

Of the 203 cases of nagana, the various species of domestic animals were infected as follows:—

	<i>T. congolense.</i>	<i>T. vivax.</i>	<i>T. brucei.</i>	Mixed Infection.	Total Smears of Each Species.
Horses.....	2	—	—	—	3
Mules.....	—	—	2	—	8
Donkeys.....	7	—	3	—	57
Oxen.....	161	18	—	3	1,742
Goats.....	1	—	—	—	4
Dogs.....	3	—	1	—	8
Pigs.....	2	—	—	—	7

Discussion regarding Smear Examination.—It must be emphasized that only thin blood-smears were received for diagnosis. It may be assumed for convenience that (1) all smears were taken from animals believed to be suffering from nagana; and (2) only a single smear examination was made from each animal. It is seen from the above that the percentage of trypanosome-evident animals detected varied per month from 0 per cent. to 37 per cent., depending on (a) species of trypanosome; (b) stage of disease; (c) season; and (d) weather conditions. The average percentage is 14. Other striking facts in connexion with these records are: (1) the very small proportion of mixed infections, viz., 1.5 per cent.; (2) the rarity of *T. brucei* in cattle and the presence of *T. vivax* only in this host; (3) the preponderance of bovine smears as a consequence of the relatively greater cattle population.

2. SUSCEPTIBILITY OF VERTEBRATE HOSTS.

As shown by many workers, the various species of domesticated animals (as well as laboratory animals) respond differently to infection by the three trypanosomes under consideration. This method of differentiation is, however, unsatisfactory for the following reasons:—

- (1) A certain number of experimental animals are necessary, and much labour and expense are involved in the carrying out of the investigations.
- (2) Different strains of the same type of trypanosome behave diversely.
- (3) Different animals of same species vary in their reaction to the same strain of trypanosome.

For details regarding symptoms and course of infection in the several trypanosomiases, see the next section. A lesson to be learned from the section in question is that not only wild animals, but also domesticated animals, act as reservoirs of infection. So tolerant are some species to infection (e.g. the bovine to *T. brucei*, the sheep to *T. congolense*, and apparently equines to *T. vivax*), that so long as these animals are permitted to live in and around Glossina areas, the attempts made to exterminate game are futile.

3. BEHAVIOUR OF TRYPANOSOMES TO DRUGS.

This subject is dealt with in Section VI. Briefly, it may be stated that, whereas tartar emetic has what appears to be a specific action on *T. congolense* and *T. vivax*, its action on *T. brucei* is negligible.

4. SERUM DIAGNOSIS.*

The following paragraph has been kindly furnished by Dr. Robinson:—

“ A considerable number of complement fixation tests have been carried out in cases of nagana, both at Maritzburg and at Onderstepoort. The animals tested were inoculated with pure strains of *T. congolense* or *T. brucei*, but in a few cases there was a mixed infection. Antigen made from *T. equiperdum* was used for the whole series of tests, as satisfactory material could rarely be made from *T. brucei* or *T. congolense*. The results of the tests show that animals infected with *T. brucei* invariably react strongly, whereas those suffering from *T. congolense* usually give no reaction, though rarely a slight reaction was obtained. A few tests carried out with *T. congolense* antigen, of which only a small quantity was prepared on account of technical difficulties, indicate that animals infected with *T. congolense* react with it, whereas *T. brucei* animals do not. A single series of tests carried out with the sera of animals infected with *T. vivax* indicates that such animals give negative reactions when antigen made from *T. equiperdum* is used. From these results it appears reasonable to conclude that it may be possible to diagnose trypanosomiasis and to differentiate between the three species.”

Discussion.—At the present stage of development in Zululand, with the views concerning game destruction as a remedy for nagana uppermost, along with a curious apathy regarding animal husbandry in general, the examination of blood-smears as a routine measure is sufficient for all needs. In point of fact, the improvement in treatment introduced by the Veterinary Research Division has resulted in stock owners becoming more indifferent than ever to the advantages of diagnosis. It is argued, and within limits perhaps rightly so, (a) smear examination is so often negative in known infections; (b) the disease can be recognized just as easily clinically; and (c) tartar emetic acts so satisfactorily; and that under these circumstances smear examinations are a waste of time, both for the farmer and the veterinarian. In the future, however, when the need for closer settlement is realized, when drug treatment is more reliable, and the value of early diagnosis and segregation of sufferers is better appreciated, campaigns will be launched not only for the treatment of all domesticated animals harbouring infection, but also with the object of rendering *Glossina* harmless. For such undertakings smear examinations will not be sufficiently reliable, and diagnosis will be effected by means of the serum tests, which, as shown by Dr. Robinson, offer much promise. [See Robinson, 11th and 12th Rpts.: D.V.E. and R., p. 10 (Part I), 1926.]

* In 1922 serum from animals suffering from nagana was frequently dispatched to the Veterinary Research Laboratory, Maritzburg, for serum tests.

IV.—SYMPTOMATOLOGY (INCLUDING EXPERIMENTAL TRANSMISSION).

It is intended to describe briefly the symptoms observed in both artificial and natural cases of each of the three types of trypanosomiasis. These, as will be seen, vary according to the species of animal infected.

1. T. CONGOLENSE.

Ox.

Artificial Infection.—Trypanosomes were seen in *stained* smears from the peripheral blood six to fifteen days after infection, and the duration of the disease (that is, from the inoculation of virus to death) varied from 63 to 111 days. (See Table 3.) The temperature generally did not rise until about ten days after infection, when it continued high for a few days. Thereafter there was nothing characteristic, the curve varying irregularly as a rule between 100° and 103°. Trypanosomes were frequently seen during the earlier part of the infection, but as the disease became subacute, so did the parasites become less frequent. The best time to obtain positive smears was during a spell of cold weather, when clinical symptoms were most evident. Trypanosomes, when most abundant, seldom exceeded half a dozen specimens in a field. The first clinical symptoms appeared from two to seven weeks after infection and varied from salivation to photophobia, although the latter was the more constant symptom. The eyes become dull and opacities are seen on the cornea, loss of condition rapidly follows, the ears droop, and the coat becomes harsh. Scouring is, as a rule, severe, and in one case there was "filling" of all four limbs. As emaciation becomes more marked, so weakness increases and the beast therefore lies down frequently. Ultimately exhaustion is so pronounced that the sufferer is no longer able to rise, and after a day or two expires with little signs of struggling.

Natural Infection.—Clinical symptoms make their appearance as a rule two to four weeks after infection, i.e. during the first half of the year when the grass is non-succulent and innutritious. During

T. congolense (Sub-acute Infection).

Ox 872,

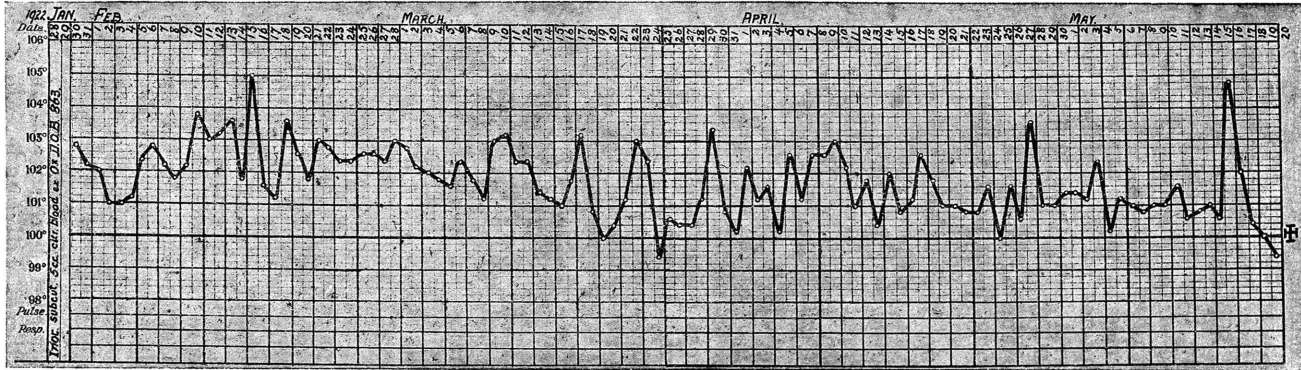


DIAGRAM 2.

the spring and early summer it would seem that they may be delayed for a further period. Generally fresh cases of infection are seen towards the end of December, and as in certain instances transmission after the end of September can be ruled out,* it would appear that season has some influence on the duration of the period of incubation and course of the disease. To one who has had cattle in suspicious areas for winter grazing, the manifestation of the following symptoms gives rise to much anxiety.

Any of the symptoms to be described may be noticed first, but there are usually several indications to guide one. A beast may show a staring coat, or be doing something that calls for attention at once, e.g. it may be standing motionless in the bright sunshine while its companions are lying down in the shade, or it may be the reverse, the remainder of the herd might be grazing and the suspect remains lying down showing no inclination to move. There may be a watery discharge from the eyes, or the eyeballs may appear slightly sunken. A good indication is the reaction of the eyes to light, for a nagana beast seems less inclined to face the bright sunshine, and blinking is therefore a common symptom. The muzzle may be dry, and a nasal discharge may also be seen. Sometimes the faeces are watery. In some cases all there is to guide one is that the faeces are black, pointing to the eating of earth, especially ant-heap. After grass has been burned, it may be noticed that the faeces are black through ingestion of burnt grass particles, showing that one must be guarded in forming conclusions. In other cases, there may be traces of blood in the faeces, and one would suspect enteritis. There may be lack of energy, especially noticeable in trek oxen, or a lessening or even complete cessation of milk yield in cows; there may be drooping of ears, salivation, and, in a few cases, a cough has been the first indication of something amiss. Sometimes all that can be noticed is a loss of condition, which, however, is not always progressive, for several animals have been observed to fall away, then regain condition, and after a change of weather, e.g. a cold spell, again lose flesh. A common attitude of resting is, when lying down, to place the lower jaw on the ground as if the neck was not sufficiently powerful to support the head. Cold weather, particularly when accompanied by rain, is a good time to pick out suspects, for owing to anaemic changes, nagana sufferers seem to feel the cold more than other animals. Dropsical swellings in the throat, chest, or abdominal regions may occasionally be observed, and it is noteworthy that these may disappear as suddenly as they manifest themselves. There may be a loss of appetite, but it is remarkable that rumination is hardly affected, as in the case of other diseases. In bulls loss of sexual power is a prominent symptom. As the disease progresses, the beast loses condition rapidly, the animal is hide-bound, coat staring, belly tucked in, and back arched, while the expression on the face is one of anxiety. There may appear, and again disappear, opacities on the cornea and the mucous membrane of the mouth is usually pallid. In time the gait is affected, being weak and staggering, and, unless kept at the kraal, a beast will topple into a donga or generally at

* An example is the trekking of cattle to fly areas for winter grazing. As the cattle return to the high veld by the end of September and cases of nagana occur at the end of the year, it may be assumed that the period of latency is at least ten weeks in such animals.

the drinking place, where, in their eagerness to get water, the stronger members of the herd push the weaklings out of the way. In some cases the accidents that occur, such as falls, are due, not to weakness, but to blindness, and even in such advanced cases treatment may bring about recovery. It was also noticed that sores easily developed about the coronary region, e.g. from tick bites, thorns, etc.

Cat.

Artificial Infection.—Three cats were experimentally infected, and in these animals the duration of the disease varied from 139 to 173 days. Trypanosomes were first seen nine days after infection. The temperature was only markedly affected in one young animal, a rise to 105° being recorded on the fourth day after infection. For five days the temperature remained high, but thereafter, apart from occasional elevations and remissions, it varied between 100° and 102°. With regard to the other two cats, the thermal reaction was of no importance. All that can be said concerning the clinical symptoms was that a gradual loss of condition occurred, this being accompanied by a fickle appetite. In time anaemia was noticed, then dullness and depression. Finally weakness was marked, so much so that exhaustion terminated in death.

Natural Infection.—No cases observed.

Dog.

Artificial Infection.—In the one case of artificial infection which ended fatally, death occurred 46 days after inoculation of virus, and trypanosomes were seen eight days after infection. The only symptom was a loss of condition, first noticeable about a month after infection; the emaciation then became most severe, leading to weakness, owing to which the dog was not able to stand. Death shortly afterwards supervened. In the case of three other dogs infected with another strain, no symptoms other than a primary rise of temperature and slight lachrymation were observed. In no other instance did *T. congolense* cause death.

Natural Infection.—Some severe cases of natural infection were encountered, in one animal death occurring five weeks after exposure to "fly," and trypanosomes being abundant before death. The chief symptoms in this animal were jaundice and emaciation. Anaemia, in addition to the description given for artificial infection, was an important point.

Goat.

Artificial Infection.—Six cases were under observation and only one ended fatally, namely, 52 days after infection. The temperature in this animal was over 103° for the greater part of the first month. It then varied between 100° and 103° until death. The temperatures of the remaining animals call for no particular comment. Trypanosomes appeared in the blood stream 14 to 27 days after infection and were invariably scanty. In the goat that died the symptoms were briefly as follows:—Photophobia, catarrhal discharge from both eyes, opacity of left cornea, marked loss of condition, weakness, and progressive anaemia.

Natural Infection.—One case was definitely diagnosed, and the course of the disease resembled very closely that described in the preceding paragraph. Trypanosomes were at times quite frequent in the blood stream.

Equines.

Artificial Infection.—Four donkeys were artificially infected, two distinct strains being employed, and in no case death occurred, although the animals were under observation for two years and over. The temperature was generally irregular during the period one to two months after infection, there being marked exacerbations and remissions. After this it settled down and seldom rose above 100°. Trypanosomes in the case of one strain were never demonstrated; and in the second were rarely seen, the first occasion being twenty days after inoculation. The first symptoms, such as photophobia and lachrymation, appeared about ten days after infection, and were as a rule transient. In some instances corneal opacities developed, but after a time these disappeared. Loss of condition also occurred, but was merely temporary. On the whole the symptoms were slight, but had the animals been worked no doubt they would have been more serious.

Natural Infection.—In the horses observed, the duration of disease was estimated to vary from four to six months. In one case clinical symptoms, e.g. photophobia and lachrymation, appeared thirteen days after exposure to the bites of *Glossina*, but trypanosomes were not seen until 21 days had elapsed. The course of the disease was characterized by loss of condition, stumbling and dragging of hind limbs when ridden, lack of energy, progressive anaemia, transient oedema, especially of the breast, catarrhal discharge and transient opacities of cornea, drooping of ears, dulness, anxious expression, desire to stand in sun, "filling" of legs, difficulty in progression in later stages owing to weakness, exhaustion, and finally death. In donkeys all three forms of disease were encountered, i.e. acute, subacute, and chronic. In the acute cases, numbering two, death followed in six weeks to two months after onset of symptoms. The symptoms were generally severe and emaciation was most marked. In the subacute cases the disease lasted two to four months, and in the chronic cases the course of the malady resembled that described for artificial infection. In addition a rash was noted on the face on several occasions. If the animals were hard worked or starved the course of the disease was hastened.

Pig.

Artificial Infection.—Four experimental pigs on which two strains were employed were kept under observation for eighteen months, but in no case did death result. The thermal reactions were at first marked, a rise to 103.4° being registered the second day after infection. After this the fever was continuously high for ten to fourteen days. Thereafter rises and falls at irregular periods occurred until approximately three months had elapsed, when the temperature remained fairly even between 100° and 103°. Parasites were only observed in one animal, this pig showing rare trypanosomes 42 days after inoculation. Thereafter they were only occasionally seen. In no case was there any clinical evidence of infection beyond thermal reaction, and the two strains used were at any rate non-pathogenic for pigs.

T. congolense (Chronic Infection).

Fig 8.

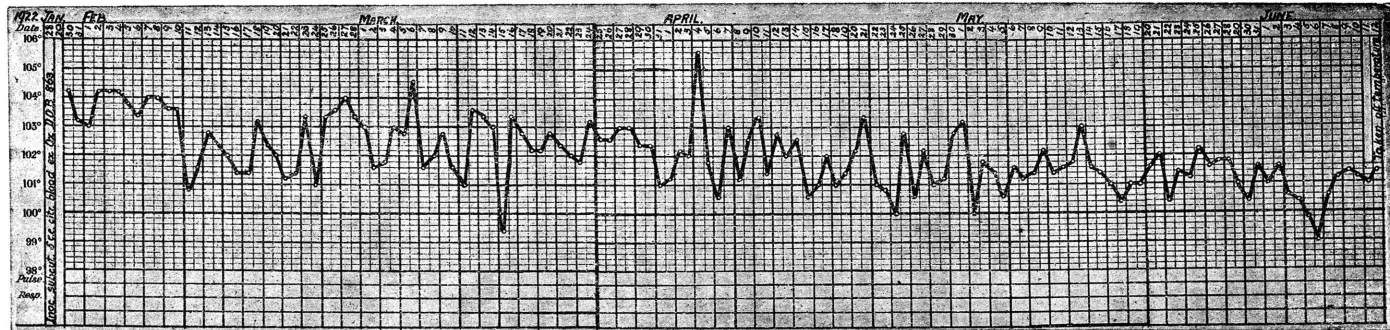


DIAGRAM 3.

Natural Infection.—Only one outbreak was investigated, and as the trypanosomes appeared identical with *T. congolense*, it is presumed *T. congolense* was being dealt with. It must be borne in mind that *T. simuae* and *T. congolense* are indistinguishable morphologically, but that the former is stated to be virulent for pigs. In the outbreak investigated, of three pigs introduced from Natal, one died six weeks after arrival in Ntambanana (and one week after manifestation of clinical symptoms) from acute febrile disease characterized by anaemia, refusal to feed, rapid emaciation, and paralysis of hindquarters. Blood-smears of this animal and an in-contact showed trypanosomes. (See coloured plate II.) The in-contact was treated with atoxyl, and recovery was apparently permanent.

Sheep.

Artificial Infection.—Three sheep were artificially infected, but apart from a continuous fever (which commenced two to four days after injection of virus), somewhat resembling that seen in the pig, there was little of clinical importance. One animal showed lachrymation and a transient oedema of throat region, and another gave birth to a weakly lamb which died the following day. Trypanosomes were seldom observed; only in one case were they demonstrated, namely, 28 days after injection.

Natural Infection.—No cases of *T. congolense* in sheep were seen, but it was reported by natives that sheep in fly areas sometimes died of a disease marked by wasting and anaemia.

Remarks on T. congolense Disease.—Contrary to what has been generally described, it was found that *T. congolense* was responsible for the vast majority of cases of nagana, particularly in the ox. Two fairly distinct types of disease were encountered:—

- (1) A subacute infection invariably associated with the ox, but also seen in the other species of domesticated animals.
- (2) A chronic form generally met with in species other than bovine, much depending on the strain of trypanosome and the species of host. Several experimental animals were refractory to the strains employed