## TRYPANOSOMIASIS CONTROL IN RELATION TO AGRICULTURE, FORESTRY, VETERINARY AND OTHER ACTIVITIES IN BECHUANALAND

by

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Maps
1. INTRODUCTION

Bechuanaland is vast and sparsely populated; 350,000 people live in 225,000 square miles. Except for the Okavango and Chobe swamps in the north-west it is semi-arid in the east, north-east, and around the periphery of the swamps, and arid elsewhere. The Ngamiland and Chobe regions, which we will be discussing, lie north of the Tropic of Capricorn. The vegetation ranges from grassland through scrub to savannah woodland with small patches of the mesophytic so called "fringing forest" lining many of the swamp channels.

Morse et al. (1960) were struck by "the predominance of the cattle industry, emphasized by the paucity of other industrial opportunities". In 1958, 75 per cent. of the total value of exports were from the sale of cattle and cattle products. Ninety per cent. of the country's 1,325,000 cattle are African-owned, of which there is an average annual offtake of five per cent.

So much for the background of the country. What of those parts affected by trypanosomiasis? Ngamiland and the Chobe have a striking feature in common - the swamps of the Okavango and Chobe river deltas which are essentially the same in character and the effect they have on the vegetation cover. Both draw their water from the heavy rainfall area of the Angola highlands. The Okavango river enters the Protectorate in its north-west corner and meanders through a papyrus covered "collar" for 60 miles before flooding into its 7,000 square mile triangular delta. It is 100 miles long and its base which connects the Mababe depression to Lake Ngami is 140 miles wide. The Chobe swamp is smaller but so similar that description is unnecessary. Both influence the normal Kalahari scrub to make it more mesophytic in nature and produce a phase which is ideally suitable as habitat for the tsetse fly. This occurs in patches within the flooded areas and within a band of heterogeneous vegetation varying in width from a few miles to as much as 30 around the perimeters of the deltas.

Considering Ngamiland and the Chobe district together from the economic angle, animal is more important than human trypanosomiasis, and its effect is most greatly felt in the cattle industry and in mixed farming areas. We will therefore take the veterinary aspect first, followed by agriculture, medical, and forestry and game in that order of importance.
2. THE VECTOR AND THE PARASITES

2.1 The tsetse fly

The only species known to exist in Bechuanaland is *Glossina morsitans* Westw. Zumpt (1958) collected several hundred specimens from Ngamiland and the Chobe and found them all to be sub-species *morsitans* Westw. This is interesting because there is now a continuous infestation from Bechuanaland through the Caprivi Zipfel along the Kwando river into Barotseland and Angola, and this is all presumably the western race *G. morsitans morsitans*, whereas the Zambesi belt, which is an *orientalis* Vanderplank infestation, was joined with the Bechuanaland belt at Kazungula before the rinderpest pandemics of 1894-1896 (Aspinall et al., 1960; Macaulay, 1942). It is probable that the two sub-species met in the Chobe.

In the mid-nineteenth century *G. morsitans* was found by the early European hunters in the top eastern corner (Fuller, 1923). This infestation was part of the belt that occupied Mozambique, the Sabi basin of Southern Rhodesia and the Transvaal. Flies had retreated from this part of Bechuanaland before rinderpest.

Map 2 shows the shrinkage of the Okovango/Chobe fly-belt from its pre-rinderpest limits to the residual foci immediately after rinderpest. Aged Africans tell of the existence of these pockets. The subsequent rate of expansion was remarkable, particularly during the 1942-1962 period. This was noticeable west of the Okovango swamp where advances were greatly accelerated by pedestrians and vehicular traffic. Macaulay chronicled the early history, the immediate post-rinderpest position and compared the line drawn by Stigand 1922 with his own. Allowing for the errors made by both in the Tsau/Toteng section where their lines include a block of unsuitable habitat, the flies recovered roughly 3000 square miles between 1922 and 1942 and 6500 square miles in the next 20 years.

The story is typical of the *morsitans* belts throughout most of Africa. While people were able to retreat and still find water and grazing for their stock there was little trouble. In the Okovango, settlements eventually concentrated around the delta, and the seriousness of the situation was only realized when the cattle of those people who would not move away started to die. The advance westwards was the most significant economically though the advance that took the Naragha Valley earlier
and subsequently threatened Maun, the capital, also radically affected the economy. The spread of animal trypanosomiasis across the Chobe flats assisted streptothricosis in the almost complete annihilation of the cattle population.

2.2 Cattle trypanosomes

*Trypanosoma congoense*, *T. vivax* and *T. brucei* are encountered in Bechuanaland. Macaulay found only *T. congoense* but since then *T. vivax* infections are found frequently and *T. brucei* rarely. The normal carrier is the tsetse fly but mechanical transmission by other biting flies doubtless occurs during the rains. An atypical *T. vivax* infection leading rapidly to acute septicaemia was noticed in some beasts around Maun, and mechanical transmission was suspected.

2.3 The human trypanosome

Mackichan (1940) outlined the history of the discovery of sleeping sickness. The disease was suspected from the beginning of the century, but it was not until 1934 that trypanosomes were found in the blood of two sick people. Lewis (1955) noted that in 1939 Gear & de Meillon positively identified *Trypanosoma rhodesiense* from a smear taken from a Bechuanaland sleeping sickness case, and that this identification was confirmed by Fairbairn in 1953 from material sent to him from Ngamiland.

Ormerod (1960) correlated the presence of large dense cell inclusions seen in the trypanosomes of a strain which he collected from Ngamiland with the normal chronic form of the disease found in the Zambesi region. The trypanosomes from Lake Victoria, where the disease is acute, possess small granules, while the central Tanganyika form is intermediate and so is the infection type.

Mackichan's "probable infected areas" were Diyei in the Chobe district, two localities on the Kwaai river, Zankuio, the Naragha Valley, and two localities on the Taoghe flood plain between Nokaneng and Tsau. The Naragha was the most heavily infected and he advocated the complete evacuation of the people and their stock. In 1942 an epidemic flared up between Nokaneng and Tsau with over 300 cases and evacuation was once more the means of controlling the disease. The following table, originally compiled by Lewis from records and now brought up-to-date, shows the fluctuations in the number of cases since 1941.
<table>
<thead>
<tr>
<th>Year</th>
<th>Total No. of cases</th>
<th>No. of deaths</th>
<th>Cases among Tsetse fly Control Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>1941</td>
<td>5</td>
<td>-</td>
<td>No record</td>
</tr>
<tr>
<td>1942</td>
<td>318</td>
<td>87</td>
<td>&quot;</td>
</tr>
<tr>
<td>1943</td>
<td>92</td>
<td>32</td>
<td>&quot;</td>
</tr>
<tr>
<td>1944</td>
<td>9</td>
<td>3</td>
<td>&quot;</td>
</tr>
<tr>
<td>1945</td>
<td>2</td>
<td>-</td>
<td>&quot;</td>
</tr>
<tr>
<td>1946</td>
<td>12</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>1947</td>
<td>11</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>1948</td>
<td>27</td>
<td>-</td>
<td>22</td>
</tr>
<tr>
<td>1949</td>
<td>35</td>
<td>-</td>
<td>14</td>
</tr>
<tr>
<td>1950</td>
<td>23</td>
<td>3</td>
<td>22</td>
</tr>
<tr>
<td>1951</td>
<td>11</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>1952</td>
<td>34</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>1953</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1954</td>
<td>2</td>
<td>-</td>
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<td>1955</td>
<td>1</td>
<td>-</td>
<td>-</td>
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<tr>
<td>1956</td>
<td>9</td>
<td>-</td>
<td>No record</td>
</tr>
<tr>
<td>1957</td>
<td>17</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>1958</td>
<td>64</td>
<td>5</td>
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</tr>
<tr>
<td>1959</td>
<td>43</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>1960</td>
<td>112</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>1961</td>
<td>74</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>905</td>
<td>149</td>
<td>121</td>
</tr>
</tbody>
</table>

The steady rise since 1957 is attributable to increased medical activity, confidence in the modern late case treatment and the increased man/fly contact. This applies particularly to the Nokaneng and Gomare regions which, in recent years, have produced a large proportion of the number of cases. The 1960 and 1961 figures are broken down below to show the distribution. The 32 cases at Zankuio in a population of 373 in 1960 suggested a minor epidemic. It was dealt with by prompt treatment of infected persons.
Year | 1960 | 1961
--- | --- | ---
Seronga | 2 | 4
Jao | 2 | 5
Gomare | 12 | 22
Nokaneng | 16 | 8
Tsau | 4 | 2
Maun | 10 | 9
Boro | 5 | 4
Shorobe | 5 | 5
Zankuio | 32 | 3
Mababe | 2 | 0
Chobe | 9 | 2
Others | 1 | 7
Tsetse fly control staff | 12 | 3
Total | 112 | 74

Lewis (1955) explained that the overall density around the swamp where most people were concentrated, is between 18.5 and 23.3 persons per square mile. Fairbairn (1943) recorded that Maclean calculated that a density of 5 to 25 per square mile is most favourable for the epidemic spread of sleeping sickness. Nash (1960) advised us not to forget the Busoga epidemic in Uganda when 200,000 souls perished, and stated that though the number of cases nowadays seemed trifling, it is the potential of the disease which is alarming.

The position in Ngamiland is not alarming but the potential is certainly present in some areas.

3. THE PEOPLE

The four main tribes of Ngamiland are the Batawana, Bayei, Mampukushu and Damara. The Batawana, though in the minority, are the rulers. They are cattle owners but use their oxen to plough lands. The Bayei are most numerous, inhabit the perimeter of the swamp and the islands, fish, hunt and cultivate with or without the use of cattle. The Mampukushu occupy the upper reaches of the Okovango. They also fish and hunt and use their cattle as draught animals. The Damara is the true cattle breeder. He does little ploughing and feeds on meat, milk, blood and homemade butter, all of which he gets from his livestock. The Damara and Batawana readily sell their cattle for their needs and to enrich themselves.
Census figures for Bechuanaland are very inaccurate but it is interesting to note that the population of Ngamiland rose from the recorded total of 31,000 in 1942 to 38,565 in 1961. The increase could be the result of improved medical facilities, increased immigration of Damara and, to a lesser extent, Mampukushu from South West Africa. However inaccurate these figures might be, it is nevertheless certain that there has been no reduction in population resultant from the spread of trypanosomiasis.

At the same time there is no doubt that they suffered as a result of a re-distribution imposed on them by trypanosomiasis. They lost, by total evacuation, the production areas of the Naragha valley and the Taoghe flood plain between Tsau and Nokaneng. In other areas, notably Shorobe to Boro, and Gomare to Sepopa their production potential dropped because they had to remove most of their cattle.

The Damara and Mampukushu suffered least; the former because they braved the rigours of the desert and took their cattle well away from the danger; the latter because the advance is only now reaching their part of the country. The Batawana were slow in moving, and when they did so it was only just ahead of the advancing fly, so that they lost much. Worse off were the Bayei as they were only becoming accustomed to owning and using cattle when the catastrophe overtook them. They chose their traditional river way of life rather than evacuate and save their cattle.

The tribe occupying the Chobe area when rinderpest arrived was the Masubia whose customs were similar to the Bayei's. A band of exiled Batawana with their cattle was settled at Kavimba and Kachikau in 1910. They prospered on the fertile Chobe flats. The Masubia bought cattle from them and both sections carried on a vigorous trade in cattle and maize. But now they are very poor. The Batawana suffered most not only because they lost their riches, but also because they were deprived of their traditional pattern of life. For animal proteins they now rely on small stock and their last remaining traditional pastime, hunting. The Masubia reverted to fishing.
4. VETERINARY ACTIVITY

4.1 The Ovango

4.1.1 Cattle industry

The cattle population is 114,600. The annual offtake can be as high as ten per cent., and the gross value can realize £180,000 per annum. All export cattle are routed through a quarantine camp where they receive a free clearing dose for trypanosomiasis.

Most cattle are owned and sold by the Damaras and the Batawana who live around the Lake from which the annual offtake is high. The Mampukushu and Bayei own and sell fewer because many of the swamp cattle are stunted and seldom reach the embargo weight of 850 lbs, and because cattle traders are reluctant to purchase beasts from the fly belt, or areas from which cattle must be trekked through a fly belt for export.

Some cattle are sold to the European-owned butcheries in Maun or to the "tree" butcheries in all large centres, but this trade is not brisk as most Africans get a good proportion of their animal protein from small stock, of which there are 35,700 goats, and game or fish, two natural resources with which the district is richly endowed.

4.1.2 The effect of trypanosomiasis on cattle distribution

We have shown that there was no problem until retreat from the fly to adequately watered pastures was no longer possible. In 1956 veterinary opinion held that underground water development would enable cattle to be completely removed from the periphery of the swamps and so solve not only the trypanosomiasis problem but also that of fascioliasis. While attempts were made to hold the fly advances geophysical surveys followed by test drilling proceeded in the hinterland. Results were disappointing and potable water was not obtainable in all areas where good grazing was available.

1 "Tree" butchery: the animal is slaughtered under a tree and suspended in it for subsequent cutting up.
Meanwhile a redistribution took place. Before Macaulay's survey 10 000 cattle moved out of the Nokaneng/Tsau area, and 20 000 were evacuated from the Naragha. Since then 10 000 left the Nokaneng/Gomare area, 3500 moved out of the Seronga region, and 10 000 left Tsau. Animal trypanosomiasis changed the pattern of an even distribution around the swamps. Fifty-two per cent. of the cattle are now concentrated south of Makakun around Lake Ngami, 20 per cent. are on the Okovango north of Sepopa and Seronga and 11 per cent. are along the Botletle river. Five per cent. went to the western desert leaving a mere seven per cent. and five per cent. respectively in the Maun/Shorobe and the Nokaneng/Gomare areas, which used to carry such a lot of cattle. The total rose from 112 400 in 1942 to 123 000 in 1954 and fell to 114 700 in 1961. Many factors contributed to the drop in the last seven years, and trypanosomiasis was undoubtedly one. More important than the decline in numbers is the permanent damage done to the "lake" and Botletle pastures due to overstocking. The grass can only support the cattle when there is above average rainfall. A slight drought leaves the lake a dustbowl and browsing alone sustains the beasts. There is a resultant great increase in the calf mortality rate. Swamp pastures are little affected by the lack of rain and the condition of the cattle remains uniformly good despite the presence of liver fluke. Some slight relief may result if cattle are moved to the few successful boreholes put down south-east of the lake. The water potential in the western desert is as yet unknown, but the limiting factor may be the poisonous plant Dichapetalum cymosum, the exact limits of which are also unknown.

4.1.3 Achievements in control

Macaulay gives details of the operation of trypanosomiasis treatment centres from their inception in 1937 to 1941. Three thousand and forty five were treated and discharged as cured while there were 348 deaths. Treatment was with tartar emetic. The centres were operated till 1951 but later details are not available. Their closure, we understand, was because of lack of funds and support of the natives who became disturbed at the effect on their cattle of inefficient injecting techniques.
Apart from this work, which was fairly successful in the early days, little was done. It was impossible to put surveys, investigations and control by drug therapy on an organized basis. Treatment was carried out sporadically by traders for their own and African cattle, and by veterinary officers by request. Continuity in survey work was disrupted by staff shortages and no investigations were possible. Since 1957 foot and mouth disease outbreaks added to the staff problems, and as no permanent trypanosomiasis unit was in existence this work continued to be neglected. Provision was made in 1961 for a Veterinary Department team to conduct scientifically planned work but the necessary professional staff were only very recently recruited.

There are notable exceptions to the forced veterinary inactivity. In 1959, 1500 head remained on the Nokaneng flats. Fly density was light and a scheme was started to investigate the possibilities of keeping the cattle under chemotherapeutic protection so that the grain production of the area would not suffer further through lack of draught oxen. Protection from trypanosomiasis was guaranteed. Influx was uncontrolled and, as protection meant free treatment, in no time the numbers of cattle doubled. Because funds were limited, original regimes involving mass prophylaxis with antrycide were abandoned in favour of curative treatment on request. This was possible as the incidence was found to be low. So far the scheme is successful and little treatment has been necessary. A similar scheme involving the Shorobe cattle is also operating successfully. For little expense 3500 to 7000 cattle are maintained in two highly productive mixed farming areas.

Because of the difficulties cited above trypanosomiasis work has largely devolved on anti-tsetse measures. As in other parts of Africa the objects are to stabilize the tsetse front and reclaim for development as required (Aspinall et al.: 1960; Whiteside, 1958). Advances on Maun, the administration and tribal headquarters, were held up by game control. Consolidation with discriminative clearing and ring-barking took the form of a "defence in depth" protective arc around the township. Clearings along the Taoghe between Nokaneng and Tsau in 1943 failed to hold the encroachment westwards. Expansions of the bolt occurred northwards towards Gomare and southwards past Tsau towards Makakun. A discriminatively-cleared barrier across Tsau helped to reduce movements in that area and a protective barrier at Makakun has not yet been threatened. A similar barrier was put across Gomare and this was backed by a deep ring-barked zone. This seems to have stopped
movement northwards. But a westerly encroachment from the swamps north of Gomare took place, slowly at first, until it reached very suitable habitat, when it turned rapidly north to Sepopa and south towards Gomare. On the eastern flank a very powerful thrust developed north of Shorobe which threatened to engulf settlements along the Maun/Shorobe road. While this was being dealt with by discriminative clearing a density build-up became evident in the swamp islands of Santandadibe just beyond the protective arc around Maun. Small but obvious improvements in the animal trypanosomiasis position resulted from these tsetse control efforts. In 1950 stock were completely absent from the Maun area, and today there are 3500. Some of these are traders' cattle held for four months pending the export season. They receive a certain amount of treatment while the African herds are largely unprotected and untreated. Macaulay was worried about the cattle from Toteng to Sehitwa because of the advance down the Naragha. There are now over 3000 more in this area. Confidence in tsetse control measures resulted in the reintroduction of 3000 head this last year.

Having destroyed the Chobe cattle on the flats the tsetse continued past Kachikau to Kavimba and started to filter down the narrow flood plain of the river. Timely bush clearing between Ngoma and Kavimba inhibited this advance. The habitat from Kachikau to Kavimba was ring-barked and catches at the deflying stations together with those on fly rounds reflected a marked improvement. Ploughing oxen are now kept between Ngoma and Kachikau.

4.1.4 Awareness of the trypanosomiasis problem

Whiteside describes how the control of animal trypanosomiasis in Kenya was at first an administrative problem of keeping cattle away from fly, later a tsetse problem, then a choice between drugs and tsetse control and finally a single problem with many angles of attack. Ford (1960) says much the same thing when he recounts how "we are seeing the problem as it should be seen, as a single whole". We, in Bechuanaland, have still not emerged from the "tsetse problem" stage.

A realistic assessment of the trypanosomiasis problem will be impossible without kilometric knowledge of the distribution of cattle in all areas where the tsetse fly is likely to transmit the disease, and in areas which are affected by seasonal
movement of cattle in and out of fly-infested zones because of the danger of mechanical transmission. This knowledge should be accurately plotted on a map showing the fly line. The next need is for detailed and repeated trypanosomiasis surveys round the perimeter of the fly belt where cattle are in permanent or seasonal contact with tsetse. Blood smears should be examined from as many cattle as possible within 20 miles of the fly line. The information so obtained would provide an early indication of changes in the tsetse position. An advance could be predicted long before tsetse are caught. An improvement in the trypanosomiasis incidence rate will be a valuable yardstick against which to measure the success of anti-tsetse measures.

A start will be made in the Shorobe and Makakun/Setateng areas. Field laboratories will be built and these will be served by a mobile laboratory. There is provision for the purchase of 400 cattle for use in trypanosome challenge investigation in selected areas and for experiments in chemotherapy. Trypanosomiasis work in all areas will be combined with investigations into the helminthiasis problem. The trypanosome challenge studies will open with controlled experiments using test herds in the Naragha valley, in the lower reaches of which the tsetse density is very light.

4.1.5 Tsetse control plans as part of the future development of the cattle industry

The limits of tsetse infestation in most areas are now plotted and shown on the maps accompanying this paper. Intensive sampling will be continued in the Ikwaga/Shakawe area to determine the potential for further advances, and to study the results of defence measures taken. Similar studies will continue south of Tsau and from Toteng to Shorobe. The limits in the Seronga section have yet to be demarcated accurately.

Taking Ngamiland as a whole blood meal sampling reveals the preference of G. morsitans for ruminants (41.9 per cent.) and suidae (35.5 per cent.). The single animal most favoured is the warthog (26.6 per cent.) followed by kudu (12.3 per cent.). Man provided 5.1 per cent. Perhaps the most interesting is ostrich which gave 4.7 per cent. For the purpose of understanding the game/fly/trypanosome complex in relation to vegetation and the domestic host a closer examination of the food preference is necessary in the various areas. Ashcroft, Burtt & Fairbairn (1959)
indicated the probable importance of antelope as reservoirs of sleeping sickness, and suggested that wild pigs may be important for trypanosomes pathogenic to cattle. Nash discussed the possible existence of restricted localities where the incidence of trypanosomiasis is high; ideal conditions are the suitability of vegetation for tsetse infestation and the local dependence of the fly on a few animals of a species capable of holding well a trypanosome reservoir. The following table compares figures in three areas for suidae and ruminants with special reference to warthog and kudu.

<table>
<thead>
<tr>
<th>Host</th>
<th>Area</th>
<th>West</th>
<th>Maun</th>
<th>Ngabe (North-east of Shorobe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suidae</td>
<td>West</td>
<td>9.5</td>
<td>37.7</td>
<td>45.4</td>
</tr>
<tr>
<td>(Warthog)</td>
<td>Maun</td>
<td>9.5</td>
<td>27.5</td>
<td>41.3</td>
</tr>
<tr>
<td>Ruminants</td>
<td>Maun</td>
<td>50.1</td>
<td>44.0</td>
<td>41.3</td>
</tr>
<tr>
<td>Kudu</td>
<td></td>
<td>26.2</td>
<td>7.7</td>
<td>22.7</td>
</tr>
</tbody>
</table>

The preference for antelope suggests a high incidence of sleeping sickness in the west, where, in fact, the disease is prevalent. The Maun area might be more important in relation to animal trypanosomiasis. Twenty-one bait cattle were kept in a part of the Naragha valley since April 1961 and 37 infections resulted despite the low apparent density (0.275). Infections were cleared with Berenil. Both diseases could be common in the Shorobe area. Cases of human trypanosomiasis do occur and blood slide surveys in cattle reveal a fairly high nagana incidence.

Discriminative clearing and discriminative ring-barking are the methods of control locally favoured for consolidation. A joint project with WHO is planned to test the use of insecticides to eliminate fly and to halt movement. If the results are satisfactory then spraying will be a fast weapon to employ in combination with the more permanent methods. Resettlement might also be valuable as part of a combined attack but this awaits land-use surveys.

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1 Apparent density is defined as the number of flies per 10 000 yards.
Unfortunately most effort in the immediate future must be expended on stabilizing the fly front. To hold the line and keep the status quo will not be enough and plans for a counter-attack have been formulated to reclaim valuable ranching and mixed farming country to reduce the stocking rate in over-grazed regions, and put the economy of the cattle industry on a sounder footing. Areas earmarked for treatment are south of Tsau, the Nakaneng/Gomare Taoghe flood plain, the Naragha valley and the sandveld between the central and western swamp drainage systems. Between 20 000 and 30 000 cattle could be moved from crisis areas.

4.2 The Chobe problem

With the advance of trypanosomiasis and streptothricosis the cattle population of 12 000 in 1939 dropped to 9700 in 1942 and dwindled to a paltry 800 in 1961. This put paid to the export trade and also reduced the grain production. The Chobe Game Reserve has now been proclaimed in the area between the Chobe Flats and Rhodesia where the export markets lie. The export trade could never be resuscitated as Rhodesian Veterinary authorities would not entertain the importation of beasts likely to have been in contact with game animals. There is therefore no incentive to reclaim completely the old holding grounds. Nevertheless it is recognized that local requirements must be met in respect of ploughing oxen, slaughter stock and milking cows. Provision has been made to reclaim sufficient grazing land for 2000 beasts.

5. AGRICULTURE

The Batawana were driven out of the well-watered fertile valleys of the Naragha and the Taoghe and the Bayei, who preferred to remain at the rivers, lost most of their ploughing oxen. The Naragha is still unreclaimed and so is the Taoghe between Tsau and Nakaneng. Crops in order of importance are maize, grain sorghum, beans and ground-nuts.

Although hand-hoeing is the original cultivation method practised by the indigenous Bayei, the cattle-owning Batawana built up a mixed farming tradition around the ox-drawn mouldboard single furrow-plough, and introduced it to the Bayei who were eager students. The method of ploughing is primitive in the extreme but it did enable farmers to meet their own requirements and still leave
a surplus for sale. The animal factor in the form of manure and urine helped to maintain soil fertility. Despite the loss of some areas and the reversion to hand-hoeing in others it is still possible for Ngamiland to produce a surplus of maize in good years. There is no incentive to increase this surplus because the price demanded by the producers is too high to offset costly transport and an export trade cannot be established. If the price could be lowered to permit export then the economic value of mixed farming land would be eight times that of ranching land. One beast (ranching) needs 40 acres and gives £16 gross return. Forty acres (mixed farming) planted with mealies gives 120 bags valued at £120 (20 shillings a bag).

Considering that the Agricultural Department was under-staffed for years it is understandable that Ngamiland was formerly regarded as the Cinderella. But it was also realized that the interests of communities affected by trypanosomiasis could not be forever ignored and agricultural survey work has now commenced. One of its main objects was to determine the need and possibilities of resettlement in relation to trypanosomiasis control plans. In addition, the Oxford Committee for Famine Relief has voted money for a small experimental farm to investigate the best methods of agriculture under local conditions, and to explore the possibilities of introducing cash crops.

The opportunities of using resettlement as an attacking control method against trypanosomiasis are limited because the lack of population pressure, the abundance of land and the general low soil fertility do not create conditions suitable for dense settlement. Though this is generally true, there are localized areas where the density is very high. A small area, three square miles in extent, in the Shorobe swamps, supports 137 persons per square mile. What is urgently needed is a detailed village to village population map with the fly line superimposed on it. The position will then be clearer. Density figures in areas where concentration of settlement have acted as a deterrent to advances would be invaluable for the future, as trypanosomiasis control plans might be able to incorporate controlled re-distribution of population. The insistence of the Agricultural Department on stock being introduced early in any scheme, and the dangers of sleeping sickness will require the tsetse density to be reduced to a safe level before people and
their stock can be allowed in. Each element of trypanosomiasis control would play its proper role in a combined attack and this is as it should be. Tsetse control will reduce the density, drugs will keep stock and people free from disease, and resettlement will consolidate and eventually justify expenditure with increased productivity.

The demands of the local population to safeguard the present production areas and to recover traditionally fertile areas have been taken regard of in the formulation of control plans.

6. MEDICAL ACTIVITIES

By dint of energetic blood slide surveys in zones of high infection, the Medical Department has so far been able to discover infected persons, treat them and so keep the incidence of sleeping sickness down to a reasonable level. The abandonment of the much feared tryparsamide drug in favour of Mel B has made the task easier.

District wide epidemiological surveys are urgently needed now that the man/fly contact has increased in many areas. The results of sliding should be correlated with population studies with the view to being able to confidently assess the possibility of outbreaks in regions where the densities of tsetse and human beings are conducive to the rapid spread of infection. Funds have been provided for field dispensaries and a mobile team under a doctor. The task of starting the work has fallen on the already over-taxed district medical team because of the inability to recruit the required staff. But it is gratifying to know that Zankuic and the Chobe have been covered this year and that soon the riverine strip between Ikwaga and Nakaneng will be visited. Seronga is next on the list.

Laboratory facilities have been provided to study the "healthy carrier" question and also the role of game animals as reservoirs of infection. In this connexion it is interesting to note that the Tsetse Fly Control Department has examined blood slides from game animals shot since July 1961 and six brucei group infections were found in 581 slides examined. Three each were from warthog and antelope.
While vector control was used in many areas to bring down the infection rate by reducing the contact between fly and man, the Medical Department greatly assisted in the protection of control personnel by regular sliding and prompt treatment of cases. Since 1941, 121 workers have been treated. Action against the tsetse will continue to form a big part in sleeping sickness control. If flies can be kept away from villages then the danger will pass though the regular recurrence of a limited number of cases will continue among the hunters who venture into the swamps. This will be no serious problem.

7. FORESTRY AND GAME

Forestry comes under the Department of Agriculture. The only forest is a belt of "mokusi" (Baikiaea plurijuga Harms), 3000 square miles in area in the northwest corner of the Protectorate. It covers a large portion of the Chobe district. A sand-covered lime-stone ridge extends from Goha Hills to Kachikau and thence along the line of the Chobe river to Kazane. It separates the "mokusi" which clothes a gently undulating sandy plateau from the tsetse habitat on the flats. The valuable timber trees which occur in numbers that make exploitation worthwhile are B. plurijuga itself and Pterocarpus angolensis DC. A timber concession was granted to a company which worked the area for some years prior to 1953 and then went bankrupt due to inefficiency and transport difficulties. The Economic Survey Mission considered that the forest should be conserved so that it could yield a small revenue and supply timber for territorial use. Government hopes that a proper survey with the aid of air photographs will reveal the presence of stands that might attract other companies.

Though catches on fly rounds showed that tsetse do not become established in this vegetation community, it is nevertheless fortunate that the advance was held up and thrown back as sleeping sickness was recently found at Kachikau and this would have discouraged any interested parties.

This success in tsetse control is doubly fortunate as tourists can enter the newly-proclaimed Chobe Game Reserve without the fear of sleeping sickness. Further south, an encroachment of tsetse eastwards along the Ngwezumba river system is holding up Game Department plans to introduce a safari hunting scheme on the
Mababe Depression. The possibility that movement is connected with elephant migration resulted in a deferment as disturbance of game might accelerate the eastwards trend. Plans were laid to conduct an ecological survey and to follow it up with control measures. Further incursions would endanger the Ngamiland cattle export route and the Colonial Development Corporation ranch at Panda-ma-Tenga. The Game Department will be free to develop this revenue earning scheme as soon as fly are thrown back to a line where consolidation blocks can be established.

8. CONCLUSION

1. There is no doubt that expenditure on trypanosomiasis control should be measured against the effect on the economy. Efforts, so far mainly against the vector, have been largely defensive. The cattle population has been squeezed into areas which have become over-grazed but as yet there has been no loss of export potential. Some grain production areas have been lost to the fly. With investigations into the nature of the trypanosomiasis problem about to begin, together with basic studies on agriculture, Ngamiland is poised to go forward and reclaim lost pastures and mixed farming land. Much money will still be needed and the returns will not be apparent for some years; even then they may not be commensurate with expenditure. In this connexion Morse et al. (1960) had this to say:

"Ngamiland is properly to be regarded as a crisis area and measures to assist it, whether medical, veterinary, agricultural, hydrological or commercial, should not be judged by purely economic reasons."

2. Hornby said in 1941, "the solution of the trypanosomiasis problem in the semi-arid lands of Tanganyika involves not only tsetse eradication but also, by improved pasturing methods, the institution of more stable forms of land-usage" (cited by Ford, Whiteside & Culwick, 1948). These words are as true today for Ngamiland. It is therefore pleasing to record that the ecological investigations on carrying capacity of the veld, which were suggested by the Economic Survey Mission, will be extended to all districts of the Protectorate.

3. Ford ( - ) looked forward to a demand for land by a healthy and expanding population as this, he said, would be the most potent weapon against trypanosomiasis. He quoted, as example, the successful reclamation of Sukumaland, Tanganyika by the Basukuma. If it can be demonstrated that enlightened animal husbandry, grazing,
conservation, farming and cattle trading are the best basis for increased and continued prosperity, then the stimulus to solve the trypanosomiasis problem will not be lacking.

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MAP. 1
BECHUANALAND PROTECTORATE

ANGOLA
CAPRIVI ZIPFEL
Linyanti R.
Chobe
MAUN
Lake Ngami
Okavango Swamps
Mababe
Francistown
Shashi R.
Limpopo R.
Dawson R.
Okwe R.
Tshabong O
Lobatsi
Mahalapye
Gaborones
Transvaal
SOUTH AFRICA

FEDERATION OF RHODESIA AND NYASALAND

CAPE PROVINCE

Fly-Belt 1962
Fly-Pockets 1900
Fly-Belt 1850