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A Nationwide Survey of Tabanidae Fauna of Cameroon

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Abstract

Background: Tabanid flies are a neglected group of haematophagous dipterans, yet contains 4400 species, regrouped under 144 genera. They are mechanical vectors of important pathogens, including viruses, bacteria and protozoa of humans, domesticated and wild animals. As it is over 50 years since publication of a preliminary nationwide record of tabanids of Cameroon identified 84 species, updated information is provided.

Objective: To provide current data on the species composition, abundance and distribution of Tabanidae of Cameroon in the 5 main agro-ecological zones (AEZs).

Methods: From 2015-2017, a systematic entomological prospection using Nzi, Vavoua, Biconical and Sevi traps (N=106) was conducted in 604 trap-points over 11,448 traps days, in the 5 main AEZs of Cameroon.

Results: A total of 25,280 tabanid specimens were collected, identifying 25 species with 8 not previously documented in Cameroon, including: *Tabanus Latipes* Macquart, 1838 (1 ♀), *Tabanus ricardae* Surcouf, 1906 (1 ♀), *Tabanus fasciatus* Fabricus, 1775 (32 ♂♂, 6♀♀), *Haematopota pluvialis* Linnaeus, 1758 (18 ♂♂), *Haematopota decora* Walker, 1850 (19 ♂♂, 3 ♀♀), *Haematopota nigripennis* Austen, 1914 (18 ♂♂), *C. distinctipennis* Austen, 1906 (47 ♂♂, 5 ♀♀) and *Ancala fasciata* Fabricus, 1977 (34 ♂♂, 7 ♀♀). The distribution maps of the newly identified tabanids differed between AEZs, with most from the Guinean savanna. The highest Tabanidae apparent density (ADT) was recorded in the Sudan savanna region and the mean apparent densities of species with type-localities was statistically significantly different (Student t-test=2.519, *df*=24, *P*=0.019). The highest species diversity was found in the rain forest.

Conclusions: This study increased the list of Tabanidae recorded in Cameroon from 84 species in the preliminary record to 92 species, with most of the newly identified species occurring in the Guinean savanna AEZ. The high diversity and abundance of Tabanidae in the livestock/wildlife interface areas of the rain forests and Sudan savanna AEZs respectively, suggests risk of mechanical transmission risk of pathogens. Investigations of the microbiota within the Tabanidae in the different AEZs to define their role as disease vectors are proposed.

Background

Tabanids (Diptera, Tabanidae) form one of the largest group of hematophagous flies with about 4400 species and 144 genera [1]. They are well known by the local names of three medical and veterinary important taxa notably horse flies (*Tabanus*), deer flies (*Chrysops*) and clegs (*Haematopota*). Tabanids inflict direct effects such as nuisance and painful bites leading to blood loss, stress and weight loss of host and indirectly transmit major pathogenic agents including bacteria, viruses, protozoa and helminths [2–5] mechanically [6, 7]. The major blood-meal host of tabanids consist of humans, ruminants and wild animals [4,8]. The consequence of their blood feeding trait is the mechanical transmission of one of the ...an Africa (SSA), African Animal Trypanosomiasis (AAT) [2, 4,

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9–12], in addition to the biological transmission of *Loa loa* filariasis [13, 14]. The importance of studying the Tabanidae in relation to the mechanical transmission of pathogenic trypanosomes was emphasised at the 1948 African Conference on Tsetse and Trypanosomiasis in Brazzaville [15]. Despite the importance of tabanid flies, they are a neglected subject of research [4, 16].

Tabanidae of central Africa and other Ethiopian regions are either misidentified or poorly known and this applies in Cameroon. Apart from preliminary studies that reported 62 [15] and 84 [17] species respectively, there appear to have been no updates on their checklist and distribution. A survey in the Central African Republic indicated that 54 to 64 species constituted the Tabanidae fauna of this country [18]. The updated Tabanidae checklist of Ivory Coast reported the occurrence of 70 species [19]. The Tabanidae of Algeria consisted of 49 species [20, 21] as confirmed in a recent update [22]. The Tabanidae checklist of Kenya [23], the re-description of Tabanidae of East Africa (Uganda, Tanzania and Kenya) [24], and the tabanids reported in Gabon [25,12, 26] all provide current information. However in Cameroon, the first preliminary study only focused on the identification, aspects of the bionomics and vector role of horseflies in French Cameroon (forest area of the south region) [15]. Apart from the most elaborate preliminary countrywide report on the Tabanidae of Cameroon [17], other reports only presented a scanty record in the Sudan savanna [27, 28]. The present study aims to update information on the diversity, abundance and distribution of the Tabanidae species in the main AEZs of Cameroon.

Methods

Description of collection sites

The study zones consisted of the five main AEZs of Cameroon (Fig. 1). The geographical coordinates and climatic characteristics of the different AEZs are presented (Table 1).

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Table 1
The surveyed AEZs with their geographical coordinates and climatic characteristics.

SN	Agro-ecological zone	Study region	GPS coordinates	Altitude (meters)	Climatic conditions fly collection areas
I	Sudan-savanna	Far North	10°775' N 14°917'E	304	Sudano-sahelian climate with two seasons (rainy and dry). Average monthly temperature is 28°C. Rainfall is 400 to 1200mm/year.
		North	7°77796' N 14°929' E	545	
II	Guinee-savanna	Adamawa	7°00334' N 13°01' E	1000	Sudanese climate type with average monthly temperature of 20-26°C. Rainfall is 1500mm/year.
III	Highland plateau	North West	5°92523' N 10°009' E	900	Cold climate with mean monthly temperature of 19°C. Rainfall is 1500–2000 mm/year.
IV	Rain forest	Littoral	3°23333' N 9°567' E	35	Very humid, hot and variable equatorial climate with average monthly temperature between 22 to 29°C. Rainfall is 2500–4000 mm/year
V	Mosaic forest	East	6°23333' N 13°25' E	890	Guinean climate type (hot and humid). Rainfall is 1500–2000 mm/year

Entomological field surveys

Tabanid trapping was conducted simultaneously in the different AEZs for three years (2015–2017), using different trap types, including Nzi, Vavoua, Biconical, and Sevi. The Nzi, Vavoua and Biconical traps have been reported to catch tabanids in Cameroon [29, 30] whereas the Sevi trap is a modification of the malaise (René Malaise) and Canopy traps [31]. It was designed by Sevidzem SL (first author) in Ngaoundere, tested by the MSEG team in the tsetse flies infested region of North Cameroon, and confirmed as a trap for tabanids [27]. A description of the Sevi trap is provided (Additional file 1). The same number of traps and types were not deployed in the sampled AEZs because of the differences in topography, limited trap number/types and personnel to monitor them. The geolocalization of trap-points was conducted using a Global Positioning System (GPS) handset (GPS eTrex®; Garmin (Europe) Ltd, Southampton, UK). The trapping effort, defined as the number of traps multiplied by the trapping days (traps days), was recorded. The present prospection was conducted within 108 days using 106 traps, resulting in trapping effort of 11,448 traps days.

Sudan-savanna of Far North

Tabanidae prospection in this region was carried out in the following type-localities: Kalang, Kainide, [illegible] Nzi traps [32]. The traps were set in potential tabanids

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breeding points such as in marshy areas around livestock drinking points, in open grass savanna that represented livestock grazing spots and in gallery forests. Trapping was conducted three days consecutively per month throughout the study period. Traps were set and activated in the morning (8: 00am) and cages emptied in the evening (6:00pm).

Sudan-savanna in the North

Trapping here was carried out in three type-localities: Mbele, Zone 27 and Zone 26. Thirty nine traps (25 Vavoua [33], 10 Biconical [34], 2 Nzi [32], and 2 Sevi [27] were deployed in the study zone. Trapping sites were mostly beside the Game reserve, beside the river and in livestock grazing spots. Traps were activated in the morning (8:00 am) and their cages emptied every evening (6:00pm) for three days consecutively per month.

Rain forest of the Sanaga maritime

In the rain forest of Sanaga, prospection type-localities consisted of the abattoir (open forest), palm oil plantation (open forest with mainly tall palm trees and > 50 N'Dama cattle) and around the Game reserve (humid and closed forest with tall canopy trees). Three different traps : Biconical (n = 6), Vavoua (n = 6) and Nzi (n = 6) were used. The traps were set in the morning (6:00am) and emptied every evening (6:00 pm) for three days consecutively per month throughout the study period.

Guinee-savanna of Adamawa plateau

The prospection type-localities in the Guinee savanna zone consisted of Velambai (lake Djalingo with open grass savanna), Mbidjoro (open grass savanna, forest-savanna mosaic) and Vina du Sud (river vina with gallery forest). The trapping points were in villages with intensive cattle breeding activities. As in the rain forest of the Sanaga, three different traps (Biconical (n = 6), Vavoua (n = 6) and Nzi (n = 6)) were used for this activity. The traps were set in the morning (7:00 am) and their cages emptied every evening (6:00 pm) for three days consecutively per month throughout the study period.

Mosaic-forest in the East

The survey in this zone was carried out using Nzi (n = 3) and Vavoua (n = 3) traps. Traps were set in three environments: gallery forest, overnight cattle corrals, and river banks (watering point for cattle). These three biotopes were identified in four type-localities: Minali, Oudou, Camp Général and Gabong of the Société de Développement et d'Exploitation des Productions Animales (SODEPA). The trapping points were all in the SODEPA ranch which is a public structure involved in intensive cattle production activities. The trap cages were emptied after 24h for three days consecutively per month throughout the study period.

Highland plateau of North West

Five Biconical traps were set at livestock drinking points and grazing areas in the following type-localities: Bali top quarters, Saphery, Babah, Njinki, Tchaboutchou, Munam and Ntchuobo. Flies were collected from

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the traps each day before night fall (6: 00 pm) for three consecutive days per month throughout the study period.

Fly identification

All specimens were conserved in ethanol [35] and identified using a stereo microscope (Carl Zeiss™ STEMI 2000-C). The identification of tabanid flies was made following published morphological identification keys [36, 37, 38].

Sex determination

The sex of newly identified tabanid specimens was determined using published criteria [38], where females naturally possess a larger inter-ocular width than their male counterparts.

Determination of abundance

The abundance of trapped tabanids was translated as their apparent density (ADT), stated as the number of flies per trap and day (f/t/d) [12] as follows:

$$\mathrm{ADT} = \frac{\mathrm{NTC}}{\mathrm{NTxND}}$$

Where:

ADT: Apparent density,

NTC: Number of tabanids captured,

NT: Number of traps,

ND: Number of trapping days

Statistical analyses

Field survey records were completed in Access 2013 (Microsoft) data bases and joined to the type-locality shape files produced from gpx flies from GPS handsets in ArcMap™ version 10.1, Geographic Information System (GIS) software (Environmental Systems Research Institute, USA). Data was analysed using the JASP 0.13.0.0 statistical software [39]. The Student t-test was used to compare the mean ADT of tabanid species with type-localities of the different AEZs. The significant level of the test was stated at $p<0.05$.

Results

Distribution of tabanids in the prospected type-localities

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The present prospection from 2015 to 2017, occurred in 25 type-localities with 605 trap-points of the 5 major AEZs of Cameroon (Fig. 2). This resulted in the collection of 25,280 tabanid specimens, with 25 identified species regrouped under 5 genera (*Tabanus*, *Chrysops*, *Haematopota*, *Ancala* and *Atylotus*) that were members of 3 tribes, notably Tabanini, Chrysopini and Haematopotini. At the genus level, the 4 genera of *Haematopota*, *Ancala*, *Chrysops*, and *Tabanus* were highly encountered in the mosaic-forest/rain-forest more than in the savanna, whereas *Atylotus* was only encountered in the savanna and never trapped in the forest. *C. longicornis* was the only *Chrysops* that occurred in forest and savanna collections, but the other *Chrysops* were either forest restricted (*C. silacea*, *C. dimidiata, C. funebris*) or savanna-restricted (*C. dimidiata*). *H. decora* and *An. fasciata* occurred in forest and savanna collections, whereas *Atylotus agrestis* was only restricted to type-localities in the Guinee savanna and Sudan savanna. Only *Tabanus taeniola* was caught in all the propected type-localities (Table 2).

The abundance of tabanids with prospected type-localities

The species of tabanids caught in the different type-localities recorded highest abundance in some sites as compared to others. Highest ADT occurred at Diddel Tanne in the Sudan savanna of the Far North region, with such dominance caused by *Atylotus agrestis* (136.25 f/t/d**)**. Lowest ADT was recorded in most type-localities in the plateau highland of the Northwest region (Table 3). However, the mean ADTs of tabanid species with type-localities was statistically significantly different (Student t-test = 2.519, *df* = 24, *P* = 0.019).

Species diversity in the sampled type-localities

The type-locality with highest species diversity was the palm oil plantation (13 species) site located in Mouanko around the Douala-Edea Zone (DEZ) in the rain forest. Then followed the Vina du Sud type-locality (12 species), a riverine-gallery forest-savanna mosaic. The least species number (1 species) identified was in collections from Kainide and Kalang type-localities (savanna of Far North region) and in Bali Top Quarters (BTQ), Saphery, Babah, Njinki, Tchaboutchou, Munam and Ntchuobo in the plateau highland of the North West region (Fig. 3).

Checklist of the Tabanidae of Cameroon

Information on the nationwide zoogeographical distribution of tabanids of Cameroon was last made available over half a century ago, reporting the occurrence of 84 species [17]. Taxonomically, tabanids from reviewed data sets (84 species) plus those from the present study (25 species including 8 new species) belong to 3 sub families: Tabaninae, Pagoniinae, and Chrysopinae. Further re-grouping, place them under 14 genera *Hippocentrum* (n = 2 species), *Haematopota* (n = 19 species), *Ancala* (n = 3 species), *Euancala* (n = 1 species), *Atylotus* (n = 3 species), *Philoliche* (n = 3 species), *Chrysops* (n = 9 species), *Sphecodemyia* (n = 1 species), *Thriambeutes* (n = 1 species), *Hinea* (n = 1 species), *Tabanocella* (n = 3 species), *Tabanus* (n = 44 species), *Thaumastocera* (n = 1 species) and *Mesomyia* (n = 1 species). These genera belong to six tribes- Bouvieromyini, Rhinomyzini, Chrysopini, Philolichini, Tabanini and Haematopotini (Table 4).

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Table 4

Checklist, classification and type-localities of tabanids of Cameroon reported between 1970 and 2017. The species in asterisk (*) are those identified between 2015–2017 that were not found in the list of Tabanidae of Cameroon reported by Ovazza et al. [17].

Sub family	Tribe	Genus	Species	Type-localities
1)**Tabaninae Latreille, 1802**	Haematopotini Baquaert, 1930	*Hippocentrum* Austen, 1908	*H. strigipenne* Karsch, 1889	It was found at the slope of Mt. Cameroon with the name *H. concise.* Also signaled in Metchum, Wum, Oku-forest, Yaounde, Bertoua and Maroua. All the other localities are situated in the forest and post forested zones. Thus, localities in Cameroon do not show the limit of the extension of this species. Itard et al. [18] found it in the Central African Republic (C.A.R.). According to Ovazza et al. [17], the presence of *H. strigipenne* in Cameroon was due to the presence of palm oil trees, soil in forest, galleries and savanna forest relics. The mentioned authors testified that this species was present throughout the year.
			H. versicolor Austen, 1908	This species seemed to be rare in Cameroon. It was cited in unprecised localities by Oldroyd [48] with single indication in Maroua in the dry savanna.
	Haematopotini Baquaert, 1930	*Haematopota* Meigen, 1904	*H. griseicoxa* Oldroyd, 1952	As propounded by Oldroyd [48], the genus was very homogenous with diagnostic characteristics. The distribution of this genus was not only limited to the Ethiopian region but way beyond. *H. griseicoxa* can be found in Kumba, Garoua Boulai and in the Soudano-sahelian zone of Ngaoundere [17]. It is a forest species.

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Sub family	Tribe	Genus	Species	Type-localities
			H. ciliatipes Bequaert, 1930	It was apparently rare and can be found in Yaounde and along the Yoko/Deng Deng road in the Lom and Djerem division (East). Mostly caught in gallery forests [17].
			H. inornata Austen, 1908	Its type-locality was Wum, but recent prospections revealed their presence in the Guinean-savanna of Cameroon [17].
			H. germaini Ovazza and Mouchet, 1967	It was caught in the Oku forest. Mostly infest gallery forests [17].
			H. rufula Surcouf, 1909	This species was in Cameroon for the first time by Oldroyd [48] in Galim of the Adamawa in the Guinee-sahelian region [17].
			H. dukei Ovazza and Mouchet, 1967	It was caught in mount Bamboutous and 2□□ species sorted in Dschang at an altitude of 1600m by Ovazza et al. [17].
			H. crevei Oldroyd, 1952	It was collected in Mamfe in the rain-forest of the South west region of Cameroon [17].
			H. partifascia Bequaert, 1930	It was signaled in Adamawa, Banyo and Tibati. All its biotopes were located in the Guinee-savanna [17].
			H. barombi Oldroyd, 1952	This species is frequent in Cameroon. It Is found in forest and forest relics of mountainous regions and in transition zones, typical of Kumba [17].
			H. guineensis Bigot, 1891	This species occured in all forest regions, some already signaled in Meme, upper Nyong, Kribi, Mbalmayo and Bamboutous [17].

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Sub family	Tribe	Genus	Species	Type-localities
			**H. pluvialis* Linnaeus, 1758	This species was recently caught in the mosaic-forest precisely in the Gabong site of East Cameroon.
			H. abyssinica Surcouf, 1908	This species was first identified in Bui and along river Faro [17].
			H. ochracea Bezzi, 1908	This species was identified in Ayo Nyong.
			H. patellicorne Enderiein, 1925	This species was described in the Guinee-savanna areas [17].
			H. okui Ovazza and Mouchet, 1967	This species was caught in the Oku forest [17].
			H. heptagramana Speiser, 1915	This species was only known by the holotype which came from Soppo in Mt. Cameroon [17].
			H. laiessens Austen, 1908	This species was caught in Mamfe and Oku in humid forest areas [17].
			**H. negripennis* Austen, 1914	This species was recenty caught in the mosaic-forest precisely in the Gabong type-locality of East Cameroon.
			**H. decora* Walker, 1850	This species was recently identified in the Savanna of Ngaoundere precisely in Galim, Velambai and Mbidjoro.
	Tabanini Latreille, 1802	*Ancala* Enderlein, 1922	**A. fasciata Fabricus*, 1977	This species was characteristic of dense forests of Gabon and Congo Brazzaville. It seemed not to exist in Cameroon during the study of [17].

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Sub family	Tribe	Genus	Species	Type-localities
			A.f. nilotica Fabricus, 1977	This species existed in the northern savannas and in forested areas such as: Upper Sanaga, Nyong and Mfoumou, Lom and Djerem, Logone and Chari [17].
		Euancala Enderlein,1922	*A. latipes* Macquart, 1838	This species was identified in Tchad and north Nigeria. It is found in all forest and savanna areas of Cameroon [17].
		Atolytus Osten-sacken, 1876	*A. agrestis* Weidemann, 1828	This species was found in Maroua in the Logone and Chari division [17].
			A. fuscipes Ricardo, 1980	This species was identified in Garoua in the Sudan-savanna of North Cameroon [17].
			A. albipalpus Walker, 1850	This species was found in the Logone and Chari and Waza in the Sudan-savanna [17].
		Tabanus, Linnaeus, 1758	*T. (hybromitra) severini* Surcouf, 1907	This species was found in Mefou, 50km along the Yaounde-Ebolowa road and in Nkolbissong [17].
			T. (t) billingtoni, Newstead, 1907	This species was identified in Mt Cameroon and Bamoum [17].
			**T. fasciatus* Fabricus, 1775	This species was recently caught in the gallery forest in Galim of Ngaoundere. And in the Camp site, Oudou, Gabong and Minali type-localities of the SODEPA ranch of Ndokayo in the Mosaic-savanna.

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Sub family	Tribe	Genus	Species	Type-localities
			T(t) marmorosus Surcouf, 1909	This species was identified around the Congo Basin and in Uganda. It can be found in Cameroon in areas such as Kumba, Lekie, Nyong and Mfoumou, Upper Sanaga, Ntem, Kribi, Mbam, Lom and Djerem. It was discovered in Garoua, Bertoua and Ngaoundere [17].
			T(t) obscurefumatus Surcouf, 1909	This is a rare species and was found in forest confinement and in transition zones like along the Kumba road and Ebolowa [17].
			T(t) sufis Jeannicke, 1867	It was found in Logone and Chari [17]. It was recently identified in the Sora Mboum Sudan-savanna of North Cameroon by Lendzele et al. [27].
			T(t) pertinens Austen, 1912	This species was identified in Garoua in the Sudan-savanna of the North region of Cameroon [17].
			T(t) leucostostomus Loew, 1858	This species was identified in Maroua in the Sudan-savanna of Far North region of Cameroon [17].
			T(t) gratus Loew, 1858	It was found in Garoua and Logone and Chari [17]. It was recently caught in the savannas of Ngaoundere and North Cameroon [27].
			T(t) triquetonatus Carter, 1915	This species was caught along river Nyong and seemed to be abundant in Cameroon [17].

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Sub family	Tribe	Genus	Species	Type-localities
			T(t) argenteus Surcouf, 1907	This species was found in Kumbo, Edea road, Bertoua [17]. It was Recently found in the Douala-Edea Game Reserve.
			T(t) variabilis Loew, 1858	This species was found in Lom and Djerem, Bertoua and Maroua [17].
			T(t) insiginis neavi Austen, 1912	This species was found in Kadei, Bertoua and frequent in mosaic-forest zones [17].
			T(t) canus Karsch, 1879	This species was caught in Yaounde, Lekie and was noticed in the evening with light. It was caught in Maroua and usually found in forest and post forest areas [17].
			T(t) fulvicapillus Carter, 1912	This species was reported by Oldroyd [37] in Cameroon, but its locality was indicated in Congo Brazzaville.
			T(t) rageani Oldroyd, 1954	This species was found in Mefou, Kribi and Douala in forest relics [17].
			T(t) pluto Walker, 1848	This species was caught in Mamfe in the humid forest in the South west region of Cameroon [17].
			T(t) xanthomelas Austen, 1912	This species was found in Ivory Coast, Guinea, C.A.R and Cameroon (Benoue and river Fako) [17].
			T(t) biguttatus Weidemann, 1830	This species was found in Bertoua, Garoua, Maroua, Logone and Chari. It was recently identified in the North (Sora Mboum) and Ngaoundere.
			T(t) anaeus Surcouf, 1907	This species was described around Kumba in the humid forest of the South West region [17].

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Sub family	Tribe	Genus	Species	Type-localities
			T(t) rufricus Palisot de Beauvois, 1807	This species was signaled in all forest regions [17]. Recently caught in Minali type-locality of East region.
			T(t) doaldsoni Carter, 1912	This species was caught at Esseka [17].
			T(t) scholae Oldroyd, 1954	The series-type of this species was from Kumba in the humid forest of South west [17].
			T(t) par Walker, 1854	This species was identified in Mamfe, Maroua and Logone and Chari. This species was savanna-like and penetrated the forest. It was identified in the Savanna of north Cameroon (Sora Mboum) by Lendzele et al. [27].
			**T(t) latipes* Macquart, 1838	This species was recently caught at the palm oil plantation and around the abattoir in the Sanaga maritime zone.
			T(t) zoulouensis Ricardo, 1908	This species was found in Bamoum in the west highland of West Cameroon [17].
			T(t) thoracinus Palisot de Beauvois, 1807	This species was found in Maroua in the Sudan-savanna of the Far North region of Cameroon [17].
			T(t) boueti Surcouf, 1907	This species was caught in the Upper Nyong in the rain forest of Cameroon [17].
			T(t) besti Surcouf, 1907	Oldroyd [48] in Ovazza et al. [17] reported it in Kumba, Ivory Coast, Foumbam and Lom and Djerem.

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Sub family	Tribe	Genus	Species	Type-localities
			T(t) ianthinus Surcouf, 1907	This species was idenfied in Nyong and Mfoumou and Mbarain in the Mosaic-forest of Cameroon [17].
			T(t) lubutuensis Bequaert, 1930	This species was caught in Fako, Meme, Mefou and Lekie. It was confined in the forest relics of Cameroon [17].
			T(t) obscurehirtus Ricardo, 1908	This species was identified to be widespread in all forest zones [17].
			T(t) combustus Bigot, 1891	This species was known by Oldroyd to be found in the forest. During this period, it was not signaled in Cameroon. It was not equally signaled in present collections.
			T(t) secedens Walker, 1854	This species was caught in all forest and post forest regions such as Mefou, Lekie, Nyong and Soo, Nyong and Mfoumou [17]. It was recently caught in the Diddel tanne type-locality of the Far North region of Cameroon.
			T(t) congoiensis Ricardo, 1908	This species was widespread in Cameroon especially in areas such as Lekie, Nyong and Soo, Nyong and Mfoumou, Upper Sanaga, Upper Nyong, Ebolowa and Bertoua [17].
			T(t) crosskeyi Tendeiro, 1964	This species was described in Guinea (Bisao). Series of females were captured in the forest of Cameroon (Ekombitie) [17].
			T(t) conformis Walker, 1848	This species was collected along the Slope of Mt Cameroon, river Mungo and Foumbam [17].

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Sub family	Tribe	Genus	Species	Type-localities
			T(t) fuscipleuris Oldroyd, 1954	This species was collected in Manyu in the humid forest of the South West region of Cameroon [17].
			T(t) taeniola Palisot de Beauvois, 1807	This species existed in all parts of Cameroon and was abundant in Savanna regions. It occured in Manyu, Garoua, Nyong and Mfoumou, Ayos and Upper Nyong [17]. It was recently identified in the Savanna of North Cameroon [27].
			T(t) leverani Surcouf, 1907	This species was present in Cameroon, but abundant in Savanna-guinean zones [17].
			T(t) hamoni Ovazza and Valde, 1958	This species was described in the Upper Volta of Nigeria, C.A.R., Logone and Chari and Waza [17].
			T(t) nyasac Ricardo, 1900	This species was identified in the Logone and Chari division of the Far North of Cameroon [17].
			**T(t) ricardae* Surcouf, 1906	This species was recently caught in the Guinee-savanna notably in Velambai and Vina du Sud type-localities.
			T(t) ustus Walker, 1850	This species was reported by Brygoo to occur in the region of Ayos.
2) Pangoniinae Loew, 1860	Philolichini, Mackerras, 1954	*Philolichie* s.str. Wiedemman, 1828	*Philolichie (stenophara) semilivida* Bigot, 1981	This species was reported in Kumba, Mefou, Mbalmayo and Kribi [17].
			P. (ommastiosteres) rodhaini Bequaert, 1924	Oldroyd [38] described this species as *Stenophara adama* and Rageau et al. [15] described it in Cameroon in the Lekie.

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Sub family	Tribe	Genus	Species	Type-localities
			P.(subpangonia) gravoti Surcouf, 1903	This species was identified in Mefou, Nyong and Soo, Ntem and Ebolowa [17].
3) Chrysopinae Meigen 1803	Chrysopini Meigen, 1803	*Chrysops* Meigen, 1803	*C. zahrai* Oldroyd, 1952	This species was found in Donga Mantung, Oku (altitude of 2000m), summit savannas, Ngaoundere road (altitude of 1300-1500m) linked to zones of these altitudes [17].
			C. griseicollis Bequaert, 1930	This species was described in Kumba in the humid forest of the South West region of Cameroon [17].
			C. maximus Krober, 1920	This species was caught in Kumba, Ndop Plain (Marshy savanna and forest areas at altitude of 1100m). It was equally caught in Foumbam at altitude of 1300m in savanna and forest-galleries [17].
			C. dimidiata Wulp, 1805	This species was signaled in Kumba and Oku forest [17]. It was identified around the Douala-Edea Game reserve.
			C. silacea Austen, 1907	This species was signaled in Nigeria. *C. dimidiata* and *C. silacea* coexisted in the same habitat. It was also reported in Congo Brazzaville by Ovazza and Taufflier [49]. Recently identified around the Douala-Edea Game.
			C. langi Bequaert, 1930	This species was caught in Kumba, Mefou and Yabassi [17].
			C. longicornis Macquaert, 1930	This species was found in Manyu, Kribi, Ambam and Wouri. It was recently identified in the Adamawa Plateau.

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Sub family	Tribe	Genus	Species	Type-localities
			C. funebris Austen, 1907	This species was found in Meme and Mezam by Ovazza et al. [17] and recently signaled in Oudou and Gabong type localities of the mosaic-forest of East Cameroon.
			**C.distinctipennis* Austen, 1906	This species was recently identified by Lendzele et al. [27] in Sahel savanna of North Cameroon. It was formerly described in the document of Ovazza et al. [17] as *C. stigmaticalis*.
	Rhinomyzini Enderlein, 1922	*Sphecodemyia* Austen, 1907	*Sphecodemyia gromieri* Oldroyd, 1957	This species was caught in Kribi in the rain-forest [17].
		Thriambeutes Grunberg, 1906	*T. nigripennis* Enderlein, 1925	This species was collected at River Ngoko [17].
		Hinea Adams, 1905	*H. praestabilis* Grunberg, 1913	This species was collected in Kumba in the humid forest of the South West region of Cameroon [17].
			H. rodhaini Bequaert, 1913	This species was collected from Mefou [17].
		Tabanocella Bigot, 1856	*T. stimulans* Austen, 1910	This species was collected from Kumba, Nyong and Mfoumou, Lekie, Nyong and Soo, Ntem and Kribi [17].
			T. schoutedeni Fain, 1947	This species was very rare but was found along the Bamenda-Mamfe road [17].
			T. oldroydi Grenier and Rageau, 1955	This species was collected from Lekie and Mefou [17].
		Thaumastocera Grunberg, 1906	*T. akwa* Grunberg, 1906	The series-type of this species was collected from Lolodorf and Kumba in Cameroon [17].
	Bouvieromyini Mackerras, 1955	*Mesomyia* Macquart, 1850	*Mesomyia* (*dasycompsa*) *apiformis ssp cincta* Enderlein, 1925	This species was collected along the river Sanaga area and livestock areas of Kumba [17].

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The recent surveys (2015–2017) led to the identification of 8 species that were not present in the list of tabanids of the preliminary survey and increased the list of tabanids of Cameroon to 92. The systematics and descriptions of the type-localities as well as the distribution maps of the 8 recently identified species are as follows:

1) Tabaninae Latreille, 1802

Tabanini Latreille, 1802

Tabanus Linnaeus, 1758

Tabanus Latipes Macquart, 1838 (1♀)

Type-localities: Only one female of this species was caught using the Nzi trap set in the marshy land of the abattoir (3°83333' N and 10°05' E) in Mouanko in the rain forest of the DEZ of Cameroon (Fig. 4a).

2) Tabaninae Latreille, 1802

Tabanini Latreille, 1802

Tabanus Linnaeus, 1758

T. ricardae Surcouf, 1906 (1♀)

Type-localities: Only one female of this species was caught by a Nzi trap set in the marshy cattle grazing field around Lake Djalingo (7°42667' N and 13°945' E) of the type-locality of Velambai in the Sudan-savanna (Fig. 4b).

3) Tabaninae Latreille, 1802

Tabanini Latreille, 1802

Tabanus Linnaeus, 1758

Tabanus fasciatus Fabricus, 1775 (32♂, 6♀)

Type-localities: Individuals of this species were caught with the Nzi trap set in the gallery forest (7°00334' N and 13°01' E) of the Sudan savanna of Adamawa, in the Camp site, Oudou, Gabong and Minali type-localities of the SODEPA ranch (4°0833'N and 13°45'E) of Ndokayo in the mosaic savanna (Fig. 5a).

4) Tabaninae Latreille, 1802

Haematopotini Baquaert, 1930

Haematopota Meigen, 1904

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H. pluvialis Linnaeus, 1758 (18 ♀♀)

Type-locality: Only females of this species were caught with Nzi traps set in the mosaic forest (5°33972’ N and 14°188’ E) precisely in the Gabong type-locality of the East region (Fig. 5b).

5) Tabaninae Latreille, 1802

Haematopotini Baquaert, 1930

Haematopota Meigen, 1904

H. decora Walker, 1850 (19 ♀♀, 3 ♂♂)

Type-locality: This species was caught with the Nzi and Vavoua traps in the savanna of Adamawa precisely in Galim (7°00334’N and 13°01’ E), Velambai (7°42667’ N and 13°945’ E) and Mbidjoro (7°44778’ N and 13°726’ E) (Fig. 6a).

6)Tabaninae Latreille, 1802

Haematopotini Baquaert, 1930

Haematopota Meigen, 1904

H. nigripennis Austen, 1914 (18 ♀♀)

Type-locality: Only females of this species were caught with Nzi traps set in the Gabong type-locality of the mosaic savanna of the SODEPA ranch (4°0833’N and 13°45’E) (Fig. 6b).

7) Sub family Chrysopinae Meigen, 1803

Chrysopini Meigen, 1803

Chrysops Meigen,1803

C. distinctipennis Austen, 1906 (47 ♀♀, 5 ♂♂)

Type-locality: This species was caught using Nzi traps set in the Guinee savanna of Adamawa (7°00335’ N and 13°01’ E) and Sudan savanna (7°77115’ N and 14°983’ E) of North and Far North regions respectively (Fig. 7a).

8) Tabaninae Latreille, 1802

Tabanini Latreille, 1802

Ancala Enderlein, 1922

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Type locality: This species was caught using the Nzi trap set in some type-localities in the rain-forest (palm oil plantation (3°23333’ N and 9°567’ E) and abattoir (3°83333’ N and 10°05’ E)) in the DEZ, Guinee-savanna (7°00335’ N and 13°01’ E) and mosaic savanna (5°25694’ N and 14°155’ E) (Fig. 7b).

Discussion

These surveys, conducted from 2015 to 2017, led to the identification of 25 species, much less than the 84 species recorded in the preliminary study of 1970 [17]. However, 8 species not previously recoded in Cameroon were identified, including: *Tabanus Latipes* Macquart, 1838 (1 ♀), *Tabanus ricardae* Surcouf, 1906 (1 ♀), *Tabanus fasciatus* Fabricus, 1775 (32 ♂♂, 6♀♀), *Haematopota pluvialis* Linnaeus, 1758 (18 ♂♂), *Haematopota decora* Walker, 1850 (19 ♂♂, 3 ♀♀), *Haematopota nigripennis* Austen, 1914 (18 ♂♂), *C. distinctipennis* Austen, 1906 (47 ♂♂, 5 ♀♀) and *Ancala fasciata* Fabricus, 1977 (34 ♂♂, 7 ♀♀). The new species record increases the list of the Tabanidae identified in Cameroon to 92 species and is higher than that reported in the other countries within the Afro-tropical region, including Central African Republic [18], Ivory Coast [19], Algeria [20–22], Kenya [23, 24], Zambia [11], South Africa [11], Nigeria [40], Uganda and Tanzania [24], Congo [41], Liberia [42], and Gabon [12, 25, 26]. The higher number of species in the preliminary survey compared to this present study, could be due to several factors, including: the limited number of sampled sites (n = 25) in the different AEZs in the current study compared to several (> 25) type-localities in the preliminary study; the preliminary survey used sweep nets whereas the present study used tsetse traps; and ecological changes influencing fly distribution and densities.

The higher Tabanidae list (92 species) of Cameroon compared to that of the other countries of the Afro-geographical region likely reflects the presence of more diverse AEZs contributing to the successful development and survival of several species of tabanids. The newly identified tabanid species of Cameroon all existed in the list of Tabanidae from neighboring countries of the Central and West African sub-regions [11, 12, 19, 25, 40]. A review on the genus *Chrysops* of Africa with focus on Cameroon [14] mentioned only the occurrence of *C. silacea* and *C. dimidiata*, whereas our survey reveals 5 species, notably *C. distinctipennis*, *C. longicornis*, *C. funebris*, *C. silacea* and *C. dimidiata*. The possible reason for the previous scanty record of the species of this genus [14] could be because the earlier entomological surveys were limited to the forest regions of Cameroon, where *C. silacea* and *C. dimidiata* are omnipresent. Interestingly, the 1955 report on the presence of 5 species of *Chrysops* [15], notably *C. dimidiata* van der Wulp, *C. Silacea* Austen, *C. funebris* Austen, *C. longicornis* Macquart and *C. stigmaticalis* Loew was conducted in the same study areas as those in the review on the genus *Chrysops* [14]. However, neither of these reports identified *C. distinctipennis*, a species recorded in the Guinean savanna ecozones of Cameroon in our current study.

Tabanus taeniola was the most abundant species in the forest and savanna and this likely reflects the environmental conditions favorable to this species, one reported to be most frequent in the collections of other authors in the Afro-geographical zone [9, 12, 27, 43, 44]. Further, highest tabanid mean apparent density was recorded in the Sudan savanna type-localities, a finding similar to that presented in the 2020 [illegible] apparent absence of glossines in this region and high apparent

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densities of tabanids. This highest abundance of tabanids in sites of Far North region of the country is likely due to this being a major cattle rearing region of Cameroon [46, 47] and containing the Waza Park that harbours diverse and high numbers of domestic and wild animals serving as blood meal hosts for this fly group. The presence of cattle and wild animal hosts, plus the conducive environmental conditions of this region, presumably favours the development and survival of tabanids.

Highest tabanid species diversity was recorded in the rain forest of the DEZ than in other AEZs. The rain forest equally recorded the highest number of species (n = 13) than any other sampled AEZ. The likely reason could be the favourable environmental conditions of this AEZ for several species of tabanids and because it was the least anthropized of the sampling sites, with wild animals and N'Dama cattle serving as blood meal hosts and providing a suitable environment for tabanid development and survival [25]. The rain forest sites consisted of tall palm trees equally interspaced to provide high luminosity, canopy trees for shelter, rivers and abundant marshy land for breeding, with the presence of palm trees has been reported to harbor high numbers of different species of tabanids [17]. The 1955 study in forest areas of South Cameroon indicated the abundance of breeding sites for female tabanids that favored their proliferation in this zone [15].

Conclusions

The present study registered 25,280 tabanid specimens that were regrouped under 25 species. Of the 25 species recorded, 8 did not figure in the preliminary list of Tabanidae of Cameroon previously published [17], notably *Tabanus Latipes* Macquart, 1838, *Tabanus ricardae* Surcouf, 1906, *Tabanus fasciatus* Fabricus, 1775, *Haematopota pluvialis* Linnaeus, 1758, *Haematopota decora* Walker, 1850, *Haematopota nigripennis* Austen, 1914, *C. distinctipennis* Austen, 1906 and *Ancala fasciata* Fabricus, 1977). Identification of these novel species increased the Tabanidae number of the country from 84 to 92. The newly identified species were mostly found in the Guinean savanna. The highest Tabanidae apparent density was recorded in the Sudan savanna region whereas the highest species diversity was noticed in the rain forest of the DEZ. The high diversity and abundance of Tabanidae in the livestock/wildlife interface areas of the rain forest and Sudan savanna AEZs respectively strongly suggests the risk for the mechanical transmission of dangerous pathogens. Future investigations on this group to studying the microbiota they harbour are proposed, to establish their potential epizootiological role in the transmission of diseases in the different AEZs.

Declarations

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Author contributions

SLS and GLYA conceptualized the study. SLS, JFM, and AAK undertook collection of field data and species identification. AAK and SLS constructed all the Tabanidae distribution maps. SLS and AAK drafted the manuscript, and JFM and GLYA critically reviewed and edited subsequent drafts. All authors read and approved the final manuscript.

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Availability of data and materials

The description of the Sevi trap that was used in this study for the first time is provided within Additional file 1.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

CARPA
Center for support to Research and Pastoralism
IRAD
Agricultural Research Institute for Development
LEV
Laboratoire d'Ecologie Vectorielle
MINEPIA
Ministry of Livestock Fisheries and Animal Industries
MSEG
Special Mission for Tsetse flies Eradication

References

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1. Roskov Y, Kunze T, Paglinawan L, Orrell T, Nicolson D, Culham A, et al. Species 2000 & ITIS catalogue of life, 2013 annual checklist. Catalogue of life annual checklist. Technical report. Species 2000/ ITIS, Reading, UK; eds. 2013; ISSN: 1473-009X.
2. Krinsky WL. Animal disease agents transmitted by horse flies and deer flies. J Med Entomol. 1976;13:225–74.
3. Foil LD, Hogsette JA. Biology and control of tabanids, stable flies and horn flies. Rev Sci Techniq. 1994;13:1125–58.
4. Baldacchino F, Desquesnes M, Mihok S, Foil LD, Duvallet G, Jittapalapong S. Tabanids. Neglected subjects of research, but important vectors of disease agents! Infect Genet Evol. 2014;28:596–615.
5. Duvallet G, Boulanger N, Arthropods RV: Definition and Medical Importance. In Skin and Arthropod Vectors (Chap. 2). Edited by Nathalie Boulangie. Elsevier Inc; 2018; p. 29–51.
6. Zumpt F. Medical and veterinary importance of horse-flies. S Afri Med J. 1949; 23 : 359 – 62.
7. Wells EA. The importance of mechanical transmission in the epidemiology of nagana: A review. Trop Anim Hlth Prod. 1972;4:74–88.
8. Mamoudou A, Mbanwei M, Fongho SP, Sevidzem SL, Farikou O, Rebecca G, et al. Tabanids (Diptera: Tabanidae) fauna composition in different sites and biotopes of Far-North, Cameroon. J Biol Nature. 2016;6(3):146–54.
9. Mounioko F, Maganga GD, Mavoungou JF, Zinga Koumba CR, Koumba AA, Sevidzem SL, et al. Molecular Screening of *Trypanosoma spp*. in *Glossina*, *Stomoxys* and Tabanids in the Moukalaba Doudou National Park (South-West, Gabon). World J Vet Sci. 2018; 6:52–61.
10. Bitome-Essono P-Y, Ollomo B, Arnathau C, Durand P, Mokoudoum ND, Lauriane Yacka-Mouele L, et al. Tracking zoonotic pathogens using bloodsucking flies as 'flying syringes'. eLife. 2017;6:e22069. DOI:10.7554/eLife.22069.
11. Moeti OT, Makhosazanay YM, Namangala B, Amos C, Nthatisi IM, Musinguzi SP, et al. Characterization of tabanid flies (Diptera: Tabanidae) in South Africa and Zambia and detection of protozoan parasites they are harbouring. Parasitology. 2017;144(9):1162–78.
12. Zinga-Koumba RC, Bouyer J, Mavoungou JF, Acapovi-Yao GL, Kohagne TL, Mbang Nguema OA, Ondo Obame KP, Mutambwe S. Evaluation de la diversité des diptères hématophages dans une clairière marécageuse du Gabon à l'aide des pièges Vavoua et Nzi. Rev Elev Med Vet Pays Trop. 2013;66(3):91–6.
13. Duke BOL. The development of Loa in flies of the genus Chrysops and the probable significance of the different species in the transmission of loasis. Trans R Soc Trop Med Hyg. 1955;49(2):115–21.
14. Kouam MK, Kamgno J. The African *Chrysops.* In Biological Control of Pest and Vector Insects (Chap. 3). Intech Open; 2017; p. 286–298.
15. Rageau J, Grenier P, Adam JP. Tabanidae du Cameroun français. Ann Parasitol hum camp. 1955;30(3):243–71.

Loading [MathJax]/jax/output/CommonHTML/jax.js

16. Setser EA, Joy JE. Putative Sensory Structures Associated with the Food Canal of *Hybomitra difficilis* (Diptera: Tabanidae). Proc W Va Acad Sci. 2017;89(2):18–23.
17. Ovazza M, Mouchet J, Rickenbach A. Tabanidae du Cameroun: II. Les espèces connues et leur répartition. Cah. O.R.S.T.O.M., sér Ent mét et Parasitol. 1970; 8(1):323–351.
18. Itard J, Finelle P, Rickenbach A. Contribution à l'étude des Tabanides (Diptera) d'Afrique Centrale: les Tabanides de la République Centrafricaine. Rev Elev Med Vet Pays Trop. 1963;16(2):159–72.
19. Lydie AYG, Lendzele SS, Desquesnes M, Dia ML. An updated list of Tabanidae (Diptera: Insecta) in Ivory Coast. J Insect Biodiv Syst. 2017;3(1):69–79.
20. Surcouf MJ. Note sur les Tabanidae d'Algérie et de Tunisie. Arch Inst Pasteur Tunis. 1913;183–186.
21. Leclercq M, Maldès JM. Inventaire des Tabanidae d'Algérie et du Maroc et description d'une espèce nouvelle (Diptera, Brachycera). Nouv Rev Entomol (N.S.). 1987; 4:79–84.
22. Zeghouma D, Bouslama Z, Duvallet G, Zuhair SA. Horse flies and their seasonal abundance in El Tarf Province of northeastern Algeria. J Vector Ecol. 2018;43(2):305–11.
23. Jezek J, Oboňa J, Wamiti W, Njoroge N. Upswing of collections of horse flies (Diptera: Tabanidae) held at the National Museums of Kenya, Nairobi. Acta Mus Siles Sci Natur. 2017;66:53–63.
24. Mugasa CM, Villinger J, Gitau J, Ndungu N, Ciosi M, Masiga D. Morphological re-description and molecular identification of Tabanidae (Diptera) in East Africa. ZooKeys. 2018; 769: 117–44. https://doi.org/10.3897/ zookeys.769.21144.
25. Mavoungou JF, Makanga BK, Acapovi-Yao G, Desquesnes M, M´Batchi B. Chorologie des Tabanidae (Diptera) dans la réserve de biosphère Ipassa-Makokou (Gabon) en saison des pluies. Parasite. 2012;19:165–71.
26. Bitome-Essono PY, Dechaume-Moncharmont F-X, Mavoungou J, Mba RO, Duvallet G, Bretagnolle F. Distribution and abundance of hematophagous flies (Glossinidae, *Stomoxys*, and Tabanidae) in two national parks of Gabon. Parasite. 2015;22(23):1–11.
27. Lendzele SS, Abdoulmoumini M, Lydie AY. Spatial repartition of tabanids (Diptera: Tabanidae) in different ecological zones of North Cameroon. Biodiv Int J. 2017;1(2):64–8.
28. Fongho SP, Njiokou F, Garabed R, Mamoudou A, Arabi M, Malam AT. Etude préliminaire des vecteurs mécaniques potentiels des trypanosomes animaux dans la région de l'Extreme Nord du Cameroun. Rev Elev Med Vet Pays Trop. 2019;72(3):133–6.
29. Hiol V, Sieumeni AD, Mamoudou A, Sevidzem SL, Njan-Nloga AM, Nukenine EN. Spatio-temporal dynamics of Glossinidae, Tabanidae and Stomoxyidae around the Douala-Edea Wildlife Reserve in Cameroon. Am J Entomol. 2019;3(2):36–42.
30. Mamoudou A, Ikoum D, Sevidzem SL, Njan Nloga AM, Sieumeni Djoguep A, Mohammadou B, et al. Bovine trypanosomiasis and vectors in Lom and Djerem Division of East-Cameroon. Afri J Biol Sci. 2020;2(3):20–9.
31. Hribar LJ, Le Prince DJ, Foil LD. Design of a canopy trap for collecting horse flies (Diptera: Tabanidae). J Am Mosq Control Assoc. 1991;7(4):657–9.

Loading [MathJax]/jax/output/CommonHTML/jax.js

32. Mihok S. The development of a multipurpose trap (the Nzi) for tsetse and other biting flies. Bull Entomol Res. 2002;92:385–403.
33. Laveissière C, Grébaut P. The Trapping of tsetse flies (Diptera: Glossinidae). Improvement of a Model: the Vavoua Trap. Trop Med Parasitol. 1990;41(2):185–92.
34. Challier A, Laveissière C. Un nouveau piège pour la capture des Glossines (Glossina: Diptera, Muscidae) description et essais sur le terrain. Cah. O.R.S.T.O.M., sér Ent mét et Parasitol. 1973; 11:251–262.
35. Votýpka J, Brzoňo vá J, Ježek J, Modrý D. Horse flies (Diptera: Tabanidae) of three West African countries: faunistic update, barcoding analysis and trypanosome occurrence. Acta Trop. 2019;197:105069.
36. Surcouf JMR, Ricardo G. Etude monographique des Tabanides d'Afrique (groupe des "Tabanus"), Masson et Cie, Editeurs, Paris; 1909. p. 278.
37. Oldroyd H. The Horse-Flies of the Ethiopian Region (Diptera: Tabanidae). II. *Tabanus* and related genera. British Museum (Natural History), London, UK; 1954. p. 338.
38. Oldroyd H. The Horse-Flies of the Ethiopian Region (Diptera: Tabanidae). III. Subfamilies Chrysopinae, Scepsidinae and Pangoniinae and a revised classifi- cation. British Museum (Natural History), London, UK; 1957. p. 496.
39. JASP Team. JASP (Version 0.14.1) [Computer software]. 2020; https://jasp-stats.org.
40. Ahmed AB, Okiwelu SN, Samdi SM. Species diversity, abundance and seasonal occurrence of some biting flies in Southern Kaduna, Nigeria. Afr J Biomed Res. 2005;8:113–8.
41. Surcouf J, Roubaud CE. Tabanides recueillis au Congo français par la mission d'études de la maladie du sommeil. Bull LWZZS Hist Nat Paris. 1908;5:221–5.
42. Leclercq M. Tabanidae (Diptera) du Liberia et d'autres pays africains RuZZ Znsf Agron Gembloux. 1965; 33(l):135–137.
43. Sevidzem SL, Mamoudou A, Woudamyata AF, Zoli PA. Contribution to the knowledge of ecodiversity and density of tsetse (Glossinidae) and other biting flies (Tabanidae and Stomoxyinae) in the fly controlled-infested livestock/wild life interface of the Adamawa plateau- Cameroon. J Entomol Zoo Stud. 2015;3:329–33.
44. Mounioko F, Mavoungou JF, Zinga-Koumba CR, Engo PE, Koumba AA, Maroundou AP, et al. Etude Préliminaire des vecteurs Mécaniques des trypanosomes dans la localité de Campo et ses environs (Sud-Ouest du Cameroon). Faunistic Entomol. 2017;70:95–105.
45. Tongue LK, Ngapagna AN. Emerging Vector-Borne Diseases in Central Africa: A Threat to Animal Production and Human Health. In Current Topics in the Epidemiology of Vector-Borne Diseases. Intech Open. 2019; 1–14.
46. Ziébé R, Thys E, De Deken R. Analyse de systèmes de production animale à l'échelle d'un canton: Cas de Boboyo dans l'Extrême-Nord Cameroun. Rev Elev Med Vet Pays Trop. 2005;58:159–65.

Loading [MathJax]/jax/output/CommonHTML/jax.js

47. MINEPIA. MINEPIA Policy Document. Yaounde. Cameroon: Ministry of Livestock Fisheries and Animal Industries; 2013. p. 29.
48. Oldroyd H. The Horse-flies of the Ethiopian Region (Diptera: Tabanidae). 1. Haematopota and Hippocentrum. British Museum (Natural History), London, UK; 1952. p. 226.
49. Ovazza M, Taufflieb R. Tabanides d'A.E.F. Bzzll. Z.E.C., n.s. 1952; 4:131–141.

Tables 2-3

Tables 2-3 are available as a download in the Supplementary Files section.

Figures

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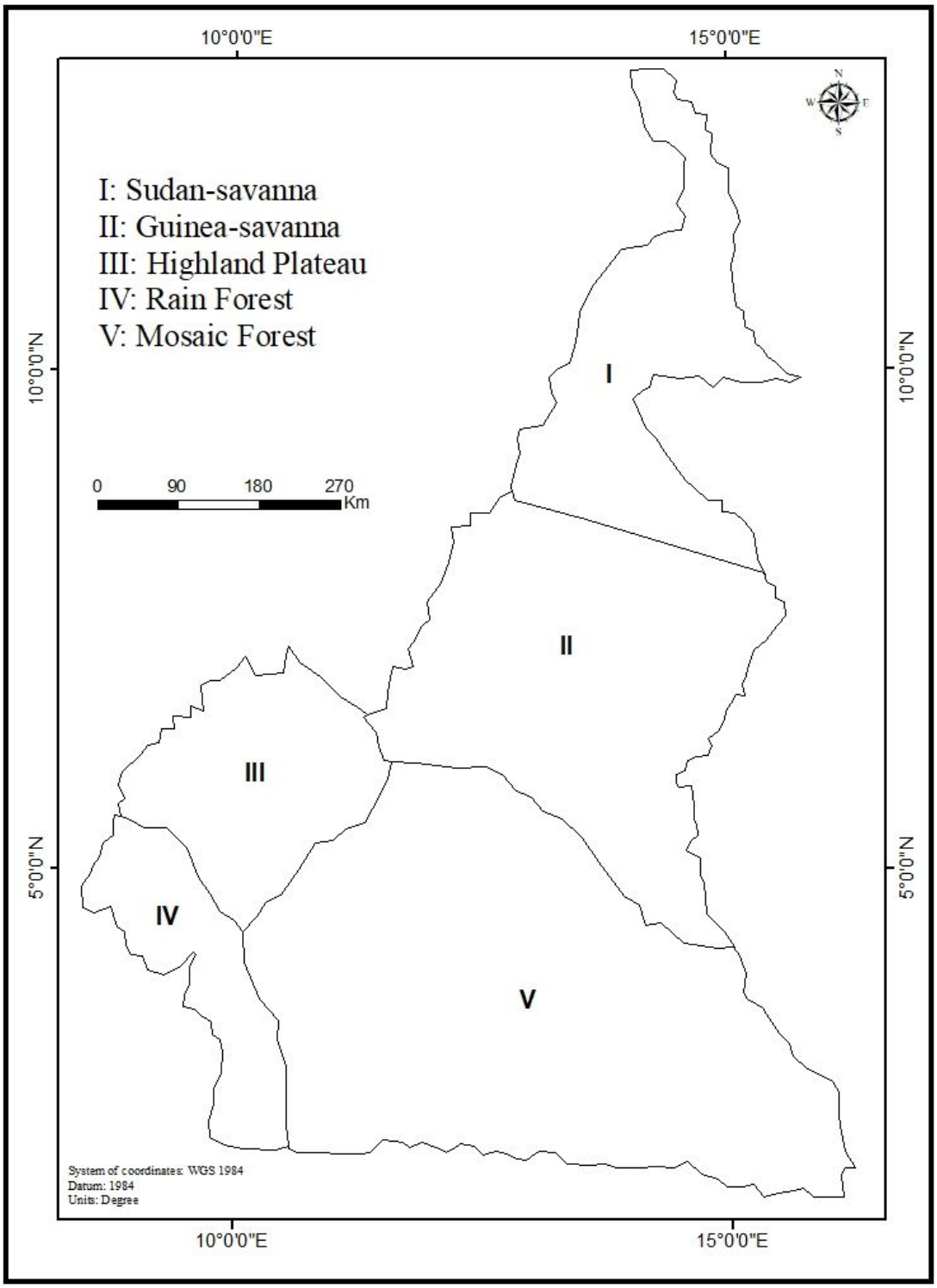

Figure 1

Map showing the different agro-ecological zones of Cameroon. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by

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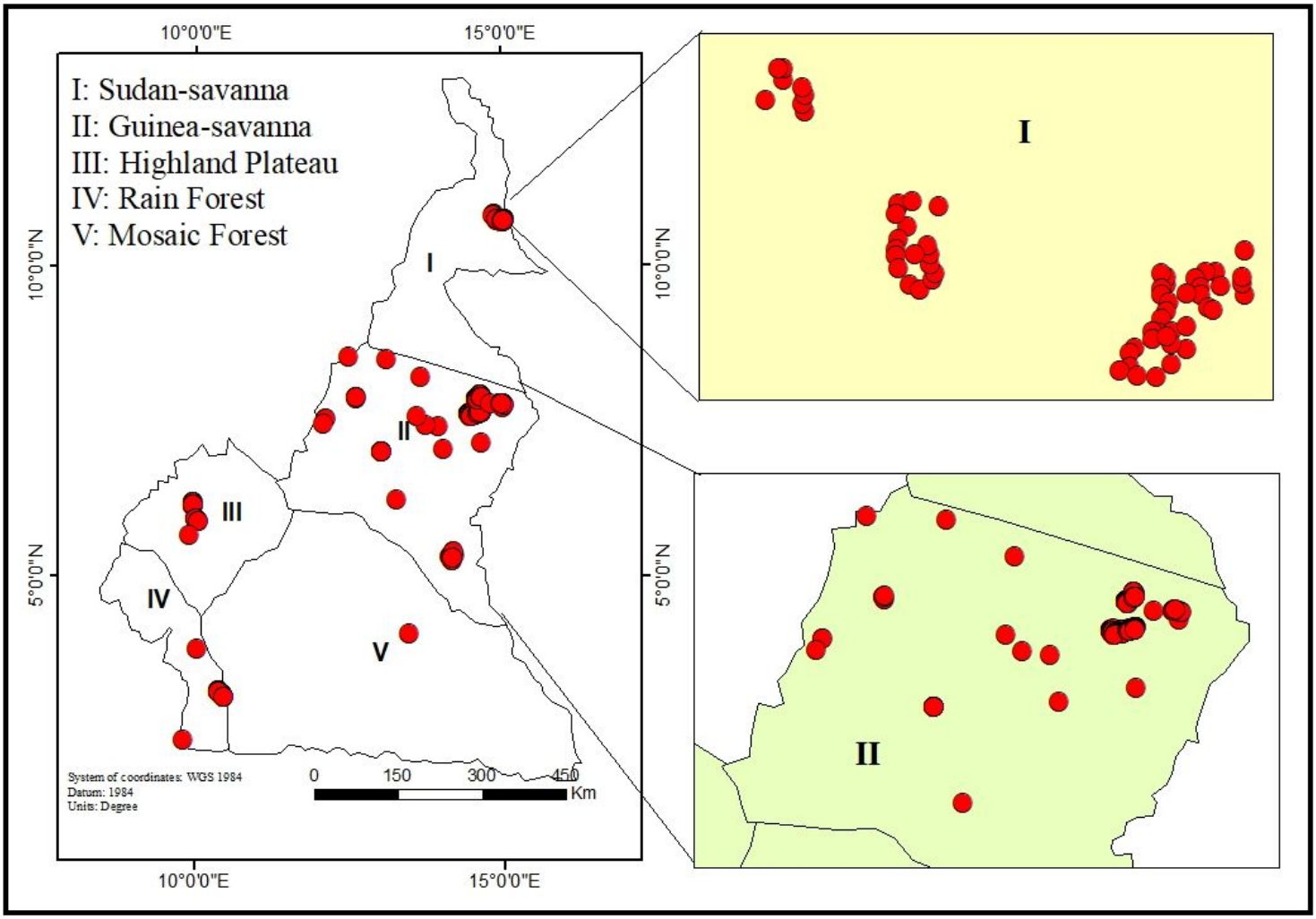

Figure 2

Map showing the trap-points in the prospected zones of Cameroon. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

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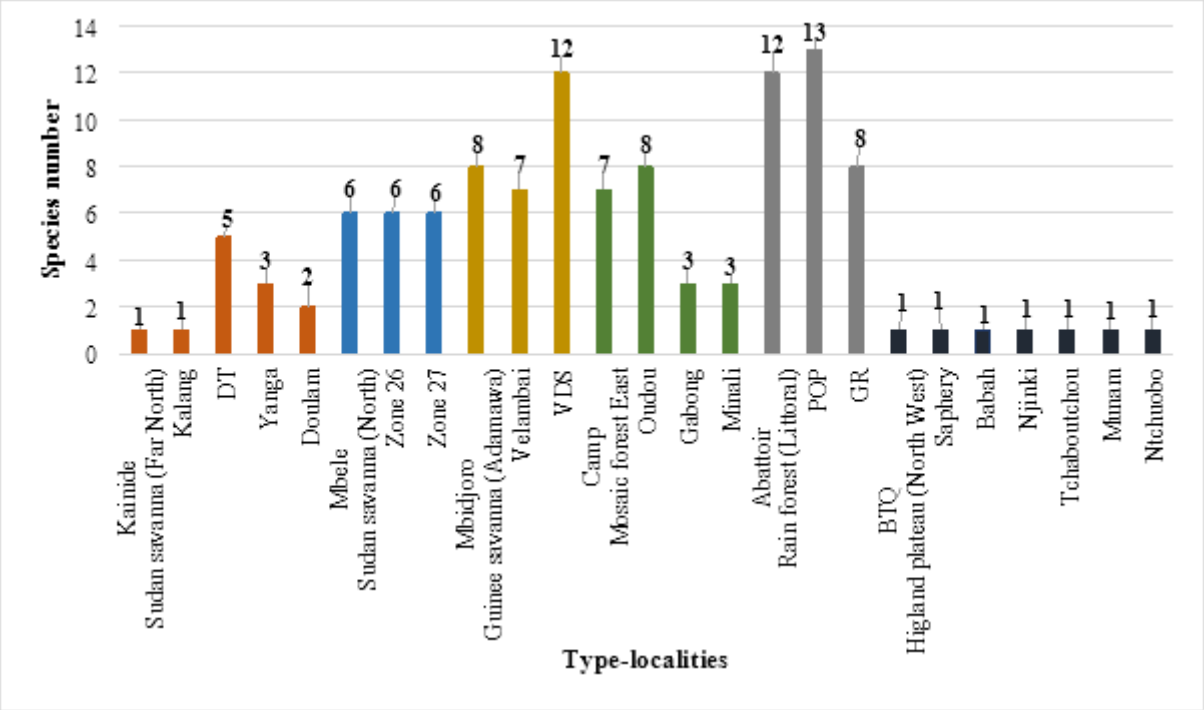

Figure 3

Number of species of tabanids in the prospected type-localities (2015-2017) SS: Sudan-savanna, GS: Guinee-savanna, MF: Mosaic-forest, RF: Rain forest, VDS: Vina du Sud, DT: Diddel tanne, POP: Palm Oil Plantation, GR: Game Reserve, and BTQ: Bali top quarters.

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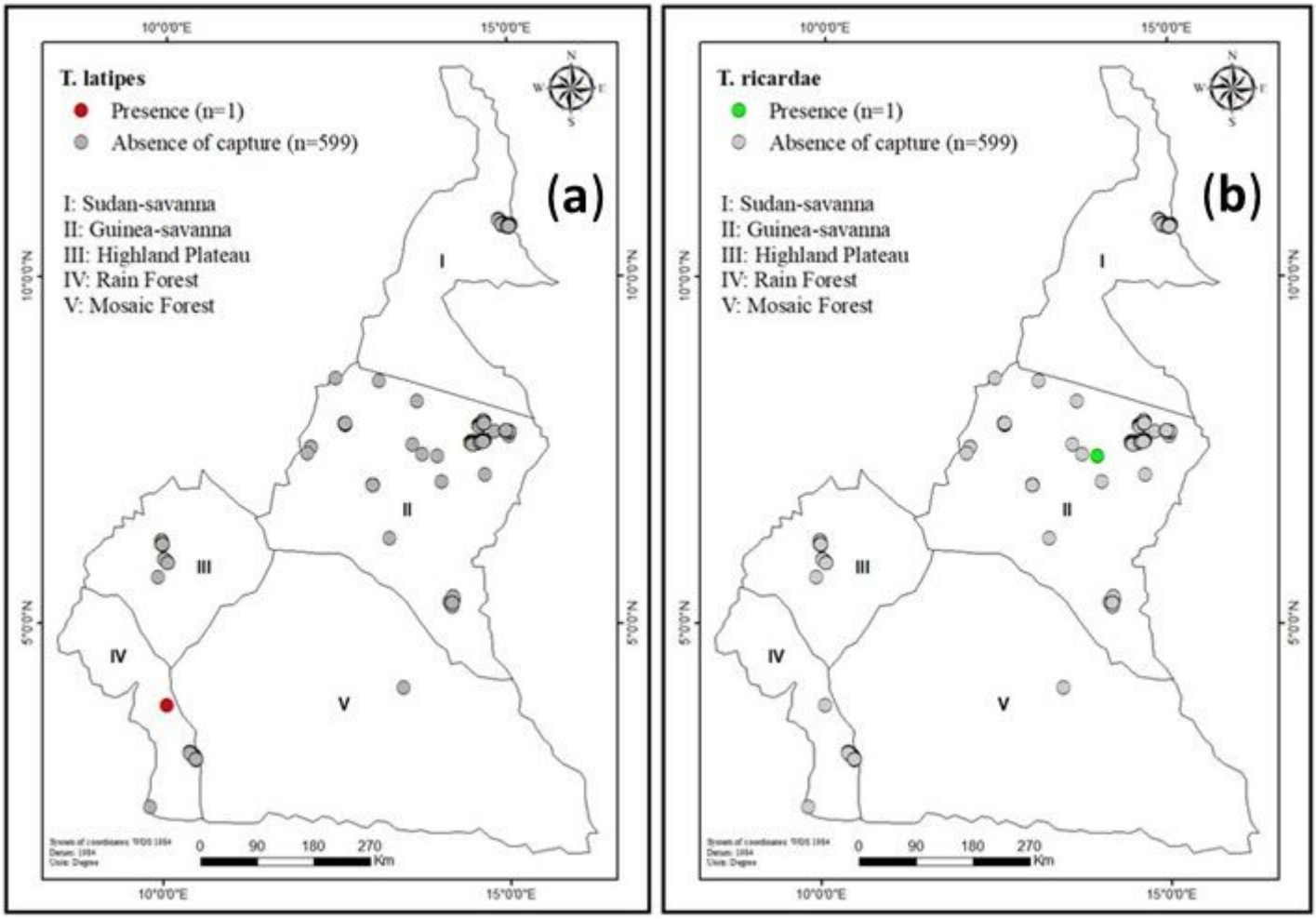

Figure 4

Distribution map of T. latipes (a), T. ricardae (b). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

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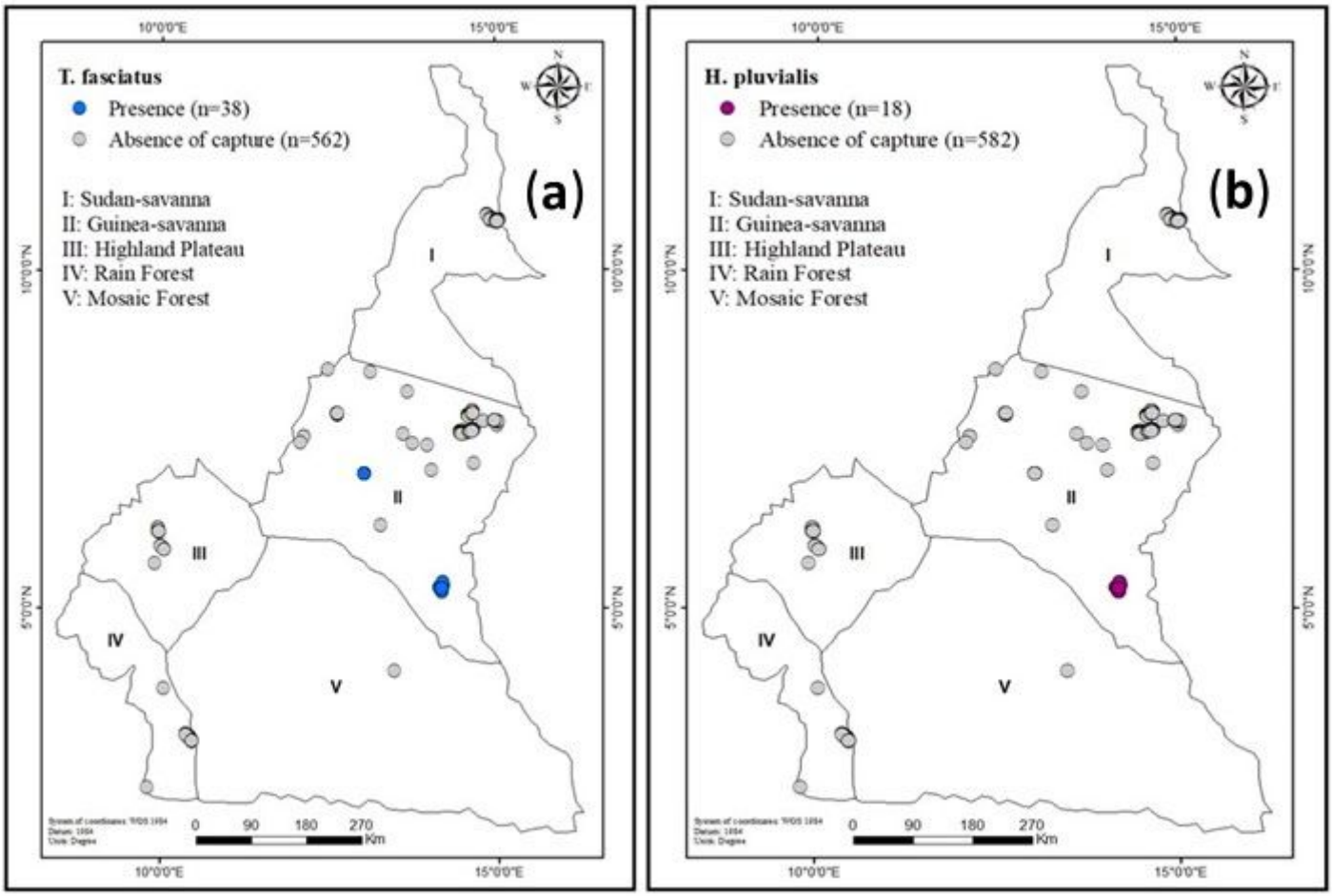

Figure 5

Distribution map of T. fasciatus (a) and H. pluvialis (b). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

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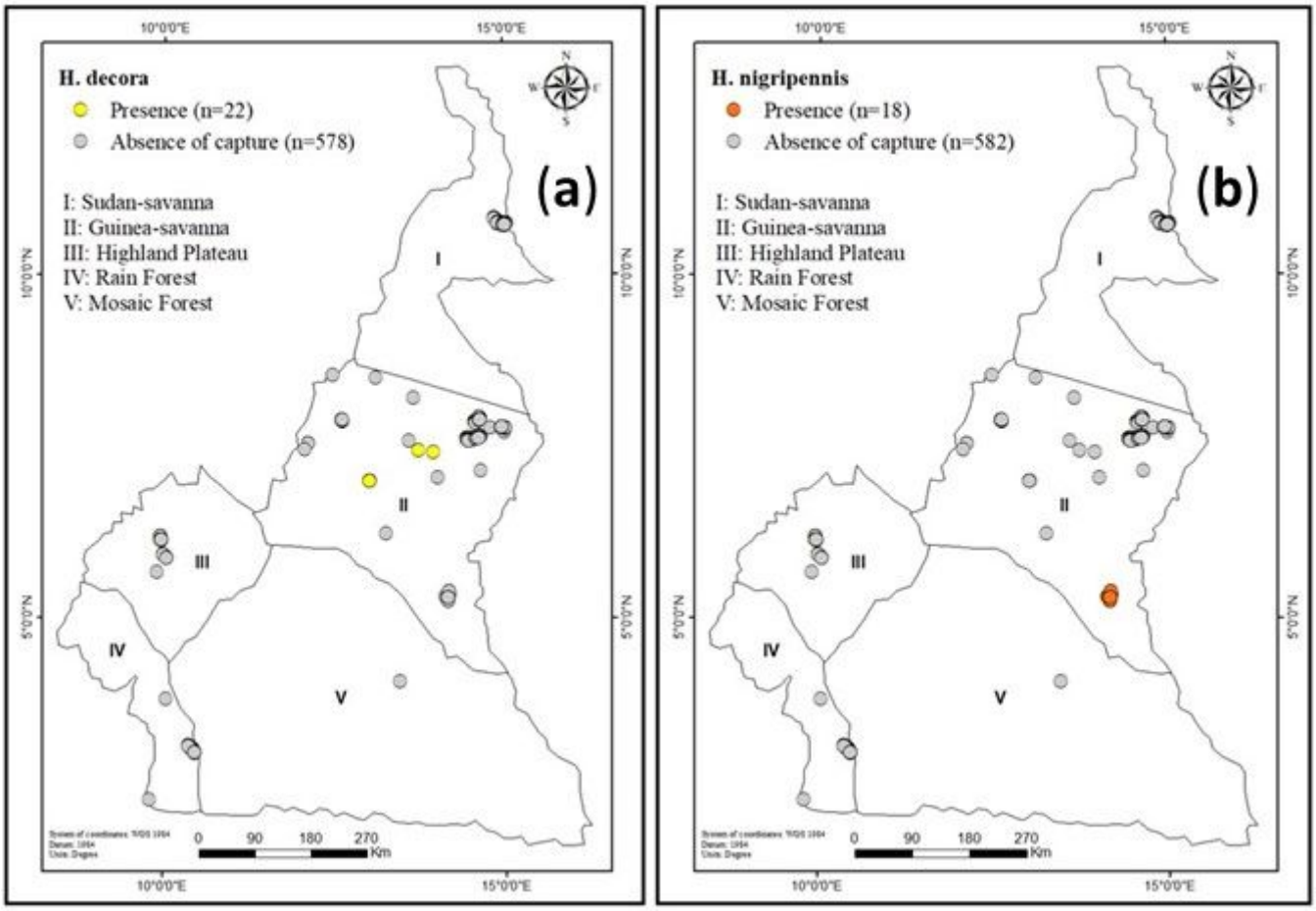

Figure 6

Distribution map of H. decora (a) and H. nigripennis (b). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

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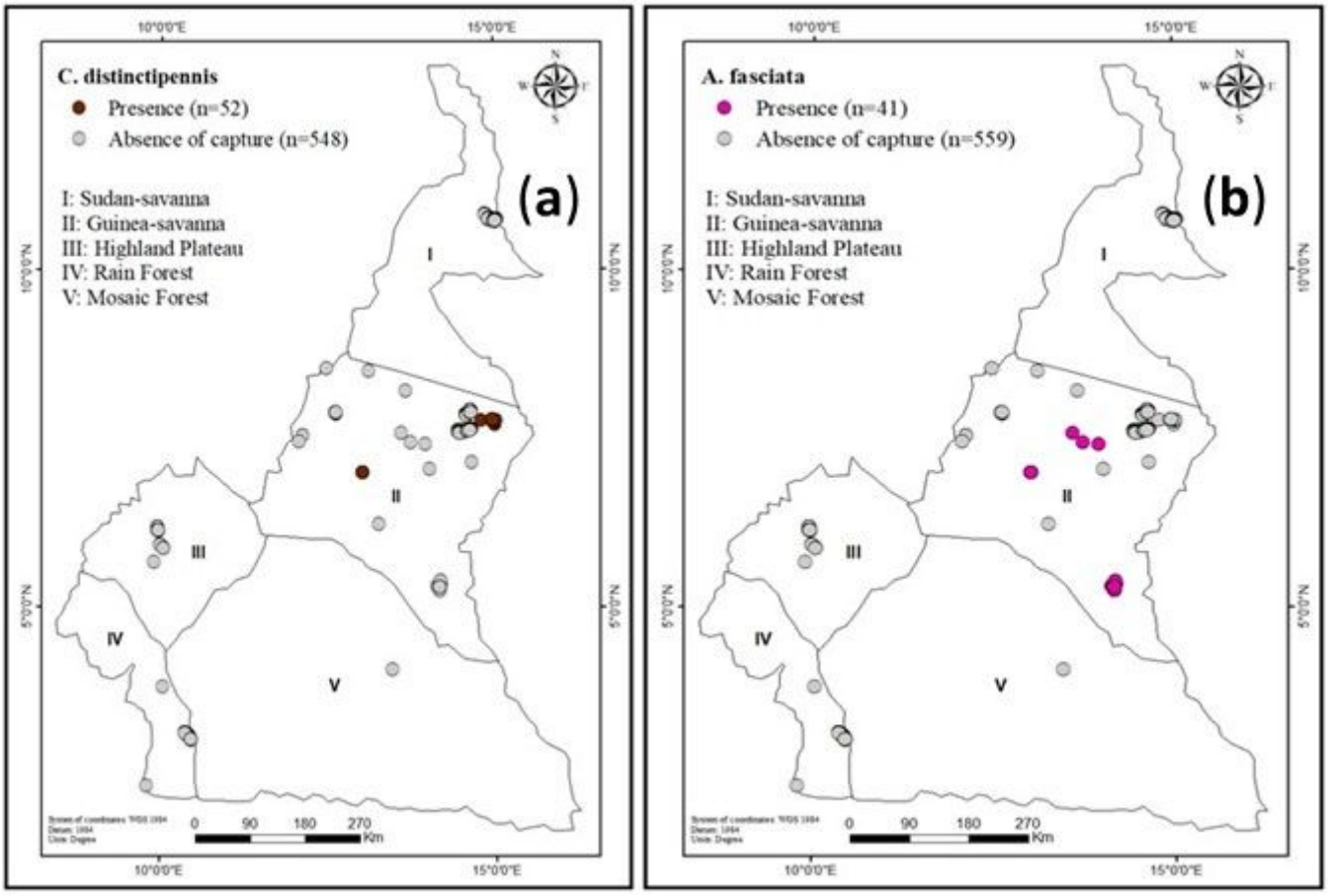

Figure 7

Distribution map of C. distinctipennis (a) and A. fasciata (b). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

Supplementary Files

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- Additionalfile1.pdf
- Graphicalabstract.jpg
- Tables23.pdf

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