SOME NOTES ON BILHARZIASIS.

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Bilharziasis, although spread over a wide geographical area, is perhaps better studied in Egypt than elsewhere. Bilharzial infection in some degree exists in such a very considerable proportion of the male population of this country that the presence of our own troops here, where of necessity they must often be in close proximity to heavily infected native populations, makes the problem of direct military importance. Before dealing with the parasite or the manifestations of its presence in the human body, it will be of interest to note briefly some facts as regards its history and geographical distribution. There is evidence of its existence in specimens belonging to the Twelfth Dynasty, that is, from B.C. 4,000 to B.C. 2,500. This material, which exists in the British Museum, will, I hope, in more fortunate times than the present, yet become the subject of detailed investigation. Much later than this must be noted the discovery of the presence of eggs of the Schistosomum hematobium in an Egyptian mummy of the Twentieth Dynasty (B.C. 1,250 to B.C. 1,000), by Sir Armand Ruffer.  

Apart from these facts, the following considerations have always led me to believe that the baneful effects of this parasite not only existed but were widely recognized in the Nile Valley from the most ancient times. Remedies for the relief and cure of haematuria, for instance, are both numerous and frequently mentioned in the documentary fragments we possess of ancient Egyptian medicine.

Now, haematuria is such a common early manifestation of this disease in the bladder that it is only natural to infer that the remedies mentioned had been diligently sought for the relief of the bleeding from vesical bilharziasis. Again, calculus of the urinary bladder was probably quite as common amongst the innumerable dead of ancient Egypt as it is amongst the long-suffering "fellaheen" to-day, and this distressing malady, at least in this country, frequently follows chronic bilharziasis. The numerous armies which have passed in successive waves of invasion over Egypt must have contracted here and carried away with them the common

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diseases of the Nile Delta. When we read, for example, in the Memoirs of Napoleon's surgeons, that amongst the medical problems which they had to face in order to maintain the fighting efficiency of his forces, hematuria and ophthalmia were amongst the most common, we have little difficulty in reaching the certain knowledge that bilharziasis to an undetermined extent undermined the strength of his troops. If we may reason backwards by analogy, one is tempted to ask to what distance may this same disease have been carried into the Farther East by the armies of Alexander the Great, who took some of his best fighting material from Egypt itself.

In view of the fact that some of us may yet be called upon to take medical charge of troops in various parts of our scattered Empire before the close of this stupendous War, I think it will not be out of place to give a brief review of the area over which the occurrence of bilharziasis is known. In this continent, whilst Egypt is appropriately termed its home, it occurs throughout Tripoli, Tunis, Algeria, Morocco, and from Suez right down the East Coast to the Cape of Good Hope. With the opening up of trade routes, it is known to have crept along the railway into Uganda; it has long existed in Abyssinia, it is present in some degree in most of the provinces of the Sudan, and finally, it has recently been noted both in the Zambesi basin and in the extensive area under the Protectorate of France around Lake Tchad. Of more particular importance is its presence amongst the desert Arabs both to the east and west of Egypt, whose use of the shallow surface wells of the smaller oases becomes significant from a military point of view. Farther beyond Egypt, to the east, it is known to exist amongst the lower classes at least in Syria, Arabia and Mesopotamia. It is probably too early, as yet, to expect its occurrence amongst those of our troops who have been invalided from the campaign in the Tigris valley. At least, I have searched for the ova of the parasite in as many as possible of those who have, on their return from Mesopotamia, found their way into a general hospital, without finding any evidence of their presence. It is met with in large tracts of country in China, but I must be content simply to mention its presence in at least five large provinces of the Yangtsekiang basin, and in at least four of the provinces of Japan, where, with characteristic thoroughness, Japanese medical officers have been instructed to look out for it. It is also found in Cyprus, Mauritius, and the West Indies, and even with the addition of these its geographical distribution is scarcely complete. As
troops are being accepted for service from many regions in which bilharziasis is endemic; it would be well to bear in mind that in a slight degree it may actually exist in men, for example, from the West Indies, who have been certified as fit for military service. If our colonial troops, serving on a much smaller scale in South Africa, were the means at that time of carrying the infection back with them to Australia and elsewhere, who shall say in what unexpected parts bilharziasis may, later on, manifest itself, when the massed armies of the Empire are again disseminated at the close of the War?1

I cannot enter upon any description of the changes produced by this worm in the body without first giving, as briefly as may be, an outline of the main phenomena in the interesting life cycle of the parasite. It is indeed fortunate that we are now in a position, thanks to the able researches conducted by Japanese parasitologists on the life-history of S. japonicum, and later by those of Lieutenant-Colonel Leiper, R.A.M.C., on S. haematobium in this country, to present a complete account of it. First then, the living ova which are voided in the urine or faeces of an infected person hatch out under the influences of warmth and contact with fresh water as very active ciliated miracidia. The life of these is limited—their period of greatest activity being the first eight or ten hours after emerging from the ovum. Whilst many undoubtedly perish, some find their way into a suitable mollusc, which so far have been found to be very numerous in the infected localities. Two species of mollusc, planorbis and bullinus, have been shown by Leiper to act as intermediary hosts of the two varieties of worms in Egypt. Infection of the mollusc, it will be gathered, takes place in considerably less than one day after the hatching out of the miracidium. An interesting intra-molluscal phase of development now takes place, into the details of which it is not necessary to enter. The result is, however, that after certain developmental changes, occupying from three to four weeks, elongated organisms having characteristic bifid tails (called cercarids) are emitted from the intestinal canal of the mollusc in very large numbers. These cercarids are the infecting phase of the parasite for man, and reasoning from the manner in which they appear to penetrate the skin of a young mouse, or other susceptible animal suspended in water containing them, we may infer that in man they penetrate

1 An outbreak of rectal bilharziasis has occurred, since this paper was written, amongst the Australian troops quartered at Tel-el-Kebir.
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those parts of his immersed body in which the skin is thinnest. Of course the possibility that the cercariae may also enter the stomach with swallowed water is not to be excluded. These cercariae resemble the adult worm in some respects. Like the latter, they possess two suckers—one oral sucker, terminal in position, and one ventral, by which they can securely attach themselves to any surface. Moreover they have no pharynx at the commencement of the oesophagus—a feature which also differentiates the adult worm from the other distoma trematodes.

It is important to note that the life of cercariae in water is limited, and that in order to develop into the mature worms, which they do without undergoing any further metamorphosis, they must reach the definitive host within forty-eight hours. Having once managed to effect an entry, they commence a long migratory journey in the body, and those which are fortunate enough to reach the liver are transformed in that organ into the sexually mature worms, male and female. So far as experiments hitherto conducted permit us to conclude, it would appear that the time which must elapse between the entry of the cercariae and the detection of live ova in the urine and feces of the animal infected is about two months, i.e., the transformation from cercariae into adult worms which have taken up their abode in either bladder or rectum has occurred well within this period. It would appear, however, that in the case of man, this period covers three and a half to four months.

The characteristics of the adult worms are described in various accessible publications, so that I do not propose to do more here than lay stress on a few points of practical importance, having a bearing on the production of the pathological changes in man. Although the male worm would at first sight be judged to be cylindrical, it must be remembered that it is quite a flat, "leaf-like" worm, which appears cylindrical because the "leaf" is rolled on the axis of its midrib, so to speak, in such a fashion that the two lateral margins are either in close contact or more frequently overlap considerably. The worm, by this infolding of itself, is thus converted into a small tube in which the female is wrapped during the period of sexual life. The female is considerably longer than the male, and is of thin, hair-like, cylindrical appearance. Both sexes are provided with suckers, one of which is terminal, serves as a buccal cavity, and opens at once into a short straight oesophagus, while the other is ventral in position and serves either to fix the worm to a surface or as an aid to
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locomotion. For the latter purpose it serves to secure the extended worm to a fixed point towards which, as a point d'appui, the remainder of the worm then contracts. The external surface of the male worm is covered with numerous projecting bosses of minute size, and these doubtless aid in its intravenous movements. The youngest adult worms in the human body are found in the liver and vessels of the portal system. They travel to their permanent resting-places by way especially of the inferior mesenteric vein.

The course of events may be approximately stated to be as follows: As the worms attain sexual maturity, they make their way slowly into the main trunks of the portal vein. Arrived there, coupling of the sexes takes place, and the long, downward journey to the pelvis against the blood-stream is commenced. This only terminates in the minute venous radicles of the posterior vesical plexus and those of the descending colon and rectum. This pelvic voyage against the blood-stream must take a considerable time—it is difficult to say how long. It is probable, however, that it is entered upon by sexually immature worms, and that maturity is reached during its progress. Ova, more or less perfect in form and state of development of contents, are being cast off freely into the venous stream during the journey to the pelvis. These are carried back as passive particles to the liver, where they remain embedded in the tissue, undergoing slow degenerative changes and ultimate calcification.

It is, however, in the smaller veins in the situations already named in the depths of the pelvis that real deposition of ova begins, and it is the increasing multitudes of deposited ova imprisoned in the walls of the bladder and rectum which by their presence give rise to the inflammatory and other tissue changes which are the bases of the symptomatic manifestations. Dr. Looss, with whom I was associated for several years on the staff of the School of Medicine in Cairo, used to tell me that the manner of egg deposition by these worms was something like the following: The female, just prior to the act of depositing her ova, he believed, protruded herself beyond the gynaecophoric canal of the male as far as possible in a distal direction, that is, towards the true capillaries, and after depositing her ova, which were thus situated a short but appreciable distance beyond the actual situation of the male worm, withdrew her slender body into the shelter of that of the male worm. It is thus conceivable that if the coupled worms were impacted in a small vein just proximal to its subdivision into two, three or more branches, the female at successive periods of egg
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deposition might reach with her extended body down each of these subdivisions in turn, so that the resulting groups of ova that emerged from the minute veins into the surrounding tissue spaces would have something of a fan-like distribution. Within a short time, at any rate, after the deposition of the eggs, they penetrate the vein wall, passing towards and through the mucous membrane of bladder or rectum as the case may be, in order to reach a free surface and, by means of one or other of the excreta, reach haply some fresh water, and thus recommence the cycle of changes by which the species is perpetuated.

These eggs probably possess very little inherent power of movement. Their progression towards the desired surface probably depends to a large extent on the muscular contraction of the wall of the viscus in which they are situated, aided to a certain extent by the piercing qualities of the sharp spine, terminal or lateral as the case may be, with which they are provided. As physicians we are directly concerned with the fate of and the changes set up by the presence in countless numbers of those ova which never reach the surface of bladder or bowel.

I must refer here to the results of a very large number of observations which I have made on the distribution of ova which often occur beyond these limited areas. During the course of a research on the nature and frequency of malignant disease occurring primarily in the urinary bladder and grafted on to bilharzial affections of that organ, I had occasion to examine microscopically small nodules of malignant tumour, the results of widespread dissemination from the primary site, and was struck with the presence of ova either in or in close proximity to such nodules in situations like remote lymphatic glands, the pericardium, the cardiac muscle, &c. It was therefore clear that ova, although largely laid, if the foregoing be true, within the limits of the portal circulation, could and did overstep these limits and pass over into the systemic vessels. This led me to examine, first of all, by means of injections of an alloy having a very low melting point, the freedom of the anastomotic communications between the portal and systemic venous system of the pelvis. Without entering into any description of the detailed anatomy, I became convinced that these were at once both larger and more numerous than most of the anatomical works have led us to suppose, and I cannot but think that in cases where, as in the natives of this country, severe bilharzial infections are the rule, the passage of ova in some degree into the systemic venous system, the settlement of a considerable
number in the lungs, and the distribution of the remainder by the arterial vessels, is a common, if not a regular occurrence.

I cannot state in detail here the results of my examination of the most varied organs and tissues in the body for the presence of ova. In many of these situations ova may exist in comparatively small numbers without inducing such pathological changes as would give rise to clinical symptoms, but special mention must be made of the results of their presence in the cerebrospinal nervous system. They may be found in comparatively small numbers in various parts of the brain, and more particularly in the meninges in a position corresponding to the position of the middle meningeal artery, though I cannot say that, beyond some thickening of the membranes, they have caused a distinct meningeal affection. It is quite otherwise, however, in the case of the spinal cord. Certain cases of chronic bilharziasis occur in Egypt from time to time, in which definite but somewhat anomalous groups of symptoms referable to the lower part of the spinal cord make their appearance in the later stages of the malady. Sometimes these symptom-groups will imitate locomotor ataxia, and sometimes disseminated sclerosis. In such cases microscopical examination of the cord has revealed the presence of completely calcified ova surrounded by well-marked signs of neuroglial hypertrophy.

To one other possible fact of this more extended distribution of ova I should like to refer, and that is this. Although visible and apparent bilharziasis is not nearly so frequently met with in the female as in the male, the fact remains that examination, by special methods, of the uterus and ovaries of young girls in this country shows the occurrence of ova in these situations, sometimes in considerable numbers. Indeed, I have seen both ovaries so altered by a chronic oophoritis, which could only be attributed to their presence, that I do not hesitate to conclude that this disease,

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1 The outline of a typical case may be given as follows:—A male fellah, aged 35, had complained of numbness in the legs with increasing difficulty in walking for five months before admission to hospital. During the latter part of this period he had been quite confined to bed, unable to walk at all, and, on admission, sacral bedsores and trophic ulcers were present on the limbs. Clinically the disease, so far as it could be analysed during hospital residence, resembled disseminated sclerosis rather than locomotor ataxia. At post-mortem (February 18, 1912), he had a few signs, by no means pronounced, of old bilharziasis in the bladder, but examination of various parts of the body showed that in addition to the presence of eggs in the spinal cord, there had occurred a widespread distribution of them in various organs.
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persisting from infancy, may be the cause of sterility in young married native women.

Some idea of the widespread prevalence of bilharziasis in Egypt may be gathered from the fact that, as based on the discovery of imprisoned ova in bladder, rectum, or other situations post mortem, I determined the existence of the disease, either in an extinct or active form, in no less than 60 per cent of 600 male subjects between the ages of 5 and 65 years of age. This series was examined consecutively, as the bodies came to the post-mortem room in the routine course of work.

Allusion has been made during the course of this paper to two varieties of ova, one possessing a terminal, the other a lateral spine. Helminthologists assure us that these ova belong to closely allied but distinct species of Schistosomidae, and affirm the existence of certain anatomical differences in the worms which give rise to one or other variety of egg. Further, they state that the species of worm which gives rise to the lateral-spined ovum has a special predilection for the colon and rectum as its habitat in the body, whereas that from which the terminal-spined ovum is obtained attacks the bladder. This statement rests upon such facts as the following: In Martinique, for example, the intestinal form of the disease is said to exist alone, characterized by the presence of lateral-spined ova exclusively—the same statement being reported as true for other localities also. Apart from my own observations, however, which only apply to Egypt, and to which I shall allude later, I should like to mention that in Morocco,1 in a group of five cases in which bilharzial ova were found in the feces, only one showed ova possessing lateral spines.

In addition to this, French workers in the Lake Tchad2 district, who examined the scholars of a village school, found that out of twenty cases in which ova were present in the urine, one case was characterized by the constant presence of lateral-spined ova, on repeated examination, whilst terminal-spined ova were present in the remaining nineteen.

My own observations in Egypt abundantly confirm these com-


paratively few observations. As a result, I am of opinion that if the walls of bladder and rectum are treated by special maceration methods in dilute alkali, so that their entire calcified egg contents can be submitted to microscopical scrutiny, mixtures of the two varieties of egg will generally be found in both. It, however, remains true that in the case of the bladder terminal-spined ova largely predominate, though I cannot say the same in the case of the rectum, where frequently the two species seem to me to be sometimes fairly evenly mixed.

Even if our troops unfortunately contract, as to a certain extent they must, a bilharzial infection of rectum or bladder by bathing in or drinking the water of pools not only in Egypt and South East Africa, but also in the Tigris Valley, we may foretell with reasonable safety that the disease will never attain the terrible hold and produce the serious ravages which occur in heavily infected natives of Egypt.

At the worst I hope that, as in the case of the South African War, we may not have to look forward to more than an impaired state of health from this cause, which, after some considerable time (three to five years) may disappear altogether. The essential facts with regard to its mode of infection are now so well known that the necessary measures for its avoidance may be made precise, and should be stringently enforced, in the hope that military efficiency may not be impaired in the immediate future, and that the country may be saved the payment of large sums in compensation to men who need not have been infected. It is safe to say that once men of any unit are found to be reporting sick with symptoms such as slight suprapubic uneasiness and a desire to micturate more frequently than usual, if these symptoms are found to be related to the presence of bilharzial ova in the urine, more men in that unit than those complaining will certainly be affected. I found this to be the case some years ago in connexion with a certain regiment stationed at Kasr-el-Nil Barracks in Cairo, when Colonel (then Major) Fell, R.A.M.C., first reported its presence to me, and afterwards conducted a careful, systematic examination of the men.
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