A TOUR OF INVESTIGATION AS TO THE PREVALENCE OF KALA-AZAR IN KASSALA AND BLUE NILE DISTRICTS, SUDAN, FROM JANUARY 12TH TO MAY 16TH, 1909.

By Captain L. Bousfield.
Royal Army Medical Corps.

(Continued from p. 183.)

The disease has appeared amongst the troops, but as far as the Egyptians are concerned only two cases were found on this tour, one a shawish of the works department at Gedarif, the other an Onbashi in the Medical Corps, from Singa, in the Khartoum Military Hospital.

The shawish apparently contracted the disease either at Kassala or along the Atbara on the way to Gedarif. He was first taken ill at El Fasher.

One suspicious case was seen at Kassala in the 4th Battalion, but the parasite could not be demonstrated.

The Arab Battalion gives more cases, three being definitely diagnosed, one in the 1st Company, one in the 3rd Company, and the third being a morasla of office. My belief is that the 3rd Company is seriously infected, and it is founded on the following points:

No. 612, a shawish, an Abyssinian, belonging to the 3rd Company, was diagnosed as kala-azar on October 23rd, 1908, the films being sent to the Gordon College, and the report being "evidence of Leishman-Donovan bodies, very few in number, some free, others phagocyted." He was first taken ill at Gallabat on July 7th, 1907, and was ill one month with fever, and then sent by sick convoy to Gedarif Hospital. He then had fairly good health till September 21st, 1908, when he was admitted to Kassala Hospital and kala-azar was found. He greatly improved under quinine 30 grains daily, and the spleen decreased in size. Further spleen films did not reveal parasites, and he had no fever, and so was returned to duty. His tukl, &c. were burnt on admission to hospital. Later he moved to Gedarif, being kept under medical supervision.

I saw him at Gedarif on February 14th, 1909, and found him thin, but in fair health and feeling well. The spleen was enlarged

1 Final Report.
1\(\frac{1}{2}\) inches below the costal margin, and the liver was normal to percussion. There was slight anæmia, but no jaundice. The temperature was 99°2 F. in the morning when first seen, but subsequently when taken night and morning was normal, or 99° F. Splenic puncture revealed no parasites. He lived with his wife in a tuki and she showed no signs of disease, and no bugs were found. I saw him again on March 22nd, 1909, and his condition was the same. This apparently is a case that has either recovered, or one that is enjoying a long period of improvement.

But my opinion is that such a case, and any really suspicious case, should not be allowed to remain in the Army on account of our very limited knowledge of the method of conveyance of the disease and of the capability of a chronic case infecting others. The disease amongst the troops is at present very limited and, therefore, I believe this risk is unwarrantable.

On examining the 3rd Company I found two cases suspiciously like kala-azar (No. 1080 and No. 270), but I was unable to prove the diagnosis by finding the parasite.

On referring to the deaths that had occurred in the Arab Battalion the following cases raised suspicions that they may have been caused by kala-azar, and it is striking that they are all in the 3rd Company:

- Natar, No. 103 died 931 Gedarif, Feb. 23, 1908 Diarrhoea.
- " 931 May 21, Kala-azar (?)
- " 116 Kassala, Nov. 21, Diarrhoea.
- " 1,182 Dec. 5, Anaemia and cancrum oris.

It does not seem unreasonable to have serious suspicions that these may have been cases of kala-azar, since two were diagnosed as "diarrhoea," not dysentery or typhoid fever, the latter being rare in the Sudan, while diarrhoea as the terminal event in kala-azar is extremely common—one might say the usual thing—in the Sudan.

"Anæmia and cancrum oris," the former a well-known symptom of advanced kala-azar, the latter a common final complication and one but rarely seen in the Sudan except amongst young debilitated children.

No 931 evidently was so like kala-azar that he was diagnosed as such.

On referring to the shawish we found that the disease probably started at Gallabat in 1907; this town we knew to be infected, and as these cases all occurred in 1908, I think it is dangerous to keep such a man in the Service.

Mafaza, prior to this investigation, was thought to be the hot-
294 Investigation as to Prevalence of Kala-azar

bed of the disease, and on piecing together all the available information it is found that thirteen cases from this station have died, eight definitely proved as kala-azar, and the remaining five almost certainly of the disease.

These cases are now enumerated:

<table>
<thead>
<tr>
<th>Case</th>
<th>Date of death</th>
<th>Disease</th>
<th>Place of death</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) No. 1,128 Medical Corps</td>
<td>Aug. 27, 1907</td>
<td>Kala-azar</td>
<td>Cairo</td>
</tr>
<tr>
<td>(2) Police A. A.</td>
<td>Oct. 14, &quot;</td>
<td>&quot;</td>
<td>Wad Medani</td>
</tr>
<tr>
<td>(3) &quot; A. W.</td>
<td>&quot; 18, &quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>(4) W. Onb., Medical Corps</td>
<td>Feb. 14, 1908</td>
<td>&quot;</td>
<td>Kassala</td>
</tr>
<tr>
<td>(5) Police No. 138</td>
<td>&quot; Mar. 21, &quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>(6) H. W., Abyssinian</td>
<td>April 8, &quot;</td>
<td>&quot;</td>
<td>Mafaza</td>
</tr>
<tr>
<td>(7) Police No. 148</td>
<td>&quot; Jan. 14, 1909</td>
<td>&quot;</td>
<td>Gedarif</td>
</tr>
<tr>
<td>(8) S. W. L, Sudanese</td>
<td>April 8, &quot;</td>
<td>&quot;</td>
<td>Mafaza</td>
</tr>
</tbody>
</table>

The remaining five cases I think are almost certainly kala-azar:

<table>
<thead>
<tr>
<th>Case</th>
<th>Date of death</th>
<th>Disease</th>
<th>Place of death</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Arab</td>
<td>Nov. 8, 1907</td>
<td>Kala-azar</td>
<td>Kassala</td>
</tr>
<tr>
<td>(2) Morasla of Mamour</td>
<td>Dec. 12, &quot;</td>
<td>Dysentery</td>
<td>Gedarif</td>
</tr>
<tr>
<td>(3) Female servant of Mamour</td>
<td>Dec. 27, &quot;</td>
<td>General oedema</td>
<td>&quot;</td>
</tr>
<tr>
<td>(4) Mamour</td>
<td>Feb., 1908</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>(5) Police No. 165</td>
<td>&quot; 6, 1909</td>
<td>Kala-azar</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

In this list, Nos. 2, 3, and 4 came from the same compound, were taken ill about the same time, and all died within three months of one another.

Nearly all the above mentioned cases in both lists were taken ill while at Mafaza.

On referring to the police I find that out of forty-seven men who were stationed at Mafaza in 1907 and 1908 eight have died, the causes of death being as follows:

<table>
<thead>
<tr>
<th>Disease</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kala-azar</td>
<td>4</td>
</tr>
<tr>
<td>Influenza and cancrum oris</td>
<td>1</td>
</tr>
<tr>
<td>Cancrum oris</td>
<td>1</td>
</tr>
<tr>
<td>Killed by buffalo</td>
<td>1</td>
</tr>
<tr>
<td>Cause unknown</td>
<td>1</td>
</tr>
</tbody>
</table>

Thus it appears probable that six died of kala-azar—i.e., rather under 13 per cent.

It is to be regretted that during my visit in Kassala Province there was a general move of all the police, so that many were not seen. However, I inspected four at Gedarif, who were on their way from Mafaza to Gedarif, and one was not well and had an enlarged spleen, but another, No. 109, was considered to be possibly kala-azar and the Senior Medical Officer, Kassala, was notified to keep him under medical observation.
On arriving at Mafaza it was found that this policeman (No. 109) had occupied the same tukl as policeman No. 165 (see above), and both apparently cohabited with the same prostitute.

All the police present at Mafaza appeared healthy except No. 140, who had a very large spleen, but was not wasted to any degree; spleen puncture showed no kala-azar parasites.

Two prostitutes who had lived with police, who died from kala-azar, were examined and found to be apparently perfectly healthy.

It was a matter of surprise to find at Mafaza very few cases even resembling kala-azar. Indeed, only one case was definitely diagnosed during my stay, and only four others were found to be likely, and of those only two were clinically certain. A house to house inspection was made of all the six villages comprising Mafaza, and thus it appears that the disease came in a more or less epidemic form, and was practically restricted to the Government employees.

It was found quite impossible to trace the origin of the disease, but my belief is that it came from either—

1. An Abyssinian I found with kala-azar in May, 1908, and who, although he stated he had only been ill six months, appeared to me to have been ill considerably longer, or

2. The two police, who came from Singa in May, 1907, for two months to Mafaza on cattle-plague duty. These two died at Wad Medani in October, 1907, and may have imported the disease to Mafaza from Singa, which we know now to be considerably infected.

The frequent changes of officials and police render it almost impossible to get reliable information on this outbreak, and there is no doctor to refer to, but it is satisfactory to be able to report fairly confidently that this town is not a centre for the disease, and at present contains very few persons likely to be suffering from it.

The somewhat drastic measures taken in 1908, of burning the tukls, angareebs, &c., have proved eminently satisfactory and should encourage this procedure in the Sudan, especially as it is not expensive, for the finest tukl seldom costs more than one pound Egyptian.

In cases where death occurred the tukl, angareebs, and contents likely to harbour bugs were burnt, and Government compensation not exceeding £1 (one pound Egyptian) per tukl was given; the value was usually estimated by the mamour and sheikh, and checked by myself, and the amount paid on a chit given by the medical officer to the owner, who presented it to the mamour.
Other cases were isolated in their tukls, and a new tukl was built for the rest of the family at Government expense; angareebs, &c., from the old tukl were not allowed to be taken to the new, and any infringement of this was to be punished by a refund of the money given for the new tukl.

In the event of death, orders were given for the old tukl and contents to be burnt down without any recompense. In stations where there were several cases, a special compound and tukls were built for their accommodation. However, this caused considerable trouble at Gallabat, for one woman, who was seriously ill, on being informed that she would be removed to this isolation compound, was taken away during the night to a village about 12 miles distant, and had to be brought in by police.

It was found wiser not to insist on isolation until just before departure, as such a procedure frightened away any new patients, and quite destroyed any further chances for medical work, or of obtaining information; this occurred at Gallabat.

Personal supervision of the destruction of articles is absolutely necessary, and all such articles should be marked, otherwise old and useless things are substituted, compensation obtained, and the infected angareebs, &c., taken to other tukls.

With Government compensation there is no difficulty with regard to destruction of houses and articles, but isolation in separate quarters is a most difficult procedure to carry out.

A glance at the map (p. 165) shows that the disease is extremely widespread, though at present it seems to have gained no great hold upon the people.

The following recommendations are put forward with a view to combating the spread of the disease:—

(1) Burning of infected tukls, angareebs, &c.

(2) Isolation of those attacked by the disease and compulsory isolation quarters for chronic cases. One such settlement would be sufficient for a radius of 80 to 100 miles, provided the Government provide transport for the patients. Some form of Government supervision of such settlements will be required.

(3) Special quarters should be allotted to the Abyssinians in the larger towns, such as now exist in Gedarif, and compulsory residence in this quarter enforced. No difficulty should be encountered in carrying out this, as they desire to live together.

(4) Officials should take great care when selecting Abyssinians as servants; when medical advice is wanting, any showing emaciation with enlargement of the abdomen, should be rejected. Enlist-
ment of this race for the Police, Arab Battalion, &c., should be carried out with great caution.

(5) Inspectors, mamours, and all officials who have to visit small villages, should have tents as part of their travelling equipment. The custom now prevalent is that an official, when visiting a village, is shown into a sheikh's compound and supplied with an angareeb to sit on. Since at least 75 per cent. of native angareebs harbour bed-bugs, this is a dangerous procedure, which can easily be obviated by making a policeman or servant carry on his camel or mule, a small camp chair which can be placed ready for the official. This I believe to be of the greatest importance; it is easy to carry out.

(6) Native angareebs should never be employed on trek, and only new ones should be purchased, and these should be carefully examined to see if they harbour bugs. It is important to see that police and servants do not borrow angareebs on safaria.

(7) My impression is that rest-houses are safe, except in isolated places, where the travelling natives naturally use them, if nobody else is present. I failed to find bugs in any rest-house in Kassala Province, and have not been attacked by these pests in them.

However, it must be stated that I most carefully examined the Inspector's house at Gallabat, and could find no trace of bugs (the wooden ceilings could not be searched), and I informed the Inspector that I thought his house was free and he agreed with me.

But when the rains started he sent me an indignant and bantering letter, informing me that bugs were falling in masses from the ceilings, and that he had had to clear out all his furniture.

I would strongly recommend the destruction of this house, which is in very bad repair, and which was occupied in 1907 and 1908 by a kala-azar patient.

(8) Further investigation is urgently needed up the Blue Nile, which appears to be the most extensively infested district.

Ample time should be allowed to the medical officer, if any good results are to be obtained.

(9) Medical officers, civil and military, should be taught the symptoms of this disease, as at present most of them know nothing or very little about it. Usually they are not proficient at microscopic work, and those who have the necessary knowledge have no microscope and apparatus.

I would strongly urge the proper teaching of native officers, and the posting only of those proficient at such work in the Kassala and the Blue Nile districts. This instruction could be given at Cairo, when the officers join or return from leave, or it might be carried
Investigation as to Prevalence of Kala-azar

out at Khartoum. Without these steps I consider that the medical departments will be quite inefficient in dealing with this disease, which is at present undiagnosed, and so no preventive measures are instituted.

(10) Dogs should not be kept by officials.

(11) At present angareebs are used by the troops and police. I would strongly recommend that only new angareebs be allowed to be bought unless the previous owners are known. That all angareebs be placed uncovered exposed to the sun from early morning to sunset. This could be enforced without great difficulty, and is now being carried out at Gedarif, Gallabat, and Mafaza. Officials should be ordered to make constant inspections at odd times to see that this is carried out, and the offenders punished or fined.

(12) The invaliding from the army and police of all those who are weak and wasted, and have enlarged livers and spleens.

The number thus affected is at present very small, and the possible risk to others considerable (see account Third Company Arab Battalion).

My belief is that with our present very incomplete knowledge of this disease it is extremely dangerous to keep such men in the fighting and administrative forces of the Government. With proper discretion I think this procedure will limit the disease amongst Government employees; and the cases should always be sent to or be seen by the Senior Medical Officer of the District before invaliding, and he could then make suitable arrangements to prevent them spreading the disease amongst the civil population.

All that is required is a firm and dictatorial dealing with such cases, a proceeding justified when one considers the fatal character of the disease and the danger to the general public.

(13) The most effective way of getting rid of bugs from woodwork, crevices in walls, &c., is to play the flame direct from a painter's lamp, and subsequently coat with a thick wash of lime.

Owing to the very short time allotted, it was considered advisable to make a definite diagnosis by splenic puncture. The writer is well aware this procedure is open to criticism, but circumstances must be taken into consideration, and as patients were usually seen but once, even if blood-counts, &c., had been made, the diagnosis would still have been in doubt, and the slight risk to the patient had to be faced rather than leave a case at large to infect the general community. Altogether I have now performed over 120 splenic punctures without any dangerous symptoms or bad results.

My experience of liver puncture, a procedure held to be safer,
is small; the procedure has not been successful in finding parasites; latterly it has only been employed in suspicious cases of kala-azar who presented but slight enlargement of the spleen. Possibly when patients are in hospital under constant observation, liver puncture is the more justifiable method; but if the result be negative, I can see no reason why splenic puncture should not be employed, provided the right method be used. I have met several instances where doctors have used a small exploring needle and syringe for splenic puncture, and to my mind this is but courting disaster, and quite unnecessary.

Recently in Egypt a doctor told me of two fatal cases, one from splenic and the other from liver puncture, but in these two cases such a syringe and needle had been employed. Only three of my cases showed any symptoms after puncture and these were trivial:—

(1) One case vomited and fainted about ten minutes after puncture, but rapidly recovered, and showed no further bad symptoms, and was quite well the next day, and also ten days later when seen by Captain Drew.

(2) A case with a maximum temperature of 100° F. for some days previously had the evening after puncture a rise to 105° F., but no bad symptoms or signs.

(3) One case had pain for twenty-four hours over the seat of puncture, but had no accompanying signs. In no case have I seen any symptoms or signs pointing to blood effusion into the peritoneal cavity, and the only case that in any way worried me was the man who fainted, and this was evidently a case of shock.

Spleno-medullary leucocytoma is practically unknown in the Sudan, and if time allows can always be excluded by peripheral blood examination.

The method employed was as follows: If a stay was prolonged, and the chance of seeing the patient again was good, then a peripheral blood-examination was made; if not, a splenic puncture was undertaken thus:—

(1) The limits of the spleen were carefully determined by palpation and percussion.

(2) The skin cleansed by—

(a) Soap and water. The spot chosen varies with the size of the spleen, but it should not be too close to the edge of the organ.

(b) Spirit or turpentine.

(c) Lysol solution.

(3) An ordinary all-glass hypodermic syringe with a hypodermic needle about 1½ inches long, is thoroughly boiled, the receptacle found most convenient being a small native brass coffee-pot, only used for this purpose.
The site of puncture is again verified before puncture. The patient is told to take a deep breath and hold it; several preliminary exercises are done, so that he fully understands what is required, and that he is not to let go his breath till the needle is withdrawn. The needle is then inserted rapidly and vertically, and several drops of blood are at once drawn off. The proceeding does not cause pain to any degree, and the whole performance is finished in about five seconds or less.

In some cases the lax and thin abdominal wall allows of the spleen being more or less fixed against the lower ribs by inserting the hand under its edge and pressing firmly upwards and outwards, and in these cases inspiration need not be employed. The cases where danger may occur are those which are very nervous or very young; my small experience does not seem to point to advanced anaemia being a cause of danger; many patients punctured were extremely anaemic. In such cases should sudden expiration take place, it is of the utmost importance, I believe, to hold the syringe very loosely, so that the movement of the syringe in the direction of the long axis of the spleen is in no way hindered, and thus the needle with the spleen is not fixed; if held firmly and fixed, the needle is very liable to cause a rupture of the splenic capsule.

It is, of course, no good giving instructions with regard to holding breath to very young children; but in several cases expiration occurred in nervous patients; the hand, however, being ready at a moment's notice to allow of the swaying movement of the syringe prevented any tearing of the capsule, and on the needle again recovering a vertical position it was at once withdrawn without any bad sequelae. It was found that if the syringe rapidly filled with blood, the chances of finding parasites were small, and the blood usually had more or less characteristics of peripheral blood; probably in these cases the blood came directly from a splenic sinus.

In a few cases it was found almost impossible to draw off any blood, in one case even after three punctures; usually, however, enough was obtained, though not sufficient to make a good film. In these cases it was noticed that the spleens were difficult to puncture, but they did not appear to be fibrous in nature. By giving a few slight lateral movements to the needle the splenic pulp is slightly damaged, and blood can in some cases be drawn off, as in puncture of a lymphatic gland, though such a procedure should be avoided unless absolutely necessary.

In three definite cases, and in several that were clinically
certain, the blood withdrawn had to the naked eye the appearance of slightly-clouded serum, though undoubtedly coming from within the spleen itself; this was noted especially in severe and rapid cases of kala-azar.

Usually three films at least were made, and this was found to be absolutely necessary, for frequently the first, and often the second, revealed no parasites, while they were found in the third.

A positive spleen puncture settles the diagnosis, but a negative result still leaves one in doubt. Two cases at Gallabat are mentioned to illustrate this point.

One, a boy, had all the clinical signs of kala azar, a splenic puncture was performed and true splenic blood was drawn, but no parasites could be found. Later, he was again punctured, and after prolonged search a few typical Leishman-Donovan bodies were discovered, altogether entailing over six hours microscopic work, and the diagnosis was not positively settled till I had left Gallabat over a month.

Photographs 4 and 5 show a case that is almost certainly one of chronic kala-azar, for prolonged and heavy doses of quinine had no effect on the fever, which was of a low type, and no malarial parasites could be found in the peripheral or splenic blood before quinine treatment. Anaemia was present, also slight oedema of the legs, and leucopenia with increase of mononuclear leucocytes; there was moreover a history of repeated attacks of diarrhoea. Though punctured on three different occasions, no typical parasites could be found; several atypical ones, however, were observed—i.e., without a blepharoplast. His wife was very wasted and weak, and had been ill with continued fever for five months. She was anaemic, her spleen was enlarged 1 inch, and her liver ½-inch, below the costal margin. There was oedema of the legs, but she showed no other signs of disease, and quinine had no effect on the fever. The only child was fat and well, but had a considerably enlarged spleen. I felt sure that the man and his wife were infected with kala-azar, and yet after the most prolonged search no typical parasites could be discovered.

No cases that presented only atypical bodies were included in the list of those definitely diagnosed, though it is a striking fact that these bodies were only found in those with typical parasites, or in cases that were clinically kala-azar. These atypical bodies are illustrated in Plate I., figs. 7, 8, and 9, and in Plate II., figs. 1 and 2.

In ten cases the parasites were readily found, and the diagnosis settled by a few minutes microscopic work, but the remaining
twelve needed much laborious work before they could be demonstrated. Leishman's stain in tabloid form, supplied by Messrs. Burroughs Wellcome and Co., was usually employed, and was nearly always extremely satisfactory when made up with Merck's pure methyl alcohol. On several occasions it was noticed that the stain would not work, but deposited at once; yet the next day, using the same solution, the same distilled water and the same pipettes, the stain worked excellently.

Major Cummins states that the number of parasites found had no relation to the severity of the infection. My experience certainly does not coincide with his, for my cases, which were acutely ill with the disease, practically invariably presented a large number of parasites in the splenic films, and only required a few minutes for microscopic diagnosis, provided that true splenic blood was withdrawn. In contrast to this, the chronic cases presenting prominent abdomens, large livers and spleens, and a low fever, and which could easily be diagnosed on clinical grounds alone, presented very few parasites, and often it was extremely tedious to demonstrate them, and in several such cases there was an absolute failure.

Fifty-six splenic punctures were performed during this tour, and twenty-two positive results were obtained. In thirty-nine cases, which were undoubtedly kala-azar from a clinical standpoint, nineteen showed parasites in their splenic blood—i.e., in about 48.5 per cent. of the clinical cases the parasite was demonstrated.

As explained, many hours were often spent over splenic films before the parasite was found, and it is an open question whether, if the same time had been spent over the peripheral blood, the parasites would not have been found in films from it; the time being short, it was considered more advisable to examine blood from the more favourable source.

Very seldom was splenic puncture objected to, though I regret it was necessary to invariably inform the patient he was going to receive some potent medicine into his spleen, otherwise he would never have consented; in the circumstances I think such a statement is truly justifiable.

Other aids to diagnosis, such as the type of fever, the effect of quinine, leucopenia and differential counts, could seldom be employed, owing to the impossibility of following up the cases and to lack of time.

In places where a stay of several days was possible peripheral blood examination was made, and also differential counts in doubtful cases, before proceeding to splenic puncture. I must
PLATE I.

1. Parasites found in chronic case (3 years' duration): 1. Typical Parasite; 2. Slightly degenerate enlarged Parasite; 3-6 are believed to be further stages in the degeneration of the Parasites within the body.

7-9. Forms only seen in chronic cases—apparently Parasites in which the blepharoplast resembles in size and staining the macro-nucleus, unless it be a divided macro-nucleus.

10-11. Degenerate forms found in very chronic cases (5 years' duration).

12-14. Degenerate forms found in case (7-6 months' duration).

These forms were found frequently in long-standing agyraxial cases, which presented typical symptoms and signs of Kala-azar, and are believed to represent degenerative processes occurring in the Parasites within the body.

PLATE II.

1-2. Parasites similar to those depicted on Plate I.

3. Parasites showing curious division of blepharoplast.

4. Parasites found in leucocyte in the peripheral blood.

To illustrate "A Tour of Investigation as to the Prevalence of Kala-azar in Kassala and Blue Nile Districts, Sudan, from January 12th to May 16th, 1909."

By Captain L. Bousfield, R.A.M.C.
admit that even after a differential count, without the other aids I was almost as much in the dark as before.

Appended is a table giving a few results—four from kala-azar patients, four from very suspicious cases, and one from a very chronic benign tertian case (see photographs 2 and 3).

<table>
<thead>
<tr>
<th>Cases</th>
<th>Differential Counts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kala-azar (1) (2) (3) (4)</td>
<td>Suspected kala-azar (1) (2) (3) (4)</td>
</tr>
<tr>
<td>Finely granular polymorphonuclear</td>
<td>25  60 28 45</td>
<td>27 44 43 54</td>
</tr>
<tr>
<td>Coarsely granular eosinophile</td>
<td>1 1 2 1</td>
<td>1 1 2 1</td>
</tr>
<tr>
<td>Large mononuclear</td>
<td>32 18 30 16</td>
<td>25 23 23 21</td>
</tr>
<tr>
<td>Lymphocyte</td>
<td>40 20 24 24</td>
<td>47 29 29 50</td>
</tr>
<tr>
<td>Mast cell</td>
<td>0 0 0 1</td>
<td>1 0 5 1</td>
</tr>
<tr>
<td>Transitional</td>
<td>2 2 2 2</td>
<td>2 2 1 1</td>
</tr>
<tr>
<td>Free nuclei</td>
<td>15 15 15 15</td>
<td>15 15 15 15</td>
</tr>
<tr>
<td>Megaloblast</td>
<td>3 3 3 3</td>
<td>3 3 3 3</td>
</tr>
</tbody>
</table>

This list gives some idea of the results obtained, and from its perusal it is evident that not much reliance could be placed on the differential counts. In some cases the finely granular polymorphonuclear count in kala-azar was high, but usually low, between 30 and 45 per cent.

The percentage of large mononuclears was usually high, but varied greatly; it is always a matter of difficulty to classify the small and large mononuclears, for so many intermediate types are seen, and the results vary with the observers' ideas.

In Case 3 of the kala-azar patients many apparently free nuclei were observed; this was observed in several other cases, but the numbers were not noted.

The chronic malaria case showed no malarial parasites in the peripheral blood, which was examined on two occasions, but the splenic blood contained many benign tertian rosettes.

Malarial parasites were not found in a single case of kala-azar, either in the peripheral or splenic blood, and in the suspected cases only in four instances. Considering how extremely common malaria is, this is very remarkable, and I can only suggest that it is a case of the survival of the fittest. The weaklings dying off from malaria in early childhood, those with stronger constitutions surviving and growing up gain an immunity, so that although suffering from malaria during the rainy season, yet they are capable of ridding their general circulation of the parasites when
Investigation as to Prevalence of Kala-azar

once the malarial season is over, in spite of their not taking quinine.

This tour was made during the non-malarial season. In several cases the peripheral blood was watery and spread on the slides extremely badly. In three virulent cases it resembled cloudy serum microscopically.

The type of parasite usually encountered was the typical one now so well known as to need no description. Most of the forms were free and well developed, but in cases where difficulty was found in discovering them it seldom occurred that only one was seen; usually in the immediate surroundings of the field others could be found, while the rest of the slide was barren.

In chronic cases it was frequently extremely difficult to demonstrate the parasite, though on several occasions structures were seen, which I believe to be degenerated parasites. These are illustrated in Plate I. The cytoplasm in these bodies was often degenerated, staining badly, often taking a reddish tinge and showing granulation and excessive vacuolation; the macronucleus was often ill defined and faintly stained, the blepharoplast (?) diffuse and staining like the macronucleus.

These, however, appeared to be parasites owing to their definite borders, the protoplasm staining blue and containing a chromatin mass, and what appeared to be an altered and degenerate blepharoplast. These changes were never noted in the smaller and younger parasites, nor in those of virulent cases. Excessive vacuolation was seen in parasites after a single injection with orsudan (see Plate III.).

Further, in chronic cases, parasites (?) were found which showed no signs of a blepharoplast as usually seen, but two more or less equal chromatin masses usually equally deeply stained—sometimes one, usually the smaller, somewhat more deeply coloured (see Plate I., figs. 7 and 9, and Plate II., figs. 1 and 2). Such structures were only seen in kala-azar cases, or those clinically like this disease. Is it possible there may be a sexual form, possibly one of conjugation? These forms did not appear degenerate like the others already described.

Fairly frequently parasites were observed of about the diameter of a normal red corpuscle, sometimes quite circular in outline, but typical in the possession of nucleus and blepharoplast, but the cytoplasm was more granular and vacuolated than in the younger oval forms. One parasite seemed to be within a red cell and appeared to be exactly in focus with the edge of corpuscle, but since this was the only one seen in a very large number of films,
PLATE III.

1–4. Leishman Parasites after one injection of orsudan, showing marked vacuolation.

PLATE IV.

Structures, possibly Kala-azar Parasites, found in an apparently perfectly healthy dog which lived in a compound containing a very virulent Kala-azar case, a woman aged about 22, at Gallabat.

1–8. Structures found in smears from spleen.
9–11. From liver smears.
12–16. From mesenteric glands, which were much enlarged.
17. Only structures in any way resembling a Leishman-Donovan body found in the kidney smears.

To illustrate "A Tour of Investigation as to the Prevalence of Kala-azar in Kassala and Blue Nile Districts, Sudan, from January 12th to May 16th, 1900."

By Captain L. Bousfield, R.A.M.C.
it is probable that it was superimposed. Parasites within cells were not seen with any great frequency.

In only two cases were parasites found in the peripheral blood, in one case free, and in the other free and in phagocytes; no attempt was made to find parasites in centrifuged blood. The peripheral blood of one case was taken with the idea that the case was probably malignant malaria, but some free Leishman-Donovan bodies were found. This man gave a history of only fifteen days fever, with good health previous to the attack.

Occasionally a parasite with a bi-partite blepharoplast was observed; in one case the adjacent ends of this divided micronucleus were distinctly enlarged (see Plate II., fig. 3).

The "urnroot" fish, which exists in large numbers in the pools of the River Rahad, from which the population of Mafaza draw their water supply, was examined and blood smears made from the heart's blood, liver, spleen, and also with intestinal contents, but nothing like a Leishman-Donovan body in the human body was found.

Camels' blood was examined on two occasions, but nothing abnormal was noted.

Bed-bugs (Cimex lectularius) were dissected on several occasions and smears made from the foregut and salivary glands, midgut, and the hind gut with reproductive and malpighian glands.

One bug was full of blood which had been sucked from a woman suffering from virulent kala-azar.

Considerable practice and previous experience is required for this work, and without such knowledge it is difficult to say what is normal or what is abnormal in the microscopic specimens. Nothing definite was found, though in the midgut (of the one from the kala-azar case) two possible parasites were seen and possibly a sporocyst. A fair number of eosin-staining spirochete-like bodies were also seen.

Two dogs were killed and smears made immediately from the spleen, liver, kidneys, mesenteric glands, and heart's blood—

(1) A dog, male, about 4 years old, belonging to an extremely acute case of kala-azar and living in the same tukl with the patient, was killed and examined at Gallabat.

It was very well nourished and exceptionally clean for a native dog. No parasites were found.

Nothing abnormal was noted in the organs except that the mesenteric glands draining the small intestines were greatly enlarged and of a deep maroon colour, while the two largest appeared lighter in colour, and as though they were about to break 22
Investigation as to Prevalence of Kala-azar

down and suppurate. The intestines drained by the glands showed no microscopic disease.

Smears were made from the spleen, liver, kidneys, and mesenteric glands, and a few structures were found which were extremely like Leishman-Donovan bodies (see Plate IV.). It is impossible to say definitely what these are, as films only were made, and it was quite impossible to attempt any cultures.

Very few bodies, scattered here and there, could be found in the films, and in the kidney films only one was found after prolonged search.

All that can be said is that these structures have a striking resemblance to kala-azar parasites, and work should be carried out on dogs in the Sudan.

(2) A dog caught at Kassala wandering about the town. It was extremely emaciated, and many ticks were fixed near the

ERRATA.
On p. 306, for “microscopic” read “macroscopic.”
On p. 307, the nineteenth line should read: “but in those which were intact no intra-corpuscular bodies could be found.”

vestigations, often at the expense of considerable trouble to themselves, and to record that every help and courtesy was afforded me by the English and Egyptian officials and the medical officers, amongst whom I would specially thank El Sagh, Mohammed Eff, Ali Niklawi, Sudan Medical Department, who gave me much assistance and information and kindly sent me several detailed reports on the cases at Singa and from whom I hear that one more proved case and two more clinically certain have come to light since my visit at Singa, and thus the total number should be raised by three, one proved and two highly suspicious.

APPENDIX.

Unidentified bodies were found in the splenic blood of a case suspected to be suffering from kala-azar.

The history of the case was as follows:—

An Arab, aged about 35, had lived all his life at Tuheilem, near the Atbara, near Gallabat. He had been ill two or three months with cough and stated he had at times expectorated blood. He was very thin and wasted. There was no other history of illness
down and suppurate. The intestines drained by the glands showed no microscopic disease.

Smears were made from the spleen, liver, kidneys, and mesenteric glands, and a few structures were found which were extremely like Leishman-Donovan bodies (see Plate IV.). It is impossible to say definitely what these are, as films only were made, and it was quite impossible to attempt any cultures.

Very few bodies, scattered here and there, could be found in the films, and in the kidney films only one was found after prolonged search.

All that can be said is that these structures have a striking resemblance to kala-azar parasites, and work should be carried out on dogs in the Sudan.

(2) A dog caught at Kassala wandering about the town. It was extremely emaciated, and many ticks were fixed near the genitals and in and around the ears; no other parasites were found.

No gross disease was noted in the internal organs, but the spleen was enlarged and pale, and scattered over its surface were a number of milky patches, apparently local thickenings of the capsule.

The intestines were practically empty. Smears revealed no parasites except filariae in considerable number in the liver and spleen (see Plate V.). Nothing in any way resembling a Leishman-Donovan body was seen.

I wish to thank all who most kindly assisted me in my investigations, often at the expense of considerable trouble to themselves, and to record that every help and courtesy was afforded me by the English and Egyptian officials and the medical officers, amongst whom I would specially thank El Sagh, Mohammed Eff, Ali Niklawi, Sudan Medical Department, who gave me much assistance and information and kindly sent me several detailed reports on the cases at Singa and from whom I hear that one more proved case and two more clinically certain have come to light since my visit at Singa, and thus the total number should be raised by three, one proved and two highly suspicious.

Appendix.

Unidentified bodies were found in the splenic blood of a case suspected to be suffering from kala-azar.

The history of the case was as follows:—

An Arab, aged about 35, had lived all his life at Tukeleim, near the Atbara, near Gallabat. He had been ill two or three months with cough and stated he had at times expectorated blood. He was very thin and wasted. There was no other history of illness
Filaria, probably *Filaria immitis*, found in a very emaciated dog from Kassala. Many filarises found in smears from spleen and liver. Deep Leishman's staining: - *a*, cephalic end; *b*, transverse break; *c*, sheath; *d*, V spot; *e*, central viscus; *f*, tail spot; *g*, transverse striation well shown; *h*, head as seen in another specimen.

Structures found in spleen blood from case at Tukeleim, man aged about 38.
1. Normal red cell.
2-8. Parasites. No intra-corpuscular forms found. Distributed about the slides, but usually more or less aggregated together.
7-8. Found lying together as drawn. Short detailed account of case given.

To illustrate "A Tour of Investigation as to the Prevalence of Kala-azar in Kassala and Blue Nile Districts, Sudan, from January 12th to May 16th, 1909."

By Captain L. Bousfield, R.A.M.C.
and he stated he had never had fever, but when seen at 10 a.m. his temperature was 100.2° F.

**Family History.**—His wife had died three months previously after three months continuous fever. She had no dysentery, cough or expectoration of blood. His boy, aged about 5, was said to be quite well, but on examination both the liver and spleen were found to be considerably enlarged and his temperature was 100.1° F. The father and the child himself said he had not been ill with fever. The lungs and heart appeared normal.

**Physical Examination.**—Marked wasting and general weakness. Patient evidently seriously ill. Slightly anaemic. Conjunctivae not yellow. No oedema. No physical signs of lung or heart disease. Spleen enlarged one inch below the costal margin. Liver not enlarged. A splenic puncture was performed, but very little blood could be withdrawn and the slides were made with difficulty. Microscopical examination revealed neither kala-azar nor malarial parasites, but some curious bodies were discovered which are drawn in Plate VI. The films were bad, many red cells were distorted, but in these intra-corpuscular bodies could be found. It is greatly to be regretted the case was only seen once and no peripheral blood taken. Further, the films were not examined till the next day, as my microscopical apparatus had to be left behind owing to the difficult and stony track from Gallabat to Tukeleim.

Possibly these structures are haemogregarines. The average length was 3 to 5μ, breadth about 0.5μ. The central portion was nearly always narrower than the extremities, which were rounded. The outline was definite, the protoplasm stained blue and contained a nucleus which usually extended completely across the structure. No chromatin dots were noted scattered about in the protoplasm and there was no pigment. No trace of an enclosing red cell could be seen.

Possibly forms 7 and 8 represent vermicules fixed during motion.

Fig. 3 shows a double nucleus, situated in the centre, the smaller lying against the convex border of the parasite in its long axis.

Fig. 6 shows forms very similar in shape to the diplococcus of pneumonia, having blue bodies with definite chromatin transverse bars.

It seems worth reporting this case and drawing the structures, though it is scarcely possible to say definitely what they are, though they appear from their definite borders, staining properties, &c., to be parasites. They are scattered here and there throughout the two films taken.