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FOURTH REPORT

OF THE

WELLCOME TROPICAL RESEARCH LABORATORIES

AT THE

GORDON MEMORIAL COLLEGE

KHARTOUM

VOLUME A.—Medical

ANDREW BALFOUR, M.D., B.Sc., F.R.C.P. EDIN., D.P.H. CAMB.

DIRECTOR

Fellow of the Royal Institute of Public Health, the Society of Tropical
Medicine and Hygiene, and the Incorporated Society of Medical
Officers of Health; Member of the Association of Economic
Biologists; Corresponding Member Société de
Pathologie Exotique and American Society
of Tropical Medicine; Medical Officer
of Health, Khartoum; etc.

PUBLISHED FOR

DEPARTMENT OF EDUCATION, SUDAN GOVERNMENT
KHARTOUM

BY

BAILLIÈRE, TINDALL & COX, 8, HENRIETTA STREET, COVENT GARDEN, LONDON

1911

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REMARKS ON
KALA-AZAR IN THE KASSALA AND BLUE NILE DISTRICTS
OF THE SUDAN

BY

CAPTAIN L. BOUSFIELD, M.A., M.D. (CANTAB.), M.R.C.S., L.R.C.P., R.A.M.C.
Late attached Egyptian Army

The Sudan Government caused an investigation to be made with the object of finding out if kala-azar existed or was prevalent in the above-named districts in 1909. A report was submitted to the Government in May of that year, and this article, at Dr. Andrew Balfour's request, deals with the main points in that report.

The tour lasted from the middle of January to the middle of May, 1909, and, during that period, some 1,300 miles had to be covered, 900 of which were by camel, and, since more than half of the available working time had to be spent on general medical work, the actual time at my disposal for this investigation was quite inadequate for anything further than a rough estimation of the amount of the disease present in the various communities visited. Extent of tour

Those who may wish to see a fuller account are referred to the August and September numbers of the *Journal of the Royal Army Medical Corps*, 1910.

The accompanying table shows the towns and villages visited and the number of cases, divided into three classes :

- (1) Proved microscopically.
- (2) Clinically certain.
- (3) Highly suspicious.

Only those in whom definite parasites were found are included in Class 1.

The table shows that 57 proved and suspected cases were seen and points to the Blue Nile being seriously infected, for only three places were visited, viz., Sennar, Abdin and Singa, and yet ten cases were found in them.

When the report was written, 42 cases of proved kala-azar had been found in the Sudan, and of these, 15 at least had contracted the disease on the Blue Nile.

Of these 42 cases, 41 have been diagnosed since May, 1907, and have contracted the disease either on the Blue Nile or in the Kassala District.

The fact that the disease has been found mainly amongst government officials and employees calls for attention, when one remembers that they are far more under the medical eye than are the natives.

The map shows the distribution of the cases proved and suspected, and an attempt has been made to piece together all available information, so that the map is a composite one showing all known cases in these stations and does not represent the numbers seen on this tour; since its compilation, fresh cases have come to light. Distribution
along river
banks

There is fair evidence to support the belief that all the cases shown in the Sudan area (dotted tint) were imported.

Thus it seems probable that, as in India, the disease tends to cling to river banks, but it is to be noted that in none of these places off the rivers was I able to stay longer

than two days, a time totally insufficient to gain a very reliable knowledge as to the existence of cases. However, it can be definitely stated that the disease exists to no large extent in these towns and villages at present. Visits extending to a week or more were made only at Gallabat, Mafaza, Singa, and Sennar.

Province	Place	Number of patients treated	KALA-AZAR			Total, proved and suspected
			Proved	Clinically certain	Highly suspicious	
Kassala ...	Kassala	Hospital	1	2	3	6
	Tomat	12	1	—	—	1
	Sofi	12	—	2	1	3
	Wad Heleiwa	7	—	1	—	1
	Gedaref	Hospital	3	—	2	5
	Shesheina	19	—	—	—	0
	Abu Galud	21	1	1	—	2
	Seraf Sayeid	12	—	—	1	1
	Gallabat	161	3	4	3	10
	Tukelein	4	—	—	1	1
	Doka	5	—	1	—	1
	Kom Shetta	14	—	—	—	0
	Matna	9	—	—	—	0
	Galel-el-Nahl	7	1	—	—	1
	Wad Shusha	None could be induced to attend for treatment				
	Mafaza	152	1	2	2	5
	Keili ¹	—	1	—	—	1
	Lueisa	9	1	—	—	1
Blue Nile	Singa	Hospital	5	3	2	10
	Abdin	25	2	1	—	3
	Sennar	152	3	0	2	5
White Nile ...	Costi	6	—	—	—	0
Total ...		627	23	17	17	57

In no place was the disease in any way evident, and cases had to be found by careful enquiry and examination. The following facts are cited to show that in some cases the disease is epidemic to a limited degree even at the present time, though in the vast majority of cases I could only find single individuals attacked, the other members of the family or community showing no signs of the disease.

(1) At Sennar two servants of an official were found very ill with the disease, one died while I was there and the other was apparently dying. Further enquiries elicited the report that two other servants had died in Khartoum after a good deal of fever in 1908,

¹ Case found on return in Khartoum Military Hospital.

both having greatly enlarged spleens; proof of their deaths in Khartoum I was not able to obtain. The marmiton (cook's boy) also died of fever in the same year. All apparently occupied the same quarters.

(2) At Mafaza, between August, 1907, and April, 1909, amongst those occupying the police lines, eight died of this disease, while another policeman, the sub-mamour and his two servants almost certainly died from this cause.

(3) At Abdin, two brothers were found, one with definite kala-azar, while the other had been ill for two years with fever and had a spleen reaching to the umbilicus.

There was practically no time to study the important question as to how the disease is transmitted, but the following facts were forcibly impressed upon one.

(a) Bed-bugs are extremely common; quite 75 per cent. of the native angareebes harbour them;

(b) Angareebes in places away from the river banks seem to harbour bugs just as frequently as those in places situated on the rivers.

The following facts, with reference to the presence or absence of bugs in angareebes, were ascertained in 20 cases of kala-azar:—

- (1) Live bed-bugs found in eight instances;
- (2) Recently deposited eggs, but no live bed-bugs found in four instances;
- (3) No signs of bugs or their eggs in four instances;
- (4) In the case of those who did not use angareebes, or had not used them in the place where seen, bed-bugs were found in four instances.

All the bugs examined were believed to be *Cimex lectularius*, owing to their presenting distinctly flattened or concave edges on the dorsal aspect of the pro-thorax.

Cimex rotundatus has, I believe, at present never been identified in the Sudan.¹ The disease in the Sudan certainly seems to spread, in some cases, through the members of a household or community, and this suggests that it may be conveyed by the bed-bug. Against this view, however, is the striking fact that in the Sudan, as in India, the disease appears to cling to river banks, and yet bed-bugs are equally common in places on and away from the river and infected persons must frequently be visiting these places off the river.

The popular belief, which I have often heard expressed, that angareebes strung with strips of hide do not harbour bugs is quite fallacious, as many such angareebes were seen teeming with these pests. In view of the possibility of the disease being carried from domestic animals to human beings, the animals kept in the *tukls* or *hooshes* of those suffering from kala-azar were noted, but in no instance were animals, evidently ill, discovered. The domestic animals seen were donkeys, sheep, goats, dogs and chickens.

Trade, habits, and food seemed in no way connected with the transmission of the disease, but it still has to be determined whether river water, or the eating of fish, may not be a means of conveying the disease in the Sudan, a possibility in view of the tendency of the disease to cling to river-side villages and the frequent initial intestinal disturbance.

The disease runs in many cases a very severe and rapid course, and of those diagnosed on this tour, eight were known to be already dead in June, 1909. The average duration of the illness, according to the statements of the various patients, who, however, are not by any means entirely to be relied upon, was twenty-one-and-a-half weeks, while five terminated fatally in thirteen weeks. Nine cases gave a history of illness of less than three months, while five more stated the disease had lasted five months or less. The most rapid case was that of a woman aged about 18, at Kassala; she and her husband were

Associated cases

Bed-bugs

Clinical type often severe and rapid

¹ It has now been found in the Red Sea Province and the Lado district.—A.B.

most definite in their assertions that she had been ill only twenty days before admission to hospital where she died six days later.

Another case, a boy at Abdin, declared most definitely he had only been ill 15 days, and had not previously had fever. He was evidently very ill indeed, but probably the history was faulty as his spleen nearly reached the umbilicus; his peripheral blood showed Leishman parasites.

Chronic cases were seldom seen; three, however, gave histories of five years (Lueisa), three years (Abdin), and two years (Abu Galud) respectively.

Is the disease
a recent intro-
duction into
the Sudan?

The following points make one inclined to the view that the disease may be a new arrival amongst a previously uninfected people: (1) The virulent character; (2) the comparatively few chronic cases observed (this, in my opinion, is a very suggestive fact); (3) the epidemic character the disease has assumed at Mafaza and Sennar; (4) the absence of history of a past epidemic, though this is naturally extremely difficult to determine owing to the ever-present malaria after the rainy season both near and away from the rivers; (5) the failure of medical recognition, though it must be kept in mind that the disease has been but comparatively recently separated from malaria and many medical men are still ignorant about this malady.

No information was obtained as to the incubation period of the disease, though much attention was paid to this point.

The only case that in any way threw light on this point suggested 16-18 days as the incubation period.

The incidence of the disease appears to favour the months of July, December, and January, which correspond to the commencement of the cool and rainy season and the few months following the end of that season. It is often quite impossible to obtain definite information from a native about the date of onset, but the following table gives the approximate months of onset of all the cases, proved or suspected, that I have been able to follow:—

Incidence by
months

KALA-AZAR CASES

Month	Proved	Suspected	Total
January	5	3	8
February	2	3	5
March	1	2	3
April	1	2	3
May	—	—	—
June	—	1	1
July	6	—	6
August	—	5	5
September	2	—	2
October	1	—	1
November	—	7	7
December	5	—	5

A point to be carefully remembered in the Sudan is that it is quite common for a kala-azar patient to have had malaria and to give a history of fever every alternate

day, probably recognising the malarial paroxysms while failing to recognise the fever on the intermediate days.

The average age of those affected was about 18 years, the eldest being about 40 and the youngest about 6. These figures are only approximate, as the ages had of course to be judged on appearance and medical examination. Age, sex and race

Nineteen out of the twenty-two were males, the three females being extremely ill, and, in fact, manifestly moribund, when seen.

This great preponderance of males over females only illustrates the difficulty a doctor experiences in seeing the female population of a Mohammedan community; in all probability the two sexes are attacked equally.

The attached table gives the nationality:—

Nationality					Kala-azar	Suspected Kala-azar	Total
Arab	...	...	...	...	13	20	33
Sudani	...	...	...	...	5	1	6
Mixed origin	...	...	...	...	2	8	10
Egyptian	...	...	...	...	2	1	3
Abyssinian	...	...	...	...	—	3	3
Turk	...	...	...	...	—	2	2

It is also worthy of note that four Englishmen have been reported as contracting the disease in the Sudan.

The preponderance of Arabs is but natural, considering that they greatly exceed the other types in number in the districts visited.

From a study of the death-rate statistics in the main stations visited it would appear that the death-rate is rising considerably in Singa, Gallabat and Mafaza, especially in the first-named town. The fallacies are that the populations of these towns vary greatly, often year by year, and, further, every year probably sees an improvement in registration.

The actual figures for Singa are for 1907, 224; for 1908, 361; and till the end of March 1909 (*i.e.* 3 months), 109.

I believe the death-rate at Singa is increasing in a greater ratio than is the population; it is to be noted that 109 deaths were registered up to the end of March, and if this be kept up for the three remaining quarters, then the total for 1909 will be 436. The death-rate is usually greater in the latter half—*i.e.* during the rains and subsequent fever period—than in the first half of the year, so that probably this total will be exceeded and the death-rate will have *more than doubled in three years*. Death-rate

The onset was either by short attacks of fever, frequently repeated, or by a serious continuous attack.

Personal observations on the type of fever were of too short duration to be of any value, but it was noted that the chronic cases seldom had any fever or only a rise to 99° F. at night; most of the cases seen within a few days of death had a normal or subnormal temperature.

Wasting was marked, especially in the chronic and very acute cases (*vide* Figs. 32, 33a, and 34). Many of the subacute type showed but slight signs of emaciation, and this renders the diagnosis more difficult, since it is not easy to determine whether some Arabs,

who are naturally thin, are wasted, especially as many are poor and therefore badly fed. Emaciation was marked in eleven cases, slight in eight, and not evident in three.

Weakness was noticeable in all cases, but especially in the very acute, while in the subacute it was not very striking.

Protuberance of the Abdomen. In thirteen out of the twenty-two cases the abdomen was not prominent, while in several cases it was actually the reverse. Those who had large abdomens were the chronic cases, and the average duration of these cases, when seen, worked out to nineteen months.

Clinical
characters

The fact that 59 per cent. showed no protuberance is, to my mind, highly suggestive of a new disease, likely to take on an epidemic character. No chronic case was seen without some protuberance of the abdomen, a condition probably essential, and due to nature making accommodation for the greatly enlarged spleen and the enlarged liver.

Enlargement of the Spleen. In nineteen cases out of the twenty-two the spleen was enlarged to within an inch of the umbilicus or to a greater extent. In the remaining three the spleen was palpable or extended one inch below the costal margin. In all cases the enlargement was regular, the edge definite; tenderness on palpation was complained of in three cases.

Very large spleens were always and only found in chronic cases; the very acute having but comparatively slight enlargement of this organ and no prominent abdomen.

Enlargement of the Liver. In seventeen out of the twenty-two cases the liver was distinctly enlarged though in most cases to no great degree. The largest extended downwards to the level of the umbilicus and the liver dulness was increased upwards one costal space. In no case was it noticed to be smaller than normal.

Jaundice was found in two cases, but in neither to a marked degree.

The conjunctivæ were distinctly of a yellowish tinge in seven of the twenty-two cases.

Pigmentation was only once seen, and then it was doubtful if it was due to kala-azar, and was confined to a curious bronzing of the face. There were no special changes noted in the skin, hair, or nails, and the nervous system appeared normal in most cases.

Mental depression was very marked in four cases, but all were acutely ill; one case was extremely deaf (no quinine had been taken), the power of speech was greatly impaired, and there was marked mental dulness for three weeks before death. No malignant tertian parasites were found in this case.

Diarrhœa was a very marked and serious complication in twelve out of the twenty-two cases. It was often, according to accounts, accompanied by the passage of blood and slime in the stools.

Undoubtedly several cases started their disease with attacks of diarrhœa, and my belief is that the majority had this complication early in the course of the disease.

The frequency of diarrhœa, accompanied by the passage of blood and slime in the stools, naturally suggests the possibility of infection through the alimentary tract, and is a point that should be carefully investigated in the Sudan.

Edema of the legs was noted five times, one patient presenting œdema of legs, face and a slight effusion into the peritoneal cavity, while another showed œdema of legs and face. In the few cases where the urine was examined no trace of albumin or bile could be found.

Absence of
suppurative
processes in
the cases seen

Suppurative processes were practically absent. Only one proved case showed some boils scattered over his legs, and one suspicious case had a suppurative condition of the scalp; this is no greater percentage than would be found amongst the general population.

Pain was never a marked symptom, though several complained of attacks of pain over the splenic region, these attacks apparently lasting several days and due, possibly, to sudden enlargement of the organ or to adhesions.

Headache, pains in the lumbar region and in the shins were sometimes encountered, but invariably accompanied by fairly high fever.

Epistaxis was troublesome in one case, and bleeding gums were encountered on several occasions.

Hæmoptysis was complained of by one patient, who showed no physical signs of phthisis, and there was no available sputum for examination when the patient was seen. Impossibility of performing post mortems

It is much to be regretted that no post mortem examinations were made, but this was next to impossible owing to there being no available place, the *tukl* being usually in a compound occupied by many other people, and the prejudice against such a procedure very strong.

Figs. 32-35 (page 135) illustrate various types of the disease as met with in the Sudan:—

1. A subacute case.
2. Comparison between chronic malarial and kala-azar patients.
3. Extremely acute case of kala-azar.
4. A doubtful chronic case of "kala-azar."

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, etc., 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. Calcium chloride was never administered and many cases walked away 15 to 30 minutes after puncture. Splenic puncture

My experience of liver puncture, a procedure held to be safer, is small, and in the few cases in which I have employed it, I have been unable to find parasites. The cases had but slight splenic enlargement and therefore liver puncture was undertaken, but they may not have been examples of kala-azar.

When patients are under observation, probably liver puncture should be first employed, and, if negative, splenic puncture undertaken. 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:— Dangers of faulty technique

1. One case vomited and fainted ten minutes after puncture, but rapidly recovered and had no further unfavourable symptoms.

2. A case, whose maximum temperature had been 100° F., had a rise the evening after the puncture to 105° F., but then reverted to his former type of fever.

3. One case had pain for twenty-four hours over the site of puncture, but no accompanying signs.

I have never seen any signs or symptoms pointing to blood effusion into the peritoneal cavity.

The method recommended for puncture

The method employed for splenic puncture was careful cleansing of skin, hands, and sterilisation of an all-glass hypodermic syringe, with a *hypodermic* needle about $1\frac{1}{2}$ inches long.

The site of puncture was carefully located before the little operation. The patient was told to take a deep breath and hold it; several preliminary exercises were carried out, so that he fully understood what was required and that he was not to let go his breath till the needle was withdrawn. The needle was then inserted rapidly and at right angles to the spleen, and several drops of blood were at once drawn off. The proceeding did not cause pain to any degree, and the whole performance was 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 who are very nervous or very young; my small experience does not seem to point to advanced anæmia being a cause of danger; many patients punctured were extremely anæmic. 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 might be very liable to cause a rupture of the splenic capsule.

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 the 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 not easy to puncture, and the difficulty was probably due to a thickened capsule. 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.

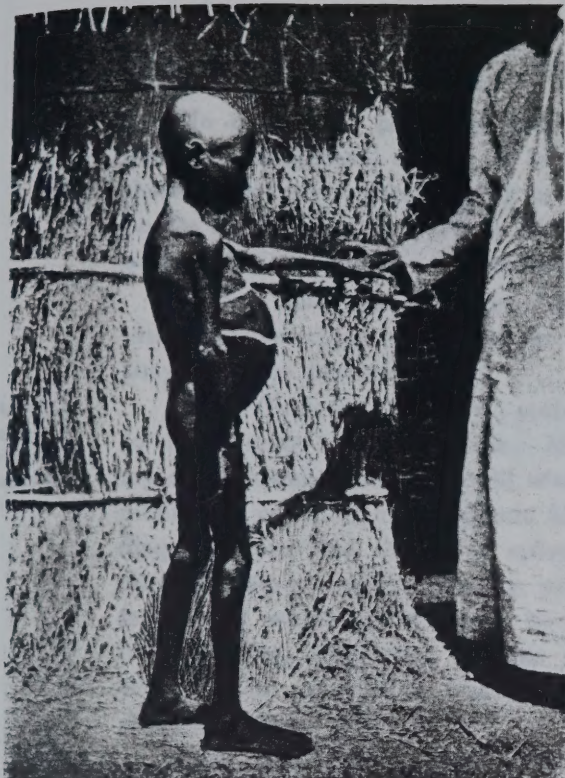
A positive spleen puncture settles the diagnosis, but a negative result still leaves one in doubt.

Appearance of the blood withdrawn

In three definite cases, and in several that were clinically kala-azar, 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.

The method employed for splenic puncture has been given in some detail, but it must be kept in mind that this method was used with natives, who are not highly strung, and either do not show or do not feel pain as the civilised white races do. Hence the method of taking a deep breath and holding it, by means of which the spleen is depressed and held downwards towards the pubis, might quite well with a hyper-sensitive white person be most dangerous, as the natural inclination of a person who has not full control of himself would be to let go his breath on puncture, and thus a more serious tear occur in the splenic capsule than if no previous deep inspiration was taken.

In dealing with an individual of a white race, especially if of a nervous temperament, I would suggest that it would be better to produce a reflex cessation of respiration by telling him to take a series of deep breaths and so produce a condition of apnoea for the puncture.



L. BOUSFIELD

FIG. 32.—CASE 1

Boy, aged about 9, at Gallabat. Ill probably six months. Limits of spleen and liver delineated in white paint. Emaciation marked. Died March 27, 1909.



L. BOUSFIELD

"A" FIG. 33.—CASE 2 "B"

Two cases at Singa. "A"—Boy with kala-azar. Ill eleven months. Died May 28, 1909. "B"—Girl from same house, but suffering from profound malarial infection. This photograph shows plainly the difference in wasting and in the prominence of the abdomen.



L. BOUSFIELD

FIG. 34.—CASE 3

A very severe and acute case at Gallabat. Duration three months. Died March 23, 1909. Diagnosed at first as dysentery. Marked wasting, and weakness very pronounced. Enormous number of parasites in spleen blood. Peripheral blood like serum. No malarial parasites found. Spleen not very greatly enlarged.



L. BOUSFIELD

FIG. 35.—CASE 4

Case at Gallabat. An Abyssinian, ill two years. Typical parasites could not be found in spleen blood. No malarial parasites in peripheral blood. Liver and spleen enlarged. Wife ill with fever for five months. Fever in both cases unaffected by quinine.

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 VIII., figs. 7, 8, 9, 15 and 16, while others were frequently seen having no signs of a blepharoplast.

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.

Relation of
number of
parasites to
severity of
infection

Major Cummins, R.A.M.C., stated 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 wasting, 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, while in several such cases there was an absolute failure. I do not think any of these were chronic malarial cases.

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.

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.

Other aids to
diagnosis

Though a differential count is most useful when one has a patient under constant observation, yet for such a rapid tour of investigation the method was found by me of little value, the percentages varying considerably. Without finding the parasite I felt that a diagnosis, founded on not very definite clinical grounds, together with a differential count supposed to indicate the presence of the disease, was scarcely sufficient to justify isolation and destruction of property.

In the definite kala-azar cases the finely granular polymorphonuclear leucocytes were usually present in numbers varying from 30–45 per cent., while the large mononuclears varied from 16–32 per cent.

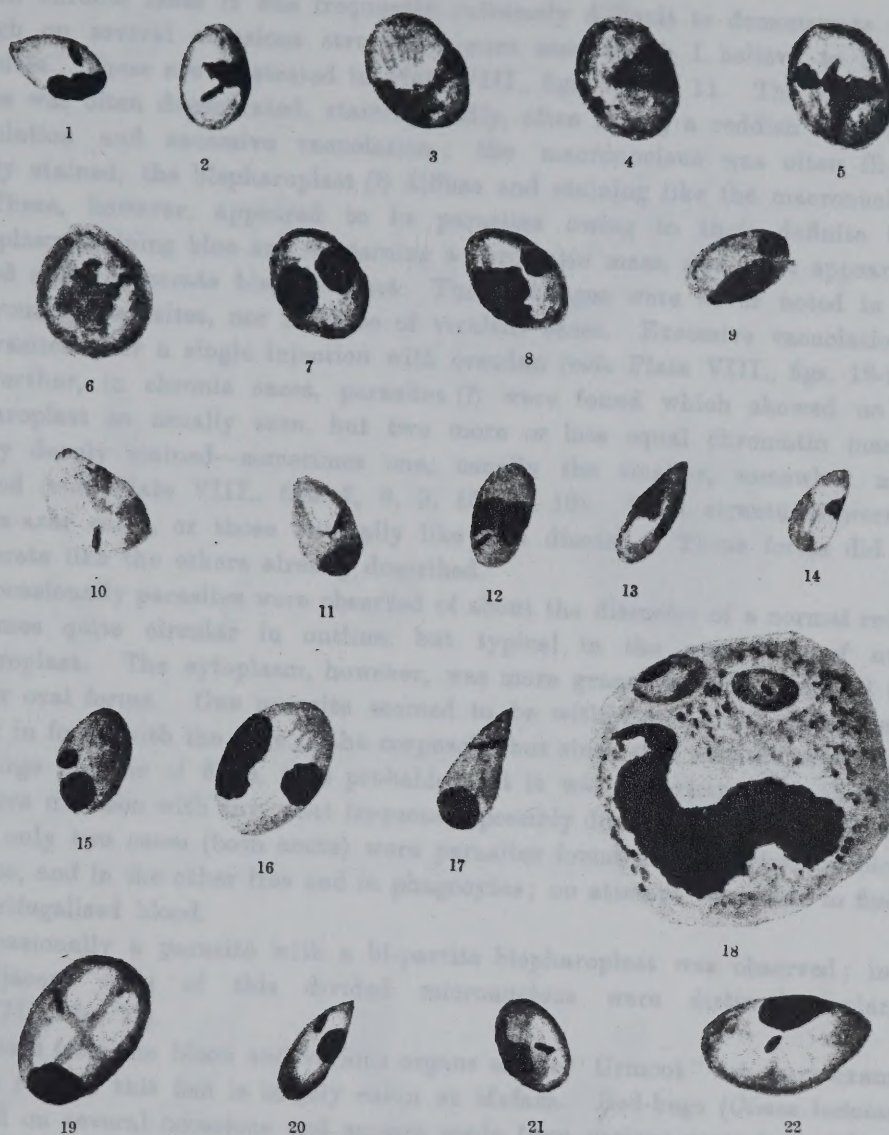
Absence of
malarial
parasites in
kala-azar cases

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 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.

The type of parasite usually encountered was the typical one now so well known as to need no description, Plate VIII., fig. 1. Most of the forms were free and well developed.

PLATE VIII



L. BOUSFIELD

KALA-AZAR

1-6. 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 macronucleus, unless it be a divided macronucleus.

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

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

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

15-16. Parasites similar to those depicted in figs. 1-14.

17. Parasites showing curious division of blepharoplast.

18. Parasites found in leucocyte in the peripheral blood.

19-22. Leishman parasites, after one injection of orsudan, showing marked vacuolation.

$\frac{1}{12}$ objective. No. 8 ocular

Types of
parasites
encountered

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 VIII., figs. 10 and 11. 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 (*vide* Plate VIII., figs. 19-22).

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 (*vide* Plate VIII., figs. 7, 8, 9, 15 and 16). Such structures were only seen in kala-azar cases, or those clinically like this disease. These forms did not appear degenerate like the others already described.

Occasionally 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. The cytoplasm, however, 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 the corpuscle, but since this was the only one seen in a very large number of films, it is probable that it was superimposed. Parasites within cells were not seen with any great frequency, possibly due to the fine type of needle used.

In only two cases (both acute) 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.

Occasionally a parasite with a bi-partite blepharoplast was observed; in one case the adjacent ends of this divided micronucleus were distinctly enlarged (*vide* Plate VIII., fig. 17).

Smears from the blood and various organs of the "Urmoot" fish were examined with negative result; this fish is largely eaten at Mafaza. Bed-bugs (*Cimex lectularius*) were dissected on several occasions and smears made from various parts but with no definite results—considerable previous practice and experience is required for this work, and without such knowledge and experience the observations are not trustworthy.

I can only say that two structures, very like kala-azar parasites, were observed in a smear from the mid-gut of a bed-bug, gorged with blood, which I had caught on the angareeb (bed) of a very virulent case of kala-azar.

Examination
of dogs

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 *ecto-parasites* were found.

Nothing abnormal was noted in the organs except that the mesenteric glands in connection with 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 down and suppurate. The intestines connected with the glands showed no macroscopic disease.

PLATE IX



DOUBTFUL "BODIES" FROM A DOG

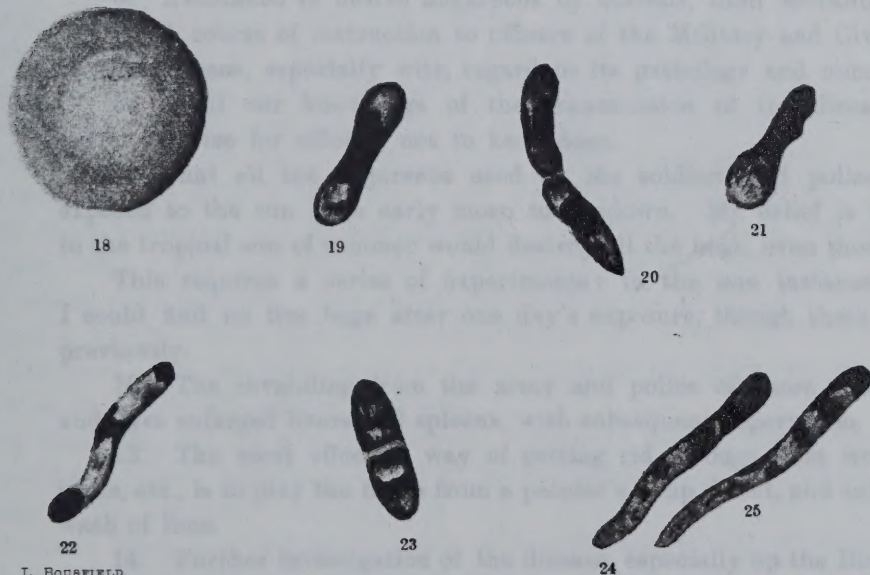
Structures, possibly kala-azar parasites, found in an apparently perfectly healthy dog which lived in a compound containing a very virulent kala-azar case, a woman aged about 22, at Gallabat.

1—8. Structures found in smears from spleen.

9—11. From liver smears.

12—16. From mesenteric glands, which were much enlarged.

17. Only structure in any way resembling a Leishman-Donovan body found in the kidney smears.



UNRECOGNISED BODIES IN KALA-AZAR SPLEEN FILMS

Structures found in spleen blood from case at Tukelein, man aged about 35.

18. Normal red cell.

19—25. ? Parasites. No intra-corporcular forms found. Distributed about the slides, but usually more or less aggregated together.

24—25. Found lying together as drawn. Short detailed account of case given.

Smears were made from the spleen, liver, kidneys, and mesenteric glands, and a few structures were found which were extremely like Leishman-Donovan bodies (*vide* Plate IX., figs. 1-17).

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. The second dog, though very wasted, showed no structures similar to the Leishman bodies, but many filariæ were found in the liver and spleen smears; this dog was a vagrant.

I wish to thank all who most kindly assisted me in my investigations, 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.

Recom-
mendations for
prevention

The following is a brief summary of the recommendations suggested to combat the disease:—

1. Burning of infected huts, angareeb, etc.
2. Isolation of acute cases, and compulsory isolation villages for chronic cases.
3. Special quarters to be allotted to Abyssinians in towns and villages.
4. Careful medical examination of Abyssinians before enlistment into the army or police, or before employment as servants to officials.
5. That all officials in the infected districts who have to visit villages be supplied with tents, and that all possess small camp-chairs.
6. Avoidance of native angareeb by officials, their servants and police.
7. A course of instruction to officers of the Military and Civil Medical Departments on this disease, especially with regard to its pathology and microscopical diagnosis.
8. Until our knowledge of the transmission of the disease is more definite, it would be wise for officials not to keep dogs.

9. That all the angareeb used by the soldiers and police be placed, uncovered, exposed to the sun from early morn to sundown. My belief is that one day's exposure to the tropical sun of summer would destroy all the bugs, even those within the crevices.

This requires a series of experiments; in the one instance in which I tried it I could find no live bugs after one day's exposure, though there were many to be found previously.

10. The invaliding from the army and police of those who are weak and wasted and have enlarged livers and spleens, with subsequent supervision.

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

14. Further investigation of the disease, especially up the Blue Nile.

This has already been done by the Second Commission sent by the Sudan Government in 1909, and its report will no doubt add very greatly to our knowledge of the extent, distribution, pathology, etc., of this disease in the Sudan.

That the acute epidemic type as well as the sporadic type exists in the Sudan is now well established, and several of the most acute virulent cases did not raise in my mind the

diagnosis of kala-azar but that of an acute fever; several times that of dysentery. It was a great surprise, therefore, to find the enormous numbers of parasites procured from the puncture of the but slightly enlarged spleen.

These acute cases are extremely important, and medical men must keep the possibility of kala-azar in mind in the case of acute fevers in the Sudan—as for chronic cases they are walking advertisements of their disease.

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 Tukelein, 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 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 anæmic. Conjunctivæ not yellow. No œdema. 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 films were made with difficulty. Microscopical examination revealed neither kala-azar nor malarial parasites, but some curious bodies were discovered which are drawn in Plate IX., figs. 19-25. The films were bad, many red cells were distorted, but in those which were intact no 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 Tukelein.

Unidentified
bodies found
in spleen of
"suspected"
case

Possibly these structures are hæmogregarines. The average length was 3 μ to 5 μ , breadth about 0·5 μ . 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 Plate IX., figs. 24 and 25 represent vermicules fixed during motion.

Fig. 20 shows a double nucleus, situated in the centre, the smaller lying against the convex border of the parasite in its long axis.

Fig. 23 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, and though it is scarcely possible to say definitely what they are, yet they appear from their definite borders, staining properties, etc., to be parasites. They are scattered here and there throughout the two films taken.





FIG. 31.—ROUGH MAP, SHOWING DISTRIBUTION OF KALA-AZAR IN KASSALA AND BLUE NILE DISTRICTS UP TO MAY, 1909

The Sudan area (dotted tint) may be considered to be practically free, except from imported cases
P = Definitely proved cases
S = Suspected cases

To these cases must be added—

- (1) From White Nile (one) (2) Late Dr. Pirrie (3) From Keili (one) (4) From Singa (one)

FOURTH REPORT
OF THE
TROPICAL RESEARCH LABORATORIES
AT THE
GORDON MEMORIAL COLLEGE
KHARTOUM

VOLUME A.—Medical

ANDREW BALFOUR, M.D., E.Sc., F.R.C.P. (Edin.), D.P.H. (Camb.)
DIRECTOR

Fellow of the Royal Institute of Public Health, the Society of Tropical
Medicine and Hygiene, and the Incorporated Society of Medical
Officers of Health; Member of the Association of Economic
Biologists; Corresponding Member Société de
Pathologie Exotique and American Society
of Tropical Medicine; Medical Officer
of Health, Khartoum; etc.

DEPARTMENT OF EDUCATION SUDAN GOVERNMENT
KHARTOUM

BY

ALBERT FINDALL

ORIENTA STREET COVENT GARDEN LONDON