6. DISCUSSION

6.1 Prevalence and incidence of bovine trypanosomosis

Results from the trypanosomosis monitoring indicate that 10 years after the tsetse control operations in the Adamaoua region, the incidence of this disease in the plateau is still relatively low (0-2.1%). This finding is in accordance with the observation that no tsetse flies were detected in the plateau. The mean PCV of the animals in the plateau would be expected to be higher than in the buffer zone and the valley, but this was not the case. The lower PCV recorded in the plateau suggests occurrence of other anaemia causing conditions, presumably tick infestation, helminthosis, haemoparasitosis (other than trypanosomosis) and nutritional deficiencies, in the area and also frequent treatment with insecticide in buffer zone and the valley can contribute of the lower densities of haematophagous insects, notably *Stomoxys spp* than on the plateau.

Given the relatively high incidence of trypanosomosis in both the valley and in the buffer zone, it is surprising that only very few tsetse flies (n=6) were captured in the latter zone than in the valley. This might be explained inter alia by the fact that cattle are the most likely hosts of tsetse flies in the buffer zone (few game animals) and thus receive higher challenge compared to those cattle kept in the valley where game animals are present. But also, due to the relationship between challenge and tsetse. With the exception of a few *G. tachinoides*, the tsetse survey showed almost exclusively *G.m. submorsitans.* This proved that two of the 3 tsetse species, which were present in the Adamaoua region in 1950 (Banser, 1979; Hurault, 1993), are still there. Whether or not *G. f. fuscipes* exists there, needs to be further explored. However, it can be postulated that underestimation of the abundance of tsetse flies due to the use of biconical traps , which are not ideal for catching high numbers of *G .m. morsitans* and *G. f. fuscipes* (Takken, 1985; Snow, 1977). Due to the small number of sentinel herds and traps which were used in this study, these results have to be interpreted with caution and larger surveys need to be carried out in order to re-confirm the findings of this study.

The overall level (15%) of sero-conversion during transhumance, which was observed in this study, coincided with the peak of trypanosomosis incidence rate (12-20%) in the sentinel animals in the valley. Given the important differences in sero-coversion rates from one herd to the other, the challenge in the tsetse infested valley was probably very different from one place to the other. This might be linked to the presence of areas with high tsetse densities especially near game reserves.

6.2 Tsetse distribution in Faro and Deo division

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. Although tsetse flies could not be captured on the plateau, the low incidence of trypanosomosis in cattle indicates that the flies remain present on the plateau at very low density and probably in isolated pockets causing little harm to livestock production. The current tsetse situation on the plateau seems to be very similar to the situation immediately after the eradication campaign (Cuisance and Boutrais, 1995). In the valley, on the other hand, the overall IAA of tsetse was high. This was especially the case in areas closer to the game reserve. Throughout the study period the IAA in the Game area was substantially higher than the IAA in the Transhumance area. In the Game area, the IAA increased at the beginning of the rainy season and reached maximum at the end of the season; then gradually decreased during the dry season (Fig 5.4). In contrast, the monthly IAA values were highest during the dry season in the transhumance area but remained low throughout the rainy season (Fig 5.4 and Fig 5.5). The observed changes in the IAA might be due to "real changes in fly population densities, as a result of growth or movement of tsetse, and/or changes" in capture probability (Hargrove and Packer, 1999; Vale, 1998). Although changes in capture probability cannot be excluded entirely, depending on the distributions of fly hosts which could move freely in large parts of the valley. Tsetse on average, move randomly in their habitats (Brusell, 1970).

Game animals are present in the protected wildlife zones of the Faro game reserve and Gashaga forest reserve (Fig 4.4). In addition, they are present in the extensive uninhabited areas surrounding the game parks. Hence, the monthly mean of IAA of tsetse was highest in this area because these flies require regular blood meals to survive. Especially, in areas with high ambient temperatures such as the Adamaoua, the feeding frequency is high (one meal about every 3 to 4 day) (Van den Bossche, 2004). This implies that hosts have to be available in the vicinity of the tsetse habitat. Hence, can be concluded that game population in the valley supported tsetse flies for their densities were high in and around the game areas.

In the valley, the movements of pastoralists and their herds depend on the season and are carefully regulated by the Government. In the dry season, herds move from the plateau and neighbouring Nigeria into the valley and spend most of the dry season there (October-March). Cattle are allowed to roam freely and feed unattended, mainly on crop residues on fields surrounding the valley woodland. At the beginning of the rainy season, these pastoralists and their herds move from the valley, with an exception of 5 herds (which remain there during the rainy season in non- cultivated areas at the bottom of Guemfalabo Mountain because of the presence of tsetse flies; (personal observation). Cattle (and thus tsetse hosts) are absent in the large areas of the valley during the rainy season. Those abrupt movements of large cattle herds have significant impacts on the tsetse population in the valley. During the dry season, tsetse can move freely through most of the valley area and feed on cattle. Therefore, a significant correlation exists between the abundance of tsetse and the presence of cattle (in the same or the previous month). The drop in the IAA of tsetse in the transhumance area during the rainy season can be attributed to the sudden decline in host availability. Similar observations between the apparent distribution of *G.m morsitans* and the distribution of hosts have been reported in the Eastern Province of Zambia. (Hall, 1910; Lioyd, 1916; Van den Bossche and De Deken, 2002). Thus, it seems the distributions of tsetse in the valley undergoes substantial seasonal changes depending on the presence or absence of hosts, mainly cattle. In the presence of cattle (dry season) large areas are re-invaded in the absence of them, tsetse distributions are confined to areas where games are present. And, this probably explains why high proportion of females was recorded in this game section since the area constituted a breeding ground whereas the high proportion of male flies were captured in the transhumance area.

6.3 Chemoresistance.

6.3.1 Field trials to detect drug resistance

This study is the first report of trypanocidal drug resistance in Cameroon. The trypanosomosis incidence in the group treated with diminazene was 32.5%, over a period of 8 weeks which is in fact an underestimation of the real incidence because the remanent effect of diminazene was not taken into account (Faye *et al.,* 2001). In the group treated with isometamidium the incidence was 27.5% over a period of 8 weeks. Survival analysis and the ratio of the mean hazard rate (1.38) for the control and isometamidium treated herds suggested resistance to isometamidium and a reduced protective activity of this drug. (Eisler *et al*., 2000). According to McDermott *et al.* (2003) the field study can also be used to assess only resistance to diminazene because this trypanocidal compound protects cattle for 18 to 22 days (Faye *et al.,* 2001). An important number (20 to 45, 5% according to the group) of animals which was treated with diminazene was found positive two weeks later indicating a strong suspicion of resistance to this drug. These field results were corroborated by the results of the standard mouse test using 6 isolates of *Trypanosoma congolense*. Sensitivity tests using 1 mg/kg isometamidium chloride or 20 mg/kg diminazene aceturate showed that all isolates were resistant against at least one of the drugs used whereas 4 isolates were resistant to both drugs. In order to evaluate whether the sanative pair (diminazene and isometamidium) is still effective, trypanosomes need to be cloned and examined for susceptibility/resistance to both drugs. If it would appear that multiple resistance to both diminazene and isometamidium is present at the level of the cloned trypanosomes, then there would be a serious problem because these drugs would be rendered useless for sanative purpose.

6.3.2 Prevalence of drug resistance in Adamaoua

The aim of this part of the whole study was to evaluate the prevalence of drug resistance in the Adamaoua using the standard test in mice. Out of 19 trypanosome isolates examined, a surprisingly high percentage (84.2%) was resistant to isometamidium. Concerning resistance to diminazene, a total of 13 out of 17 (76.4%) isolates were identified as resistant.

Unfortunately, because of time and financial constraints it was not possible to examine all isolates collected from field study using the single dose mouse test. However, the results of this study indicate that resistance to isometamidium and diminazene was highly prevalent in the study area. These drugs have been used for decades in the region (Banser, 1979) and drug resistance was until now not reported in Cameroon. However, a study carried out in the North of the country (Awa and Ndamku, 2006) on the efficacy of two formulations of isometamidium (Veridium® and Trypamidium®), suggested that either infections were not cleared or residual drug effects were not sufficient to prevent re-infections. This prevalence study of drug resistance represents the first large scale survey of drug resistance in the pastoral zone of Adamaoua and it shows that the situation is serious. Similar high levels of trypanocidal drug resistance were observed in Kénédougou Province of Burkina Faso where the prevalence of isometamidium resistance was 63.8 % and that of diminazene resistance was 36.8% (McDermott *et al.,* 2003). In Zambia, moderate levels of resistance to isometamidium (35% of stabilates) or to diminazene (12% of stabilates) were reported based on mice tests (Sinyangwe *et al.,* 2004).The high prevalence of isometamidium and diminazene resistance in Adamaoua region can be explained by the large-scale use of these drugs, and generic products in the region often under inadequate veterinary supervision. In the past (1960-1975), mass treatments using isometamidium and diminazene were carried out twice a year (drugs were provided free of charge by the government). These mass campaigns are probably the foundation of the widespread resistance genes in the trypanosome population. Once resistance genes are present they do not disappear easily as is shown by the examples in the Ghibe valley (Mulugeta *et al.,* 1997) and in Zambia (Sinyangwe *et al.,* 2004). The strategic treatment frequency is more difficult to estimate after this period, but data from a limited survey (interviews of cattle owners) in October 2004 show that about 90% of cattle breeders treated their animals with higher treatment frequency using isometamidium chloride (Trypamidium®), diminazene aceturate (Veriben®,Sangavet®) and other generic trypanocides (Table 3.2).