Sevidzem SL).

In each division, three nzi traps separated by at least 500 m distance were set to evaluate the daily activity of tabanids. The flies were collected systematically every two hours from 8 h to 18 h. The captured flies were put in well labeled vials.

2.3 Fly identification

The identification of tabannids was conducted using the morphological keys of Surcouf and Ricardo [28], Oldroyd [29] and Oldroyd [30].

2.4 Data analysis

The apparent density (ADT) of each species of tabanids was defined as the number of flies caught per trap per days and calculated using the following formula (1):

$$\mathbf{ADT} = \frac{\textbf{Number of tabanid flies captured}}{\textbf{Number of traps} \times \textbf{Number of trapping days}} \tag{1}$$

The biodiversity index of Shannon, which quantifies the heterogeneity of individuals in an environment, was calculated using the following formula (2):

$$\mathrm{H}' = -\Sigma\left(\left(Ni/\mathrm{N}\right) \mathrm{x} \log 2\left(Ni/\mathrm{N}\right)\right) \tag{2}$$

Where
Ni is the number of individuals of a given species.
N, the total number of individuals.

The Simpson index, which is used to determine the probability that two randomly selected individuals in a given milieu are of the same species was calculated using the following formula (3):

$$D = \Sigma\, Ni(Ni - 1) / N(N - 1) \tag{3}$$

The Piélou Equitability Index, also known as the Equity Distribution Index, was calculated according to the formula (4):

$$(E) = Ish / \log(S) \tag{4}$$

Where S, is the number of species.

The non-parametric Kruskal-Wallis test was used to compare catches with trapping sites. The statistical test was performed using the XLSTA software version 3.01.19349. The statistical significance level was kept at $p < 0.05$.

3. Results

3.1 Genera composition of tabannids

A total of 616 tabanids divided into 5 genera and 18 species were recorded in this study. The following genera were identified: *Tabanus*, *Haematopota*, *Chrysops*, *Ancala* and *Atylotus* (**Figure 3**).

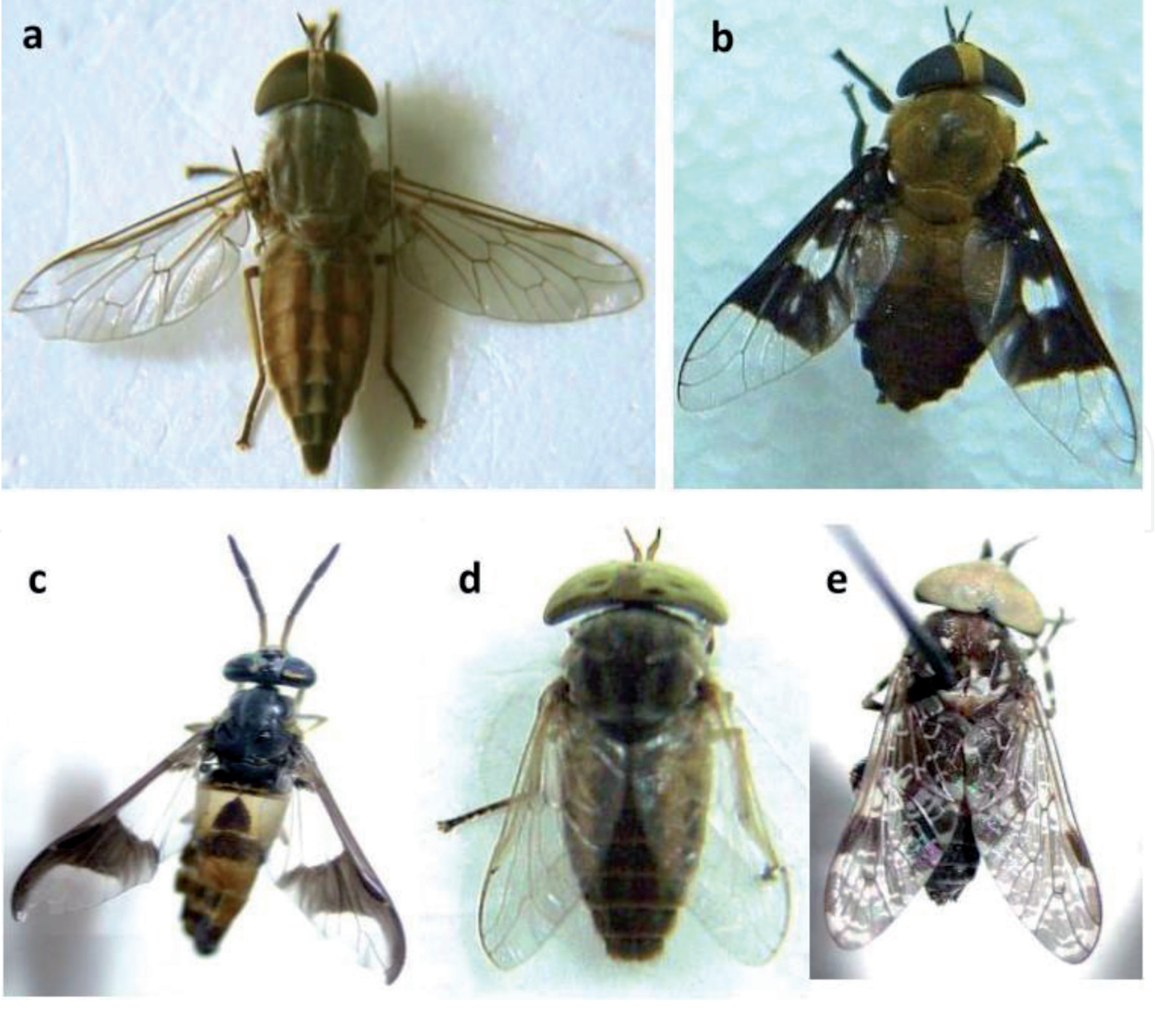

Figure 3.
Photos showing representative species of each genus identified: a) Tabanus taeniola; b) Ancala species; c) Chrysops longicornis; d) Atylotus agrestis; e) Haematopota species.

3.2 Species composition with trap type

Regarding fly catches with trap types, we noticed that the nzi trap captured more tabanids than the vavoua trap (**Table 1**).

3.3 Proportion of tabanid species

In total, 17 species of tabanids were recorded throughout the survey. The genus *Tabanus* recorded highest species number with frequent species in order of magnitude including *Tabanus taeniola* Palisot de Beauvois, 1807 (33.77%); *Tabanus par* Walker, 1854 (11.36%) and *Tabanus ricardae* Surcouf, 1906 (6.33%). The other species were weakly captured with percentages less than 2% (**Figure 4**). *Ancala fasciata* Fabricius, 1775 (0.49%); *Atylotus agrestis* Wiedemann, 1850 (0.16%); *Chrysops longicornis* Macquart, 1838 (6.33%) and *Haematopota pluvialis* (36.04%) were rare (**Figure 4**).

3.4 The abundance of tabanids with trapping site

Of the 616 tabanids caught in the Nyanga Ranch, 349 (56.66%) came from Division 1, 226 (36.69%) from Division 2 and 41 (6.66%) from Division 3. Of the 8 species of tabanids caught in Division 1, *T. taeniola* (ADT = 2.18) and *H. pluvialis* (ADT = 1.05) were the most abundant. *T. gratus, T par, T ricardae* and *C. longicornis* recorded low ADTs between 0.10 and 0.38 (**Figure 5**).

In Division 2, 13 species were captured and *H. pluvialis* (56%) was the most abundant species with ADT of 1.6 f/t/d, followed by *T. taeniola* (14%) and *T. par* (13%) with ADTs of 0.38 and 0.37 f/t/d respectively. The other 10 species were very weakly represented with ADTs less than 0.2 f/t/d (**Figure 5**).

In Division 3, 10 species were captured and *H. pluvialis* (0.15 f/t/d) and *C. longicornis* (0.15 f/t/d) were the most abundant species with same ADTs. The other

Genus	Species	Nzi	Vavoua
Tabanus (n = 13)	*Tababnus thoracinus*	1	0
	Tabanus dijonctus	1	0
	Tabanus dilitius	1	0
	Tabanus claripes	1	0
	Tabanus laverani	3	0
	Tabanus socius	7	1
	Tabanus taeniola	185	23
	Tabanus obscurehirtus	3	1
	Tabanus ricardae	13	26
	Tabanus par	55	15
	Tabanus gratus	5	3
	Tabanus marmorosus	0	6
	Tabanus sp.	1	0
Ancala (n = 1)	*Ancala fasciata*	2	1
Atylotus (n = 1)	*Atylotus agrestis*	0	1
Haematopota (n = 1)	*Haematopota pluvialis*	46	176
Chrysops (n = 1)	*Chrysops longicornis*	38	1
Total		**362**	**254**

Table 1.
Number of tabanids caught with trap type.

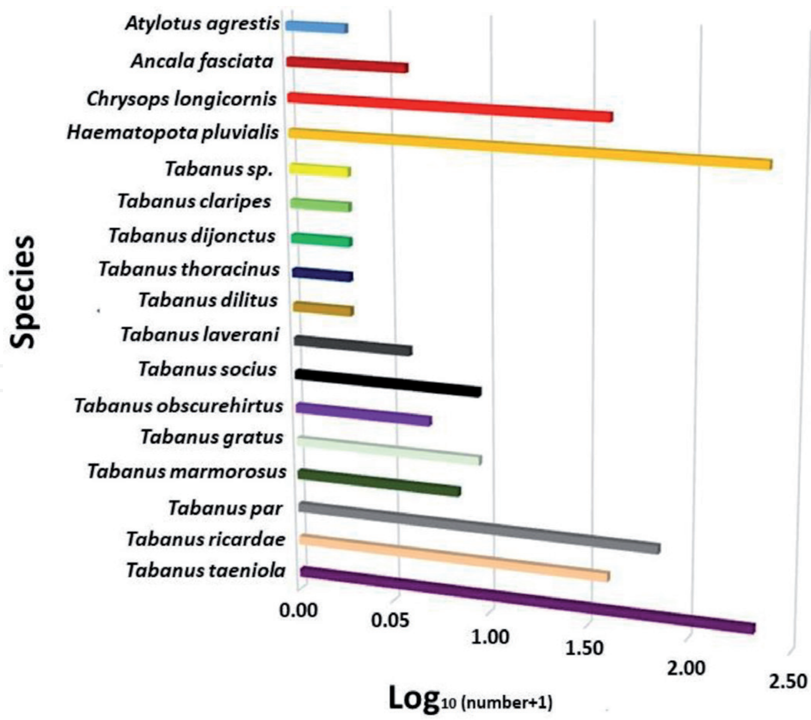

Figure 4.
Frequency of tabanids in the Nyanga ranch.

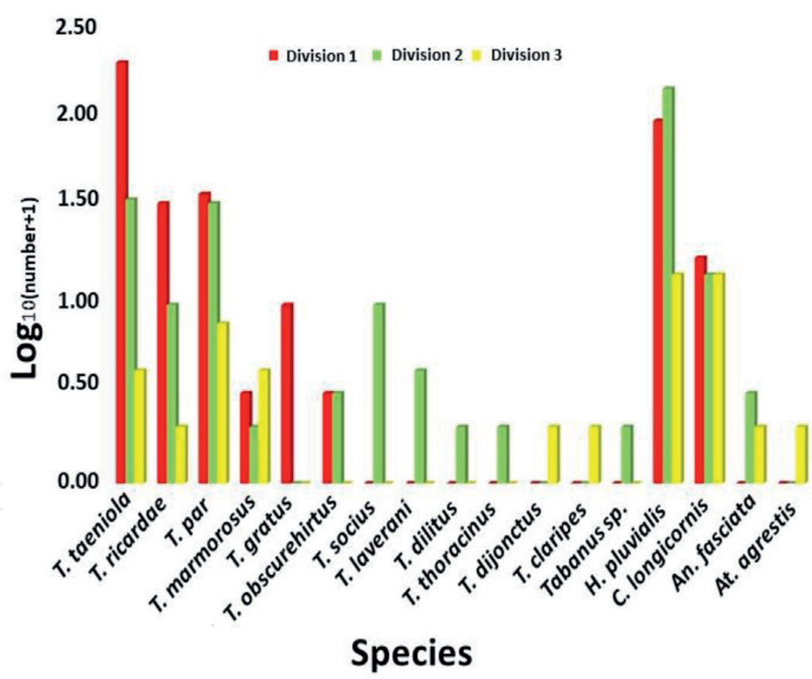

Figure 5.
Distribution of the species of tabanids with respect to the divisions prospected.

species, including *T. taeniola*, *T. marmorosus*, *T. par*, *T claripes*, *T. ricardae*, *T dijonctus*, *Ancala fasciata* and *Atylotus agrestis* had low ADTs below 0.15 f/t/d (**Figure 5**).

3.5 Diversity of tabanids

The results of the ecological indices are presented in **Table 2**. Division 3 showed the highest values in terms of biodiversity index.

The non-parametric Kruskal-Wallis test showed that the species of tabanids caught did not differ statistically with division (**Table 3**).

Ecological indices	Division 1	Division 2	Division 3
Equitability index of Pielou	0.68	0.58	0.78
Shannon index	0.61	0.65	0.78
Simpson index	0.45	0.65	0.79

Table 2.
Ecological diversity indices with respect to the divisions prospected.

Kruskal-Wallis:	
K (observed value)	1.848
K (critical value)	5.991
DDL	2
p-value (bilateral)	0.397
Alpha	0.05

Table 3.
Comparison of tabanids collected from the three divisions using the non-parametric Kruskal-Wallis test.

3.6 Daily activity of the most frequent species of tabanids with respect to prospection divisions

3.6.1 Diurnal activity pattern of H. pluvialis *and* T. taeniola *in division 1*

In division 1, *H. pluvialis* had a bimodal activity peak. This species reached the first activity peak between 10 h and 12 h and a second peak between 16 h and 18 h. Similarly, *T. taeniola* presented a bimodal activity pattern between 10 h and 12 h then between 14 h and 16 h (**Figure 6**).

3.6.2 Diurnal activity pattern of H. pluvialis *and* T. par *in division 2*

The diurnal activity pattern of *H. pluvialis* and *T. par* in Division 2 differed considerably. *H. pluvialis* recorded a unimodal activity peak between 8 h and 10 h, while that of *Tabanus par* occurred throughout the day with three peaks of activity, first between 8 h and 10 h, between 12 h and 14 h and finally between 16 h and 18 h (**Figure 7**).

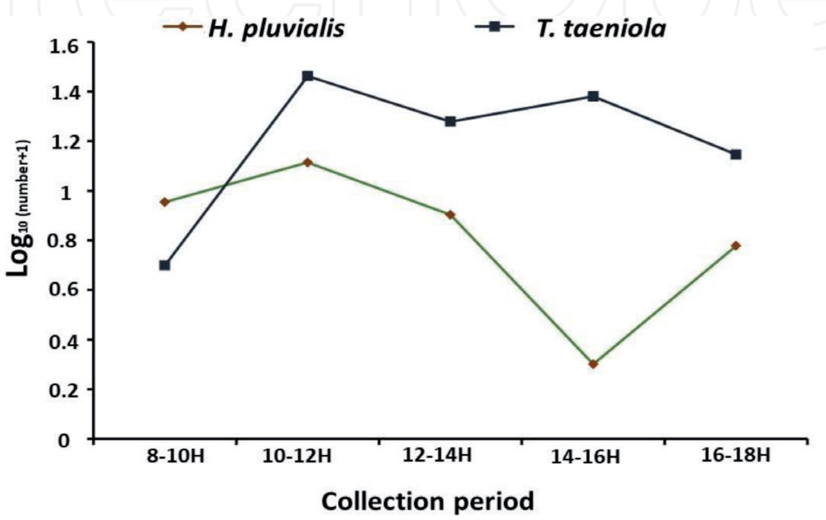

Figure 6.
Daily activity of H. pluvialis *and T. taeniola in division 1.*

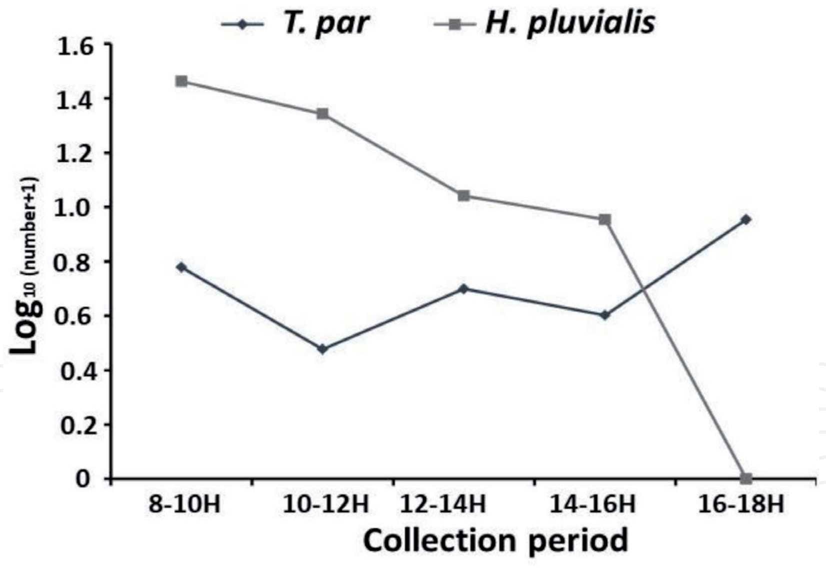

Figure 7.
Daily activity of H. pluvialis *and T .Par in division 2.*

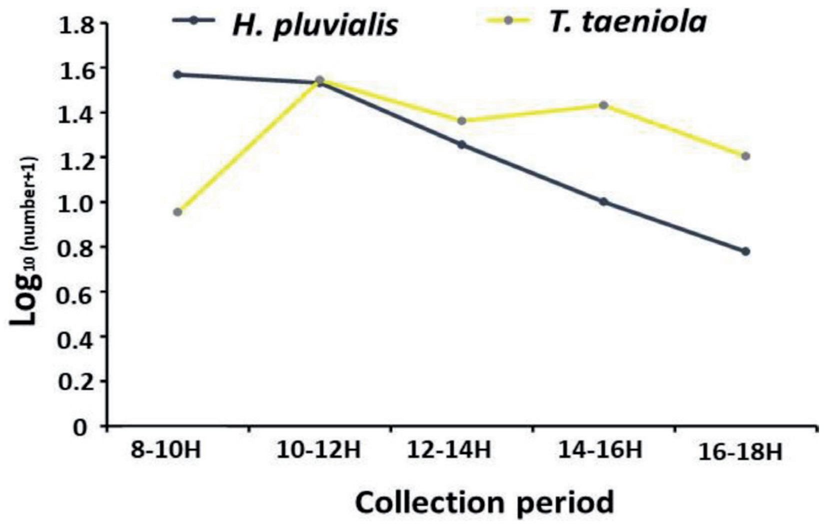

Figure 8.
Daily activity of H. pluvialis *and T. taeniola in division 3.*

3.6.3 Diurnal activity pattern of H. pluvialis *and* T. taeniola *in division 3*

In Division 3, *H. pluvialis* and *T. Taeniola* had an almost similar daily activity patterns. Their activity begins early in the morning and ends up decreasing at the end of the day. Indeed, *H. pluvialis* peak activity occurred between 8 h and 10 h and decreases gradually throughout the day. *T. taeniola* had a bimodal activity pattern, characterized by two activity peaks, one occuring between 10 h and 12 h and the other between 14 h and 16 h (**Figure 8**).

4. Discussion

This study is a preliminary inventory of tabanids, mechanical vectors of AAT in the Nyanga ranch. The results obtained in this study indicates the presence of several tabanid species that live in sympatry in the Nyanga Ranch. Five genera and 18 species of tabanids were identified in this study. We noticed that divisions 1 and 2 were strongly infested by tabanids while division 3 was weakly infested.

This distribution could be explained by the differences in the environmental and microclimatic factors of the divisions which might have created conditions more or less favorable for the development and survival of tabanids. This observation is similar to that made by Mavoungou et al. [11], Zinga et al. [19, 20] and Doumba et al. [31]. These authors observed a heterogeneous distribution of tabanids following the structuring of the prospected milieu. The infestation of an ecosystem by haematophagous flies such as tabanids is defined by the simultaneous presence of many suitable environmental factors, such as temperatures between 15° C and 25° C, good luminosity, high relative humidity and the availability of vertebrate hosts [32–34]. These conditions occurred in Division 1 where maximum catches were made. However, ecological diversity indices especially the Piélou equitability index revealed that Division 3 represented high species diversity.

In addition, some tabanid species including *H. pluvialis*, *T. taeniola*, *T. ricardae*, *T. par*, *T. marmorosus* and *C. longicornis* were captured in the three Divisions but with different ADTs. The other species were identified only in one of the three divisions. This heterogeneous distribution could be partly explained by the ecological requirements of these species and the biotic and abiotic factors of each of the Divisions that favors their development and survival. Moreso, the different vegetation (savanna and gallery forest) composition of the Nyanga Ranch could explain the presence of these species in all the prospected divisions in variable abundances. This finding is similar to that of Acapovi et al. [9] who reported an uneven abundance of tabanids in cattle rearing areas of Côte d'Ivoire.

The dominant species observed in this study were *H. pluvialis*, *T. taeniola* and *T. par*. The abundance of these three species could be explained by their bio-ecology and by the biotic and abiotic factors that exist in this ranch that may favor their development. *H. pluvialis* is known for its preference for forest and wetlands [16, 35]. It is a ubiquitous species that is particularly aggressive to humans and especially animals [11, 13, 15, 36]. The presence of forest and domestic animal species in the ranch could explain the high abundance of *H. pluvialis* in this area. Several studies have reported the occurrence of *T. taeniola* and *T. par* in savanna, forest and livestock areas [11, 14, 16, 31, 37]. In addition, *T. taeniola* is an opportunistic species that has a high adaptive capacity and is therefore found in many environments [9, 11, 30, 38]. Our results on the proportion of tabanid species caught differ from those obtained by Dia et al. [39] in Mauritania, Doutoum et al. [16] in Chad, Mavoungou et al. [11] in Gabon and Acapovi et al. [9] in Côte d'Ivoire. Indeed, in Mauritania Dia et al. [38] obtained 67.5% of *A. agrestis*, followed by 23.4% *T. taeniola* and 9.1% *T. sufis*. In Chad, Doutoum et al. [16] obtained *A. agrestis* (65%), *T. gratus* (22%) and *T. taeniola* (11%) as the dominant species. In Gabon, Mavoungou et al. [11] showed that *Tabanus secedens* (55.2%), *Tabanus obscurehirtus* (13.9%) and *Chrysops dimidiata* (11.2%) were the most important tabanid species. In Côte d'Ivoire, Acapovi et al. [9] reported *Tabanus laverani*, *Chrysops distinctipennis* and *T taeniola* as the most frequent species.

We found that the nzi trap caught more tabanids than the vavoua trap. This observation has been made by several authors who reported that tabanids are mostly attracted to the blue black color of the nzi trap and possibly their size and shape [14, 27, 39, 40].

The results on the daily activity of the various species of tabanids captured portrayed a variation in the number of catches with time of the day. These insects have an activity marked by peaks of abundance observed in the early morning between 8 h and 10 h and at dusk between 16 h and 18 h. In divisions 1 and 3, the activity peak reached between 12 h and 14 h whereas in division 2, the abundance occurred between 8 h and 10 h. These results are similar to those obtained by Mavoungou et al. [41] who showed the importance of hot hours of the day on the abundance of biting flies. Generally speaking, three main species, *H. pluvialis*, *T. taeniola* and *T. par* showed a circadian cycle at twilight with abundance peaks occurring between 8 h and 10 h for *H. pluvialis,* between 16 h and 18 h for *T. par* and 10 h and 12 h as well as 14 h and 16 h for *T taeniola*. These results are identical to those obtained by Auroi [42] who showed that the abundance of tabanids coincides with maximum radiation (the case of *T. taeniola*). However, for *H. pluvialis* and *T. par*, there is a sharp drop in the frequency at 12 h and 16 h. The depression that separates the two peaks of abundance of *H. pluvialis* and *T. par* corresponds to the hottest period of the day when temperatures exceed 27°C. High temperature values are associated with low relative humidity values. These observations corroborate with those made by Gurgenidze [43] who reported plume abundance curves with depressions between 12 h and 15 h when temperatures exceeded 32°C.

5. Conclusion

This study identified 17 species of tabanids with *T. taeniola* recording the highest frequency rate. The daily activity of tabanids differed with species and environment. We found out that Division 3 recorded highest tabanids species diversity. The nzi trap caught more tabanids than the vavoua. A more in-depth study on this taxon is underway to identify the pathogens they harbor.

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Conflict of interest

The authors declare that they have no competing interests.

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