Seasonal distribution and abundance of tsetse flies (*Glossina* spp.) in the Faro and Deo Division of the Adamaoua Plateau in Cameroon

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Abstract

Ten years after the large-scale tsetse control campaigns in the important cattle rearing areas of the Faro and Deo Division of the Adamaoua Plateau in Cameroon, the seasonal distribution and abundance of tsetse flies (*Glossina* spp.) were determined. During a period of 12 consecutive months (January–December 2005), the tsetse population was monitored along four trap transects consisting of a total of 32 traps and two flyround transects traversing the study area, which comprised the tsetse-infested valley, a buffer zone and the supposedly tsetse-free plateau. Throughout the study period, a total of 2195 *Glossina morsitans submorsitans* and 23 *Glossina tachinoides* were captured in the traps and 1007 *G. m. submorsitans* (78.8% male flies) were captured along the flyround transects. All *G. tachinoides* and almost all *G. m. submorsitans* were captured in the valley. Five *G. m. submorsitans* were captured in traps located in the buffer zone, whereas no flies were captured in traps located on the plateau. The index of apparent abundance (IAA) of *G. m. submorsitans* was substantially higher in the areas close to game reserves. In the remaining part of the valley, where wildlife is scarce and cattle are present during transhumance (dry season), the IAA of tsetse was substantially

lower. In this part of the valley, the abundance of tsetse seemed to be associated with the presence of cattle, with the highest IAA during transhumance when cattle are present and the lowest apparent abundance during the rainy season when cattle have moved to the plateau. It is concluded that the distribution of tsetse in a large part of the valley undergoes substantial seasonal changes depending on the presence or absence of cattle. The repercussions of those findings for the control of tsetse in the valley and the probability of reinvasion of the plateau are discussed.

Introduction

Transmission of animal trypanosomiasis on the Adamaoua Plateau in Cameroon has been attributed to three tsetse species (*Glossina morsitans submorsitans* Newstead 1910, *Glossina fuscipes fuscipes* Newstead 1910 and *Glossina tachinoides* Westwood 1850). The invasion by tsetse flies of this part of the country occurred around 1950 (Banser, 1979; Hurault, 1993). At that time, about 40% of the national cattle herd was kept on the Adamaoua Plateau (Banser, 1979). The impact of the invasion of tsetse on livestock production was substantial. Livestock keepers suffered losses resulting from reductions in fertility and weight gain, and mortality rates rose alarmingly (Banser, 1979). As a result of this disastrous situation, livestock keepers emigrated from the tsetse-infested regions. In Tignere, the worst affected district, the cattle population dropped from 300 000 prior to the invasion of tsetse flies to 35 000 (Banser, 1979); in the 1970s cattle were almost absent from the Tignere area (Boutrais & Cuisance, 1995). To improve this situation, the government organized biannual trypanocidal drug campaigns between 1960 and 1975 in the affected regions of the Adamaoua Plateau and in northern and eastern Cameroon. These campaigns provided preventive treatment at the start of the transhumance and curative treatment upon return or in the case of illness (Hamadama, 2001). Moreover, a tsetse control unit was created in the extreme northern part of the country in 1967. This unit launched a ground-spraying campaign with DDT (dichloro-diphenyl-trichlorethane) (Banser, 1979). In 1974, the government of Cameroon created a specialized service in the Ministry of Livestock charged with tsetse eradication. This service, headquartered in the important cattle production centre of Ngaoundéré in the Adamaoua highlands, incorporated the unit in the north to form the Mission Spéciale d'Eradication des Glossines (MSEG [Special Mission for the Eradication of Tsetse]). In the north of the country, the MSEG continued to ground spray with DDT, whereas in the hilly terrain of the Adamaoua, helicopter spraying was used. However, despite the control efforts, tsetse continued to reinvade tsetse-cleared areas of the plateau (Cuisance, 1991).

To reclaim tsetse-infested land, two aerial spraying campaigns (one in 1991–92 and another in 1994) were conducted on the Adamaoua Plateau, resulting in the effective control of tsetse flies (Cuisance & Boutrais, 1995). To prevent reinvasion from the valley, a barrier consisting of targets and traps was put in place after aerial spraying. However, bush fires destroyed most of the targets and traps soon after their deployment in 1994. Thereafter the barrier was replaced by a programme of insecticide treatments of cattle. At the end of 1994, a preliminary evaluation of the tsetse control activities in

Adamaoua showed that the eradication campaign on the plateau had not been 100% effective and that some pockets of *G. m. submorsitans* and *G. f. fuscipes* had survived (Cuisance & Boutrais, 1995). A study carried out in 2004 indicated a low trypanosomiasis prevalence and incidence on the plateau (Mamoudou *et al.*, 2006). The present study was aimed at determining tsetse distribution in the valley and in the Faro and Deo Division of the Adamaoua Plateau 10 years after the aerial spraying campaign of 1994.

Materials and methods

Study area

The Faro and Deo Division is located in the northern part of the Adamaoua Plateau and covers about 11 000 km^2 (Plan National de Vulgarisation et de Recherches Agricoles (PNVRA), 2001, unpublished data). It is bordered in the north by the Faro Game Park and in the west by the Nigerian Gashaga Forest Reserve (Fig. 1). The area lies at an altitude of 1000–1100 m a.s.l. The climate is classified as high-altitude subhumid, with an average annual rainfall of 1400 mm (De Wispelaere, 1994). The rainy season lasts from March/April to October and most of the rainfall occurs between June and September. The Adamaoua Plateau is covered with savannah-type vegetation, more than 90% of which consists of *Daniellia oliveria* and *Lophira lanceolata* (Letouzey, 1969). Other common tree and grass species are *Isoberlinia doka* and *Sporobolus africanus*, respectively (De Wispelaere, 1994).

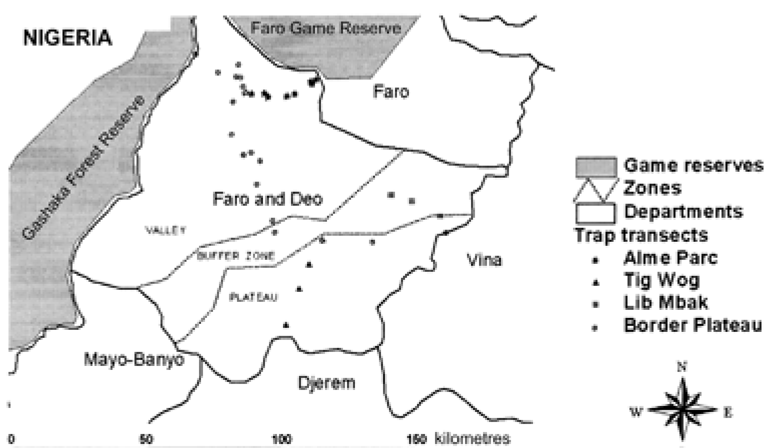

Fig. 1. Location of trap transects on the plateau, in the buffer zone and in the valley of the Faro and Deo Division, Adamaoua Plateau, Cameroon.

About 74 500 head of cattle are present in the Faro and Deo Division, some of which are kept on large ranches (Pan-African Programme for the Control of Epizootics (PACE), 2005, unpublished data). The Division has a population of about 67 400 inhabitants (PNVRA, 2001, unpublished data). At the end of the tsetse control campaigns in 1994, the Faro and Deo Division was divided into three zones consisting of the plateau, a buffer zone and the valley, from south to north, respectively (Fig. 1). Currently, large cattle herds are present on the plateau and about 3000 animals move to the valley during transhumance. During the rainy season, a large proportion of the cattle on the plateau are dipped weekly in deltamethrin (Butox®, Intervet, The Netherlands) or cypermethrin (Eradic®, France).

The MSEG identified the buffer zone as a potential barrier against the reinvasion of tsetse from the valley to the plateau (Boutrais & Cuisance, 1995). For this purpose, cattle in the buffer zone were supposed to be treated regularly with pyrethroids. Accurate data on the number and frequency of treatments are not available, but given the financial constraints of livestock owners in the area, treatments are expected to have been irregular.

The valley is an agricultural zone where the cattle from the plateau, the buffer zone and some herds from neighbouring Nigeria spend most of the dry season (transhumance). The transhumance occurs from October to March. During the rainy season, only five resident cattle herds are present in the valley. High densities of wildlife are found inside and adjacent to the game areas (Fig. 1). Tsetse flies are very abundant in the Gashaka Forest and Faro Game Reserves, where tsetse flies never have been controlled (Boutrais & Cuisance, 1995).

Tsetse monitoring

Trap transects. Between January and December 2005, the tsetse population was monitored along four transects traversing the three zones (plateau, buffer zone and valley) of the study area. A total of 32 geo-referenced biconical traps (Challier & Laveissière, 1973) were deployed, in riverine vegetation as far as was possible. Eight traps were situated in the valley along a transect (Alme Parc) adjacent to the Faro Game Reserve, three traps along a second transect (Lib Mbak) in the buffer zone and three traps along a third transect (Tig Wog) on the plateau (Fig. 1). A fourth transect (Border Plateau) of 18 traps started on the plateau, traversed the buffer zone and ended in the valley (Fig. 1). Depending on the location of the traps in the valley, this part of the Border Plateau transect was further divided into a transhumance section (traps 5–11) located in the area of the valley where cattle graze during transhumance, and a game section (traps 12–18) adjacent to the game areas (Fig. 1). Four additional traps on the plateau and seven in the buffer zone were deployed along a river and in a cattle grazing area. The trap transects traversed the various vegetation types and human settlements. Traps were functional for 24 h every week for a period of 12 consecutive months. The number of tsetse caught during that period was recorded and the species and sex of the flies were identified. For each transect a monthly mean index of apparent abundance (IAA) was calculated as the average number of flies (male and female) captured per trap per month.

Flyround transects. From January to December 2005, the tsetse population in the valley was also monitored along two flyround transects. The first transect was located in a livestock transhumance area (transhumance flyround) and the second close to the game reserve (game flyround). Each transect was about 6 km long and had 30 geo-referenced stops at approximately 200-m intervals. Flyrounds were conducted along these transects as described by Potts (1930) and Ford *et al.* (1959) using teams of two individuals. The teams used a black screen (1.5 × 1 m) suspended from a bamboo pole and kept vertically in place by a second bamboo pole at the bottom. The flyround team remained at each stop for 2 min and, using handnets, captured tsetse alighting on the screen. All flies were killed immediately after capture and each fly was put in a labelled tube.

Transects were traversed once a month alternately in opposite directions. Records were kept of the number and sex of the tsetse captured at each stop. A monthly mean IAA of tsetse was calculated as the monthly number of flies (male and female) captured per stop per flyround.

Statistical analyses

Data were managed using Microsoft excel. Statistical analyses were carried out using Minitab Release 13 for Windows 2000 (MINITAB, 2000).

Results

Trap transects

Throughout the study period, 2195 *G. m. submorsitans* and 23 *G. tachinoides* were captured in the 32 traps. No tsetse flies were captured in traps along the Tig Wog and Lib Mbak transects. The Alme Parc transect accounted for 619 male and 328 female *G. m. submorsitans* and eight male and 11 female *G. tachinoides*. A total of 65 male and 24 female *G. m. submorsitans* were captured in the transhumance section of the Border Plateau transect. The seven traps in the game section of this transect captured a total of 686 male and 473 female *G. m. submorsitans* and three male and one female *G. tachinoides*. The seven additional traps, deployed in the buffer zone, captured a total of two male and three female *G. m. submorsitans*. The monthly mean IAA of *G. m. submorsitans* varied between months and between sampling sites. It was significantly higher ($P < 0.001$) closer to the game areas compared with the transhumance areas (Fig. 2). In the valley, where cattle are kept during transhumance (the transhumance section of the Border Plateau transect), the monthly mean IAA was highest during the dry season. By contrast, closer to the game reserve (Alme Parc and the game section of the Border Plateau transects), tsetse monthly mean IAA was highest during the rainy season (Fig. 2).

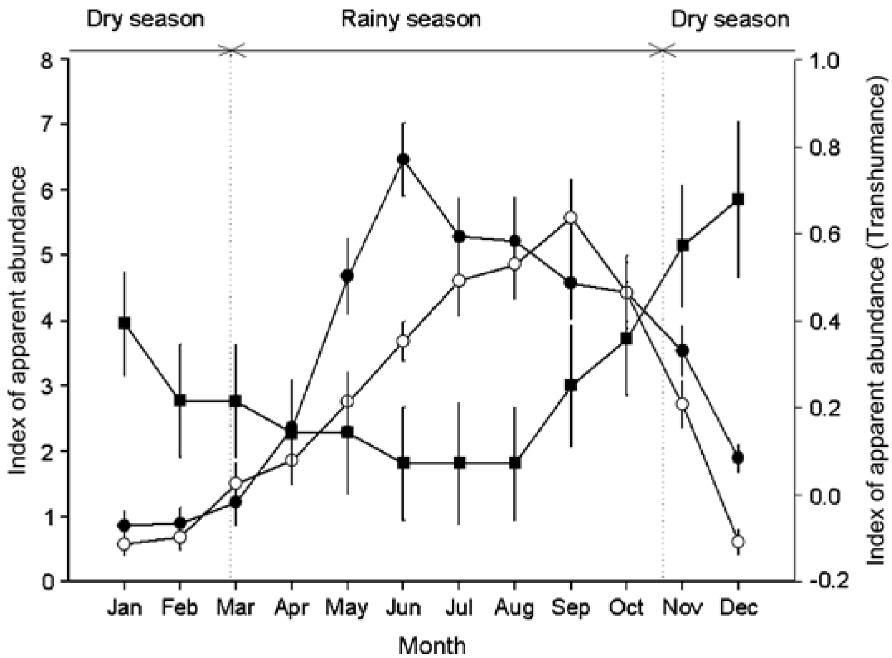

Fig. 2. Monthly mean index of apparent abundance (± standard error) of ***Glossina morsitans submorsitans*** along the Plateau Border trap transect (transhumance section, ▪; game section, •) and along the Alme Parc trap transect (○) in the valley bordering the Adamaoua Plateau, Faro and Deo Division, Cameroon.

Flyround transects

A total of 1007 *G. m. submorsitans* (78.8% male flies) were captured during 24 flyrounds. The number of tsetse captured during each flyround varied substantially between seasons and between areas (Fig. 3). Most of the flies (86%) were captured along the game flyround transect, with the highest mean monthly IAA recorded at the end of the rainy season and the lowest mean monthly IAA during the dry season. By contrast, the mean monthly IAA of tsetse along the transhumance flyround transect increased at the end of the rainy season/beginning of the dry season and reached its peak during the dry season.

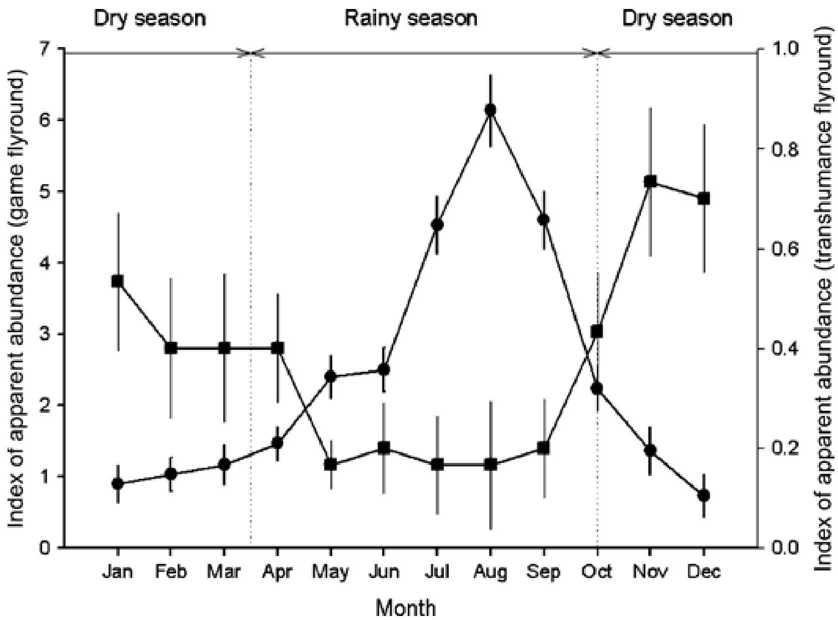

Fig. 3. Monthly mean index of apparent abundance (± standard error) of *Glossina morsitans submorsitans* along the game (•) and transhumance (▪) flyround transects in the valley bordering the Adamaoua Plateau, Faro and Deo Division, Cameroon.

Discussion

Results from this study show the presence of tsetse flies at high density in the valley and at very low density in the buffer zone of the Adamaoua Plateau. It thus seems that more than 10 years after the large-scale tsetse control campaigns, tsetse flies remain present on the plateau at very low density and probably in isolated pockets, causing little harm to livestock production. Such effective and persistent control of tsetse was also observed in northern Nigeria (Jordan, 1986). The current tsetse situation on the plateau seems to be very similar to the situation immediately after the eradication campaign (Cuisance & Boutrais, 1995). In the valley, however, the overall IAA of tsetse was high, with *G. m. submorsitans* the dominant tsetse species and *G. tachinoides* restricted to the areas surrounding the game reserves. The IAA was highest in areas close to game reserves. A previous study found that, independent of the sampling method, the overall monthly mean IAA of tsetse flies in the valley was highest during the rainy season, increasing rapidly at the beginning of the rainy season and peaking towards its end, resulting in substantial trypanosomiasis challenge at this time of year (Mamoudou *et al*., 2006). However, the sampling locations in the valley in our study resulted in the observation of opposite trends in mean monthly IAA. Indeed, in areas where cattle are present during transhumance, the monthly mean IAA reached its highest level during the dry season and its lowest during the rainy season. The combination of stationary (trap) and mobile (flyround) sampling methods probably contributed to improved sampling efficiency of the two tsetse species. Although the flyround is not a common sampling method for *G. m. submorsitans*, the high number of flies captured during a limited number of flyrounds suggests its efficiency for sampling this tsetse species. Moreover, trends in the apparent density of *G. m. submorsitans* were similar for both sampling methods.

Wildlife is present in the protected wildlife zones of the Faro Game Reserve and Gashaka Forest Reserve (Fig. 1), but also in the extensive uninhabited areas surrounding the game parks. This wildlife provides an important source of food for the tsetse population. It is thus not surprising that the IAA of tsetse was generally high adjacent to game reserves, with an increase during the rainy season when climatic conditions for tsetse are most favourable. In the other parts of the valley, by contrast, wildlife is scarce but cattle are present at high density during the dry season (transhumance). During transhumance, herds move from the plateau and neighbouring Nigeria into the valley and spend most of the dry season in the valley (October–March). Cattle are allowed to roam freely and feed unattended, mainly on crop residues. At the beginning of the rainy season, pastoralists and their herds leave the valley. Hence, with the exception of five resident cattle herds, large host animals are absent from extensive parts of the valley during most of the rainy season. These abrupt changes in the availability of hosts seem to have significant repercussions for the distribution and density of the *G. m. submorsitans* population in the valley. Indeed, during the dry season, tsetse can move freely throughout most of the valley where hosts (wildlife or cattle) are readily available. During the rainy season, after most of the cattle have left the valley, wildlife remains and constitutes the most important source of food. As a result, tsetse are more confined to those areas where wildlife is present. The association between the distribution of savannah species of tsetse flies and their hosts has been observed elsewhere (Brightwell *et al.*, 1992; Rawlings *et al.*, 1994; Van den Bossche & De Deken, 2002). In all these cases sudden changes in the distribution and density of cattle resulted in substantial changes in the distribution and density of tsetse flies. The findings of this study have important repercussions for tsetse and trypanosomiasis control strategies in the Faro and Deo Division of the Adamaoua Plateau. Indeed, as tsetse flies are almost absent in extensive areas of the valley bordering the plateau, reinvasion pressure of tsetse flies from the valley onto the plateau is low. Invasion pressure might be reduced even further by the large-scale application of insecticides to cattle present in the valley during the transhumance period. Although tsetse flies remain present at low density on the plateau, the eradication of these pockets could perhaps be achieved through systematic use of pyrethroid insecticides on livestock.

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