Current Tsetse and Trypanosomosis Situation on Jos Plateau, Nigeria. Epizootiological Factors that May Enhance Disease Transmission and Spread

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Keywords

Cattle – *Glossina* – Trypanosomosis – Risk factor – Vectorborne disease – Jos Plateau – Nigeria.

Summary

Tsetse and trypanosomosis surveys were carried out in Jos-East, Riyom, Bassa and Bokkos local government areas (LGAs) of Jos Plateau, Nigeria. They followed reports of cases of trypanosomosis that led to the death of several livestock animals in the areas. Biconical and Nitse traps were pitched in suspected tsetse habitats. Also, cattle and sheep from selected native and Fulani herds within the areas surveyed were screened. Altogether 240 tsetse flies were caught, comprising 114 *Glossina tachinoides* and 126 *G. palpalis palpalis,* and revealing an overall apparent density of 4.63 flies/trap/day. Fly dissection showed an overall infection rate of 1.67% due to *Trypanosoma brucei* and *T. vivax*. Also, 87 *G. tachinoides* pupae were collected from Bassa and Jos-East LGAs. Other biting flies totaling 1536 were caught *(Stomoxys*, *Tabanus* and *Haematopota)*. A total of 1053 cattle and 65 sheep were screened for trypanosome infection. The hematocrit centrifugation, animal inoculation, and morphological differential techniques were used to determine trypanosome species and prevalence rates. Results revealed a 7.79% prevalence rate in cattle due to *T. brucei, T. congolense, T. vivax,* and *T. theileri*, and a 3.08 prevalence rate in sheep due to *T. vivax*. The main factors that may predispose Jos Plateau to tsetse presence and trypanosomosis infection include dry and rainy seasons' cattle migrations across the plateau to and from tsetse infested areas, abundance of other biting flies, changes in climatic conditions and increased human activities. These findings have debunked the protracted notion upholding Jos Plateau to be tsetse and trypanosomosis free; hence the safety of resident and migrant livestock, which unfortunately have increased in recent times, may no longer be guaranteed because of the trypanosomosis risk.

■ INTRODUCTION

Despite tsetse reclamation programs embarked upon by the Nigerian Government nearly forty years ago, 75% of the country's land mass is still infested by 11 species of *Glossina*, main transmitters of trypanosomoses in humans and livestock. These species altogether are of countrywide distribution, from the Atlantic coastline to latitude 13°N, with the exception of the uninfected area made up of the high grounds of the Mambilla and Obudu Plateaux (17, 24). Although trypanosomosis occurs wherever the tsetse fly vector is found, its distribution in Nigeria is wider and occurs outside tsetse infested areas in the far north (22, 26).

Although situated within the subhumid zone of central Nigeria, Jos Plateau rises above the surrounding region of extensive plains and broad valleys to a height over 1200 m above sea level. The plateau together with the high grounds to its northwest form a watershed between the rivers running into the Niger in the west, the Benue in the east and lake Chad in the northeast (7, 9, 30). Also, it has relatively higher rainfall (1400-1500 mm) and lower temperatures than the adjacent areas (25). The vegetation is typical of a montane community consisting primarily of grassland with forest and woodland along rivers and stream courses, and steep slopes. The above factors, the supposedly tsetse and trypanosomosis free

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nature, plentiful water supply, and the provision of limited perennial grazing grounds, combine to make Jos Plateau very attractive and conducive for human habitation, and suitable for animal husbandry. Thus, Jos Plateau attracted over the years a constant influx of cattle, which often resulted in permanent settlement of Fulani herdsmen. Their numbers over the years have increased rapidly and the plateau is estimated to support one of the highest cattle concentrations in Nigeria (1).

Early investigations on tsetse and trypanosomosis on Jos Plateau were carried out by Marshal (20) and Ajayi et al. (2), who reported cases of natural trypanosome infection with *Trypanosoma congolense* and *T. vivax* in work oxen and Friesian heifers, respectively, which were exclusively kept on the plateau. They attributed these infections to mechanical transmission by some biting Muscidae. Similarly, Joshua (12), Joshua and Shanthikutmar (13), and Kalu (14) also reported positive trypanosome infections in cattle herds kept on the lower Jos Plateau. In addition, the above-mentioned studies revealed the presence of tsetse species, namely *Glossina tachinoides, G. palpalis* and *G. morsitans submorsitans*, and these latter also harbored matured trypanosome infections.

This survey aimed at updating the status of tsetse and trypanosomosis on Jos Plateau, and determining epidemiological factors that might enhance and sustain disease transmission and spread.

■ MATERIALS AND METHODS

Four local government areas (LGAs) (Bassa, Bokkos, Riyom and Jos-East) of Jos Plateau (Figure 1) were selected based on reported cases of trypanosomosis. Affected districts within the LGAs were surveyed for tsetse and trypanosomosis. Thirty biconical and Nitse traps were pitched between 100 and 120 m apart in suspected tsetse habitats along rivers and streams, human settlements, forest islands, ranches and plantations. They were monitored for 48-72 h before relocation to another trapping site. Whirling hygrometer was used to determine the percentage of relative humidity and temperatures of the experimental areas. Tsetse species caught were identified, sexed, dissected and examined for trypanosome infection (16). The age determination of flies was based on the use of the modified wing fray analysis technique for males (3) and the use of the ovarian configuration technique (27). Pupae were sought and collected from breeding sites on receded rivers, streambeds and banks. Cattle and sheep from selected native and Fulani herds within areas surveyed were screened. About 5 ml of blood was drawn from the jugular vein of each animal into bottles containing an anticoagulant (EDTA). The hematocrit centrifugation technique (HCT) (31), animal inoculation technique (AIT) (10) and morphological differentiation technique (MDT) from wet and Giemsa-stained thin and thick films (11) were employed in the determination of trypanosome species and prevalence rates in the livestock screened. Animals found positive were treated with Berenil.

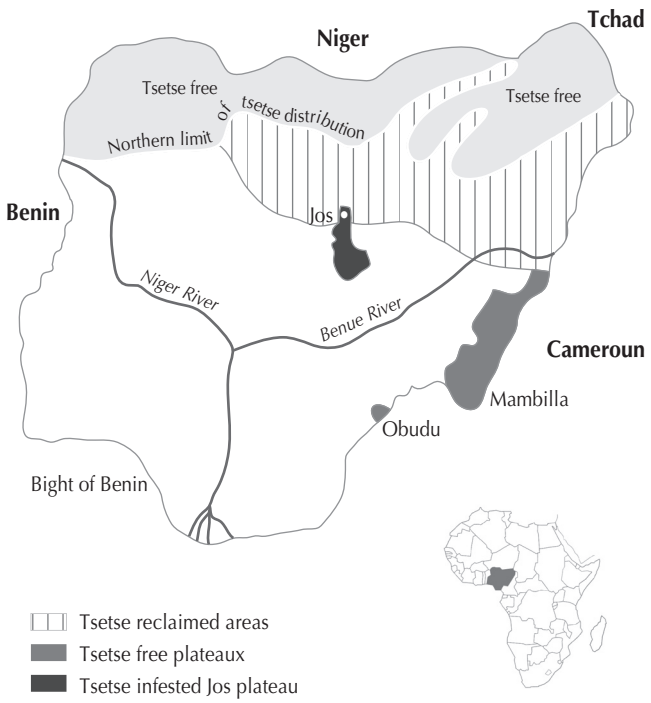

Figure 1: *Current tsetse distribution map of Nigeria.*

■ RESULTS

The average daily mean minimum and maximum temperatures were 22 and 32°C, respectively, whereas the average daily mean relative humidity at noon varied from 23 to 47%. A total of 240 tsetse flies, comprising 114 *G. tachinoides* and 126 *G. palpalis palpalis* were caught in both biconical and Nitse traps (Table I), revealing an overall apparent density of 4.63 flies/trap/day. A breakdown of these catches showed that 79 *G. tachinoides* were caught in Federe on the northeastern escarpment in Jos-East LGA, with more than one third of these catches made from human habitations. In Bassa LGA, 35 *G. tachinoides* were caught in two locations, 11 at Kwall near Miango on the plateau and 24 at Binchin on the northwestern escarpment of the plateau. A total of 126 *G. palpalis* were caught in two LGAs, 17 flies at Kumai on the southeastern escarpment in Bokkos LGA, and 109 flies at Sop on the eastern escarpment of the plateau in Riyom LGA. A breakdown of catches by sex favored females, which in most cases were hungry flies. A total of 87 *G. tachinoides* pupae were collected from the dry season breeding sites as follows: 58 at Federe, 21 at Binchin and 8 at Kwall. Fly dissection revealed an overall trypanosome infection rate of 1.67% (Table I).

Other biting flies (Table II) totaling 1536 were caught in the following ratios: 1205 *Stomoxys* spp., 242 *Tabanus* spp. and 89 *Haematopota* spp. The cattle and sheep prevalence rate reached 7.51%, with a 7.79% prevalence due to *T. brucei, T. congolense, T. vivax* and *T. theileri* in cattle and a 3.08% prevalence due to *T. vivax* in sheep (Table III). Chi-square comparison of virulence by location did not yield any significant variation ($P > 0.05$).

■ DISCUSSION

Past and recent investigations on tsetse and trypanosomosis on Jos Plateau have reported the presence of both the vectors and the disease in livestock (2, 12–14, 20, 22). The present findings have undoubtedly lent support to these reports. In addition, as evidenced by the pupae collected, the authors confirmed the breeding of *G. tachinoides* on the escarpments of Jos Plateau. The failure to find pupae during the rainy season may not be attributed to cessation in breeding (21), in view of the dissection results that revealed the majority of females caught during the same period having instar larval stages *in utero*, thus indicating high reproductive potentials. Perhaps it was due to difficulty in locating rainy season breeding sites. The sustenance of the adult population all year round may be indicative of the continuity in breeding.

The high proportion of females caught in traps during this investigation was normal, in view of a similar observation made by Glasgow and Duffy (8), who concluded that traps are valuable because

Table I

Number of tsetse flies, pupae, and trypanosome infection rates recorded at LGAs of Jos Plateau

LGA (location)	Num. pupae (female ratio)	Num. *G. tachinoides* (female ratio)	Num. *G. palpalis*	Apparent density (flies/trap/day)	Infection rate with trypanosomes (%)
Jos-East (Federe)	58	79 (45)	0	5.64	2.53
Bassa (Binchin)	21	24 (19)	0	1.71	8.33
Bassa (Kwall)	8	11 (7)	0	0.78	0.00
Bokkos (Kumai)	0	0	17 (10)	0.28	0.00
Riyom (Sop)	0	0	109 (78)		
Total	87	114 (71)	126 (92)	4.63	1.67

LGA: local government area

Table II

Number of other biting flies caught from LGAs of Jos Plateau

LGA (location)	*Stomoxys* spp.	*Tabanus* spp.	*Haematopota* spp.
Jos-East (Federe)	296	45	10
Bassa (Binchin)	187	62	23
Bassa (Kwall)	321	69	19
Bokkos (Kumai)	289	53	37
Riyom (Sop)	112	12	0
Total	1205	242	89

LGA: local government area

Table III

Prevalence of trypanosomosis in the livestock screened at LGAs of Jos Plateau

LGA (location)	Num. of animals screened	Prevalence	*Trypanosoma* spp.*
Jos-East (Federe)	28 (cattle)	14.26	*T. brucei* *T. congolense*
Bassa (Binchin)	563 (cattle)	9.59	*T. brucei* *T. congolense* *T. vivax* *T. theileri*
	43 (sheep)	4.65	*T. vivax*
Bassa (Kwall)	31 (cattle)	9.67	*T. vivax*
Bokkos (Kumai)	431 (cattle)	4.87	*T. congolense* *T. vivax*
	22 (sheep)	–	
Total	1053 cattle 65 sheep	7.79 3.08	

LGA: local government area
* Identified from infected animals

they catch a high proportion of females. The low prevalence recorded in the present investigation compared to those reported by Kalu (14) might have arisen due to differences in the points of intervention. Whereas Kalu might have performed his investigation during the peak of the outbreak, the present study and that of Joshua (12) might have been carried out at the onset of the outbreak, hence the low recorded prevalence.

In Nigeria in the last thirty years, increased human activities such as farming, hunting, road construction and rural expansion have led to major increases in the human population. This has resulted in an overall reduction in natural tsetse habitats, wildlife hosts of several *Glossina* spp. (28), and the corresponding alteration in the pattern of tsetse distribution, with tsetse species now seeking for more conducive habitats with abundant hosts. Human habitats are fast becoming tsetse conducive, with the riverine group species exhibiting peridomestic behaviors. An example of such behaviors has been reported for *G. tachinoides* and *G. palpalis* in Nsukka area (19), and for *G. palpalis* in Donga's (5). Similarly, the *G. tachinoides* caught at Federe in this investigation were also found to exhibit peridomestic behavior, feeding on domestic pigs, cattle, sheep and goats, and a biting nuisance to humans in their houses.

Known for its conducive climate, Jos Plateau has continued to be the site of increased human settlements originating from all over the country, leading to a population explosion, increased human activities and profound pressure on the land, wildlife and forest resources (4). These effects on land use in conjunction with local (or global) changes in climatic parameters have become so pronounced that severe climate degradation with decline of rainfalls and increase in temperatures occurs now on the plateau. The daily mean minimum and maximum temperatures of 22 and 32°C, respectively, and the daily mean relative humidity at noon, which varied from 23 to 47%, were far above the values obtained previously on the same Jos plateau (15). The impact of these parameters on tsetse distribution needs to be more precisely evaluated.

The absence of *G.morsitans submorsitans* in this investigation contradicts earlier reports on the presence of this fly in the area (12, 13). The disappearance of this tsetse species from its known belts on the low-lying areas nearest to Jos Plateau might have happened because of its fast disappearing preferred habitat (savannah woodlands) and hosts (wild bovids) (23, 26). The reported decline or disappearance of *G. m. submorsitans* and *G. longipalpis* from their known defined belts in the northeast, northwest and central agroecological zones of Nigeria (23, 26) is similar to the alterations that occur in tsetse distribution resulting from habitat modifications (6). This therefore shows

that the *morsitans* group of tsetse is the most affected when habitat and wildlife are interrupted. Undoubtedly, Jos Plateau might be regarded as one of the areas the most affected by this phenomenon.

The ascension of *G. tachinoides* from the lowland escarpment to the plateau may be similar to the pattern observed in *G. palpalis* at Ganawuri, on the southwestern escarpment of Jos Plateau (29). These flies, at certain periods of the year most especially when climatic conditions in the low lying areas become unbearable, associated with the absence of animal hosts resulting from the desertion of the area by Fulani herdsmen in view of high tsetse challenge, may as a survival strategy tend to increase their spread to the conducive top of the plateau, through riverine vegetation that still persists along streams and rivers that drain from Jos Plateau into the low-lying tsetse infested areas. They may also follow migrant cattle routes that cross the plateau (18). In villages or Jos metropolis, they may feed on bountiful domestic animal hosts kept by the natives and Fulani herdsmen who either are migrants or had settled to take advantage of the supposedly tsetse and trypanosomosis free Jos plateau. These flies probably rest and/or breed under shady clusters of mango trees, pockets of forest islands, which are mostly used as forest reserves, sacred rites or cemeteries as observed in Donga (5). They may prevail throughout the year or might retreat when environmental conditions on the plateau become unfavorable, particularly during the coldest and driest periods (December-February). This corroborated observations by Swynneton (28), i.e. the establishment of a new permanent focus of infestation by any tsetse species depends on the suitability of the environment for breeding.

Migratory cattle from the low-lying tsetse infested areas might provide sources of infection for the susceptible livestock breeds that are solely kept in the area. Such flies and cattle movements can be accompanied by the introduction of new and virulent trypanosome strains, which often result in outbreak cases (14, 22). *G. tachinoides* have been caught along streams and at a livestock market within Jos metropolis (Onah, pers. commun.). Similarly, several cases of trypanosome infections in domestic ruminants kept by staff of the National Veterinary Research Institute (NVRI) and the Nigerian Institute for Trypanosomiasis Research (NITR) have been observed in Vom. Such infections most often resulted in abortion, stillbirth or death of pregnant animals. Efforts made to trap tsetse flies in Vom area were unsuccessful. Once the disease has been introduced, the spread in the absence of the tsetse vector might be sustained through the activities of mechanical transmitters such as *Stomoxys* spp., *Tabanus* spp. *Haematopota* spp., etc., which abound in the area.

■ CONCLUSION

The present findings have established the territorial expansion of the riverine tsetse species to Jos Plateau and it is likely that this may have resulted in a corresponding countrywide increase in the distribution of the fly, since there has not been any report of its decline from the known areas of infestation to suggest otherwise. Hence, the protracted notion upholding Jos Plateau as tsetse and trypanosomosis free is no longer valid. It is recommended that the establishment of cattle ranches on the plateau must be based on recommendations from tsetse and trypanosomosis surveys. Also, tsetse and trypanosomosis status of other plateaux such as those of Mambilla and Obudu may therefore need to be reassessed. Finally, due to the dynamic nature of tsetse distribution, it is recommended that periodic country-wide distribution surveys should be intensified to determine the full extent of tsetse and trypanosomosis advances and their impact on the economy.

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Résumé

Dede P.M., Halid I., Omoogun G.A., Uzoigwe N.R., Njoku C.I., Daniel A.D., Dadah A.J. Situation actuelle sur les glossines et la trypanosomose sur le plateau de Jos au Nigeria : facteurs épizootiologiques pouvant faciliter la transmission et la propagation de la maladie

Des enquêtes ont été menées sur les mouches tsé-tsé et la trypanosomose dans les régions administratives locales de Jos-Est, Riyom, Bassa et Bokkos, sur le plateau de Jos au Nigeria, suite à des cas de trypanosomose ayant causé des mortalités chez le bétail. Des pièges biconiques et Nitse ont été posés dans les zones favorables aux glossines. Des bovins et des ovins sélectionnés dans la zone étudiée dans des troupeaux de race indigène ou Fulani ont été examinés. Au total, 240 glossines ont été capturées, parmi lesquelles 114 *Glossina tachinoides* et 126 *G. palpalis palpalis*, correspondant à une densité apparente par piège et par jour de 4,63 mouches. La dissection a révélé un taux d'infection à *Trypanosoma brucei* et *T. vivax* de 1,67 p. 100. Quatre-vingt-sept pupes de *G. tachinoides* ont été recueillies dans la zone de Bassa et de Jos-Est. Par ailleurs, 1 536 insectes piqueurs autres ont été capturés *(Stomoxys, Tabanus* et *Haematopota)*. En tout, 1 053 bovins et 65 ovins ont été examinés pour la recherche de trypanosomose. Les techniques de l'hématocrite, d'inoculation à l'animal, et de diagnostic différentiel morphologique ont été utilisées pour déterminer les espèces de trypanosomes et les taux de prévalence. Un taux de prévalence de 7,79 p. 100 (due à *T. brucei, T. congolense*, *T. vivax* et *T. theileri*) a été trouvé chez les bovins, et de 3,08 (*T. vivax)* a été obtenu chez les ovins. Les facteurs principaux prédisposant le plateau de Jos aux infestations glossiniennes et à la trypanosomose ont été : les migrations saisonnières des bovins transitant par le plateau vers ou à partir des zones infestées de tsé-tsé, l'abondance d'autres insectes piqueurs, les changements des conditions climatiques et l'accroissement des activités humaines. Ces résultats contredisent la notion longtemps gardée consistant à considérer le plateau de Jos comme n'hébergeant pas de tsé-tsé et donc indemne de trypanosomose ; ainsi, la sécurité des troupeaux, résidant ou migrant sur le plateau et dont la population a malheureusement augmenté récemment, ne peut plus être assurée à cause du risque de trypanosomose.

Mots-clés : Bovin – *Glossina* – Trypanosomose – Facteur de risque – Maladie transmise par vecteur – Plateau de Jos – Nigeria.

Resumen

Dede P.M., Halid I., Omoogun G.A., Uzoigwe N.R., Njoku C.I., Daniel A.D., Dadah A.J. Situación actual de la tsé-tsé y de la tripanosomosis en la meseta de Jos, Nigeria, Factores epizootiológicos que pueden fomentar la transmisión y la distribución de la enfermedad

Se llevaron a cabo encuestas sobre la tsé-tsé y la tripanosomosis en zonas del gobierno local (LGA) en Jos Este, Riyom, Bassa y Bokkos de la meseta de Jos, Nigeria. Estas fueron seguidas a reportes de casos de tripanosomosis que llevaron a la muerta de varias cabezas de animales en estas áreas. Se instalaron trampas bicónicas y Nitse en hábitat sospechosos. También se examinaron bovinos y ovinos de hatos Fulani y nativos seleccionados dentro de las áreas estudiadas. En total, se capturaron 240 moscas tsé-tsé, incluyendo 114 *Glossina tachinoides* y 126 *G. palpalis palpalis*, y revelando una densidad total aparente de 4,63 moscas/trampa/día. La disección de las moscas mostró una tasa de infección general de 1,67% debida a *Trypanosoma brucei* y *T. vivax*. También, 87 pupas de *G. tachinoides* fueron colectadas en LGA Bassa y Jos Este. En total, se capturaron 1536 otras moscas picadoras *(Stomoxys*, *Tabanus* y *Haematopota)*. Un total de 1053 bovinos y 65 ovinos fueron estudiados para la infección de tripanosomas. La centrifugación del hematocrito, la inoculación de los animales y las técnicas diferenciales de morfología fueron utilizadas para determinar las especies de tripanosomas y las tasas de prevalencia. Los resultados revelaron una tasa de prevalencia de 7,79% de *T. brucei, T. congolense, T. vivax,* y *T. theileri* en ganado y una prevalencia de 3,08% de *T. vivax* en ovejas. Los principales factores que predisponen la meseta de Jos a la presencia de tsé-tsé y a la infección por tripanosomosis incluyen las migraciones de ganado durante las estaciones seca y lluviosa a través de la meseta desde y hacia zonas infestadas con tsé-tsé, la abundancia de otras moscas picadoras, cambios en las condiciones climáticas y el aumento de las actividades humanas. Estos hallazgos eliminan la noción anterior que mantenía que la meseta de Jos es una zona libre de tsé-tsé y de tripanosomosis. Por lo tanto, la seguridad del ganado residente y migratorio, el cual ha desgraciadamente aumentado en tiempos recientes, podría no estar garantizada debido al riesgo de tripanosomosis.

Palabras clave: Ganado bovino – *Glossina* – Tripanosomosis – Factor de riesgo – Enfermedad transmitida vectores – Meseta de Jos – Nigeria.