NOTES ON SCHISTOSOMIASIS IN THE SUDAN. 1

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I.

The complete medical survey of the Sudan is a matter of peculiar difficulty on account of the vast size and the wild nature of the country. Other factors which impede investigation are the lack of water, of good roads and the variable climatic conditions. The whole area is sparsely populated and the tribes are mostly savage, ignorant and primitive in their characteristics. Much excellent work has been done in the short period of the British occupation, but the shortage of medical personnel and funds has greatly hindered the progress of medical work.

The exact geographical distribution of schistosomiasis in the Sudan is, therefore, not yet definitely known, but as will be seen later the areas of potential spread are very large.

Writing in 1904, Balfour said that endemic haematuria (bilharziasis) was of frequent occurrence in the Egyptian soldiery and was not supposed to exist in the Sudan save in such cases as had acquired infection in Egypt or elsewhere. Three Khartoum schoolboys (two of them brothers), however, had been sent to the laboratories and all three of them had shown blood and characteristic ova in the urine. They had all three drunk water from a school well, and all three had drunk from, and bathed in, the Blue Nile. All the schoolboys were examined (seventy-three in number) and seventeen per cent were found to be infected.

In the same year cases of schistosomiasis among Arabs who had not been to Egypt were reported from Kassala Province. "They may have visited Abyssinia."

Again, writing in 1908, he said, "At present it is not much in evidence, save amongst those who have lived in Egypt."

In 1909 the disease was found to be very prevalent in West Sennar (the present Blue Nile and Fung Provinces). Although suspected to be present before 1921, at that date its endemity in Dongola Province was proved.

Since the war, which naturally prevented much actual research work, the Medical Directorate have adopted a general progressive policy in regard to the detection, prophylaxis and treatment of schistosomiasis. So much so, in fact, that it has been detected and dealt with in various places in the provinces of Kordofan, Darfur, Nuba Mountains and the White Nile.

1 Being extracts from a thesis presented for the M.D. degree and published by permission of the Dean of the Faculty of Medicine, Edinburgh University.
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Province. Cases have been reported as far south as Mongalla. There are no records of its having been found to any extent in the Bahr el Ghazal Province.

II.

Potential Endemic Areas.

It is of course understood that the question of endemcity and spread of the disease always postulates the presence of two factors, namely the infected individual, and of the intermediate hosts.

What has been said in regard to the actual distribution of the disease is equally true of the distribution of the intermediary hosts. Their exact range of distribution is not yet definitely known.

Leiper said, in reference to *P. boissyi*, that it had an extremely limited range in Egypt but a wide range in the Sudan, and that it had been recorded on several points of the White Nile from Abba Island to the Bahr el Zaraf. This was in 1916.

Archibald reported, in 1923, *Isodora (Bullinus) innesi*, the carrier for *S. hematobium*, as being present in quantity in Dongola Province.

The distribution as known at present would seem to be as follows:—

<table>
<thead>
<tr>
<th>Province or District</th>
<th>Endemic carrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Nile Province (including Gezira Irrigation and the Fungi Province)</td>
<td><em>B. contortus</em>, <em>B. forskali</em>, <em>P. pfeifferi</em> and <em>P. alexandrinus</em>.</td>
</tr>
<tr>
<td>Nuba Mountains Province</td>
<td><em>B. contortus</em>, <em>B. forskali</em>.</td>
</tr>
<tr>
<td>Kordofan</td>
<td><em>B. contortus</em>, <em>B. dybowskii</em>.</td>
</tr>
<tr>
<td>White Nile Province</td>
<td><em>P. boissyi</em>.</td>
</tr>
<tr>
<td>Mongalla Province (Yei River)</td>
<td><em>Physopsis africana</em>.</td>
</tr>
<tr>
<td>Dongola Province</td>
<td><em>B. innesi</em>.</td>
</tr>
<tr>
<td>Upper Nile Province</td>
<td><em>P. boissyi</em>.</td>
</tr>
</tbody>
</table>

When it is recalled that the freshwater, sinistral and spiralled snails of the genus Bullinus are the intermediary hosts of *S. hematobium*, and that for *S. mansoni* the small flat freshwater molluscs of the genus Planorbis act in the same capacity, it will be noted that in districts not included in the Nile Valley in the Sudan, the common type of schistosomiasis one expects to find is due to *S. hematobium* infection. This is borne out in actual practice.

*Physopsis africana*, which is the immediate host present in Mongalla Province, has been incriminated by Dr. Anne Porter as being a mollusc which harbours both *S. hematobium* and *S. mansoni*.

III.

The Economic Importance of Schistosomiasis.

The economic importance of schistosomiasis in a developing country like the Sudan, depending as it does on agriculture, cannot be over-estimated.

In such a large country where the population is only about 6,000,000 it must be realized that the great obstacle to development is lack of labour.
This is especially seen in the difficulty which the Sudan Plantations Syndicate have in gathering sufficient labour in the Blue Nile Province to do the necessary work of cotton growing. They employ large numbers of Falatah, a travelling fanatical Mohammedan people from the west coast.

Further the development of agriculture in the Sudan depends on adequate and, if possible, increasing supplies of water; this again is dependent on the opening up and developing of an increasing number of irrigation canals. These will, of necessity, radiate from the main water supply, which is the Nile and its tributaries, and, as there is an inexhaustible supply of potential hosts in the Nile, spread of infection to the irrigation canals will certainly follow.

The prophylaxis and eradication of the disease, therefore, present a very big problem for solution.

In Egypt, a country which is also largely dependent on agriculture and with similar difficulties in regard to water supply, Ferguson stated that in 1910 more than 1,000 post-mortem examinations made by him at the Kasr el Aini Hospital in Cairo revealed the presence of the disease in 40 per cent of Egyptian males between 5 and 60 years of age.

Leiper found, at a village called Marg, that forty-nine out of fifty-four school children were affected. It has already been noted that Balfour found seventeen per cent of school children infected in the Sudan in Khartoum in 1904. In Dongola Province 5,000 people (thirty per cent of the population) were examined in 1927 and 9.7 per cent were found to have schistosomiasis.

The incidence of the disease would seem to be considerably less in the Sudan than in Egypt, but the figures are hardly comparable as there is such a difference in the populations.

IV.

GENERAL PROPHYLAXIS.

The Sudan provides an interesting illustration of the different methods which may be employed against schistosomiasis both in irrigated and in non-irrigated areas.

In a country such as this the nature of the terrain, the habits, religion and the customs of the people vary so greatly, that the problem is one which has to be solved separately for any given area.

The Gezira, in the Blue Nile Province, is an artificially irrigated area, where irrigation is under control, and where from the commencement of the scheme for cotton growing, scientific methods of approach to bilharzia treatment and prophylaxis have been put into effect with considerable success.

Dongola Province is an example of both an irrigated and a non-irrigated area, where for various reasons irrigation cannot be strictly controlled. It is a district with a comparatively small population which is an important source of intelligent labour. The inhabitants are moreover of the fanatical Mohammedan type. In this area we have, therefore, religious
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prejudices, deeply-rooted insanitary practices, and old-standing agricultural customs, complicating the prophylactic picture. Prophylaxis is, therefore, neither so thorough nor so successful as it is in the Gezira.

In both of these areas, where the water supplies are from the Blue and the White Niles respectively, prophylactic measures such as rotation of crops, Government control of water, efficient sanitation, examination and treatment of infected persons, clearing of vegetation and other measures of snail destruction and prophylaxis are all practised.

In this paper there is not the space to recapitulate, or discuss, these different methods. It is, therefore, proposed to deal with the third type of area found in the Sudan, which is the purely non-irrigated one.

V. SCHISTOSOMIASIS IN A NON-IRRIGATED AREA.

In 1925-26 the writer was in medical charge of the Nuba Mountains Province and had the opportunity, in the ordinary course of duty, of noting the incidence of schistosomiasis among the peoples of that province.

The province has a population of about 478,200 people and an approximate area of 31,300 square miles. Artificial boundaries separate it on the north and west from Kordofan province, and on the east from the White Nile Province. In the south the Bahr el Ghazal, a tributary of the Nile, separates it from the Bahr el Ghazal Province. It consists largely of mountainous country and most of its eastern territory is unexplored and unmapped. The nearest point at which its territories approach to the Nile is at Kaka, and it has no real or permanent offshoots of the Nile running through it.

The greater part of the water supply is therefore adventitious in character and the inhabitants, owing to natural limitations, are concentrated in areas to the north, west, and south.

As part of a general scheme the Sudan Government are developing the growing of "rain cotton" in the province very successfully. Large areas are consequently under cultivation, and a large amount of labour is employed. In addition labour has to be obtained for the necessary work of repairing and developing roads, transporting merchandise, building, and other Government work. The people have at the same time to grow their own foodstuffs, otherwise they cannot live.

The presence and increasing incidence of a debilitating disease such as schistosomiasis with its potential powers of spread, makes it necessary that, if progress is to be maintained, its eradication should be attempted.

At Talodi, the chief town, there were two schools for boys, one maintained by the central Government and one by the local authority. The interesting point to note is that the larger school drew its scholars from the whole of the surrounding district, and the other, the school maintained by the local authority, from Talodi itself.

Except for a few children of either pure or mixed Arab descent they
were all of Nubawi origin, and therefore shy, of comparatively low intelligence, and permeated with all the ignorance, apathy, and superstition common to their kind.

VI.

OBSERVATIONS AMONG SCHOOL CHILDREN AT TALODI.

These children at Talodi have been selected as a convenient example to illustrate the type of schistosomiasis met with in a non-irrigated area of the Sudan, and also to illustrate the wide distribution of endemic foci in
a province which relies on adventitious and unconnected water supplies, and which, apparently, has no permanent watercourses draining into the Nile. A province which is, moreover, dependent to a large extent on the annual rainfall for the replenishment of these water supplies.

The incidence of the disease among these children should not be taken as typical of the incidence of the disease among the peoples of this particular province, as comparatively large numbers of cases were actually seen and treated during various tours made round the districts.

It is worthy of note that all, or nearly all, of the cases met with in this province were found to be suffering from the same species of schistosoma as that which prevailed among the school children, namely, *S. haematobium*. A study of the distribution of the intermediate hosts would lead one to expect this. In the two schools mentioned, the average number of scholars attending during the period of observation was ninety at the larger or Government school, and thirty-five at the smaller or locally controlled school.

The ages of the scholars attending the central Government school ranged from 7 to 8 years, to as high as 16 or 17 years. The local school consisted of small children whose ages varied from 4 years to 7 years.

During the period of nine months in which these school children were under observation seventeen cases of bilharzia were discovered. Sixteen of these were pure *S. haematobium* infections, and one only was found to be a case of *S. mansoni* infection. This case occurred in the local school among the younger children and, at the time of its occurrence, there was some speculation as to how infection had been incurred, as before this case, and subsequently to it, all cases of schistosomiasis found in the Talodi district were due to *S. haematobium*.

It was discovered subsequently that the child had been to Ed Dueim in the White Nile Province some nine or ten months previously with his father, and it was presumed that the infection was acquired there.

In only one case of the *S. haematobium* infections were rectal symptoms present and terminal-spined ova found in the faeces. Repeated examinations failed to reveal the presence of lateral-spined ova in this case.

The first and third stages of the disease as described in textbooks were not seen in these children. It may be taken as almost certain that the first stage of the disease is hardly ever seen amongst natives.

With a view to discovering possible endemic foci in the district, whenever a case was found the names of the patient and that of his father were taken. In every case the children infected were found to have been inhabitants of villages where bilharzia was known to be prevalent, or in which the disease was afterwards discovered. In none of the cases was infection found to have been derived from the Talodi Gebels (mountains) themselves.
Statistics regarding the age of onset of the disease, or its monthly incidence, were unreliable for various reasons and have therefore not been quoted. Some children would only attend the schools for a month or two, and would then go back to their villages. They might then return to the schools for another short period. Others would commence attendance, perhaps, at the age of 16, and others again at the age of 4 or 5 years.

They were, on the whole, healthy and well-grown for their ages. The prevailing diseases amongst them were chronic malaria and dysenteric diarrhoea. This dysentery was due to various causes, but more often than not was amœbic in origin. As a result of the malaria enlarged spleens were by no means uncommon, occurring approximately in about twenty per cent of the total number of children.

VII.

Vesical Schistosomiasis (S. haematobium).

The symptoms of this form of the disease are well known and have been well described in various treatises and textbooks. No attempt, therefore, will be made to give a complete description of the disease. Only certain symptoms which occurred among the sixteen cases of pure S. haematobium infection found among the Talodi school children during the period under review, will be described and discussed.

The symptoms varied within wide limits. As would be expected, the most characteristic sign of the presence of the parasite in the wall of the bladder was the passage of blood at the end of the act of micturition. This terminal haematuria was sometimes accompanied by a sense of urinary irritation, but frequently no such irritation was experienced at all. Blood was contained solely in the last few drops of urine as a rule, but occasionally the whole of the urine passed was blood-tinged and periodically clots were noticed.

It should be especially noted that pain was not an essential or necessarily a prominent feature of the disease. Ova and blood were often passed in the urine without the patient experiencing any trouble. This was especially noted in four of the cases observed.

The cardinal symptom in eleven of the cases was a burning or scalding urethral pain (hence the native name of the disease “boule har” meaning hot urine). This happened during the passage of urine, but it was described occasionally as a deep-seated pain, perineal, or referred to the penis. Following this symptom came a terminal haematuria which was sometimes a constant feature, and at other times most irregular in its occurrence.

The pain when it occurred was not always referred to one area. It was many times complained of as occurring in the perineum, the urethra,
the suprapubic region, or in the loins, and occasionally even in the small of the back.

As already noted in one case rectal symptoms were present with the passage of blood and mucus in the stools. Actually in this case the symptoms, with marked tenesmus, were so acute as to amount almost to a dysenteric attack. The patient's stool was actually being examined with a view to discovering the presence of amebae when the terminal-spined ova were discovered. This patient was found later to be passing terminal-spined ova in the urine also.

In his experience obtained with the Expeditionary Force of the Sinai Peninsula, O'Connor observed that clinically the most severe dysenteric cases due to schistosoma were associated with the species *S. haematobium*.

The blood-picture presented certain constant changes. In ten cases the average count was 9,045, thus revealing a moderate leucocytosis. There was a relative decrease of the polymorphs, and an average eosinophilia of 9·5 per cent was found on making differential counts.

No abnormality was noted in the red cells or haemoglobin, except that usually a slight secondary anaemia was present.

VIII.

**Intestinal Schistosomiasis (S. mansoni).**

Only one of the series of cases was due to infection by *S. mansoni*.

The outstanding symptom in this case was marked emaciation. There was some pain found on palpation of the liver and spleen, which were somewhat enlarged. Inquiry elicited the fact that the patient had suffered from intercurrent attacks of diarrhoea and occasionally from fever. Pruritus was present round the anus. While under observation the intestinal symptoms were fairly slight and consisted mainly of a sense of rectal uneasiness, and occasional attacks of dysenteric diarrhoea, with the passage of blood and mucus in the stools. Tenesmus was sometimes complained of, and sometimes intestinal colic was present. The duration of the individual attacks of diarrhoea was not constant but varied from two to five days. Between the attacks the stools were solid and showed abundant yellow mucus.

Microscopical examination of the stools showed the presence of lateral-spined ova in the mucus. No ova were found in the urine.

Occasionally the stools were streaked with blood, but real clots were not observed macroscopically.

The blood on examination showed marked eosinophilia (12 per cent) and a moderate leucocytosis. The red cells had markedly pale centres and the polymorphs were decreased in number.

Pulmonary symptoms were absent except for the morning cough which these natives usually have.
IX.

TREATMENT ADOPTED.

The infected children were treated by a short course of intravenous tartar emetic injections up to a total dosage of fifteen grains. The injections were given thrice weekly, the initial dose being half a grain in one cubic centimetre, the second one grain, and thereafter doses of one and a half grains were administered until the total amount had been given. This course was quite successful in all except five of the cases. The symptoms, that is to say the presence of ova, the haematuria, and the pain on micturition, disappeared, on an average, after the administration of ten grains of tartar emetic.

In five of the patients the haematuria, and the passing of ova returned when a week or two had elapsed after the completion of the course, the urine in the interval having been negative on examination. These five were then given a course of emetine by intramuscular injection, in exactly the same dosage and over the same period as for the tartar emetic injections.

This was quite successful in all the cases and at the end of the period under review the cure still seemed to be complete and there had been no recurrence of the disease in any one of the boys.

No untoward symptoms were noted except that in two of them abscesses formed round the site of intravenous injection. This happened probably because owing to the smallness of the veins (one patient was 5, the other 7 years of age), a small amount of the antimony solution had escaped into the tissues.

Usually a slight cough occurred after the tartar emetic injections, but to this no importance was attached. The same phenomenon has been noted to occur almost invariably after the intravenous injection of quinine given in the treatment of malaria.

The first injection was diluted with five cubic centimetres of sterile saline, and thereafter the saline was gradually increased to a total of ten cubic centimetres.

The emetine was diluted with an equal portion of distilled water for the intramuscular injections.

It should be noted that among these children a very careful watch was kept for signs of cardiac depression while the course of emetine was being given.

The results of the treatment were controlled by observations made upon the ova in the dejecta of the patients. Thirty to sixty cubic centimetres of warm water were added daily to the freshly passed urinary deposits. If ova are left too long in alkaline urine they fail to hatch, care was therefore taken that the deposits examined were always freshly passed. The diluted solution having been made in a glass vessel the hatching of the ova was watched.
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It was found that as the treatment progressed the ova took longer and longer to hatch, and finally they were no longer passed. Any that were passed in the later stages of treatment were dark and shrivelled.

Usually after about ten grains of antimony had been injected, ova failed to pass and the hematuria cleared up.

In the case of the *S. mansoni* infection direct observations were made upon the stools passed.

X.

The Therapeutic Attack.

The great advantage of the therapeutic attack is that the relief of symptoms is so obvious that the native’s innate suspicions are removed, and his co-operation ensured without effort. It will be readily understood that without this co-operation successful prophylaxis is impossible of attainment.

The effect of successful treatment with antimony tartrate in countries like Egypt and the Sudan is that, as a rule, the natives are only too willing to give the method a trial and to be injected and cured. There is no interference with religious prejudices, long standing private habits, or economic practices.

They are getting, in any case, something for nothing, and provided the Government of the country concerned is an enlightened one and will provide the necessary facilities, the results are bound to be successful and gratifying.

By using therapeutic treatment close contact is secured with the native, and many opportunities are obtained for propagating simple sanitary truths to the people directly concerned.

This result we owe to Christopherson’s discovery of the valuable effects of tartar emetic in schistosomiasis, which he made in Khartoum in 1918-19.

XI.

Prophylaxis in a Non-Irrigated Area.

The Nuba Mountains Province is, as has been stated, dependent largely on adventitious water supplies. The natives differ markedly from the rest of the Sudanese in their racial characteristics, although they themselves vary in districts. Generally speaking, however, they are a tall well-developed race who are very attached to their native “gebels” or mountains. They are typical of the inhabitants of bilharzia-stricken countries in their ignorance and primitiveness. Implicit faith is displayed by them in their native “fkkis” (magicians or medicine men), and they are prone to view the white man and his works with suspicion.

For these reasons, together with their fatalistic apathy in regard to their own personal welfare, sick people are rarely seen in the early stages of an illness. They are much more commonly seen when nearly “in extremis.”
Education tends to break down this diffidence and lack of confidence, but, even so, only two out of the total number of cases of schistosomiasis in the school children actually reported sick of their own accord.

The people are accustomed to urinate and defecate promiscuously all over the countryside, but not necessarily near water.

The Mohammedan population is small, and in this they differ markedly from the natives of Dongola province (vide supra) who are mainly fanatical Mohammedans.

All the factors favourable for endemicity and spread of the disease are present in the Nuba Mountains Province. These are a warm climate, heavy but not continuous rains, abundant and wild vegetation, bad conservancy methods (in the native villages) and the fact that the natives wade through and drink any available water in an indiscriminate manner.
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The water supplies, which are abundant during the rainy season, gradually dry up in the dry season, and consists then mainly of "foulahs," "birkets" or "khors." That is to say, the water supply is mainly obtained from surface water contained in ponds, ditches, and shallow wells. On these both man and animals depend.

The snail propagating its species in the summer season is spread over the country by the heavy rains and naturally accumulates in these scattered watering places in the dry season; the infective native is present and so the vicious circle is carried on.

The scattered nature of the infection in the province is well shown by the map on p. 271.

There are monkeys and baboons in the province also, and it may be that they assist in the spread of the disease.

That all areas are not equally infected is obvious also from a study of the map, but whether this is due to the absence of the intermediate host, or to the fact that the different tribes of natives do not intermingle to any extent, is not known.

Seventeen cases of schistosomiasis have been mentioned, 16 occurring in the larger Government "kuttab" or school, and one in the smaller "khalwa" (school) which was only Government aided, and which contained the smaller children who hailed from Talodi itself.

An analysis of these 17 cases shows the scattered nature of the infection also. Of these cases one was a case of S. mansoni infection and the patient probably obtained his infection in the White Nile Province at Ed Dueim, which has already been referred to as an endemic area for schistosomiasis in the Sudan. This was the only case which occurred among the smaller children.

Of the other 16 cases 10 came from the Kawahla district, 3 from the vicinity of Gebel Fungor, 2 from Eliri, and 1 from Kadugli, all of which places it will be seen from the map are bilharzia-infected districts. None of these cases actually came from Talodi itself, and it may be mentioned that no adults found to be infected in the province up to that time were ever traced to have caught their initial infection there.

This was probably because the water supplies in Talodi were obtained from two Government-controlled deep wells which were well protected and locked up when not in use. In addition efficient sanitary arrangements and methods of sewage disposal were enforced.

Although not found it is inconceivable that the intermediary hosts were not present in the neighbourhood.

It has been shown that the disease is amenable to treatment, but in large districts such as the Nuba Mountains Province, only half-developed, with a wild and rocky terrain, and with poor roads, it will be easily understood that it is not feasible to procure successful destruction of the elusive intermediate hosts.
The methods of approaching the prophylactic problem, therefore, in an endemic area such as this would seem to be (a) therapeutic treatment of the infected individual; and (b) the gradual provision of pure and protected water supplies.

For (a) travelling hospitals with a trained staff would be efficient, or failing these the provision of bilharzia "teams." Each team should consist of a medical man with one or two orderlies trained in the giving and preparing of the antimony injections and able and willing to examine the dejecta for the parasite.

For (b) the gradual sinking of deep wells and the filling in or treating by chemicals of the isolated ponds and ditches, would seem to be the solution. It is realized that it would not be always feasible or possible to find sites where wells, able to provide sufficient water, could be sunk in all the infected districts. In districts such as these, attempts should be made to clear the vegetation and to train the banks of the available surface water supplies, and methods of therapeutic attack should be concentrated upon.

XIII.

It will be long before efficient sanitation and cleanly habits in regard to defaecating and urinating, although they are ideals to be encouraged and hoped for, will be adopted by the ignorant and savage peoples of districts such as this. Their racial suspicions, apathy and superstitions, will provide many disappointments for workers amongst them. Much difficulty will be experienced in getting some of the people, especially the women and children, to submit to treatment and complete the course of antimony injections.

But, with a remedy such as tartar emetic, or its organic or inorganic compounds, to hand together with an enlightened Government policy and the gradual spread of education, the future in regard to the control and elimination of the disease is not unhopeful.

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