THE ERADICATION OF HELMINTHIASIS FROM THE EGYPTIAN ARMY.¹

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(1) PARASITIC WORM INFESTATION AMONGST EGYPTIAN ARMY RECRUITS.

In the autumn of 1923 the Sudan Government, not for the first time, raised the question of the admittance to the Sudan of soldiers of the Egyptian Army infested with parasitic worms. Though the Government was undoubtedly justified in demanding that its efforts at Wadi Halfa Quarantine to prevent the introduction and dissemination of parasitic worm diseases should be backed up in every possible way, there was, perhaps, a tendency to attach too much weight to the potential danger from these soldiers, less than 2,000 of whom normally proceed to the Sudan in any given year, especially as the great majority of them are stationed in Khartoum, Halfaia and Omdurman, where their general mode of life and sanitary surroundings preclude the possibility of their disseminating parasitic worm diseases, whilst most of the remainder are stationed in places where these diseases are either already endemic, or else cannot be spread for biological reasons. The occasion seemed ripe, however, for expressing the opinion that there existed more than sufficient grounds for tackling the whole problem from the purely military point of view, as one primarily and deeply concerning the health and efficiency of the army, and which it appeared to be the duty of the medical service to undertake at once and in a comprehensive manner.

It is a matter of common knowledge that widespread infestation of a

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community with parasitic worm disease lowers its standard of health, physique, efficiency and moral. Ankylostomiasis and schistosomiasis have always been very prevalent in the Egyptian Army, and, as both diseases are essentially curable, the arguments in favour of their eradication appear to be overwhelming.

The strength of the Egyptian Army is maintained by conscription from a population, the majority of whom are known to suffer from parasitic worm infestation. Every year about 90,000 youths in Egypt reach the age of 19, and become liable to be called up for military service. Recruiting commissions, which tour the provinces, weed out about 80,000 of these. A man may claim exemption on the grounds that he is the bread-winner of a family; that he is the only son of his father; or that he is the eldest son of a divorced mother; or he may buy exemption by the payment of £E20; but the great majority are rejected on sight as medically unfit, a terrible commentary on the prevailing state of health of the masses in Egypt. Should more than 10,000 be available after this preliminary examination the required number are selected by ballot, and sent into Cairo when they reach the age of 21 for final medical examination. Another 6,000 of these obtain exemption for one or other of the reasons stated above, the great majority again because they are medically unfit. Thus about 4,000 are finally taken, that is to say about four per cent of those who were originally available.

The routine method by which sufferers from parasitic worm infestation were supposed to be eliminated at the final medical examination proved to be valueless in practice.

Measures for the detection of cases of urinary schistosomiasis were confined to a naked-eye examination of the urine. Senior medical officers were long victimized by a wily ex-shawish (sergeant) of the Medical Corps, who built up a lucrative "practice" by injecting blood-stained urine into the bladders of conscripts the night before the final medical examination! Detection came, followed by swift retribution, when an unfortunate "patient," seized with an urgent desire to micturate during a cold night, and unwilling to lose the benefit of his investment, tied a cord so tightly round his penis that his bladder burst before dawn and his gangrenous organ had to be amputated shortly after!

For the detection of the less common but much more serious disease, schistosomiasis of the rectum, no test was applied at all.

The only test applied for the detection of ankylostomiasis was a naked-eye estimation of the degree of anaemia present.

An examination of the statistics of the Egyptian Army General Hospital, Cairo, for 1923, clearly demonstrates the inadequacy of the tests applied for schistosomiasis of the urinary bladder and ankylostomiasis, and also brings out the vital necessity for a test for schistosomiasis of the rectum. Thus, during 1923, no less than 14 per cent of the men treated in that hospital were admitted primarily for parasitic worm diseases, whilst, of 253
men found unfit for further service during the same period, 73, or 29 per cent, were invalided for the same cause, the majority for schistosomiasis of the rectum. In addition to this a large proportion of "fit" men are known to suffer constantly from anaemia, debility, palpitation, arrhythmia epigastric discomfort, dysuria, haematuria, passage of blood in the stools, and other signs and symptoms of parasitic worm disease, without feeling ill enough to seek hospital treatment.

Now it has long been a matter of common knowledge that the Egyptian fellah, removed from his native country and mode of life, and sent to serve as a soldier in the Sudan, succumbs all too readily to the vicissitudes of service in a climate which, even in perfect health, he is after all little more fitted to withstand than the European soldier. This failing has been commonly attributed in the past to some inherent inexplicable defect in the constitution and character of the Egyptian peasant. The statistics quoted above afford the strongest possible evidence for believing that the undisputed lack of resistance to hardship of the Egyptian soldier, far from being an inherent defect is really an acquired one, due to chronic infestation with parasitic worms. In any case until the part played by parasitic worm disease in undermining the constitutions of Egyptian soldiers has been properly investigated it would be wiser to refrain from imputing to nature what is much more probably due to neglect.

Convinced by a survey of the situation that action was called for, I felt justified, as the officer responsible for the examination of the 1923-24 batch of recruits, in introducing measures for mass diagnosis and treatment of worm diseases at the final medical examination.

(2) DISPOSAL OF ARGUMENTS AGAINST THE NEED FOR AN ANTelmINTIC CAMPAIGN IN THE EGYPTIAN ARMY.

At this time and subsequently numerous arguments were advanced against the necessity for an organized scientific campaign to eradicate parasitic worm infestation from the Egyptian Army. These arguments were calculated to impress the lay mind, and as they seemed likely, if supported, to prevent the introduction of a measure designed solely in the first instance, for the improvement of the health of the private soldier, it became necessary to refute them in terms which would admit of no misunderstanding.

It was alleged that parasitic worm diseases had always been dealt with in the Egyptian Army. But there is a fundamental difference between (a) waiting until some of the worm-infested individuals in a community have become so ill as to require hospital treatment, or even invaliding, and (b) searching out and treating all the worm-infested individuals in a community before any of them have become ill at all. The former method is palliative only; it has had a fair trial in the Egyptian Army for many years, in which it has proved a failure, as it has in every other worm-infested community in the world. The latter
method, that of the anthelmintic campaign, is radical, and has proved successful wherever it has been applied.

It was alleged that the tests already described for these diseases had given satisfactory results in the past; but this assertion is not supported by the official statistics of the Egyptian Army General Hospital, Cairo, for 1923.

It was alleged that many men get rid of their infestation by natural means in the course of five years service. But the whole weight of army statistical evidence is against such an assumption. The real truth is that far from army service enabling infested men to throw off their infestation it is directly responsible for large numbers of men who appear on superficial inspection to be perfectly fit on enlistment, breaking down all too readily under the vicissitudes of service in a bad climate. It is of course understandable that a small proportion of ankylostomes and a smaller proportion of schistosomes may and probably do die off in the course of five years service, but in view of the span of life of the worms, the number of men who could become cured in this way must be so extremely small as to be negligible. In any case as long as large numbers of men are being treated in hospital and invalided the difference, if any, in the percentage of infestation amongst recruits and serving soldiers must be ascribed to treatment and invaliding in default of direct scientific evidence in favour of the natural cure theory. Moreover, even if natural cure were proved to be a factor in the case, it appears undesirable to wait five years for nature to accomplish what science can do in as many hours or weeks. Finally it was alleged that the whole question was one for the Public Health Department of Egypt, rather than for the Army, a counsel of perfection which revealed a lack of appreciation of the gigantic nature of the problem before that Department, of the number of years likely to be occupied in solving it, and of the huge expenditure certain to be involved in its solution. The problem of the Army is, in comparison with that of the country as a whole, a relatively urgent one, capable of immediate and complete solution at a cost which would be infinitesimal compared with the benefits that would certainly ensue. Furthermore, as the Medical Corps has entire control of every phase of medical and sanitary work concerning the Army, it appears to be absolutely unjustifiable to dismiss this particular problem by laying the onus of its solution on the Public Health Department, especially as it is quite obvious that this procedure cannot possibly result in any improvement for years to come.

One might reasonably have anticipated that objections would be lodged against the scheme on the grounds of military expediency, owing to the fact that treatment, especially for schistosomiasis, would involve detention of recruits with consequent delay in their training. This fear proved groundless. The Inspector General of Egyptian Army troops in Egypt, El Lewa C. W. Spinks Pasha, D.S.O., O.B.E., considering that any attempt to improve the existing state of affairs, even if it should end in failure, was worthy of a trial, and recognizing that the slight temporary military
inconvenience involved was negligible, compared with the ultimate benefits likely to accrue, helped to further the scheme in every possible way. This attitude was assumed by all the Egyptian officers commanding units serving in Egypt, who were only too well aware of the part played by parasitic worm diseases in sapping the vitality and efficiency of their men.

(3) Organization of Routine Measures for Mass Diagnosis of Ankylostomiasis amongst Egyptian Army Recruits.

The Adjutant-General of the Egyptian Army, El Lewa H. J. Huddleston Pasha, C.M.G., D.S.O., M.C., having given provisional approval to the scheme, I approached the Public Health Department. Interviews with Dr. Charles Todd, Director of the Laboratories, and with Dr. Mahommed Khalil, Lecturer in Helminthology at the School of Medicine, Cairo, were followed by visits to the Anthelmintic Annexes at Kasr el Aini Hospital and Qualioub, at both of which places one could not fail to be impressed by the scientific thoroughness with which hundreds of cases of ankylostomiasis and schistosomiasis were being diagnosed and treated every day.

The necessary apparatus was purchased and a small supply of carbon tetrachloride borrowed from the Public Health Department.

These preparations having been made, it was decided, as a preliminary experiment, to get to work on a batch of about 300 recruits for the Police School, Abbassia. These are conscripted by the Recruiting Department at the same time and under exactly the same conditions as recruits for the Army. But here an unexpected check occurred owing to the Commandant of the Police School objecting to experiments being carried out on his men. As he was not under military discipline it became necessary to apply for support to the Ministry of the Interior. Unfortunately, the Commandant had preceded me by two hours, and left again armed with covering authority for his attitude. I asked for and obtained an interview with Abd el Razik Pasha, the Under Secretary of State for the Interior in the Yehia Ministry, a courtly and intelligent Egyptian gentleman, whom I bombarded with the statistics and photographs collected during investigations carried out at Wadi Halfa quarantine. Whether his conversion was the result of conviction or the outcome of a desire for peace, is neither here nor there. At any rate I left at the end of half an hour armed with a counter order which completely smoothed away all further difficulties.

The recruits for the Police School were sent by the Recruiting Department to the Egyptian Army Hospital at the rate of seventy a day. From this number about fifty were selected who had every appearance of perfect health. They were then sent back to the Recruiting Department, where a few would make good, their claims to exemption on grounds not connected with their health. The balance, perhaps forty-five, after being detailed to their units, were returned to the hospital, where they were passed through the newly-organized anthelmintic annexe.
On entering the annexe, each man was given a serial number for the
day which, together with his name, unit and province, was entered on a
form especially printed for the purpose.

The faeces of each recruit were collected in a numbered chamber-pot. A
teaspoonful, approximately three grammes, was removed by an orderly and
emulsified thoroughly in a saturated solution of ordinary sodium chloride
contained in a sixty-cubic-centimetre porcelain ointment pot. This emulsion
was filtered through a double layer of gauze into a small Erlenmeyer flask
of 80 to 100 cubic centimetres capacity, which was then filled to the neck
with saturated solution of sodium chloride (fig. 1). In a few minutes all
ankylostoma ova floated to the top of such a solution, so by the time the
last of the series of emulsions had been prepared the first was ready for
examination. With a stout wire loop the top layer of the emulsion was
removed and placed on a slide, three or four dips serving to remove the
whole of it, and with it practically all the ankylostoma ova in the original
three grammes of faeces. A proportion of ascaris, taenia, and schistoma
ova are also floated by this method. The findings were noted in the
appropriate columns of the special form. Lastly a yellow index card was
prepared for each patient.

The results of this examination are shown in Table I.

<table>
<thead>
<tr>
<th>Nature of infestation</th>
<th>Number infested</th>
<th>Percentage infested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ankylostomiasis</td>
<td>212</td>
<td>73</td>
</tr>
<tr>
<td>Schistosomiasis</td>
<td>152</td>
<td>52</td>
</tr>
<tr>
<td>Ascariasis</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Other infestations</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>
FIG. 2.—Administering carbon tetrachloride.

FIG. 3.—Swallowing the dose.
It was decided to treat the 212 police school recruits who harboured intestinal parasites with five cubic centimetres of carbon tetrachloride, given plain by the mouth, immediately after diagnosis without the administration of a preliminary purge, but on a naturally empty stomach, that is to say before the morning meal (figs. 2 and 3). A purge of twenty-five grammes of magnesium sulphate in fifty cubic centimetres of water was given two hours after the administration of the carbon tetrachloride.

The after effects were strikingly mild. The majority of the men experienced no symptoms whatsoever, whereas the minority complained only of slight epigastric discomfort, dizziness, and, in a few cases, nausea. One man only said he felt very sick, but even he did not vomit. The men with symptoms were separated from the men with none, and in a short time it was noticed that the former were all lying down and silent whilst the latter continued to sit up and joke and chat with their comrades (fig. 4).

All the men were carefully re-examined three months later. Seventy-nine per cent were found to have been completely cured, whilst the condition of the remainder had so greatly improved that three grammes of faeces would only yield an occasional ovum after prolonged search in cases in which the same quantity of faeces before treatment had yielded field after field packed with ova.

At Wadi Halfa Quarantine, in 1920, I treated 12,500 men with four grammes of thymol, and 1,500 men with three cubic centimetres of cheno-podium oil, and I can safely say that for efficacy, ease of administration, mildness of after-effects, safety and cheapness, carbon tetrachloride is incomparably the best anthelmintic yet discovered for the mass treatment of ankylostomiasis amongst Egyptians.
B. H. H. Spence

(5) DISPOSAL OF ARGUMENTS ADVANCED AGAINST THE USE OF CARBON TETRACHLORIDE.

In the course of this and subsequent work, certain arguments were advanced against the use of carbon tetrachloride which it will be convenient to dispose of now.

On the strength of an unrecorded experiment, conducted with one litre of the medicine, it was alleged that it would only cure one per cent of cases. This argument is untenable, as the statistics of the Public Health Department of Egypt show that 6,000 cases of ankylostomiasis were treated with carbon tetrachloride at Qualioub Anthelmintic Annexe in 1923, and that seventy-six per cent were cured. It was also possible at a later date to quote my own carefully controlled experiment, which fully confirmed this result.

It was alleged that carbon tetrachloride was a dangerous medicine, about which we ought to know more before using it on a large scale. This argument would have been valid had it not been very generally known at the time it was advanced that the effects of carbon tetrachloride are mild and evanescent in the extreme compared with those following the administration of thymol and chenopodium oil, and that such cases of poisoning as had been recorded took place in the early days, and had long since been proved to be due to the effects of carbon bisulphide—a very poisonous impurity present in commercial carbon tetrachloride. Moreover, the experiments conducted in the Public Health Laboratories in Egypt had shown that a dog could without injury take a dose of eight cubic centimetres per kilogramme of body weight, which is equivalent to a dose 100 times larger than that actually administered to human beings in practice. Its harmlessness was further vouched for by the fact that, as the result of the human and animal experiments conducted by the Public Health Department of Egypt, the medicine was at that time being used in the four anthelmintic annexes, in all the Government hospitals, and in most of the private hospitals in Egypt.

One very unusual argument advanced, presumably as a reason for not treating the sufferers at all, was that a better medicine might be found. One had almost apologetically to point out that a better medicine than carbon tetrachloride might and probably would be discovered, but the principles underlying mass diagnosis and treatment with the best medicine available would always remain the same.

(6) ORGANIZATION OF ROUTINE MEASURES FOR MASS DIAGNOSIS OF SCHISTOSOMIASIS AMONGST EGYPTIAN ARMY RECRUITS.

The urines of recruits were collected in conical glasses bearing their respective numbers. A special form of glass with a rounded bottom was used (fig. 6, A), the ordinary type with a pointed bottom (fig. 6, B) being unsuitable on account of the difficulty of getting at the ova except with the use of a very fine pointed pipette which is easily broken. As the collection
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**Fig. 5.**—Urine ready for examination.

**Fig. 6.**—Urine glasses.

B = the wrong type. A = the right type.
of urine was the first item on the day's agenda and its examination the last, the process of sedimentation was always complete in plenty of time. Sedimentation of the whole urine naturally yields a higher percentage of positive results than centrifugalization of a portion of it, so where time is no object it is the better method. The glasses must, of course, be kept scrupulously clean, and should be stored bottom up when empty, and kept covered when full, so as to exclude dust.

After allowing time for blood, pus, and ova to settle, one or two drops were transferred by pipette from the bottom of the glass to a slide and examined under the low power without a coverslip. The presence of blood, pus, or ova, was noted in the appropriate column of the special form, these data being entered subsequently on an index card.

(7) The Treatment of Schistosomiasis with Antimony Sodium Tartrate.

It was decided to treat schistosomiasis with antimony sodium tartrate. The required quantity of a six per cent solution (one grain to one cubic centimetre) was prepared and sterilized each day for use the following day.

The course consisted of twelve intravenous injections given on alternate days, Fridays excepted. The first dose was 0·5 grain, the second 1 grain, the third 1·5 grain, and the fourth and subsequent doses 2 grains each, making 21 grains in all, thus:

<table>
<thead>
<tr>
<th>First week</th>
<th>Second week</th>
<th>Third week</th>
</tr>
</thead>
<tbody>
<tr>
<td>First injection</td>
<td>0·5 c.c.</td>
<td>1·0 c.c.</td>
</tr>
<tr>
<td>Second injection</td>
<td>2·0 &quot;</td>
<td>2·0 &quot;</td>
</tr>
<tr>
<td>Third injection</td>
<td>2·0 &quot;</td>
<td>2·0 &quot;</td>
</tr>
<tr>
<td>Fourth injection</td>
<td>2·0 &quot;</td>
<td>2·0 &quot;</td>
</tr>
</tbody>
</table>

(Each c.c. contains 1 grain of antimony sodium tartrate.)
Total = 21 grains.

Each recruit under treatment was given a red or a blue index card for convenience in checking attendance, those with red cards attending on Saturdays, Mondays, and Wednesdays; and those with blue cards on Sundays, Tuesdays and Thursdays.

Recruits attending for treatment were first checked and lined up. Each man in turn then sat on a chair and placed his bared arm on a table, which was high enough to support it, fully extended from the shoulder (fig. 7). With a sterile swab an assistant swabbed the area at the bend of the elbow with spirit and compressed the upper arm till the veins stood out. A second assistant passed a sterile all-glass two-cubic-centimetre syringe to the medical officer, who filled it to the required mark with the solution, injected the contents into a vein, and replaced the syringe in a tray of tepid water. The assistant transferred it to a tray of hot water, and thence to the sterilizer, a precaution necessary to prevent undue breakage of syringes. Ten syringes kept circulating in this manner served to keep the medical officer fully supplied. The lay-out of apparatus is shown in fig. 8.
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Careful attention to every detail of organization is essential for rapid and efficient mass treatment. The success of the arrangements described above was borne out by the fact that they enabled the medical officer to give two or three hundred intravenous injections a day at the rate of one hundred an hour.

Provided that due care is given to aseptic technique, the chief danger to be apprehended is from the escape of solution into the tissues, an accident which causes immediate burning pain at the site of injection, and frequently

**Fig. 7.**—Intravenous injection of antimony sodium tartrate.

**Fig. 8.**—Apparatus for intravenous injections.
results in the formation of an abscess. If steel needles are used, and sharpened daily, such accidents need never occur, as is shown by the fact that between October 1, 1923, and January 31, 1924, 7,215 intravenous injections of antimony sodium tartrate were given in this newly-organized annexe without the occurrence of a single abscess.

Recruits were made to lie down for two hours after receiving their injection, and were not given any drill or physical training on that day. Some experienced no symptoms, whilst others complained of a transient feeling of constriction in the chest and a desire to cough, very slight in most cases. Persistent giddiness, repeated vomiting, pain and diarrhoea—the signs and symptoms of poisoning—were never observed. Recruits were instructed in drill and physical training on the days on which they did not receive an injection.

One hundred and thirty-two of the treated men were available for re-examination six weeks, and again three months, after all treatment had ceased. The results are shown in Table II:

<table>
<thead>
<tr>
<th>Findings</th>
<th>6 weeks after cessation of treatment</th>
<th>8 months after cessation of treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of recruits</td>
<td>Percentage</td>
</tr>
<tr>
<td>Living ova</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td>No ova, or dead ova, or blood only</td>
<td>117</td>
<td>89</td>
</tr>
</tbody>
</table>

The criterion of the death of the worms is failure to find viable ova in spite of careful and repeated examination after a sufficient interval of time has been allowed to elapse in order to give female worms weakened, but not killed, by the treatment a chance to resume the egg-laying function, by which their presence in the veins of the portal circulation is detected. From Table II it would appear that in the great majority of comparatively mild cases of schistosomiasis 95 per cent of the worms are killed by the course of treatment described. If, in spite of the fact that careful search after a sufficient interval reveals no living or dead ova, blood still continues to be passed in microscopic or macroscopic quantities in the faeces or urine, the probability is that it is due to a chronic ulcer, a polypus, or a calculus. The rise in the percentage of cures between the sixth and twelfth weeks shown in Table II is probably due to the natural death of worms poisoned, but not killed outright, by the treatment.

There is every reason to believe that by amplifying the course of treatment described 100 per cent of cures could be obtained amongst recruits. It is quite clear that cure depends upon finding the limit of saturation with antimony sodium tartrate which the patient can tolerate, and maintaining this till all the worms have been killed. The following course of 6 per cent solution of antimony sodium tartrate would be likely to secure this end in the case of comparatively healthy young adult males:
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The improvement in the health of the recruits was so dramatic that within six weeks the entire permanent staff of non-commissioned officers and men of the Police School asked to be examined and if necessary treated. Even more satisfactory was the opinion of the Commandant, El Kaimakam Ali Bey Zeitoun, who stated that he had never before seen any batch of recruits remain so fit under training and benefit so rapidly from it. This expression of opinion was all the more valuable in that it came from an officer who, it will be remembered, was originally entirely opposed to the scheme. He became such an ardent propagandist that news of the work eventually reached the ear of His Excellency Mahmud Pasha Azmi, Minister of War and Marine, in the Yehia Ministry, and finally of His Majesty King Fuad I of Egypt, who, ever solicitous of the welfare of his troops, gave immediate orders for the rank and file of the bodyguard to be examined and treated forthwith.

(8) DISPOSAL OF ARGUMENTS ADVANCED AGAINST THE USE OF ANTIMONY SODIUM TARTRATE.

In the course of this and subsequent work many arguments were advanced against the use of antimony sodium tartrate in the manner recommended. These it will be convenient to dispose of now.

In the first place it would be as well to explain that antimony sodium tartrate, being more soluble and less toxic than antimony potassium tartrate (tartar emetic), has now largely replaced that salt for the treatment of schistosomiasis in Egypt. Possibly the lithium salt will eventually be found to be more suitable than either. Emetine is also extensively and successfully used for the treatment of schistosomiasis, sometimes alone and sometimes in combination with antimony salts; it is much more toxic than either of the latter. It owes its reputation in part at least to the effect it has on amöbic dysentery, which not infrequently exists with, and is overshadowed by, schistosomiasis of the rectum.

It was alleged that antimony salts might have a deleterious effect on the heart.

The earliest signs and symptoms of an excessive dose are severe coughing and feeling of constriction in the chest, persistent giddiness, repeated and violent vomiting, colic and diarrhœa. Even these symptoms are not an indication for stopping treatment but merely for lowering the dose. When a poisonous dose of an antimony salt is administered all the above signs and symptoms are greatly exaggerated, the pulse...
is slow and weak, the blood-pressure falls, respirations are slow and laboured, depression is marked, collapse sets in and finally death supervenes. The signs and symptoms of chronic poisoning due to the repeated administration of excessive but non-fatal doses are general weakness, depression, headache, giddiness, drowsiness, confusion, indistinct sight, and sometimes diarrhoea. Ultimately fatty degeneration occurs in many of the organs. In the treatment of schistosomiasis we are dealing with a relatively very small quantity of the medicine, twenty to thirty grains in all, divided into small graduated doses, administered over a period of twenty-eight days. Up to 200 grains have been given to patients suffering from trypanosomiasis without producing any ill-effects. There is in fact not the slightest evidence to show that in therapeutic doses antimony salts have any deleterious effect whatsoever on heart-muscle.

The theory that antimony salts damage heart-muscle rests on faulty clinical observation. It is quite true that if a given number of patients suffering from schistosomiasis are examined after a course of treatment with antimony salts a proportion are found to have signs of heart disease. But if an equal number of patients are examined before treatment is begun an exactly similar proportion are found to have heart disease already. Finally, if care is taken to detect those who already have diseased hearts before treatment is begun, it is found that none of the remainder develop signs of heart disease either during treatment or subsequently, whilst those who already have diseased hearts are not made any worse by treatment.

The explanation of the occurrence of heart disease in untreated cases is probably that they suffer from a mild degree of fatty degeneration of the heart, which is very common in Egypt, as a result of the anaemia and debility produced by chronic infestation with parasitic worms. Many of the men who break down under the stress of army service would undoubtedly have gone through life in a civil capacity without developing any signs of heart disease. Some break down as recruits, but most of them after two or three years' service. It is amongst the latter class of men whose health has gradually declined, till they have had to be admitted to hospital, that diseased hearts are more prevalent.

In order to see if antimony sodium tartrate had any deleterious effect on heart muscle, such as was alleged, observations were made on fifty-five consecutive cases of schistosomiasis found amongst recruits. They were examined before treatment, after they had received seven grains and after they had received nineteen grains. At each examination the pulse-rate was examined before a standard exercise test, which consisted in stepping six times on to a chair, and again after the test, ninety seconds rest being allowed for the pulse-rate to return to normal. Failure of the pulse-rate to return, after ninety seconds rest following standard exercise, to approximately the same rate as before standard exercise, was regarded as a manifestation of serious derangement of the heart, in all probability fatty degeneration of the myocardium, the result of chronic intoxication due to
the effects of long-standing infestation with parasitic worms. The fifty-five cases were therefore divided into two classes: (a) those in whom the pulse-rate was approximately the same before and after standard exercise, (b) those in whom there was a difference of more than ten beats in the pulse-rate before and after standard exercise. It is in the latter class, if anywhere, amongst the men with hearts already damaged by disease, that one would have expected to find some manifestation of the alleged injurious action of antimony salts on heart muscle.

The results are shown in the Tables III and IV.

**TABLE III.**—**AVERAGE PULSE-RATES OF FORTY-SIX RECRUITS WITH NORMAL HEARTS.**

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>B.E.</td>
<td>A.E.</td>
</tr>
<tr>
<td>B.E. A.E.</td>
<td>79</td>
<td>81</td>
</tr>
</tbody>
</table>

B.E. = Before standard exercise test.
A.E. = After standard exercise test.
A.S.T. = Antimony sodium tartrate.

Table III shows that under the combined influence of military training and treatment practically no difference was found in the pulse-rates before and after standard exercise of recruits whose hearts were normal before treatment was begun. A slight increase in both rates was apparent after treatment with seven grains and training for ten days, but they had returned to normal by the twenty-fifth day, in spite of the fact that the recruits had received another twelve grains of antimony sodium tartrate and undergone another fifteen days' training. The presumption is therefore that this slight temporary increase must have been due to the effects of training.

**TABLE IV.**—**AVERAGE PULSE-RATES OF NINE RECRUITS WITH ABNORMAL HEARTS.**

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>B.E.</td>
<td>A.E.</td>
</tr>
<tr>
<td>B.E. A.E.</td>
<td>88</td>
<td>108</td>
</tr>
</tbody>
</table>

Table IV shows *inter alia* the wide average difference found in the pulse-rates before and after standard exercise of some sixteen per cent of "fit" recruits suffering from schistosomiasis who had not yet received treatment or undergone training. After treatment with seven grains and training for ten days the rate before exercise was found to be markedly increased, and, instead of returning to normal, it became, if anything, slightly faster as the result of treatment with another twelve grains, and training for another fifteen days. In view of the findings in the case of the forty-six men with normal hearts it seems reasonable to infer that the deterioration observed in the case of the nine men with hearts already deranged before treatment was the outcome of military training, and not of the administration of antimony sodium tartrate.

From these observations it is clear that antimony sodium tartrate can be administered with perfect safety to recruits with normal hearts in the doses and at the intervals recommended.
It is also clear that by taking suitable precautions it should be possible in future to eliminate at the final medical examination of recruits all those with hearts liable to break down during recruit training.

Further proof of the value and harmlessness of antimony sodium tartrate is furnished by the statistics, not yet published, of the Public Health Department of Egypt for 1923, which show that during that year no less than 29,000 patients of all ages and both sexes were treated with it at the four anthelmintic annexes, without the occurrence of a single casualty proved to be due to the medicine. As these patients all attended voluntarily, in spite of the fact that the course of treatment involves considerable personal inconvenience to the patient, and is somewhat alarming to the uneducated mind, no more convincing proof of the essential efficacy and harmlessness of the medicine could be forthcoming.

It would therefore be unreasonable, uneconomical, not to say inhuman, to withhold treatment from infested but otherwise healthy recruits on the groundless supposition that their hearts might be damaged by the treatment, especially as we know definitely that if they are not treated many will inevitably be invalided as hopeless wrecks before they have completed five years' service.

Another argument advanced against mass treatment was that cases of schistosomiasis treated with antimony sodium tartrate had been known to relapse. The word relapse, as commonly used in this connexion, conveys a totally erroneous impression of what usually occurs. It is quite true that, if in any given case treatment is inadequate, the worms will not all be killed, and after an interval signs and symptoms of active schistosomiasis will reappear. This is a relapse. It is also true that in some cases, in spite of drastic treatment which has resulted in the death of all the worms, patients continue to suffer from severe and intractable signs and symptoms of the disease, to which they eventually succumb. This is especially true of the rectal form of schistosomiasis. The great majority of so-called relapses belong to the latter category in which the signs and symptoms of the disease persist in spite of the death of the worms. The decisive factor in these cases is of course extensive and irreparable tissue damage. It is therefore wrong to describe them as relapses and doubly wrong to lay the blame of failure upon antimony sodium tartrate. Its warmest advocate never claimed that it could do more than kill off all the schistosomes in a human body, provided it was administered in adequate doses at suitable intervals. In any case, of course, the occurrence of occasional relapses would no more be an argument against the use of antimony sodium tartrate in the treatment of schistosomiasis than it would be in the case of quinine in malaria, or salvarsan in syphilis.

Christopherson and a host of workers in Egypt have long since condemned pusillanimity in the administration of tartar emetic. It is widely known that by giving inadequate doses of antimony salts at excessive intervals the worms, far from being killed, are merely stupefied, and, what
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is worse, gradually accustomed to withstand the medicine till it becomes practically impossible to kill them without jeopardizing the patient’s life, or at any rate causing the manifestation of serious intestinal symptoms. It cannot be too often or too strongly reiterated that the whole art of curing schistosomiasis with antimony salts consists in saturating the patient, and keeping him saturated, till all the worms are dead.

It was alleged that antimony salts are not as efficacious against schistosomiasis of the rectum as they are against schistosomiasis of the urinary bladder. This is not the case. As already pointed out, it is the serious complications of the former disease that are incurable with antimony salts. They cannot be expected to remove chronic ulcers, polypi and papillomata of the rectum and large intestine, complications which commonly persist in spite of the death of the worms. It is the sapping of the patient’s vitality by haemorrhage and the poisoning of his system by septic absorption that constitute the serious feature in cases of advanced rectal schistosomiasis.

Another argument advanced against mass treatment was the fact that in the month following that in which mass treatment of recruits was begun, an unusually large number of men had been invalided from the Egyptian Army General Hospital, Cairo. The fact that it had been found necessary in that month to invalid a large number of men whose disease had not been diagnosed when they entered the army some years previously, and whose health had steadily deteriorated till it had passed beyond medical aid, far from being an argument against a system of which they had never had the benefit, was the strongest possible argument in favour of it. No amount of argument, especially of the specious sort which seeks to foist the failures of a broken-down system on to a struggling new one, can ever justify the policy of standing idly by till diseased men have become so seriously ill as to require admission to hospital and then, after some of them have already reached the incurable stage, undertaking their treatment. Even if all the men referred to had been recruits, which was not the case, it would still have been possible to maintain on grounds of humanity, economy and efficiency that they were better invalided as recruits in the same condition as they were in when they joined the army, than as serving soldiers, broken in health, and therefore no longer able to earn a livelihood.

Another argument against treatment was that treated men would become reinfested on furlough. Reinfestation will no doubt occur occasionally, but there is no reason for entertaining an exaggerated idea as to its danger. When due consideration is given to the fact that it has taken twenty-one years of life and work as fellahin for fifty per cent of recruits to become infested, it becomes apparent that the percentage of serving soldiers likely to become infested during a total of seventy-five days’ furlough in five years’ service will be so extremely small as to be negligible. If progressive infestation did occur to any serious extent during service one would expect to find a higher percentage of infested men amongst serving.
B. H. H. Spence

soldiers than amongst recruits, but the reverse is the case, the figures being forty per cent and forty-nine per cent respectively, the difference no doubt being due to treatment and invaliding of serving soldiers. The soldier on furlough does not work as a fellah; he leads for a brief spell the lordly life of an idle and opulent man. In any case the danger of reinfection is not an argument against the treatment of schistosomiasis any more than it would be in the case of malaria or venereal disease.

(9) The Exact Extent of Parasitic Worm Infestation in the Egyptian Army.

Attention was next directed to recruits for the army and to serving soldiers. All recruits of the 1923 winter call and all the serving soldiers in Cairo, comprising His Majesty's Household troops, detachments of cavalry and artillery, and the 2nd, 4th and 8th battalions were systematically examined between October 4, 1923, and February 10, 1924. The results are shown in Tables V and VI.

TABLE V.—Examination of the 1923 Winter Call of Recruits for the Egyptian Army.

<table>
<thead>
<tr>
<th>Number examined</th>
<th>Ankylostomiasis</th>
<th>Schistosomiasis of urinary bladder</th>
<th>Schistosomiasis of rectum</th>
<th>Other infestations</th>
<th>Infested</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Per cent</td>
<td>No.</td>
<td>Per cent</td>
<td>No.</td>
<td>Per cent</td>
</tr>
<tr>
<td>Recruits</td>
<td>1,264</td>
<td>745</td>
<td>59</td>
<td>619</td>
<td>49</td>
</tr>
</tbody>
</table>

TABLE VI.—Examination of Soldiers of the Egyptian Army Serving in Cairo.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Number examined</th>
<th>Ankylostomiasis</th>
<th>Schistosomiasis of urinary bladder</th>
<th>Schistosomiasis of rectum</th>
<th>Other infestations</th>
<th>Infested</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Per cent</td>
<td>No.</td>
<td>Per cent</td>
<td>No.</td>
<td>Per cent</td>
<td>No.</td>
</tr>
<tr>
<td>Household troops</td>
<td>438</td>
<td>159</td>
<td>36-5</td>
<td>151</td>
<td>34-5</td>
<td>1</td>
</tr>
<tr>
<td>Cavalry</td>
<td>128</td>
<td>50</td>
<td>39-0</td>
<td>44</td>
<td>35-2</td>
<td>—</td>
</tr>
<tr>
<td>Artillery</td>
<td>200</td>
<td>137</td>
<td>68-5</td>
<td>66</td>
<td>33-0</td>
<td>—</td>
</tr>
<tr>
<td>2nd Battalion</td>
<td>534</td>
<td>198</td>
<td>37-0</td>
<td>190</td>
<td>35-5</td>
<td>7</td>
</tr>
<tr>
<td>4th</td>
<td>465</td>
<td>304</td>
<td>65-4</td>
<td>218</td>
<td>46-9</td>
<td>13</td>
</tr>
<tr>
<td>8th</td>
<td>587</td>
<td>279</td>
<td>48-5</td>
<td>277</td>
<td>48-3</td>
<td>2</td>
</tr>
</tbody>
</table>

Total 2,352 1,127 47-9 946 40-2 28 1-0 87 3-7 1,604 68-1

Thus it is seen that seventy-six per cent of recruits and sixty-eight per cent of soldiers with from one to four years' service were found to be suffering from one or more, in some cases four kinds of parasitic worm infestation. As large numbers of men are being treated or invalided every year for these diseases it is manifestly absurd to ascribe the difference in percentage to natural cure.

Variations in the percentage of infested men in different units depend upon the areas from which the majority of recruits in these units were drawn. Thus it will be seen in Table VI that 2-8 per cent of the men in the 4th Battalion have rectal schistosomiasis, a much higher proportion than any other unit examined; this is due to the fact that the 4th Battalion.
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contains a relatively large proportion of men from the Fayoum Province, an oasis to the west of Egypt, in which rectal schistosomiasis is much more prevalent than anywhere else in the country. Again, both the 4th and the 8th Battalions have a higher percentage of men with schistosomiasis of the urinary bladder than any other units examined; this is because the majority of the men in these two battalions are drawn from the Delta area (Lower Egypt) in which this form of the disease is much more prevalent than in the valley area (Upper Egypt).

It seemed advisable to push the investigation one step further by examining the ninety-eight officer cadets in the Military School, Cairo, and the fifty-two medical students from Kasr el Aini Hospital seeking medical education at Government expense with a view to serving subsequently in the Medical Corps. The result is shown in Table VII:

TABLE VII.—EXAMINATION OF OFFICER CADETS IN THE CAIRO MILITARY SCHOOL.

<table>
<thead>
<tr>
<th>Number examined</th>
<th>Ankyllostomiasis</th>
<th>Schistosomiasis of urinary bladder</th>
<th>Other infestations (chiefly Tenaoven)</th>
<th>Infested</th>
<th>No.</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>5</td>
<td>3·3</td>
<td>20</td>
<td>13·3</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>81</td>
<td>20·6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

20·6 per cent of these boys, who came from relatively good social surroundings, were thus found to be infested. Before the examination was carried out they were all asked if they had "bilharzia," and all denied it. After the examination those found to have schistosomiasis of the urinary bladder all admitted that they knew they had the disease, and in every case they were able to state the year in which they contracted it, and were even able to associate infestation with bathing in particular canals whilst staying in the country. The infestations were all light. It is interesting to note that renal colic with atypical symptoms is a fairly common complaint amongst Egyptian officers and men. Genuine cases of course occur, due to the presence of stone in the kidney, but many of these atypical cases are almost certainly due to the presence of stray ova in the kidneys and ureters.

(10) SUMMARY OF WORK CARRIED OUT IN THE ANTHELMINTIC ANNEXE OF THE EGYPTIAN ARMY GENERAL HOSPITAL, CAIRO, BETWEEN OCTOBER 1923 AND FEBRUARY 1924.

1,445 recruits suffering from schistosomiasis, ankyllostomiasis, and other intestinal infestations, and 1,214 serving soldiers suffering from ankyllostomiasis and other intestinal infestations received appropriate treatment, whilst 969 serving soldiers found to be suffering from schistosomiasis had their names noted for treatment in March, 1924, on the conclusion of the winter training season.

3,756 men were examined, involving the microscopical examination of 8,128 specimens of urine and faces.
2,038 doses of carbon tetrachloride were administered.

621 men were treated for schistosomiasis, involving the administration of 7,450 intravenous injections of antimony sodium tartrate.

The staff consisted of a portion of the existing staff of the Egyptian Army General Hospital, Cairo, namely, myself, El Yuzbashi (captain), Ibrahim Efendi Rizk, and three anfar (privates) of the Egyptian Army Medical Corps.

Before I left Egypt in March, 1924, very encouraging reports were being received from officers commanding units and medical officers doing duty with troops. The gist of these was that whereas in previous years numbers of recruits used to faint on parade and several had usually to be admitted to hospital for schistosomiasis before their training was complete, this year none at all had fainted or reported sick with schistosomiasis, a result which they unanimously attributed to the introduction of mass diagnosis and treatment. All were most anxious that the work should continue.

The cost of dealing with the 1923-24 batch of recruits worked out at well under the original estimate of £50.

(11) SUMMARY AND CONCLUSIONS.

(1) Fourteen per cent of the soldiers treated in the Egyptian Army General Hospital in Cairo, in 1923, were admitted primarily for parasitic worm infestation.

(2) Twenty-nine per cent of the men invalided in 1923 from the same hospital were invalided for the effects of chronic infestation with parasitic worms.

(3) Large numbers of "fit" men in the Egyptian Army suffer constantly from signs and symptoms of parasitic worm infestation without feeling ill enough to report sick.

(4) The Egyptian soldier is notoriously lacking in resistance to the adversities of military service in a bad climate. There is every reason to believe that this is the direct result of his constitution having been undermined by chronic infestation with parasitic worms.

(5) Ninety-one per cent of a batch of 292 recruits for the Police School, Abassia, Egypt, were found to be infested with parasitic worms, some harbouring as many as four kinds. 73 per cent had ankylostomiasis, 52 per cent schistosomiasis, 7 per cent ascariasis, and 3 per cent other infestations.

(6) The 212 ankylostomiasis cases were treated with a single dose of five cubic centimetres of carbon tetrachloride. Three months later seventy-nine per cent were found to have been completely cured. For efficacy, ease of administration, mildness of after effects, safety and cheapness, carbon tetrachloride is incomparably the best anthelmintic yet discovered for the treatment of ankylostomiasis amongst Egyptians.

(7) The 152 schistosomiasis cases were treated with twenty-one grains of antimony sodium tartrate divided into twelve doses and given on
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alternate days by intravenous injection. Of the 132 who were available for re-examination three months later, ninety-five per cent were found to have been completely cured. By amplifying the dose on the lines indicated it is probable that 100 per cent of cures could be obtained in these comparatively lightly-infested healthy-looking recruits. Cure depends upon finding the limit of saturation the patient can tolerate and maintaining it till all the worms are dead. Antimony sodium tartrate merely kills the worms; it cannot be expected to repair hopelessly-damaged tissues.

(8) Of a batch of fifty-five recruits forty-six with normal hearts suffered no harm from a full course of antimony sodium tartrate, and underwent training during their course of treatment. Nine who showed evidence of more or less serious derangement of the heart before treatment became worse under the combined influence of training and treatment; as those with normal hearts were unaffected the presumption is that the men with already deranged hearts were adversely affected by training and not by treatment.

(9) The derangement of the heart found in sixteen per cent of apparently fit recruits is probably the outcome of chronic toxæmia; due to long standing infestation with parasitic worms.

(10) The necessity for subjecting all recruits for the Egyptian Army to a simple test for cardiac efficiency was clearly demonstrated.

(11) Seventy-six per cent of the 1923-24 winter call of recruits for the Army, picked fellahin with every appearance of perfect health, were found to be suffering from parasitic worm infestation, fifty-nine per cent having ankylostomiasis and forty per cent schistosomiasis.

(12) Sixty-eight per cent of soldiers serving in Cairo were found to be harbouring parasitic worms, fifty-nine per cent having ankylostomiasis and forty per cent schistosomiasis.

(13) Twenty-one per cent of officer cadets were found to be suffering from parasitic worm infestation, three per cent having ankylostomiasis and thirteen per cent schistosomiasis.

(14) A complete case has been made out on grounds of expediency no less than of humanity for the immediate application of the methods of mass diagnosis and treatment to the rest of the Egyptian Army, and for the routine examination and treatment of all recruits in future, before they join their units, on the lines indicated in this paper.