

At the former are approximately 2,000 head of cattle, but very little is known concerning nagana in these herds. At the Hluhluwe Settlement only three farms have been allotted (end of 1922). There is no doubt that nagana will be a serious problem, as most of the area is fly-country.

Nongoma Division.

Quite half of the district might be termed high veld, only the valleys of the Ubani, Umsunduzi, and Umduna in the north, and the Black Umfolosi in the south, being low-lying country. Such valleys as the Emtweni and the Msebe, which flow into Umsunduzi River, drain the high veld and do not debouch into the low veld. Outbreaks of disease have occurred at the No. IX (Manyoni) Tank and the No. II (Mapopoma). The Department of Native Affairs reports cases from the No. XII (Ntshoweni) Tank, but there is no veterinary confirmation of the last-mentioned cases. Outbreaks, however, are possible not only in Area No. XII (Ntshoweni), but also in No. IV (Bululwane) and No. XI (Ivuna), both of which are drained by the Black Umfolosi River, and in Area No. VII (Nxwala), where the streams flow north into the Mkuzi River.

Distribution of Stock.—It can be estimated that 90 per cent. of cattle are pastured on the high veld, so there is little chance of epizootics arising, such as have been experienced in Hlabisa or Lower Umfolosi. Goats and sheep thrive in the high country, and Nongoma is undoubtedly the finest stock district in northern Zululand, the only portions not being suitable for cattle, on account of nagana, being the Umsunduzi-Umduna angle and the Mbegamuzi-Black Umfolosi area. The number of positive smears received within the last five to six years has been small (three in 1920), but this is, of course, no guide to the extent of infection. In 1907, native Nivingwela is said to have lost 30 out of 80 head of cattle at Impala Ridge.

Mahlabatini Division.

The western portion of the division is typical high veld, while the eastern is characteristic of the low veld. North and south are the two large river valleys, the Black and White Umfolosis respectively, and between them their many tributaries, e.g. the Mbegamuzi, Wela, and Nhlungwana, flow eastwards. The low veld is nagana country and infection extends westwards, as in Hlabisa, towards the high veld, outbreaks being traceable in most cases to cattle having grazed in bushveld. The worst centre of infection is Tank Area No. X (Nhlungwana), and transmission there is due to *Glossina*, which have actually been seen at the tank during dipping operations. Tanks No. VIII (Xasana) and No. IX (Hluhluwe), built in 1914, have never been used owing to heavy mortality among cattle at the time they were completed. Outbreaks have also been registered from the following tank areas:—No. I (Magistracy), No. II (Idhlebe), No. III (Ulundi), and No. IV (Nkonjeni). In some cases, e.g. Idhlebe and Nkonjeni, it has been difficult to account for origin of disease, for cattle have been grazed anything from ten to twenty miles from nearest known fly-belt. Particularly marked has been this phenomenon along the White Umfolosi River and its tributaries west of the Ulundi Drift of the Melmoth-Mahlabatini road. The Department of Native Affairs records nagana at Tank Areas No. V

(Subukuluma) and No. VII (Ekushumayeleni), which is quite probable, as they are drained by the Mbegamuzi River. Veterinary confirmation in the form of positive blood-slides is, however, lacking.

Distribution of Stock.—As in Nongoma, quite 90 per cent. of large stock are grazed in the high veld, where there is little or no danger from nagana. The remaining 10 per cent. are to be found in low veld or in the numerous wooded valleys leading up to the high veld. In the Nhlungwane Tank Area cattle are grazed in fly-country, with the result that losses from nagana are perhaps greater there than at any other tank area in Zululand. In the Crown lands, east of the magistracy, no cattle live on account of the fly. Goats and sheep are numerous on the high veld, and these animals are also kept in fairly large numbers in Glossina country.

A certain number of deaths have always been reported from the low veld, but in 1915 the most serious epizootic experienced in the division occurred, the Zungu and Mlaba tribes losing hundreds of cattle. The Zungu people alone estimated their losses at 213 head out of 511.

Emtanjaneni Division.

This is another high-veld area, the only portion where fly is found being along the northern boundary in the valley of the White Umfolosi River. With the exception of the eastern portion, which is occupied by natives and known as Native Reserve No. XI, the division has been divided up into farms (Proviso B), with the result that most cases of nagana are contracted on farms used for winter grazing in the neighbourhood of the White Umfolosi Valley. It is usual for most of the herds to be pastured in the thorn-lined valleys during this time, and infection sometimes arises through failure to return stock to the high veld on the approach of spring. The valleys leading to the fly-belt south of the Ulundi Drift may all be considered danger zones (the best known being the Ikwibi and the Upate), and the infected farms either abut on the White Umfolosi or on these streams. Cases of natural infection appear to have arisen on the following farms:—Witvolosi (No. 453), Weltevreden, Sweet Home, Overloed, and Nooitgedacht (No. 149B). Positive smears have been returned from Welcome, Schuilhoek, Koningsberg, and Emtanjaneni, and other farms, but infection in these cases probably originated elsewhere.

Along the valley of the Umhlatuzi River is situated the Nkweleni Settlement and, although no positive nagana blood-smears have been received from the area, there is good reason to believe that the disease exists in the eastern portion. The number of cattle in the settlement is approximately 3,526 head.

Of the tank areas in Native Reserve No. XI, the following have been known to be frequently infected with the disease:—No. I (Hlomo) and No. II (Mpumbulu). Both tanks are situated on the Emtanjaneni Plateau, but cattle could become infected by grazing in the bush country in the northern portion of the tank areas. In 1920 three positive results were obtained in the No. VI (Imfule) Area and one in the No. IV (Mtembeni) Area, but it is uncertain whether infection was conveyed by Glossina in the tank areas in question, especially in the latter district. No information is available concerning No. V (Ncemana) Area, but it is reported by

natives that nagana affected certain herds here in 1915 at the time of the serious epizootic. The eastern portion of Native Reserve No. XI, about Upper Enseleni Store, is the commencement of the middle veld, which extends into Lower Umfolosi Division, and forms in the latter district the Ntambanana Settlement. Most of the valleys are wooded, while here and there extension of bushveld on to adjoining hill-slopes is gradually taking place.

Distribution of Stock.—Quite 95 per cent. of cattle are grazed on the high veld, but in winter, as mentioned before, a large number are allowed to graze in the bush country in the low veld. In 1915 and 1920 were experienced the heaviest losses, both in European and native portions of the district, the native losses in the Hlomo and Mpumbulu areas alone in 1915 being estimated at 130 head. Deaths occur, however, every year and, in the Hlomo area alone, the dipping supervisor reckons them at 30 to 50 head annually. The White Umfolosi Valley in Native Reserve No. XI is almost entirely uninhabited and contains no stock except goats and sheep. This stricken area is continuous with similar country in the Mahlabatini and Lower Umfolosi Divisions in the vicinity of the two Umfolosi Rivers.

Lower Umfolosi Division.

This division contains no high veld, and as a result, nagana is exceedingly prevalent. Except for the coastal strip, a width of ten miles, the disease occurs throughout the Magisterial Division. Apart from the Crown lands situated between the Ntambanana Settlement and the Black Umfolosi River, and two small strips at the mouths of the Umfolosi and Umhlatuzi Rivers respectively, the whole division is divided into a European area and native reserves. It will be convenient to discuss the latter first. Of the half-dozen tank areas in Native Reserve No. V, Tanks No. V (Enseleni) and No. VI (Dondota) are frequently affected. At No. X (Nonhlazana) an outbreak occurred in 1920, and from No. XI (Imbabe) several positives were received the same year. In Native Reserve No. VII B, bordering the Umhlatuzi River, nagana occurs in the western portion, which is heavily bushed. In 1920 many deaths were reported, but apparently no blood-smears were obtained, as there is no veterinary confirmation of these outbreaks. There are two dipping tanks in this native reserve, No. IV (Empangeni Mission) and No. XII (Ngoloti), and it is to the former area that the report regarding nagana refers. Tank areas III (Bezolo), I (Nhlabana), II (Mdibi), and IX (Sokulu), in Native Reserves Nos. VI and IV, and No. VII (Mhlana) and No. VIII (Mtwana), in Native Reserve No. V, are in open country, chiefly sandveld, and are free from nagana.

Distribution of Native Cattle.—Over half are to be found along the sandveld. The remainder are distributed between Native Reserves No. V and No. VII B.

The European area is divided into the following settlements or groups of farms. Particulars as to period when allotted and number of cattle are also given hereunder:—

- (a) Umhlatuzi and Empangeni, 1908-12: 6,836 head.*
- (b) Kwambonambi, 1912: 5,445 head.

* Approximate number of cattle at end of December, 1922, according to Magistrate Lower Umfolosi (his minute 71 of 21st December, 1922).

(c) South bank Umfolosi River, May, 1914: 1,065 head.

(d) Ntambanana, July, 1918, to October, 1919: 4,300 head*

From as far back as 1912 there were complaints of losses from nagana in the Empangeni farms, especially at the Umhlatuzi Drift, but it was not until 1915 that the first serious outbreak was experienced by both settlers and natives alike. In this year, according to a letter sent to the Prime Minister (petitioning for assistance in their misfortune), there were "severe losses of stock on farms Nos. 229, 233, 240, 241, 244, 245, and others. On one farm 55 cattle out of 110 have been lost, and 6 donkeys out of 14, whilst the monthly cream cheque has been reduced from £15 to £2. On the neighbouring farm 17 cattle have died out of 35, and 4 donkeys out of 10. At one dip, 'Dondota' (Tank Area No. VI, in Native Reserve No. V), some 40 head of cattle died in the months of July and August out of a total of 240 head, and many more are too weak to be dipped and will die from this disease." In order to try and obtain some relief, the Magistrate asked (minute 24th August, 1915, file 4/1/20/1, Lower Umfolosi) for authority regarding the granting of free permits to natives to shoot large game, i.e. under Sub-section (2), Section 9, of Game Ordinance of 1912. This authority, he added, he would only use for the benefit of Ntambanana natives and those in Native Reserve No. V, bordering Umfolosi Game Reserve. On 3rd September, 1915, the Magistrate wrote to the Provincial Secretary as follows:—"The position is worse than before the big game was thrown open in this district, simply because no concerted action was taken with regard to driving the game back to the reserve (i.e. game reserve) on the Black and White Umfolosi." By Proclamation No. 8 of 1915 the Administration permitted the destruction of game south of the Umfolosi River. It will be noted that since 1912 cases of nagana have always cropped up in the neighbourhood of the Umhlatuzi Drift, which fact would alone lead one to suspect that it was a tsetse focus. Cases had been diagnosed at the following farms up to the end of 1919:—Nos. 229, 231, 232, 233, 234, 235, 240, 241, 244, and 245. Prior to 1920 there had also been cases on farms Nos. 182 and 189 (1915) and 205 (1917), and on Nos. K.13 (1917), K.9 (1915), K.12, and K.21 (1916), in the Kwambonambi Settlement. Up to 1919 then, nagana, except in 1915, was not a serious disease in the Lower Umfolosi District, and the great number of outbreaks recently, i.e. since 1919, have occurred in the Ntambanana Settlement. It is now proposed to deal with the disease since the establishment of the Ntambanana Settlement. This consists of a block of 80 farms, about 90,000 acres in extent, situated between the Empangeni farms given out in 1912 on the east and the Emtanjaneni Division on the west.

The country is typical middle veld, having densely wooded valleys, with a growth of bush (open bushveld) on the hill-slopes, the trees thinning out as the summits are reached. The chief rivers are the Ntambanana and the Enseleni, and with the exception of the south-western portion, which is drained by the Umzimbakazi and Umtimona Streams, all dongas and slopes eventually lead to the above two rivers. As in thornveld in other parts of the eastern portion of South Africa, there is a great tendency for bush to spread, and even at

* According to a statement furnished by the Ntambanana Farmers' Association the number was nearer 5,000 head.

the time the Boundary Commissioners visited the district in 1879 there was apparently quite a quantity of thorn scrub about. Although there are dense patches of bush in the large valleys, all "big game" had been driven north across the Enseleni River at the time the settlement was thrown open, and, except for an occasional waterbuck and kudu and a few zebra, there was only "small game" between the Enseleni River and the Umhlatuzi River. Natives, however, state that previous to 1912 large numbers of zebra and other wandering game, except wildebeest, might be found in the vicinity of the latter river. It is stated that previous to European occupation there were only 1,200 head of cattle in the district, and as the number now (i.e. end 1922) is nearly 5,000, it will be seen how much greater the chances are for an increased prevalence at the present time.

In 1918 and 1919 no cases of nagana were diagnosed microscopically in the settlement, but in 1919 a few suspicious clinical cases were noticed. As the majority of the settlers and their cattle only arrived after the winter of 1919, a serious outbreak of the disease could not be expected until the beginning of the following year. Unfortunately the new settlers were inexperienced, or they might have foreseen what a calamity would befall them in the late summer of 1920. With very little warning the disease appeared at its usual time, i.e. January and February, and the first positive slide was returned from farm No. 315 on 19th February, 1920. In quick succession there followed outbreaks, confirmed by microscopic examination of blood-smears, on farms Nos. 303, 310, 283, and 287, and by the end of September outbreaks had been diagnosed on twenty-two farms. The infection spread irregularly, but seemed particularly virulent from February to April, when quite 66 per cent. of some herds were affected. As no treatment was being carried out the mortality was severe throughout the winter, but the disease abated on the approach of summer. Many settlers unfortunately during the height of the outbreak omitted to take blood-smears, for they knew the symptoms and did not consider blood examination necessary; and others again were discouraged by the fact that blood-smears taken from known diseased animals were often returned as negative. The layman could not be expected to take an interest in an operation requiring even a little effort unless the result justified the trouble, and in this case he could not understand a negative result from a beast suffering from all the clinical symptoms of nagana. The mortality at the end of September, 1920, was estimated at 659 head, of which 69 cases had been confirmed microscopically. By the end of 1920, 115 positive slides had been returned and the mortality estimated at about 1,000 head. It must be borne in mind that a certain percentage of deaths had been due to other maladies, e.g. heartwater, redwater, gall-sickness, and even poverty. Many aged and weak cattle introduced from the Natal high veld were unable to subsist on the purely veld-grass diet and died before they became acclimatized. Computing the total losses from tick-borne disease and errors in diet at $7\frac{1}{2}$ per cent.,* it can be estimated that the losses in the Ntambanana Settlement from nagana during 1920 were approximately 900 to 950 out of a probable cattle population of nearly 3,000, i.e. $33\frac{1}{2}$ per cent. At the end of December, 1920, the following farms had been shown to be nagana infected:—Nos. 233, 239, 241, 242, 246, 247, 248, 249,

* A high figure, but purposely made high to avoid exaggerating nagana mortality.

250, 272, 283, 284, 285, 286, 287, 289, 291, 293, 296, 303, 310, 311, and 315. Infection undoubtedly existed at other farms, but no smears were submitted for examination. The most striking fact is that, with one exception, not a single *Glossina* had been seen south of the Enseleni River.

In 1921 the situation was most deplorable; farms had been left, homesteads deserted, and there remained only those who meant to succeed at all costs. The tendency to put down all deaths to nagana disappeared, and it was significant that very few smears were submitted until May, 1921. On 26th April the camp of the Veterinary Research Division was pitched on farm No. 273, at what was considered then to be the margin of the nagana area. As there were no facilities for the carrying out of reasearch work, and buildings were to be constructed, no progress was made with the investigations until the end of the year. In 1921 no less than twenty farms were discovered to be the centres of infection. The infected farms were: Nos. 233, 246, 250, 271, 277, 279, 280, 288, 290, 291, 293, 296, 302, 303, 305, 320, and the four farms, strictly Empangeni farms. Nos. 207, 209, 210, and 211. As in 1920, no tsetse were observed except north of the Enseleni River (there was one known capture on the south bank of the Enseleni River on farm No. 282). Towards the end of 1921 the treatment of stricken beasts was taken in hand, and the results with tartar emetic have been most satisfactory, so much so, that many owners do not trouble to take blood-smears nowadays, but inject a solution of the drug as soon as the well-known symptoms of nagana appear. The mortality in 1921 must have been considerable, approximately 950, for it was not until 1922 that the tartar emetic treatment was used by farmers as a *routine measure*. In spite of the fact that farmers had become tired of taking blood-smears, over 82 positive smears were registered from the Lower Umfolosi Division, 79 being from the Ntambanana Settlement.

During 1922, 129 cases of positive nagana were detected on twenty-two farms as follows:—Nos. 233, 249, 254, 265, 269, 271, 272, 274, 278, 279, 282, 283, 284, 285, 288, 290, 291, 293, 302, 311, and 316. The total number of bovines and equines in the settlement is approximately 5,000, and as 2,500 doses of tartar emetic were issued, it is obvious that, allowing two doses per animal, nearly one-fourth of the stock was treated. It will be seen that the extent of the disease in 1922 was just as marked as in 1920 and that the number of positive smears returned was almost the same.

The prospects of the settlers have never been so rosy as they are at present. Not only have they learned by bitter experience that it is a risky procedure to introduce large numbers of cattle into a nagana area, but they are realizing the advantages of agricultural development. Even if oxen die of nagana (which need not happen if tartar emetic is used wisely), a great deal can be done with donkeys, which are more resistant to the commonest type of nagana in Zululand, i.e. *T. congolense*.

During the years 1920-22, while the Ntambanana herds were being decimated, nagana also made its presence felt among the farmers at Kwambonambi Settlement. At farm Nos. K.24, K.25, and K. 59 there were diagnosed outbreaks in 1920. In 1921 only one farm, No. K.29, was proved infected, and in 1922 No. K.9

was the seat of an outbreak. Actually, however, several other farms were infected, but the disease being known, it was felt that blood-smears were unnecessary. In Kwambonambi, as in Ntambanana and other areas, the policy of the settlers in the future will be to inject suspicious cases at the very first manifestation of disease and no report will be made as to the prevalence of nagana in herds. It is obvious that under such conditions no statistics will be available in future.

The fact that there has been such a heavy mortality in the Ntambanana Settlement is not surprising when it is borne in mind that the area itself harbours *Glossina*, and that immediately to the north is a huge tract of country, probably 400 to 500 square miles, where it is not possible to keep a single bovine.

Mtunzini Division.

The first recorded case of natural infection in this division was in 1917. An inhabitant of Ginginhlovu (Mr. W. J. Weber) had returned from a hunting trip in fly-country, bringing back a dog suffering from nagana. Shortly afterwards an in-contact dog, which had never been away from home, was noticed ill, and on blood-smears being submitted to the Veterinary Research Laboratory, Maritzburg, a positive return was obtained. The month was June, when *Tabanids* are not prevalent, and as *Stomoxys* are the principal haematophagous flies at that time, it would seem that they might be incriminated. It is convenient to refer at this stage to another case of natural infection contracted at the Veterinary Research Laboratory, Maritzburg, over 100 miles away from the nearest fly-belt. At that time, October to November, 1919, a strain (apparently *T. brucei* from symptoms manifested in dog later) of trypanosomes was being kept in guinea-pigs confined in gauze cages. During November a dog belonging to a member of the staff was noticed ill and, according to a note received from the owner, Mr. Laurence Hill, the symptoms were "loss of appetite, followed a few days later by swelling under lower jaw and temperature above normal three days before death. A blood-slide taken 16th November, 1919, showed trypanosomes fairly numerous." Date of death, 18th November, 1919.

In Native Reserve No. IX, bounded on the north by the Umhlatuzi River, nagana outbreaks occurred in 1921 in Tank Area No. VIII (Umhlatuzana) and No. XIV (Obanjeni), and another outbreak was recorded by the dipping supervisor from No. XIII (Kumbukumbu) the same year. The outbreak at Obanjeni Tank is particularly interesting, as the district contains very little bush other than that found along the coast or in swamps. Fortunately the sufferer, a young beast about 1½ years, was seen by Stock Inspector Foster, of Eshowe, otherwise one might have suspected some mistake on the part of the native assistant when dealing with blood-slides from Tank Area No. VIII (Umhlatuzana). Obanjeni is nearly 15 miles from the nearest known fly centre. There are over 3,000 head of cattle in the above three areas, and of this number about half are to be found in the No. VIII (Umhlatuzana) District. In 1920 nagana was diagnosed in cattle belonging to the owner of Hlangubo store, situated about three miles south of the Umhlatuzi Drift, on the Empangeni-Eshowe road.

Eshowe Division.

Only the No. XVIII (Ndongande) Tank Area will be referred to. The whole area is bush country and is situated on the south bank of the Umhlatuzi Valley, west of No. VII (Umhlatuzana) Tank. The dipping supervisor reports the diagnosis of positive smears early in 1921, but no trace of these can be found in the veterinary records. The discrepancy regarding the statements of dipping officials concerning the receipt of positive smears and the inability to trace the outbreaks in the records of the tank areas in question may be explained as follows:—Smears are sometimes sent to the district office, e.g. Eshowe, and redirected from there to Maritzburg, where the records merely state that the smears have been received from Eshowe. The original source is unknown to the veterinary research officer, but the result of his examination, especially if positive, is communicated by the district office to the supervisor who in the first instance submitted the blood-smear.

Babanango Division.

The nagana position in this division is very similar to that in the Emtanjaneni high veld among the European cattle. The infected area comprises those farms situated in the White Umfolosi Valley north of the Emtanjaneni watershed. From the high veld, streams lined with scrub make their way to the White Umfolosi River, and in the valleys cattle are pastured during the winter. In 1922 three positive cases were returned for farm Dorsfontein, and in 1917 positive nagana was diagnosed on Overvloed and Uitzoek.

Ngotshe and Piet Retief Divisions.

The former along the Natal border and the latter at the Transvaal boundary contain country suitable for fly. No outbreaks of nagana appear to have originated in these districts, although cases are occasionally diagnosed there. Infection has usually been contracted when transport animals have been in the Zululand low veld, conveying mealies for sale to the natives.

It will be observed (see Map 1) that the nagana area overlaps the fly-country to a distance varying from 5 to 15 miles, depending on the topographical features of the district. The most interesting outbreak of nagana is that occurring at Obanjeni, since this is situated a long distance from a *known* fly centre.

III.—DIAGNOSIS AND DIFFERENTIATION OF TRYPANOSOMES.

Experience was gained in the first four of seven methods (shown hereunder) generally looked upon as useful in determining the identity of trypanosomes. Briefly these methods are:—

- (1) Morphology of trypanosome.
- (2) Susceptibility of vertebrate hosts.
- (3) Behaviour of trypanosomes to drugs.

- (4) Serum tests.
- (5) Development of trypanosomes in invertebrate host.
- (6) Cross-immunity tests.*
- (7) Cultivation on artificial media.

1. MORPHOLOGY.

As has been shown in Section I, nagana is due to infection by one or more of the following trypanosomes: *T. congolense*, *T. vivax*, and *T. brucei*.

T. brucei, Plimmer and Bradford, 1899.

This organism is being dealt with initially, as it was the first trypanosome of nagana to be discovered. Bruce (1915) has stated that in 1894 he observed the parasite for the first time. A strain he sent to England was studied by Kanthack, Durham, and Blandford (1898), but it was not until the publication of Plimmer and Bradford's work (1899) that the trypanosome received its name. In South Africa, in addition to Bruce's (1895, 1896, 1903) researches, the parasite has been studied by Theiler (1901) and Shilston (1913). It is, therefore, considered unnecessary to again describe the organism, especially since the morphology is well shown in coloured plate II. It should be added, however, that *T. brucei* is less important than the other two trypanosomes from an economic aspect, since Zululand is essentially a cattle-raising country; and, as will be noted in Section IV, *T. brucei* is but slightly pathogenic for bovines.

T. congolense, Broden, 1904.

As a great deal of controversy has centred around the name and identity of this trypanosome, the following particulars should throw some light on the much-discussed question of priority. Undoubtedly the parasite was first seen by Bruce in 1894, although it remained unrecognized as a separate species until 1904. In Plate IV, showing "Haematozoa in the blood of a cow," of Bruce's preliminary report (1895) occur forms suggestive of *T. congolense*. In 1902 when Dutton and Todd were in the Gambia, they encountered trypanosomes in the blood of horses, and these they considered provisionally as one species, their so-called "Gambian Horse Trypanosome." The organisms represented in Plate I (figs. VI to X) of their First report (1903) suggests a mixed infection of *T. congolense* (their "tadpole" form) and *T. brucei* (their "stumpy" and "long" forms). These workers, however, sent an infected horse to England [not an animal studied in the Gambia (Montgomery, 1913)], and it was from this animal that Laveran and Mesnil (1904) obtained the strain from which they described their *T. dimorphon*, Dutton and Todd.† This trypanosome, according to the illustrations shown in their contribution of March to the Académie des Sciences, is a pure infection of what is now generally termed *T. congolense*. As shown by Hornby (1921), Broden (1904) published in the month of

* In this connexion, Sergent (Edm.) and co-workers, in an article (Bull. Soc. Path. Exot., XVII, 2, 1924), state: "Il faut donc distinguer les épreuves d'immunité croisée des épreuves de prémunition croisée."

† Laveran and Mesnil state as follows: "M.M. les Drs. Dutton and Todd . . . ont découvert . . . un nouveau Trypanosome auquel ils ont donné le nom de *Tr. dimorphon* . . ."

February an account of a trypanosome, identical with that described by Laveran and Mesnil a month later, which he named *T. congolense*. On grounds of priority, therefore, the name *T. congolense* should be given preference. In South Africa *T. congolense* has been studied by Theiler (1909), Bevan (1910), and Shilston (1913), and as the organism encountered in Zululand appears identical with the trypanosome described by these authors, nothing need be said regarding morphology (see coloured plate II).

An exceedingly virulent strain of *T. congolense* was met with in the pig, suggesting *T. simiae* of Bruce (1914). Unfortunately no transmission experiments were possible at the time.

T. vivax,* Ziemann, 1905.

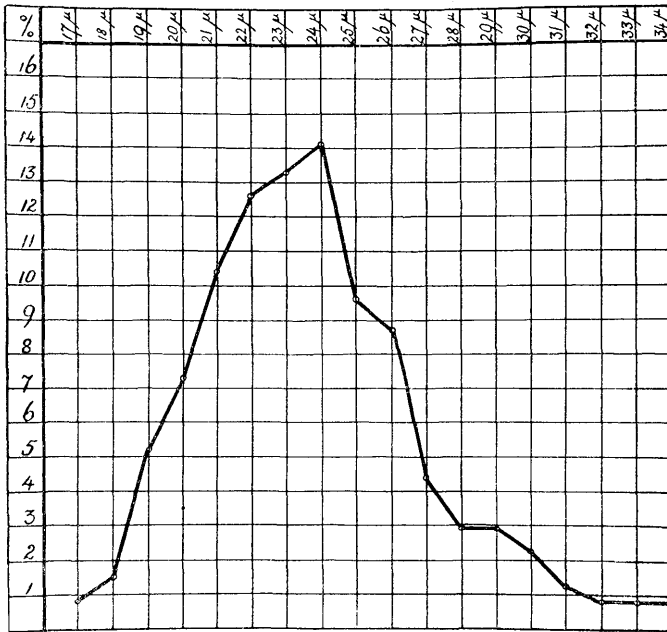
This parasite, described in detail by Ziemann in 1905, was first seen south of the Zambesi River in 1909 by Jowett (1910) in Mozambique. This author, however, failed to recognize the identity of the organism, partly owing to the fact that he was dealing with *T. congolense* at the same time. Jowett failed to transmit the trypanosome by sub-inoculations, an experience, with one exception, encountered in Zululand. *T. vivax* was recognized as one of the causal organisms of nagana in Zululand in 1921 for the first time, and for this reason an account of its morphology is given herewith.

The *living organism* is extraordinarily motile, all forms in fresh hanging-drop preparations shooting so swiftly across the field that they were unrecognizable. In their wake, however, a movement of the displaced red corpuscles was always evident. On three occasions, when a trypanosome had become enclosed by a wall of corpuscles in a clear area of liquid, the rapid movements became less marked, and after an interval they were so sluggish that they could be easily followed with the eye.

The *stained organism* has a characteristic shape, the body bearing some resemblance to an Indian club and the blunt end being either slightly pointed or entirely rounded. The opposite extremity tapers evenly to a point, from which the free portion of the flagellum continues the outline of the organism. The trypanosome assumes all shapes varying from a gentle curve to a figure resembling the figure eight. As will be seen from the subjoined diagram, the organism is monomorphic. The range with regard to length is from 16μ to 34μ , the average being 23.7μ . The breadth varies from 2μ to 4μ , the average being 3μ . The cytoplasm is clear and with Giemsa generally stains a pale blue; occasionally a red staining granule is to be observed. The nucleus generally stains a dull red, is situated towards the anterior portion of the body, and has a peculiar granulated appearance. The micro-nucleus, which stains in the same way as the nucleus, is large and spherical and lies on or close to the posterior extremity, usually about its middle. The flagellum, which often appears to rise from the micro-nucleus, is well developed and, as just mentioned, has a free portion, varying in length from 3μ to 7μ . This is generally stained bright to dull red. The undulating membrane, which is generally stained pink, is poorly developed and free from contortions. As suggested by Bruce (1914), coloured

* On one occasion a distinctly smaller organism of this type (*T. uniforme*) was encountered, but apart from its recognition, no further attention was paid to it.

illustrations have been made of the Zululand trypanosomes, and from these a good idea as to their morphological characteristics may be obtained (see coloured plates I and II).



Percentage distribution in respect of length of
T. vivax (Bovine).

Average length of 135 specimens 23.7 μ.
" breadth " " " 3.0 μ.

DIAGRAM 1.

T. theileri, Laveran, 1902, and *T. lewisi*, Kent, 1879.

These parasites were encountered as natural infections in experimental animals, the former in the ox and the latter in *Rattus natalensis*. Coloured drawings (see coloured plate I) are included in order to show at a glance the differences in morphology between them and the more pathogenic nagana trypanosomes. Small specimens of *T. theileri* and large examples of *T. lewisi* have purposely been drawn in order to emphasize the points of similarity in the two species. As will be seen, the differential feature of most importance is the appearance and situation of the nucleus.

Routine Examination of Field Smears.

Before proceeding, a few words are necessary concerning the examination of blood-smears received from the settlers. Reference has been made to the Giemsa method of staining, and it is as well to explain more fully the procedure adopted.

Generally a single *thin film of blood*, taken at the ear, was received at the laboratory. While it would have been more satisfactory to examine gland smears or thick blood-smears, one had to

be satisfied with what was received, especially after the introduction of tartar emetic treatment, when it was difficult to persuade owners to submit blood-smears at all. On the other hand, there were advantages in examining thin smears, these being:—

(a) When trypanosomes were found their morphology, and therefore species, could be determined more satisfactorily.

(b) Other blood parasites, e.g. *Babesia bigemina*, *Gonderia mutans*, *Anaplasma marginale*, etc., could be identified more easily in thin films. Smears were fixed with methyl alcohol, and after this had evaporated they were placed in a glass receptacle containing 10 per cent. solution of Giemsa stain for one hour. Thereafter the slides were washed in a basin of water, allowed to dry, and then finally examined with the oil immersion lens. Some difficulty was encountered, as would be expected under field conditions, with regard to the stain, its efficacy appearing to vary chiefly under the following conditions:—

- (a) Nature of water used.
- (b) Make of stain.
- (c) Age of blood-smear.

As a result of these circumstances the cytoplasm varied in colour from a pink tinge to a dark blue, the nuclei from a bright red to a reddish-purple, and the flagellum from a bright red to a blue colour.

For detection of trypanosomes in drug experiments at the laboratory, thick blood films were often examined after staining according to the method adopted by the German Sleeping Sickness Commission of 1906-1907 (1909). The stain, a mixture of the following:—

0.16 per cent. solution of azur II	4 c.c.
1 per cent. watery solution of cosin (BA extra)	0.43 c.c.
Water	80 c.c.

answered exceedingly well and the trypanosomes could be recognized by their two dull red nuclei.

TABLE 2.

Showing results of examination at Nagana Research Laboratory of Blood-smears (thin films) received from stock owners throughout Zululand.

Month.	Apparently Negative.	Anthrax.	<i>B. bigemina</i> .	<i>G. mutans</i> .	<i>A. marginale</i> .	Smear Useless for Diagnosis.	Anaemia.	Nagana.				<i>T. theileri</i> .	Total.	Percentage of Nagana Smears to Total Smears Received.
								<i>T. congolense</i> .	<i>T. vivax</i> .	<i>T. brucei</i> .	Mixed Trypanosomes.			
1921.—May.....	1	1	1	—	—	1	1	3	—	—	—	—	8	37
June.....	79	2	1	—	—	5	1	16	1	—	2*	—	107	18
July.....	11	—	1	1	—	2	—	4	—	1	—	—	20	25
August.....	113	—	—	—	1	8	—	15	—	1	—	—	138	11
September.....	58	—	—	—	—	3	1	7	1	—	—	—	70	11
October.....	51	—	—	1	1	3	—	10	—	—	—	—	66	15
November.....	32	—	—	—	—	1	—	8	—	2	—	1	44	23
December.....	19	—	—	—	—	—	5	2	—	—	—	—	26	7
1922.—January.....	14	—	2	—	—	2	5	5	—	—	—	—	28	18
February.....	13	—	—	—	—	—	4	2	—	2	—	—	21	19
March.....	181	—	—	—	—	2	5	23	4	—	—	—	215	12
April.....	186	—	—	—	1	3	3	19	2	—	—	—	214	10
May.....	148	—	—	1	3	7	11	19	3	—	—	—	192	11
June.....	114	—	2	—	1	3	13	10	3	—	—	—	146	9
July.....	101	—	—	—	—	2	—	12	2	—	—	—	117	12
August.....	140	—	—	1	—	7	4	12	2	—	—	—	166	8
September.....	136	—	—	—	—	2	6	6	—	—	1†	—	151	5
October.....	56	—	—	—	—	1	1	3	—	—	—	—	61	5
November.....	20	—	—	—	—	—	1	—	—	—	—	—	21	—
December.....	17	—	—	—	—	—	1	—	—	—	—	—	18	—
TOTAL.....	1,490	3	7	4	7	52	62	176	18	6	3	1	TOTAL SMEARS EXAMINED.	1,829

* Mixed *T. congolense* and *T. vivax*.

† Mixed *T. congolense* and *T. brucei*.