Preliminary note upon a trypanosome occurring in the blood of man / by J. Everett Dutton.

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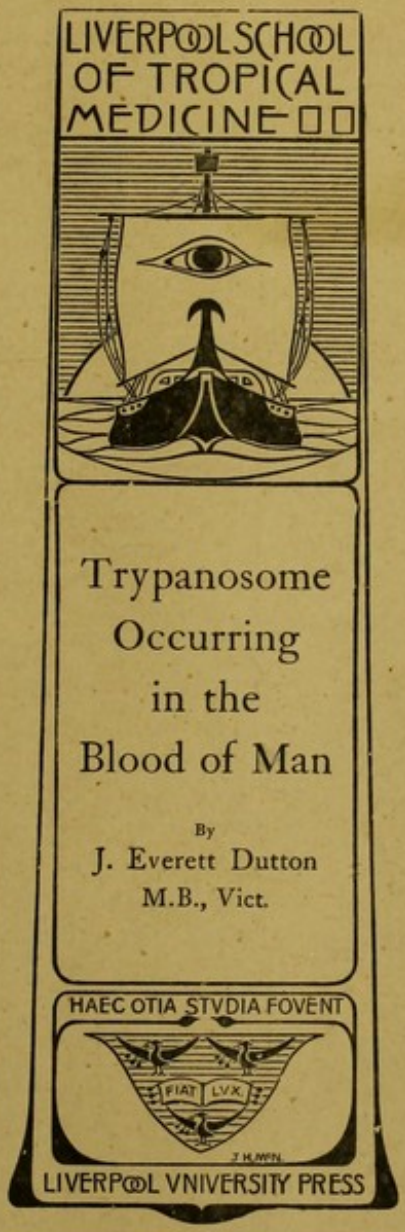

Trypanosome Occurring in the Blood of Man

By
J. Everett Dutton
M.B., Vict.

ERRATA

P. 460, line 26. Read 'aggregation' in Roman type.
P. 460, footnote. For '*T. Brucei*' read '*T. brucei.*'
P. 461, line 13. For 'Hoemoglobin' read 'Haemoglobin.'
P. 461, line 13. For 'Gower's' read 'Gowers'.'
P. 461, line 6 from bottom. For 'Labbe' read 'Labbé.'
P. 464, line 20. Insert ',' after 'oedemas.'
P. 465, line 17. For 'macro-nucleus is small' read 'micro-nucleus is small.'
P. 465, line 7 from bottom. For '*T. Brucei*' read '*T. brucei.*'
P. 467, line 20. Read after 'tsetse': *Glossina palpalis*, Robineau-Desvoidy.
P. 467, line 21. For '*Fachinoides*' read '*tachinoides.*'

PRELIMINARY NOTE UPON A TRYPANOSOME OCCURRING IN THE BLOOD OF MAN

[1902]

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By J. EVERETT DUTTON, M.B., Vict.

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History of Case

The patient is an Englishman, forty-two years of age, who, for the past six years has been in Government employ with intervals of leave, as master to the Government boat, plying weekly up the Gambia river.

His illness dates back to May last year, when he broke down, after very heavy duty which often necessitated his remaining at times on watch for the twenty-four hours. Up to this time he had enjoyed good health, except for occasional attacks of malarial fever.

On the 10th of May, 1901, he was admitted into the hospital at Bathurst, with fever, under the care of the Colonial Surgeon, Dr. R. M. Forde, to whose kindness I am indebted for permission to reproduce the temperature chart (Chart No. 1), and who will publish, at an early date, some account of the symptoms observed at this time.

On admission to hospital, patient's blood was examined (fresh preparations). No malaria parasites were seen, but Dr. Forde informed me that he saw very many actively moving worm-like bodies, whose nature he was unable to ascertain, and it was on account of this observation that he asked me to examine the blood when the patient again returned to Gambia.

On June 1, after three weeks in hospital, the patient was invalided home, and arrived in Liverpool on June 16, in a very weak state.

On August 12, he was admitted into the Southern Hospital, under the care of Dr. Macalister, to whom I am indebted for the following notes. At this time his chief complaint was general weakness and lack of energy.

On admission, temperature was subnormal; no pain, but slight headache a few days previously. Tongue furred, appetite fair, no vomiting, bowels somewhat constipated; liver slightly enlarged, but no tenderness; spleen, normal in size, could be felt below the ribs on the 13th; considerable tenderness over the splenic area.

Pulse: On admission at 12-30 p.m., pulse, 120; in the evening, 92, regular in time and force, low tension, fair volume.

Heart sounds: weak and distant, otherwise normal.

Respiratory System: on admission 32, later in the day fell to 20 per minute, slight dyspnoea on exertion.

Lungs: normal.

Nervous System: no headache, legs weak; patient said, they were much thinner than formerly, knee jerk and plantar reflexes present and easily obtainable. Sensation, normal.

Urine: normal in quantity, sp. g. 1032; no chlorides, no albumen.

Patient remained in hospital some fourteen days. Spleen became very painful about the 19th, but ultimately improved.

The pulse and respiration were always frequent and varied on exertion and with the temperature. The temperature was a peculiar feature as seen in chart 2. There were three short periods of pyrexia, temperature reaching from 101° to 102° in a few hours and rapidly falling to below normal, with intervals of about three days of apyrexia. On two occasions I examined the blood for malaria parasites, once in an apyretic interval, and once during a period of pyrexia; the examinations proved negative. It will be noticed that the pulse was much more frequent during the time he was in hospital at home, very rarely being recorded below ninety beats per minute, although temperature was, as a rule, below normal. This differs somewhat from the recorded rate during the period in hospital at Bathurst.

Patient left hospital improved, the pain over the spleen gone. He went away for a change, and finally returned to Bathurst in the early part of December, 1901. On the way out he was very ill with fever, which was diagnosed as pneumonia, though the doctor informed me that it was not a typical case. The sputum was never rusty, in fact, it was more of the nature of pure blood. It is unfortunate that no record of the case was kept at this time.

I saw him for a short while after he landed at Bathurst. His appearance was much changed; he was very much thinner, and walking readily produced fatigue.

Dr. Forde asked me to make an examination of the blood; unfortunately, I had arranged to go up the river, so it was not until my return on December 15 that I was able to do so. At 5 p.m., on this day, I took three drops of blood (three-quarter inch cover slips) fresh preparation.

Examination with Zeiss A lens revealed nothing; with a higher power (Zeiss D lens) I observed the trypanosome—to be described later. Only three of these organisms were present in the three slides.

Condition of the Patient on his Return to the Gambia

On his return to Bathurst, the patient was placed on the sick list as he had not yet completely recovered from the attack of pneumonia contracted on his way out.

General Symptoms. On examination of the patient with Dr. FORDE, December 18, 1901, we found his temperature 100·4, pulse 96, respiration 34.

Chief symptoms were weakness, marked loss of weight, could not walk far without feeling very tired. Patient did not complain of any definite symptom. There was no pain nor headache, but a little loss of appetite and sleeplessness at times. On December 16 he had a slight bleeding from the nose. There was no cough, but some dyspnoea on exertion. The general facial aspect which had been remarked upon by his friends was very striking. The face was puffy and congested. The eyes were sunken, the conjunctivae had a watery appearance, but were not congested ; the most prominent feature was the puffiness of the lower lids, which were distinctly oedematous. On examining the body generally one noticed that the skin appeared cyanotic, especially on the chest and thighs, pressure made with the hand caused a white mark which took some little time to disappear. There was some puffiness around the ankles, the skin pitting slightly on pressure ; the skin was dry ; no jaundice.

Respiratory System. No cough, no expectoration. Respirations were increased in frequency. This frequency of the rhythm was very noticeable on the slightest exertion or excitement. During the time in which I observed him, his respirations were never below twenty per minute—the usual being from twenty-five to thirty, they were never laboured. Chest somewhat barrel-shaped, breath sounds normal, no dulness, slight emphysema, otherwise the lungs appeared healthy.

Circulatory System. Pulse frequent 96, regular in time and force ; tension normal, artery normal. The pulse was always frequent, it hardly ever was recorded below 90 even when the temperature remained low.

Heart. Apex in the fourth interspace four inches from the mid line. Impulse could be distinctly seen, not diffuse ; cardiac dulness commenced above at the third rib, and did not extend to the right beyond the mid sternal line ; cardiac sounds normal, no adventitious sounds.

Digestive System. Appetite fair, no diarrhœa ; had to take an occasional aperient, no pain on abdominal palpation.

Liver. Dulness, four-and-a-half inches in nipple line ; extended just below costal margin.

Spleen. There was a slight bulging of the splenic area. Splenic dulness increased, diagonally measured seven inches. The edge of the spleen could be felt below the costal margin. There was no tenderness on palpation.

Nervous System. Nothing abnormal could be detected.

Lymphatic System. No definite enlargement of lymphatic glands.

Renal System. Urine normal in quantity, rather high coloured, sp. gr. 1020, acid, no albumen, no casts, some phosphates.

Chart No. 3 gives a record of the temperature, pulse and respirations from December 16th to January 5th. It will be seen that the temperature was very similar in character to that recorded in charts 1 and 2, namely, periods of slight pyrexia, lasting three to four days, with intervals of four or five days in which the temperature remained below normal. The temperature charts shew an irregular but distinctly *relapsing* type of fever.

From December 16 to December 18 the patient's temperature was raised, and on these days parasites were found in the blood, the greatest average number seen was fifteen under a three-quarter inch square coverglass. On December 19 the temperature fell below normal, and on this and for the next few days no parasites could be detected in the blood.

Progress of the Case. The patient during the period in which I observed him was never confined to his bed, and was able to take short walks in the afternoons; his appetite was distinctly good during the apyrexial periods, he did not complain again of pain over his spleen. On December 26 he was sent to the Cape for a change—a distance of seven miles from Bathurst, at the mouth of the river, where a good Government house facing the sea is built. Here I again had an opportunity to observe him, staying with him for two or three days. The fresh sea breezes appeared to produce some improvement. For the first few days he had a slight evening rise of temperature reaching to nearly 100°, and trypanosomes again appeared in the blood but no further symptoms presented themselves. The day before I returned to Bathurst (December 30) I made the following note.

'Mr. X slept longer than usual this morning, on getting up the puffiness about the eyes is very marked, especially the right lower lid which pits on pressure; slight injection of the conjunctivae; complains again of feeling week in the legs, the ankles are slightly oedematous; no oedema anywhere else.' The blood was examined this day at 10 a.m., 12 and 4 p.m., no parasites were seen, the temperature on the previous night only rose four points above normal.

The patient remained five days longer at the Cape and then returned to Bathurst, temperature remained low. He seemed much improved, and was allowed to resume his duties. I made a blood examination on January 5, before he went up the river, a fresh preparation proved to be negative, one parasite was found in two smears of blood.

Case was treated with gradually increasing doses of arsenic and five grains of quinine daily.

The chief clinical features of the case were as follows:

1. General wasting and weakness, especially marked in the legs.
2. Irregular relapsing fever, temperature never very high and lasting one to four days, with at times, morning remissions; apyrexial periods of two to five days, when the temperature remained normal or sub-normal.

3. Oedema, more especially about the eyes.
4. Injection of the skin and sometimes conjunctivae.
5. Enlargement and tenderness of the spleen.
6. Constant frequent pulse and respirations (hurried breathing). These symptoms associated with no definite organic lesion.

The Parasites observed in the Blood

Although many slides were made and fresh preparations of the blood examined throughout the time the patient was under observation, no malaria parasites were discovered.

In fresh blood the parasite is a very minute worm-like body, very difficult to see with a magnification of three hundred diameters; especially is this the case when only few are present in a preparation, and the parasite is amongst a clump of red corpuscles; it glides along fairly rapidly in among the red cells, imparting very little movement to them. When the movements have slowed down it is seen that one end is drawn out into a whip-like process—the flagellum; the other end is bluntly conical; attached along the body is a flange-like process—the undulating membrane; the body itself is short and thick, and its substance granular. There is a highly refractile spot situated near the posterior end (Vacuole).

Movements: The parasite usually is seen progressing with the flagellum (anterior end) in front, but at times when an obstruction is insurmountable, it shoots backwards for a short distance with the blunted end (posterior) in front. Slow progression is brought about by wave-like motions started in the flagellum and communicated along the undulating membrane. The parasite in rapid motion moves in a screw-like manner, its body rotating around the longitudinal axis so that the undulating membrane appears as if it were spirally arranged around the organism. This appearance is seen in specimens of blood preserved in two per cent. formol in normal saline.

When movements slow down, I have observed on two or three occasions, parasites, apparently attached by their posterior end to a red corpuscle indenting its capsule by the waves sent along the undulating membrane. I have never observed the red corpuscle damaged in this way. On one occasion I observed the process of phagocytosis take place on a slide one hour after the blood was drawn; a mononuclear leucocyte had partially englobed the trypanosome, only the flagellum and a small portion of the anterior part of the body remaining free.

In fresh preparations, ringed with vaseline, the parasites appear to die in a few hours after the blood is drawn (one observation three hours). In such preparations, left over night, I was never able to find the trypanosome again in the morning. Atmospheric temperature varied from 90° in the day to 65° during the night. I was unable to obtain an exact measurement of the parasite in the fresh state.

Stained Preparations. Most of the blood films were stained by a slight modification of the method of ROMANOWSKY for chromatin ; this method brings out well the structure of the parasite.

The length of the parasite, in stained preparations, including the flagellum, varied from 18 μ to 25 μ ; in preparations which were taken on December 16 (first observation) the parasites appeared somewhat longer than those taken when they appeared in the blood again on December 27 ;[1] the majority of specimens measured 22 μ, the width was 2 μ to 2·8 μ. This width, when compared to the other typanosomes is distinctly greater in proportion to the length.

The flagellum stains a light crimson, and can be traced from the anterior end of the organism along the outer margin of the undulating membrane, stopping short of the refractile spot seen in fresh preparations ; it sets in small curves along the body, and there is always present a dip opposite the nucleus. The free part of the flagellum is about one third that of the total length, but it is difficult to say where the anterior part of the body ends and the flagellum begins ; one can always see a narrow streak of protoplasm, staining blue, for some distance beneath the free part of the flagellum.

The posterior end of the organism is roughly conical, in most specimens with the point of the cone cut away on the side remote from the undulating membrane ; it is very blunt.

The undulating membrane is a narrow unstained band, somewhat wrinkled, attached along one side of the animal ; in stained preparations, it sometimes takes on a faint pink colour.

The nucleus (the macro-nucleus of PLIMMER and BRADFORD) is situated a little anterior to the middle of the body, in some specimens occupying the whole width of the animal ; it is oval in shape and stains dark crimson, due to an *aggregation* of chromatin granules.

Generally about 2·5 μ from the posterior end is a dark purple spot, well marked, shewing no definite structure ; this is the centrosome (LAVERAN and MESNIL) or micro-nucleus of PLIMMER and BRADFORD. Anterior to it there is a large clear spot (vacuole) which does not stain ; the vacuole in all the specimens is well marked ; the flagellum appears to end at the upper edge of the vacuole. LAVERAN and MESNIL[2] point out the connexion of the flagellum with centrosome from observations on *T. lewisi.*

The protoplasm does not stain evenly, it takes on a basophil reaction, and in it are fine blue-stained granules situated chiefly beneath the attachment of the undulating membrane, and also around the nucleus. Plate VI shews the trypanosomes stained by ROMANOWSKY's method. The organisms 'set' in a characteristic manner on a

1. Plimmer and Bradford state, the size and length of the body of T. Brucei varies very much with the period of the disease. *Quart. Journ. of Microscop. Sc.*, vol. 45, pt. 3, p. 452. Feb., 1902.
2. Sur le Trypanosome des Rats (T. lewisi Kent). *Ann. de l'Institut Pasteur*, September 25, 1901, p. 684

slide, viz., the body is generally bent at an angle opposite the nucleus (see Fig. 4, Plate V). I have observed this in most of the stained and in formalin preparations ; whether this is a distinguishing feature or not is difficult to decide, but it is curious to note in film preparations that the body of *T. lewisi* does not bend but sets in a crescentic manner (Plate V, Fig. 1) ; in the case of *T. brucei*, the body makes three or four curves, (Plate V, Fig. 2). The number of trypanosomes present in fresh preparations (three-quarter inch square cover glass) is indicated in Chart III. It is to be noticed that during the apyrexial period, they were not detected in the blood. I have not observed dividing forms in any of the slides made.

A blood count was made on December 18, four hours after food—

Red corpuscles numbered 3,850,000 per cmm.
White „ „ 12,000 „
Hoemoglobin was 76 per cent. (Gower's apparatus).

A differential count of the white corpuscles was made on several occasions, when the parasites were present, and when few or none could be detected in the blood. On all occasions the counts showed an increase of lymphocytes at the expense of the polynuclear, the relation being generally about 50 per cent. of the latter to 40 per cent. of the former.

The only record of a trypanosome occurring as a human parasite is one by Nepveu,[1] who, as a result of his researches in malaria carried out in Algeria, in the summer of 1888, describes various forms of organisms, streptococci, algae, micrococci, etc., as occurring in the blood of malaria patients, together with various forms of infusoria and sporozoa. He states at the end of his paper :—

'Je n'ai jamais pu trouver, malgré le plus grand soin, la trypanomonade ou le trypanosome de Danilewski, mais certainement des caractères assez nombreux semblent en indiquer expendant la présence, ou tout au moins la présence d'un hématozoaire très voisin. On rencontre, en effet dans le sang quelques éléments qui semblent représenter le stade spherique ou la période de segmentation du trypanosome (vesicules à queue, vesicules en larmes bataviques, etc.')

In 1898, he published an article *Sur un Trypanosome dans le sang de l'homme*[2] based on his previous observations in Algeria in 1888, in which he contradicts the statement given above. In one case, he found an organism with two flagella (trypanomonas of Labbe). In five others he found organisms which presented all the characters of the trypanosomes. In all cases they were associated with various parasites of malaria. The cases were chiefly pernicious forms of malaria, except in one subject, who was apparently in good health.

It is very unfortunate that no morphological details are given, and that only a few rough drawings published in his previous article are available.

1. Etude sur les Parasites du sang chez les Paludiques. *Mem. de la Société de Biologie*, 1891, T. III., p. 39-50.
2. Sur un Trypanosome dans le sang de l'homme. *Mem. de la Société de Biologie*. Séance du Dec. 24, 1898.

Diseases Produced by Trypanosomes in Animals

Up to 1901 four diseases occurring in various parts of the world were known to be produced in lower animals by the presence of trypanosomes.

'Surra' occurs in horses and mules in many parts of India and British Burmah, caused by *T. evansi* (Steel).

'Nagana,' in Central Africa and probably other parts, attacking horses, and, to a less extent cattle, due to the *T. brucei* (Plimmer and Bradford).

'Mal de Caderas' in Central South America and Brazil; the disease is similar to Surra and Nagana, and is produced by a trypanosome probably identical with that of *T. brucei.*

'Dourine' or 'Maladie du Coït' occurs in Algeria, South France, Spain, and Turkey; the pathological agent of which is the *T. equiperdum* (Doflein), *Trypanosoma rougeti* (Laveran).

In February of this year Lieut.-Col. Bruce[1] has reported a discovery by Dr. Theiler of a new trypanosome which is pathogenic to cattle. Horses, dogs, goats, rabbits, and guinea pigs appear immune. The trypanosome is twice the size of any of the ordinary trypanosomes, and Dr. Bruce proposes to name it *Trypanosoma theileri.*

The clinical symptoms associated with these diseases, although very similar, have some minor differences, and this is more especially the case with regard to Dourine, which is not such a fatal malady as Surra or Nagana.

Dr. G. Evans, in his report on Surra,[2] 1880, describes this disease occurring in the horse as characterized by fever with jaundice, petechiae of mucous membranes, especially of eye and vagina, dropsy, sometimes albumen in the urine, great prostration, rapid wasting, with a specific parasite in the blood during life, but no characteristic structural organic lesions found after death.

The average duration of the disease is probably less than two months.

The first symptom noticed is that the animal is out of sorts; there is more or less thirst, appetite capricious, coat staring, occasionally stumbling before or dragging the hind legs on the ground; then fever, more or less high, with slight catarrhal symptoms; the eyes weeping, often a mucous discharge from the nose; the submaxillary gland may be tender and enlarged, general swelling of the legs; dropsy invades the sheath of horses and between the forelegs of mares; conjunctivae yellow, with claret coloured spots on the membrana nictitans at the inner corner of the eye; in mares, labia yellow with petechiae on the mucous membrane. With rest the fever subsides and appetite returns, especially for grass; thirst continues, the animal wastes away; death may be sudden, or end in delirium, or the animal may linger for days after it is down, taking its food well.

1. *The Lancet*, March 8, 1902, p. 664.
2. Report on Surra published by the Punjaub Government Military Depart., 1880, by G. Evans, M.D.

Veterinary Surgeon J. H. Steel, A.V.D.,[1] in 1885, described very fully a disease occurring among the transport mules in British Burma, in which he found organisms in the blood of these animals, shown later to be identical with those found by Evans in India. The symptoms were very similar to those described by Evans. Steel shewed that the fever was of a *relapsing* character. In inoculation experiments under the skin, the incubation period was five days ; the first acute febrile attack lasted three days with an interval of five days before the next, when the temperature would remain about normal, with, perhaps, slight evening rises. In these apyrexial periods the symptoms abated somewhat, and the blood was free from detectable parasites. Besides the anaemia, swellings, petechiae and ulcers, etc., associated with general wasting, he pointed out the enlargement of the spleen as a constant feature in the disease, and some enlargement of the lymphatic glands. Ulceration of the stomach was found after death with a general oedematous and congested condition of the organs and areolar tissues.

Surgeon-Major Bruce,[2] in 1896, has described the symptoms of Nagana in various animals.

In the horse, the first noticeable features are that his coat stares, and there is a watery discharge from the eyes and the nose ; shortly afterwards there appears a slight swelling under the belly or a puffiness of the sheath may be noticed, and the animal falls off in condition, hind extremities tend to become swollen, at times more marked than at others, the animal becomes more emaciated ; eyes and gums are pale, and probably a slight milkiness of the cornea is observable ; no symptoms of pain ; up to the last a fairly good appetite ; animal falls down, unable to rise and dies of exhaustion. Other points recorded in his notes on the cases are the anaemia, red cells decreasing from 5,500,000 to 2,500,000 ; petechial spots on the mucous membranes, swollen glands. He describes the temperature as very irregular ; in a temperature chart given of a horse which had been taken into the ' Fly country ' and there contracted the disease, it is interesting to note the close relation between the presence and number of parasites in the blood to the rises of temperature. The disease started on October 4, temperature reaching 104·8 next day ; with numerous parasites in the blood, on October 21 and 22 temperature was normal (varied from 90° to 102°) ; on these days the blood was examined, and no parasites found. On the evening of October 23 temperature arose to 107°, and numerous parasites were present in the blood. Next day temperature dropped to 100° ; no parasites were found. On subsequent days the parasites increased from four hundred to five thousand on October 28 ; the evening previous there had been a rise of temperature to 106°. After the rise the parasites diminished slightly, with, at the same time, a slight diminution of temperature, until October 31, when

1. Report of Vet. Surgeon J. H. Steel, A.V.D., on his investigations into an obscure and fatal disease among transport mules in British Burma. 1885.
2. Tsetse-fly disease or Nagana in Zululand, Durban, 1894. Further report on tsetse-fly disease in Zululand, London, 1897

six thousand were present in the blood per c.mm. ; next day temperature reached 105·8°, with a drop to 102° on the following day, when no parasites were found. This rise and fall of temperature was again repeated with a corresponding appearance and disappearance of parasites, followed by another period in which the parasites gradually increased in the blood up to the time of death on November 6. The course of the disease presents a remarkable similarity to that recorded by Evans and Steel amongst the Surra cases in India and Burmah.

The symptoms presented in the South American disease, Mal de Caderas, are very similar to those of Surra and Nagana ; haematuria is a very frequent accompaniment and weakness and paralysis of the hind legs are the most pronounced features.

With regard to Dourine, or Maladie de la Coït, the symptoms presented in this disease are of a much less severe character. In the horse there is rarely fever. The disease shows itself in the horse after coitus in ten to twenty days, and lasts four to ten months, with swelling of the genital organs. Other symptoms present are progressive emaciation, oedema of the abdominal regions, swelling of the pastern, and weakness of the hind legs. Towards the end, eye troubles set in, paraplegia and a cutaneous eruption have been observed.

The parasites are always rare in the blood, occurring for the most part in the sero-sanguinolent fluid of the local oedemas under the cutaneous plaques, and on the mucous membranes of the vagina and urethra.

Laveran and Mesnil[1] state that Nocard has been able to kill horses by inoculating the trypanosome of Dourine in four, six, and eight weeks, and they show a temperature curve of Nagana and Surra.

Chart No. 4 shows the character of the temperature and the relation of parasites occurring in the blood (indicated by dotted curve) in an ass inoculated with *T. brucei* by Laveran and Mesnil.

If the above symptoms in animals are compared with those described as occurring in man, it will be seen that they have many points in common ; the same cachectic symptoms—loss of flesh, weakness, similar eye symptoms, oedema, etc., accompanied by an irregular *relapsing* fever, associated with the disappearance of the parasites after the pyrexial attack. Though there is as yet no experimental evidence that the symptoms described in this case result from the presence of the trypanosome ; yet here we have a case presenting peculiar clinical features which do not show much resemblance to any known disease, and along with them is a pathological agent, allied species of which cause similar symptoms in the lower animals ; for this reason I think it is justifiable to consider this case as akin to Surra or Nagana occurring in man.

1. Laveran and Mesnil, Sur le Trypanosome du Naguna ou Maladie de la Mouche Tsétsé, *Annales de l'Institut Pasteur*, Jan. 25, 1902

The Identification of the Parasite Found in Man

It is now known that the course of the disease produced by a trypanosome, varies in the different animals experimentally inoculated ; some animals being more refractory than others ; and the parasite also varies in its morphological character in the different animals, and with regard to the numbers occurring in the blood. Laveran and Mesnil[1] and others have shown that *T. lewisi* cannot be inoculated into the larger animals, dog, cat, cow, horse, mule, etc. It produces no pathological effect in rats. Divisional forms are only seen for a short time in the blood, four to eight days after inoculation (Laveran and Mesnil), and it can be easily distinguished from the other trypanosomes by its morphological characteristics ; thus, comparing *T. lewisi* with *T. brucei*, the former is smaller and thinner, length measuring 24-25 μ, breadth 1·5 μ, while the latter measures 26-27 μ length, 1·5 to 2·5 μ breadth in the rat. The general aspect of the parasite is finer, the posterior end is pointed, while in *T. brucei* it is blunt. The macro-nucleus is situated at the anterior end of the body, the macro-nucleus is placed transversely as a rule and is large (Plimmer and Bradford), the protoplasm stains less deeply with basic dyes. In *T. brucei* the macro-nucleus is placed centrally, the macro-nucleus is small, protoplasm stains well, and in it are chromatic granules situated anterior to the nucleus (Laveran and Mesnil).

Plimmer and Bradford[2] describe Amoeboid and Plasmodial modes of multiplication as well as longitudinal division in the case of *T. brucei*, while in the *T. lewisi* longitudinal division is the rule. Laveran and Mesnil[3] shew that longitudinal division differs in the two parasites. *T. lewisi* is more resistent to cold than *T. brucei*. Laveran and Mesnil[3] inoculated rats successfully with blood containing *T. lewisi* after being fifty-five days in the refrigerator at 5-7°, they were unsuccessful with blood containing *T. brucei* which had been kept three to five days in the refrigerator, although a few motile organisms were present.

In the case of tsetse trypanosome, Bruce[4] pointed out that the parasite differed in appearance in the various animals he inoculated. Plimmer and Bradford,[2] and Laveran and Mesnil[3] have studied the *T. Brucei* in the horse, dog, cat, rat, mouse, etc. In the rat and mouse the organisms are always numerous and steadily increase in the blood until death, which takes place in six to nine days. In the rabbit the parasites are only found at irregular intervals ; in the goat the disease is protracted (death in two months) and the organisms are not found abundantly in the blood ; the spleen is not enlarged. In the horse the parasites were longer and thinner than in any other animal. Laveran and Mesnil[3] state that the parasite varied from 28 to

1. Laveran and Mesnil. Sur le Trypanosome des Rats. *Ann. de l'Institut Pasteur*, Sept. 25, 1901.
2. Plimmer and Bradford. The Trypanosoma Brucii, the organisms found in Nagana. *Quarterly Journal, Micro. Society*, Vol. 45, Part 3.
3. Laveran and Mesnil. Sur le Trypanosome der Nagana ou Maladie de la Mouche Tsetse. *Ann. de l'Institut Pasteur*, Jan. 25, 1902.
4. Bruce, *loco cit.*

33 μ in the horse and ass; the breadth was the same. LAVERAN and MESNIL never observed the parasites in the blood after inoculating a pig with *T. brucei*, still its blood was very pathogenic to rats, mice, etc.; five to eleven days after inoculation. Animals naturally infected with *T. lewisi* succumb to inoculation with *T brucei* in the usual time.

In this connexion, the question of the identity of Surra with Nagana is interesting. KOCH[1] has observed no morphological differences between the two parasites. The symptoms produced in animals appear to be also identical, with the exception that cattle were considered to be more refractory to Surra, but RODGERS[2] has lately shown that in cattle in India, as also in goats and sheep the disease follows a similar characteristic course to Nagana in Africa. He points out that cattle may succumb to Surra, while in Africa they may not infrequently recover from Nagana.

RODGERS[2] has also shown that Surra can be transmitted by the bites of horse flies (*Tabanus tropicus*).

With regard to Mal de Caderas, LAVERAN and MESNIL[3] state that the parasite is identical with that of Nagana. It effects horses in a similar manner, but cattle appear to be absolutely refractory.

LAVERAN and MESNIL[3] point out that the parasite of Dourine, can be easily distinguished from the other trypanosomes by its pathological effects on animals, and its morphological characteristics. Cattle, sheep, goats, are refractory. The disease is only transmitted during the act of coitus. The parasites are rare in the blood occurring for the most part in the oedema fluids.

From the foregoing facts, it will be seen that it is impossible to identify the typanosome in man without inoculation experiments in the lower animals. It is quite reasonable to believe that the trypanosome I have described may be a known species modified in man; but on the other hand, I would point out that there has not been a case recorded of symptoms produced by trypanosomes amongst natives or whites in the countries where these diseases occur, though they are subject to the same risk of infection; for instance, in Africa the tsetse fly bites travellers, natives, and others just as much as animals.[4] I have not found any record of Nagana occurring in animals in the Gambia. Horses live well in Bathurst, and from places up the river have been sent down to other parts of the coast. At a place one hundred and eighty-five miles up the river, Baia, I observed donkeys in good condition; but at some places on the West Coast horses cannot be kept. Dr. CHRISTY informs me that he has seen trypanosomes in the blood of horses in Northern Nigeria; at Jebba all horses were examined for trypanosomes before being bought by the Government.

1. Reiseberichte, Berlin, 1896.
2. *Pro. Royal Society*, May 4, 1901.
3. *Loco. cit.*
4. See Bruce, *loco. cit.*

Dr. LAVERAN, who has very kindly examined some blood films taken from the patient wrote to me that if the morphological characters are alone considered he would regard my specimen as a new species ; it is smaller than *T. lewisi* (24 to 25 μ), *T. brucei*, (26 to 28 μ) and *T. equiperdum* (25 to 28 μ), and differs from *T. brucei* in length of the flagellum and by the small number of chromatin granules in the protoplasm.

At present then it is impossible to decide definitely as to the species, but if on further study it should be found to differ from the other disease-producing trypanosomes I would suggest that it be called *Trypanosoma gambiense*.

During the time I was in Bathurst I did not observe any symptoms occurring among the natives similar to those detailed above, but Dr. R. M. FORDE informed me sometime before I examined the patient that he had come across cases among the native boatmen presenting similar symptoms, oedema, etc. I examined the blood of some native sailors on the Government launch, some fourteen in all, with negative results ; all appeared healthy.*

Specimens were very kindly collected for me of the mangrove flies by Mr. BATTY, which are often very troublesome on board the launch. I also obtained a few specimens on my journey up the river. Two varieties were caught, a large one, which Mr. THEOBALD identified for me as *Tabanus dorsovitta*, WELKA. The small one turned out to be a species of tsetse, *Glossina longipalpis*, WIEDERMANN var. *Fachinoides*, WESTWOOD. The patient informed me that these small mangrove flies are very troublesome on the launch during the hot months—June, July, August—and that he himself had suffered frequently from their bites.

This species of Glossina has been seen by Mr. AUSTEN in Sierra Leone, and specimens have been brought from Asaba on the Niger ; by Dr. CROSS it appears to have a wide distribution in West Africa.

* Since going to press I have lately examined a series of one hundred and fifteen films obtained from native children (one to fifteen years of age), which I brought home for the purpose of estimating the prevalence of malaria in the Gambia.

In one preparation of blood taken from a child three years old, I found trypanosomes present. In the smear three parasites were counted, presenting identical characteristics ; size, shape, staining reaction, and position taken up on slide ; to the parasite described occurring in the blood of the European.

Associated with the trypanosomes were a few ring forms of malaria parasites.

The child was one of a batch of fifty examined at a native village, seven miles from Bathurst, near the mouth of the river Gambia ; these children were to all appearances healthy.

DESCRIPTION OF PLATES

Plate V

Fig. 1.—*Trypanosoma lewisi;* stained preparation of the blood of a rat. × 1400.

Fig. 2.—*Trypanosoma brucei;* stained preparation of the blood of a mouse. × 1400. The largest organism in the photograph is undergoing longitudinal division; the centrosome, nucleus, and flagellum, have almost completely split into two. Specimen kindly sent to me by Dr. Laveran.

Fig. 3.—*Trypanosoma equiperdum*; stained preparation of the local oedema fluid of an infected dog. × 1400. Specimen kindly sent to me by Dr. Laveran.

Fig. 4.—*Trypanosoma gambiense*; stained preparation of the blood of man. × 1400.

Plate VI

Trypanosoma gambiense; drawing from a specimen of blood stained by Romanowsky's method. × 2100.

CHARTS

1.—Temperature chart of case whilst in hospital at Bathurst, under care of Dr. R. M. Forde.

2.—Temperature chart whilst in Royal Southern Hospital, Liverpool, under care of Dr. Macalister.

3.—Temperature chart and results of blood examinations whilst under the author's observation after his return to Bathurst.

4.—Temperature chart of an ass inoculated with *T. brucei* (after Laveran and Mesnil).

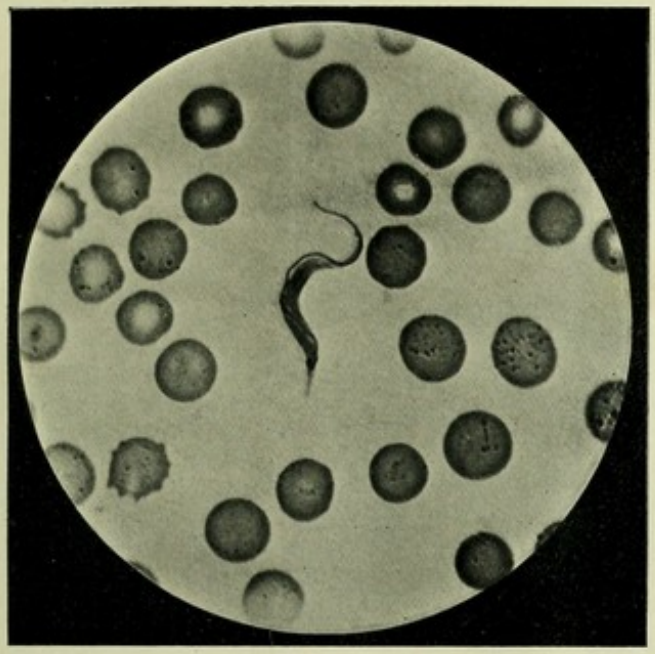


FIG. 1

FIG. 2

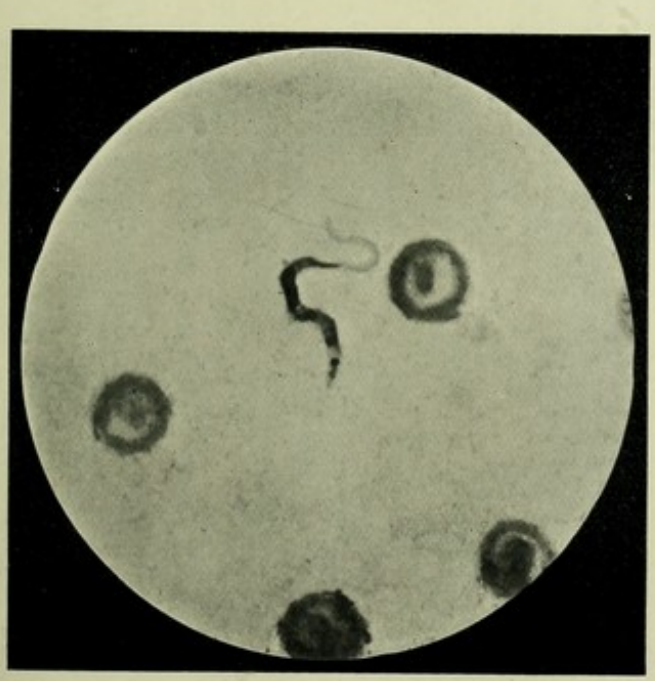


FIG. 3

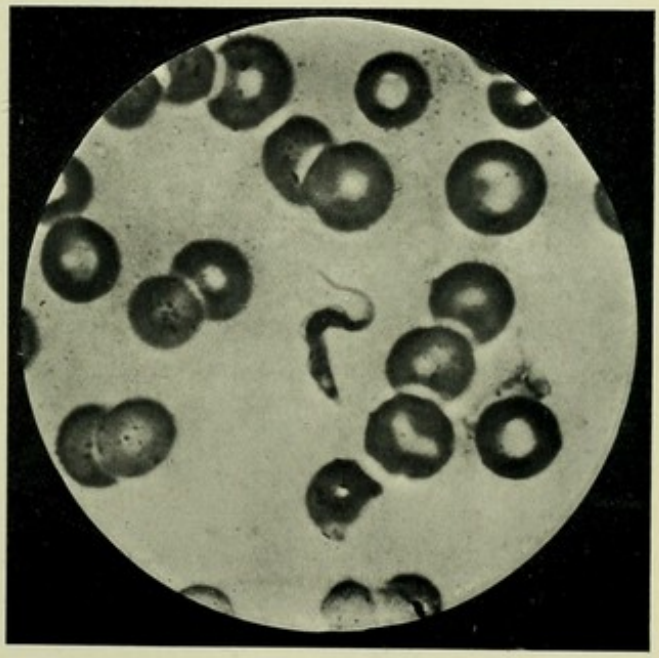


FIG. 4

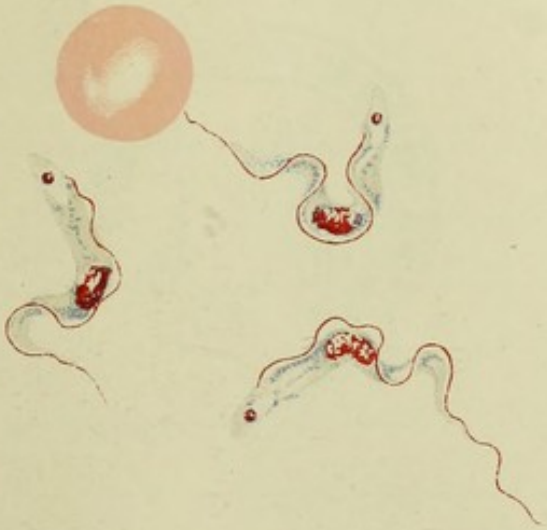


CHART Nº 1.

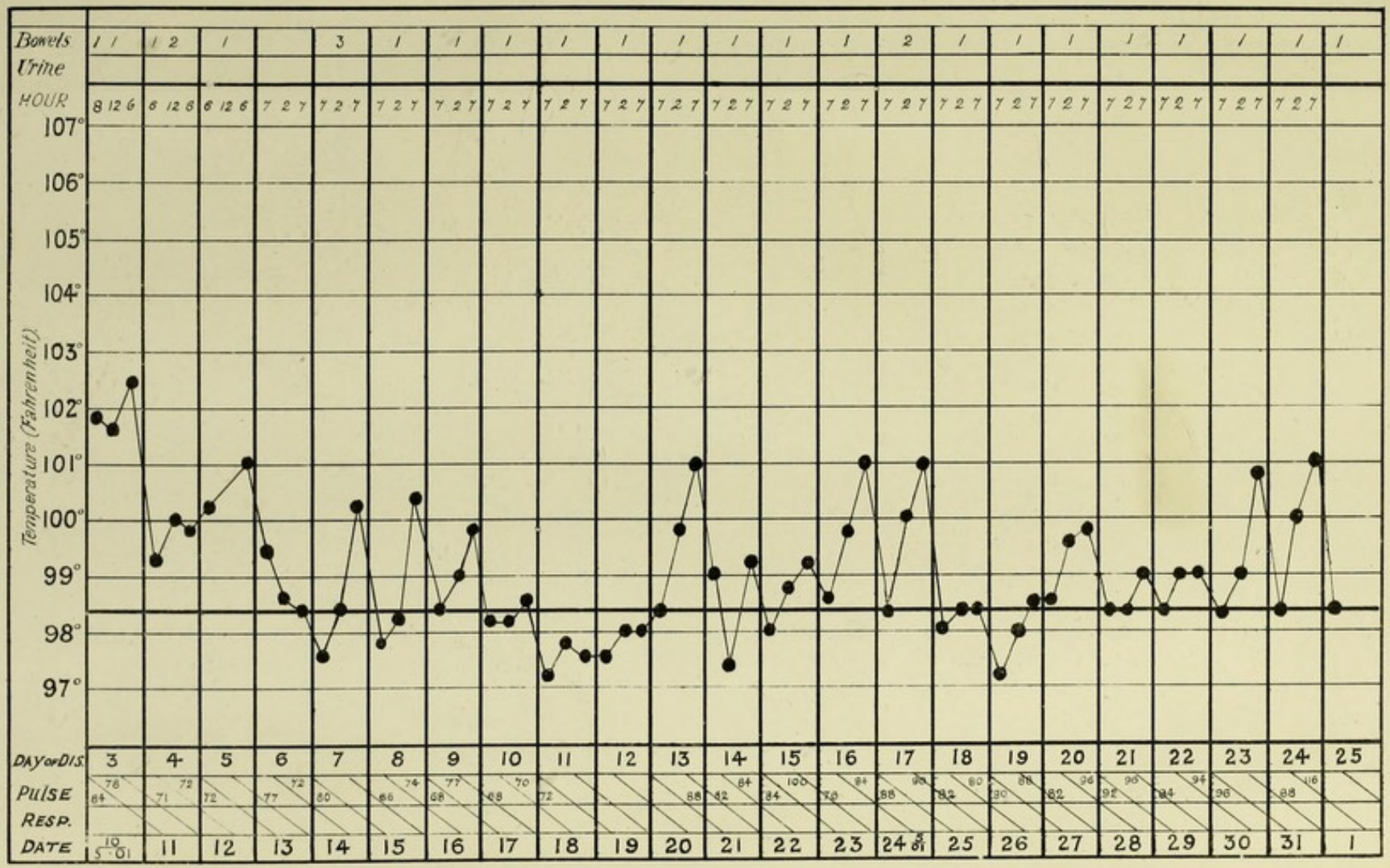

Bowels
Urine
HOUR
Temperature (Fahrenheit)
107°
106°
105°
104°
103°
102°
101°
100°
99°
98°
97°
DAY or DIS
PULSE
RESP.
DATE

CHART II.

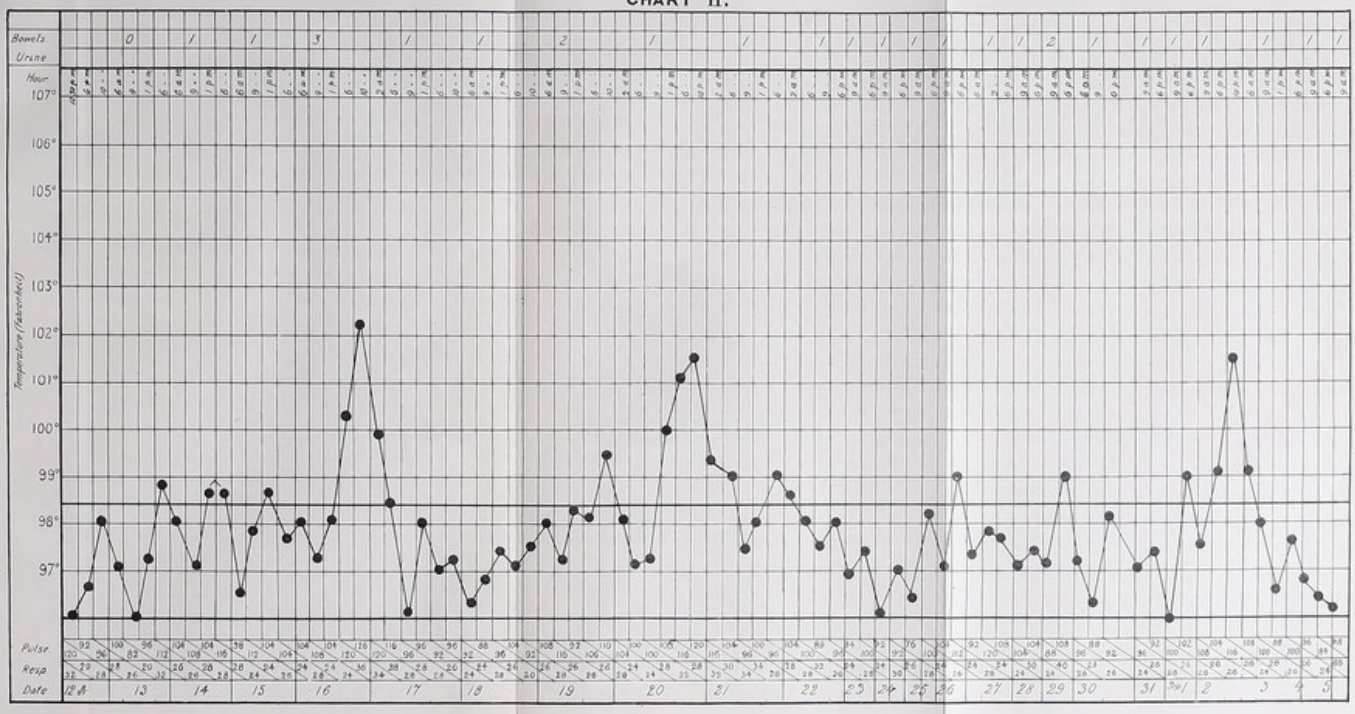

Bowels
Urine
Hour
107°
106°
105°
104°
103°
102°
101°
100°
99°
98°
97°
Temperature (Fahrenheit)
Pulse
Resp.
Date
13th
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
Sept
2
3
4
5

CHART III

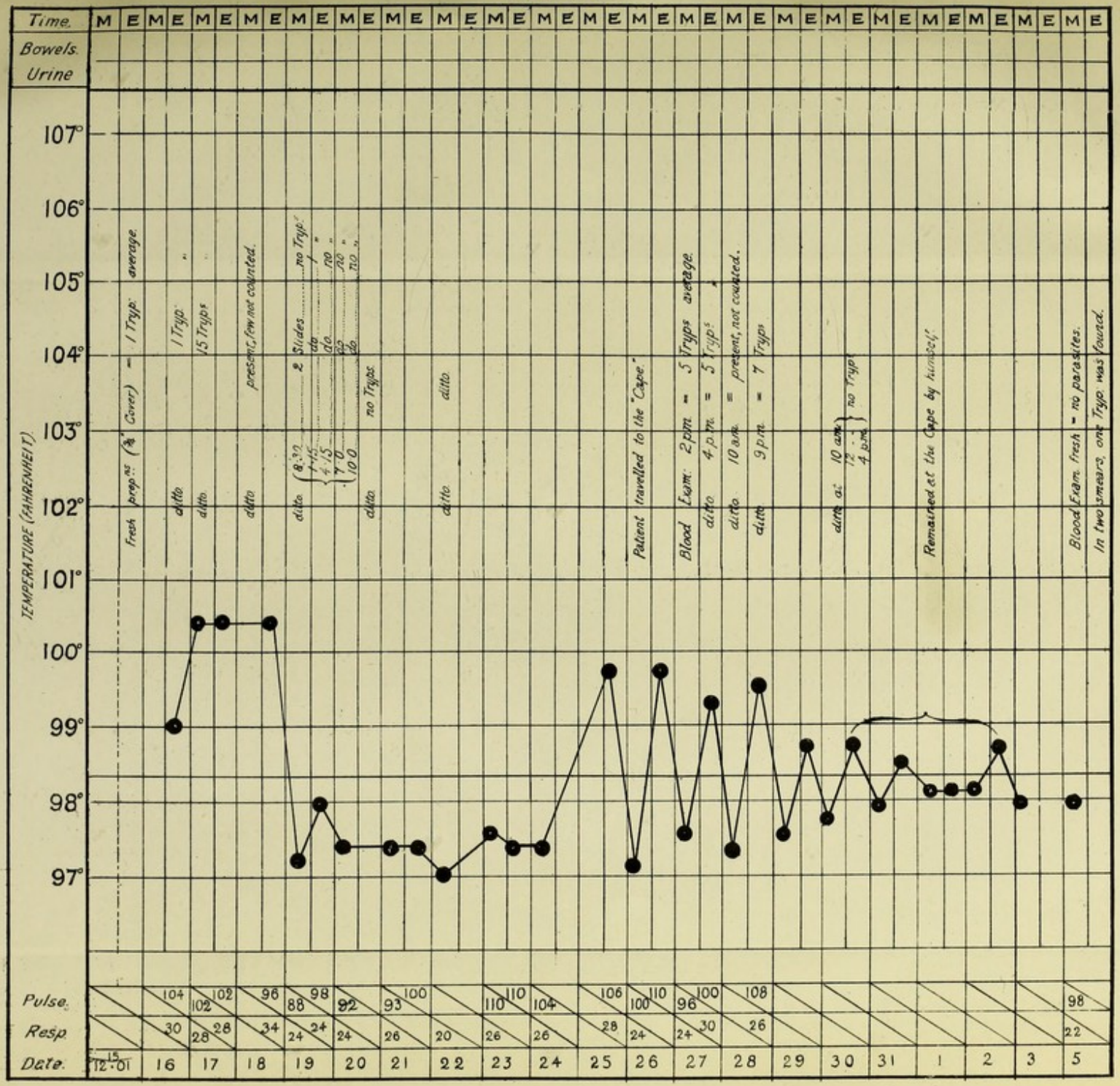
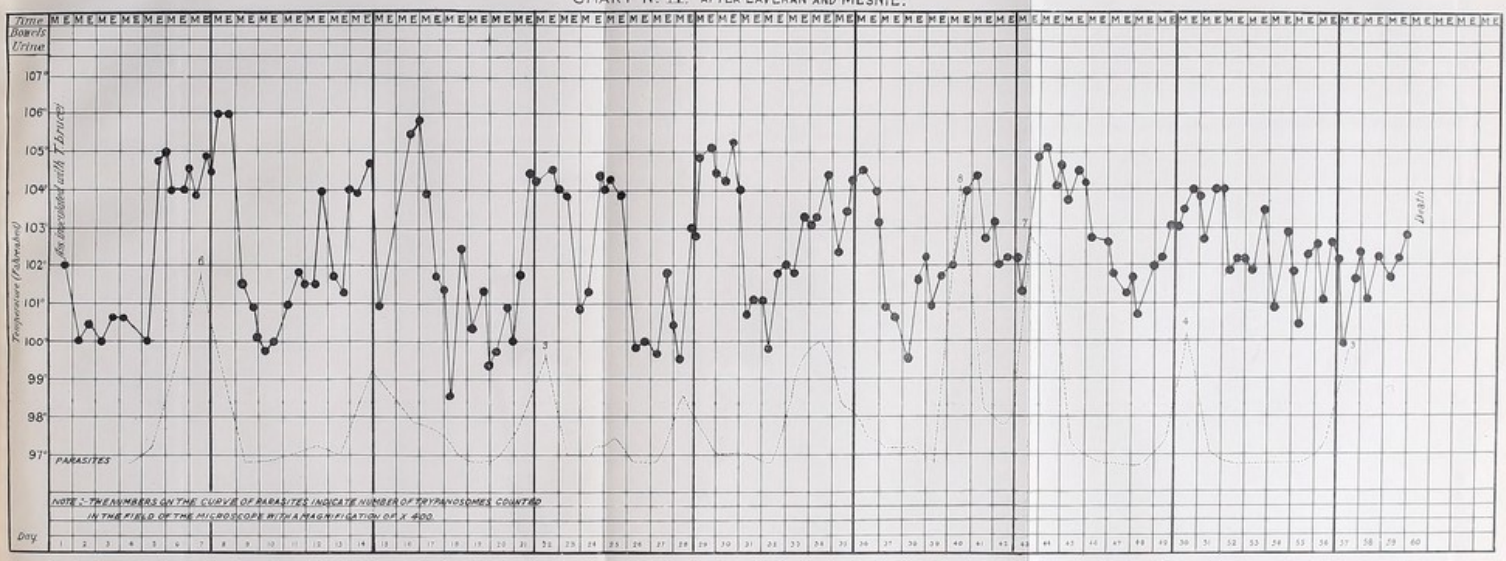

Time.
Bowels.
Urine
TEMPERATURE (FAHRENHEIT)
107°
106°
105°
104°
103°
102°
101°
100°
99°
98°
97°
Fresh prep.ns (& Cover) — 1 Tryp: average.
ditto 1 Tryp: "
ditto 15 Tryps "
ditto present, few not counted.
ditto 2 Slides..... no Tryps
ditto 8.30 1 "
4.15 do
4.15 do
7.0 no "
10.0 no "
ditto no Tryps
ditto ditto.
Patient travelled to the "Cape."
Blood Exam: 2 pm = 5 Tryps average.
ditto 4 p.m. = 5 Tryps "
ditto 10 a.m. = present, not counted.
ditto 9 p.m. = 7 Tryps
ditto at 10 a.m. 12 - 4 p.m. } no Tryp
Remained at the Cape by himself.
Blood Exam. fresh - no parasites.
In two smears, one Tryp. was found.
Pulse.
Resp.
Date.
12·01
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 5

CHART Nº IV. AFTER LAVERAN AND MESNIL.



NOTE:- THE NUMBERS ON THE CURVE OF PARASITES INDICATE NUMBER OF TRYPANOSOMES COUNTED IN THE FIELD OF THE MICROSCOPE WITH A MAGNIFICATION OF X 400.