Original Communications.

NOTES ON ANCHYLOSTOMIASIS, BEING, FOR THE MOST PART, A RESUMÉ OF A REPORT ON THE DISEASES KNOWN IN ASSAM AS KALA-AZAR AND BERIBERI.

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(*Continued from page* 173.)

Under favourable conditions of temperature, in the course of the next six days, the little embryos develop into sexually mature animals. When fully grown, these free stage nematodes reach a length of $\frac{1}{24}$ inch for the male, and of $\frac{1}{25}$ inch for the female. They have a simple, unarmed mouth, and the caudal extremity of the male is furnished with a membraneous expansion supported by clutinous rays which, however, is entirely different from the bursa of the parasitic stage, although it probably functions much in the same manner. Though not nearly so prolific as the parasites, they yet give birth to a sufficiency of ova to multiply the numbers of each colony some fortyfold at each generation.

The quantity of fæcal nutriment which is deposited along with the ova is usually sufficient to carry them through all stages of their life and growth and to fairly start a second generation in life; but beyond this, the supply does not, as a rule, last, as scavenging insects of all sorts combine with the multiplied rhabdites to consume the supply, so that, by the end of ten days, no sensible source of offence is left, and all further development of the young generation is stopped by the want of food.

It must not, however, be supposed that so desirable a consummation as their death from inanition has been arrived at, for, so far from the food supply shortening their life, it enormously increases its duration.

Paradoxical as it may appear, this is an absolute fact. Given a free food-supply, and the rhabdites are born, mature, multiply, and die within the utmost space of a fortnight. Cut off their food-supply; and, provided they find themselves elsewhere than in water, which, as we have seen, is ultimately fatal to them, they pass into a sort of lethargic state in which they may continue without further growth or development for an indefinite period. But, though life be prolonged, multiplication is brought to a standstill, so that this state of things is clearly less favourable to the welfare of the species than the short life and rapid multiplication that is associated with an abundant food-supply.

But, although dormant, the power of development is still there, and we have only to supply them with a sufficiency of fæcal matter to enable them to reach sexual maturity and to multiply as rapidly as ever.

I have cultivations now by me which were started more than eighteen months ago, which have repeatedly been allowed to lie dormant for months, under the most varied conditions of temperature and dryness, and which I can at any time start into the most rigorous sexual life and multiplication by merely damping the sand of the cultivation with a little diluted fæcal matter.

The potentialities of persistence and multiplication of the free stage are thus, it will be seen, enormous; for, once a site has been fouled by a patient, the dormant worms will render the soil infective for an indefinite period, and any fresh fouling of the infected area will at once start them into renewed multiplications.

Again, it is obvious that heavy falls of rain would gradually spread them over a considerable area, as they always live quite close to the surface, and so must be readily carried along in the muddy currents that traverse the ground when rain is at all abundant.

It is probably a matter of indifference whether embryos are the direct or indirect progeny of the parasitic stage, so far as their power of infecting is concerned. It is, however, obvious that infection by the immediate progeny of parasitic ova must be an exceptional occurrence, as they can only exist on freshly fouled sites, such as the most callous of humanity would instinctively avoid. Whereas there will be nothing whatever to warn the passer away from sites infested by the progeny of the free stage worms. Once these embryos have gained access to the intestinal canal of a fresh host, I believe they rapidly develop into the parasitic adult. Some observers have asserted that, after gaining entrance to the intestinal canal, they proceed to encyst themselves in the submucosa, but I have never met with any trace of such a condition. In my report I have left this point open; but since then I have devoted considerable study to a variety of allied species, some of which encyst, while others do not do so, and I have come to the conclusion that I could not possibly have overlooked a condition so easily recognizable as I know that caused by encysted worms to be; and hence I believe submucous encystment to form no part of the normal life history of the parasite.

In this opinion I find I am in agreement with Leichtenstern, who suggests that the worms so found had "wandered" out of their natural habitat. This may be the case, but certain recent investigations in which I have been engaged,

have brought to light the fact that certain encysting species are capable of doing so, even when they gain access to a host which is not their natural habitat, and in whose bowel they are yet unable to attain maturity after escaping from encystment. Now it appears to me at least as possible, that the worms thus found in the human submucosa may have been not *dochmii*, but examples of some encysting species whose normal habitat is one of the lower animals.

Dochmius duodenalis appears to be a purely human parasite. My attempts to infect even monkeys had only a very doubtful success, and I have met with no authenticated account of its invading any of the lower animals. Surgeon-Major O. Baker indeed speaks of finding its ova in the dejecta of a favourite spaniel (*Ind. Med. Gazette*, December 1888), but it may be considered as practically certain that the ova he observed were not those of *D. duodenalis*, but of either *D. trigonocephalus* or *D. stenocepahalus*, two congeneric species which are common in dogs, and whose ova resemble those of the human parasite very closely.

Let us now see how the free stage rhabdites are affected by external agencies.

Nourishment.—The influence of the amount of available food has already been described. If the supply be abundant and continuous, they rapidly multiply by short-lived generations; if it be scanty, they remain for indefinite periods living, but without growth or multiplication.

Oxygen.—They are essentially air and not water breathers and require a free supply of air. Hence they always are found quite in the surface of the soil, and cannot flourish in water. For the same reason burying under a few inches of soil kills them.

Heat.—They hatch out and multiply most freely at a temperature of 80-90, but can go through all their stages as low at any rate as 60°F. They are killed by temperatures exceeding 140°F., but in the dormant state at least can survive freezing light. They can go through all their stages in darkness, but the influence of daylight is, I am inclined to think, rather favourable than otherwise.

Chemical agents.—Most disinfecting agents kill them, if in sufficiently strong solution; but owing to the large area that would have to be dealt with, the only agent whose cost would not be absolutely prohibitive, is perchloride of mercury of a strength of two *per mille*, and even this could only be used with advantage in certain special situations.

Method of infection.—From what has gone before it will be seen that infection through the agency of drinking water, though not impossible, must be very exceptional. It is in the soil that the infective rhabdites live and flourish, and it is through the ingestion of this that infection, as a rule, takes place.

I have found as many as fifty rhabdites in a bit of village soil no bigger than a pea, and any one who knows the habits of natives, their carelessness in the preparation and storing of food, and their custom of eating from a dirty mat placed on the ground, must know that it is impossible for them to prevent swallowing a deal more than the regulative "peck of dirt" during their lives. Living as they do, it is difficult to see how they could avoid the daily swallowing of a certain amount of earth, especially in a muddy climate like Assam, in which each inmate of a house must daily bring into the house on his feet, clothing and hands a considerable amount of village mud. A further consequence of this is that infection can rarely be acute and rapid, but is slow and continuous, and hence the slow and insidious first advances of the disease.

In considering the symptoms of anchylostomiasis it must be remembered that, as in most other helminthiases, their severity will be proportional to the number of worms harboured. When present in at all large numbers, the malady is always serious, and commonly fatal. On the other hand, when few in number, their effects may be quite trifling. At the same time the number actually present in the intestinal canal at any given time, whether judged by the number found *post mortem*, or by the abundance of ova in the fæces, is by no means necessarily an index of the severity of the case, because the number present to-day can give us no idea of the numbers that may have been harboured at some previous stage of the case. It is owing to the non-recognition of these points that, on the one hand, we find the opinions promulgated that the disease is not essentially serious, while, on the other, we meet with exaggerated estimates of how small a number may set up serious or fatal mischief.

Leichtenstern (Deutsch. Med. Wochen, 1887, pp. 693, *et. seq.*) instances cases which seem to prove that the life of the parasite may extend to five years, but, as a general rule, it is probably very much shorter than this, and attacks of diarrhœa or shortness of nourishment, owing to the extreme anæmia they have themselves brought about, may cause them to loose their hold and be expelled; and as these complications are commonest and most severe as the end of a case draws nigh, it is not uncommon to meet with fatal cases on which, *post mortem* but few worms are left; though these very cases may often exhibit, in their most advanced condition, the structural changes of the mucous membrane originated by their previous presence.

A second point that requires emphasis is that the profound anæmia which ultimately results is not entirely caused by the actual depletory action of the worms, but is largely due to the fact that their presence sets up in the mucous membrane of the intestinal tract inflammatory

and cicatritial changes, which result in an utterly intractable dyspepsia, rendering impossible the replacement of the blood that they have abstracted.

Dyspeptic symptoms are indeed the earliest manifestation of the disease, but its advance is, as a rule, so slow and insidious that, among natives, it is rare for the patient to realise that he is so ill as to need medical attention until the second or anæmia stage is well advanced. In this stage the peculiar leaden tone of the complexion at once attracts attention, and, on examining the tongue and conjunctiva, they are found to present a deadly pallor, which I have never seen equalled in any other disease except lymphadenoma, to which disease the clinical resemblances are naturally very close. The anæmia is already very marked before the patient realises that he is seriously ill, and the conjunctivæ show a peculiar bluish white tint contrasting markedly with the anæmia of malarial cachexia, when the anæmia is a comparatively late sequel to serious indisposition, and the conjunctivæ have the dirty icteric tint of concomittant hepatic derangement.

Occasionally, where the infection has been sudden and acute, I am inclined to think that the invasion of a large number of worms may cause some pyrexia. But it is practically impossible to distinguish such attacks from intercurrent malarial fever, which is necessarily common amongst patients already depressed by dypepsia and depletion, in the very malarious regions that are the favourite haunts of the worm in India.

At whatever stage, however, the patient be first seen, the diagnosis is readily and definitely settled by the examination of the fæces for the ova of the parasite. The best plan is to place a morsel of the dejecta, of the size of a pea, in a test tube half full of 1-20 carbolic solution, to which it is well to add a little magenta-resolution; for as the ova stain but slowly, they contrast well with most of the other constituents of the fæces which stain rapidly and deeply. After thorough agitation a drop of this fluid is placed on a slide and examined under a moderate power. As the case proceeds, the consequences of the constantly increasing anæmia and dyspepsia become more and more serious. Occasional attacks of diarrhœa, often melænic, distressing breathlessness; and finally dropsies of the serous cavities, and of the lungs and cellular tissue in turn make their appearance, until at last the patient is reduced to a quite helpless condition, without either the strength or the inclination to quit his hut, even to obey the calls of nature. In kala-azar stricken villages the end of some of these unfortunates must have been most miserable, as the obvious and rapid spread of the disease, once it was introduced into a village, naturally led the people to the conclusion that it was directly and virulently contagious, so that not unfrequently the fear of infection led to the sick being left to die without food or assistance of any kind. In this last stage of the disease the profound depression of the system, resulting from the absence of a sufficiency of the oxidizable material of the blood, is evidenced by a persistently subnormal temperature of sometimes less than 94°. I had thought that this was almost pathognomonic of the malady, but I have recently met with a case of lymphadenoma which rivalled the worst instances of anchylostomiasis I have seen in this respect.

Complications. — The immediate cause of death is commonly either dysentery or pneumonia—bronchitis or dysentery. The frequency of malarial complication has already been mentioned. Other parasites too are in Assam, almost universally present. Of these the commonest is the whip worm, *Trichoceplalus dispar*, which is harboured by nearly every Assamese whether sick or healthy. Round worms too are very common, and amongst the wilder, meat eating tribes, tapeworms are often met with. Of less frequent occurrence is the little intestinal parasite *Amphistomum hominis*, which was found in three or four cases, while in one case a single specimen of the rare *Distomum Crassum* was expelled by thymol.

This last find is specially interesting, as the parasite had previously only been recorded from China and Borneo.

Treatment.—The first indication is obviously to expel the worms, and this may be accomplished with almost absolute certainty by the agency of thymol. The worms are often scotched rather than killed, and hence the administration should be continued long enough to admit of their being passed out of the tract, so that it is best to divide the drug into three doses of 25 grains each, to be taken at morning, noon, and evening. The drug is best kept in a stock solution of rectified spirit 1-4, and administered by pouring a sufficiency of this solution into a couple of ounces of water, immediately before administration. The efficiency of the drug depends largely on the fineness of its state of division, and the emulsion so formed is far more finely divided than it can be obtained by powdering in a pestle and mortar. Only concentrated but nutritious food should be allowed on the day before, and the dose should be followed up by a moderate purgative. I can see no advantage in the preparatory administration of purgatives, and, if the patient be very weak, the subsequent purge should also be omitted.

Thymol, indeed, appears to be an almost universal vermifuge, and I find it a much more certain remedy for tapeworms and lumbrics than either male fern or santonin.

So far so good; but let it not for a moment be supposed that, because the parasites have

been expelled, the patient is now on a fair way to recovery. Far from this being so, advanced cases in natives go on to a fatal termination only a trifle less rapidly than if they had been left alone—nay more; the severity of the remedy may, in some cases, accelerate the fatal issue.

You have, it is true, stopped the depletory drain, but the patient's digestive powers are too much injured for him to be capable of assimilating the coarse ill-cooked food to which he is confined by caste prejudices, and he too often dies of inanition whether treated or not. In fact, I soon came to the conclusion that it was little good treating any but early cases, and that, even in these, the benefit is only temporary, as the process of infection will necessarily recommence as soon as the patient returns to the congenial filth of his village. With people under proper sanitary control as are tea garden coolies, it is of course different. Here periodical medical inspection and prompt treatment of early cases is of immense benefit.

In European practice the prognosis of course is very different,* as by careful nursing and feeding, the injured digestive mucosa can be coaxed back to fair efficiency, if not to complete recovery. But the Indian would not touch Brand's Extract or Benger's Food, &c., even if the pecuniary resources of our dispensaries admitted of our using them; and as he cannot digest the mess of dall and rice botched up by his caste-fellow, he necessarily dies.

Outside tea gardens, jails, &c., therefore, very little is to be hoped for from remedial treatment; and hence the question of prevention becomes even more vitally important than it is in most other diseases.

From what has already been said, no one can have the least doubt as to the direction our preventive efforts should take. It is perfectly obvious that we have only to prevent the general fouling of the soil, to insist in fact upon efficient conservancy, and the further spread of the disease at once becomes an absolute impossibility. Import the whole of the infected population of Assam to-morrow into London, and not a single Cockney could possibly get infected; unless, indeed, he started a little cultivating ground in his back garden, and deliberately "fed" himself in experimental helminthological fashion.

Essentially then the disease is absolutely preventible, but practically we are met with the difficulty that the naturally filthy habits of the natives render conservancy a problem of the utmost difficulty.

The magnitude of the task may be in a way realized by reflecting upon the army of excise officers one would require, were every man, woman, and child in the country engaged in illicit distillation.

It might be admitted that much might be done by sufficiently vigorous legislation; but no enactment would be of much use without very extensive European supervision, heavy expense, and considerable interference with one of the most cherished liberties of the people—that of revelling in as much dirt as they can conveniently collect. For the attainment, therefore, of really effective conservancy in Indian villages, we must look forward to some future time, when the people by slow but steady advances will have been habituated to more cleanly habits.

It is satisfactory, however, to reflect that even the most rudimentary enforcement of conservancy would do much to diminish the disease, so that though it may be long before it can be thoroughly stamped out from "Kala-azar" villages, there should be no difficulty whatever in securing the entire disappearance of tea garden "Beri-beri."

* *Vide* Leichtenstern, Deustch. Med. Wochenseur, No. 12, 1886.

ABSTRACT OF AN ADDRESS ON FAMINE

Delivered at the London Epidemiological Society, 16th December 1891, *Surgeon-General* EWART, *President*,

BY SIR WILLIAM MOORE, K.C.I.E., Q.H.P.

AFTER mentioning some of the great historical famines, and referring to the numerous causes of famines, Sir William Moore observed, that he did not agree with Mr. Danvers, who had said in his account of Indian famines, that the usual cause was not failure of the rains. All the famines Sir William Moore had personally witnessed in Kutch, Bhooj, in Rajpootana, and in the Bombay Presidency, had been initiated by failure of the rains, although extended by other causes. As for instances, by locusts in Rajpootana in 1869, by inundation in Orissa in 1865, and by rats in Madras in 1812. Ovid had described famine "scratching up a few roots with her talons and teeth, her sapless bones seeming to start from her bent loins, and for a belly there being a belly's space. Her joints were protuberant from leanness, the orbits of her knees hunched out, and her ankle bones jutted to undue proportion." Sir W. Moore had had too many opportunities of seeing the famine stricken in all stages. He had seen them digging for roots as Ovid describes; he had seen them emaciated to skin and bone, and he had seen their corpses on the road side, or in the jungle, partially devoured by wild beasts, pariah dogs, and birds of prey. The roots, the starving dug for, and the other things eaten during a famine, had been investigated in Rajpootana by himself and by Dr. George King. In the Deccan they had been investigated by Brigade-Surgeons Gray and Lyon, and in the Madras Presidency by Dr. Short. They included barks, leaves,