

## THE PROGRESS OF ANKYLOSTOMIASIS IN CORNWALL.

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ANKYLOSTOMIASIS was first discovered in men working in Cornish mines in October, 1902 (this *Journal*, Vol. III. p. 95), though there had been many cases of illness clearly referable to this cause for some eight years previously. The number of men who were too ill to do their ordinary work was greater about two years before the cause of "Dolcoath anaemia" was identified. These men had either stopped at home or had been employed on the surface instead of underground: in this way they had avoided further infections, and in many cases had progressed towards a spontaneous cure. At the time therefore of our first enquiry the number of sick men was less than it had been. Anaemic miners were, however, still very numerous and, without anything like an exhaustive search among the 750 underground hands at Dolcoath mine, we found 14 men with less than 50 p.c. haemoglobin and 19 more with less than 75 p.c. The general pallor prevalent among the men on looking at a shift as a whole was very striking, and complaints of shortness of breath on climbing the ladders were frequent. The disease, in short, was at that time a material hindrance in carrying on the work of the mine.

Examination of the faeces and blood of men who complained of no symptoms of ankylostomiasis showed that practically every underground worker was infected in Dolcoath. In December, 1903, and February, 1904, 65 men taken at random were examined by the "blood test"<sup>1</sup> and 61 (94 p.c.) found infected. The sanitary circumstances of the mine were

<sup>1</sup> This *Journal*, Vol. IV. 1904, p. 437.

at this time extremely unsatisfactory: there were no special arrangements for the reception of excreta underground and the whole of the workings were extensively soiled with faeces. The wetness and warmth of the deeper workings and the upcast shafts contributed to make Dolcoath an ideal home for *Ankylostoma*.

Industrial efficiency was obviously confronted here with a problem of some importance. The steps taken to escape the consequences of ankylostomiasis were simple, practical and apparently efficacious. Once the nature of the disease was recognised it was, in the great majority of cases, very easy to cure those actually sick by the repeated administration of appropriate anthelmintics: in the case of Dolcoath thymol has been exclusively used. The effects of this treatment have been almost entirely gauged by the clinical results: no serious attempt has been made to ascertain whether all the worms had been killed in any particular case if the man's general condition improved so far that he was able to return to work. Having been restored to a condition of efficiency, therefore, the men returned to work in a place which was still infected. They were of course reinfected again and again; any return of symptoms was noted at once and corrected by a dose of thymol. In this way actual sickness from ankylostomiasis has been practically abolished. At the same time steps were taken to introduce sanitary reforms into the underground workings. In 1905 a Special Rule was established by the Secretary of State for metalliferous mines in Devon and Cornwall that:

“The owner, agent or manager shall cause a sufficient number of suitable sanitary conveniences to be provided above and below ground in suitable and convenient places for the use of the persons employed, and to be constantly kept in a clean and sanitary condition, and no person shall relieve his bowels below ground elsewhere than in those conveniences. No person shall soil or render unfit for use in any way any convenience or sanitary utensil or appliance provided for the use of the persons employed.”

In 1904 such sanitary appliances were actually in use in Dolcoath in the form of loose buckets or pails<sup>1</sup> which could easily be brought to surface, emptied and cleaned.

In April, 1908, we made, on behalf of the Royal Commission on Mines, further enquiries at Dolcoath and other Cornish mines to see what

<sup>1</sup> See *Report to the Home Secretary on the Health of Cornish Miners*, by J. S. Haldane, J. S. Martin and R. A. Thomas, Cd. 2091, 1904, p. 31 and figure 6.

effect these measures had produced. The conditions underground had been immensely improved, the pails were properly used and we were told that it was now very uncommon for the men to fail to use them. Personally we could find no faeces in a short search in places where, as previous experience had shown us, they would be most probably found. The general appearance of the men was quite different, and there was none of the general anaemia which had been so obvious five years before. On carefully going through two-thirds of the underground hands, we found only one case of definite anaemia in the person of a boy. There was only one man away from work with symptoms which could possibly be due to ankylostomiasis; he was not available for examination. In making a detailed examination of individuals by the "blood-test" we examined especially those who had worked at Dolcoath for periods varying from four months to three years, *i.e.* who had come to the mine since the introduction of underground pails—and who had not previously worked underground or only in such mines as were known to be free from *Ankylostoma*. Of 89 persons, mostly boys, who came in this category, 68 (76 p.c.) were found to be infected, and most of them gave a history of having had "bunches" on one or more occasions. The important conclusion follows from these results that the improved sanitary conditions underground had put an end to material illness but had had hardly any effect in diminishing the number of men infected. The whole improvement cannot be attributed to the accurate diagnosis and prompt treatment which now prevail. The management of the mine are quite clear that there has been a very large reduction in the number of cases of slight illness; and the men themselves say that "bunches" occur less frequently and less severely. The sanitary pail system, therefore, has evidently had a great effect in reducing the infectivity of the mine. That three quarters of the new hands still become infected soon after beginning work in Dolcoath shows however that the larvae must still be pretty widely spread in the mine. If however there were as many larvae as before there would be more cases of incipient ankylostomiasis. The reduction in actual illness confirms the view that as a rule severe illness is only brought about by massive infection.

The essential result of the simple measures taken is that *Ankylostoma* no longer causes any industrial inconvenience in Dolcoath. This result has been brought about without any expense or special organisation beyond the provision and care of the sanitary pails. The alternative method of treatment would have been to try and stamp out the infection altogether both in the men and in the mine, and to prevent its importa-

tion in the future by a rigorous medical examination before allowing any fresh hands to work underground. This method has been adopted in Westphalia and more or less in Belgium. Applied to mines which were in the first instance not nearly so heavily infected as Dolcoath, the method has so far failed to stamp out infection entirely. Every man infected with *Ankylostoma*, as well as the small proportion of them suffering from ankylostomiasis, is searched out, kept away from work (on compensation wages) and treated until repeated examinations fail to show any eggs in his faeces<sup>1</sup>. He is then allowed to return to underground work: the workings are of course still infective, so he becomes reinfected and the whole process has to be gone through again and again. After several years of this extremely troublesome and expensive procedure, a few men are still found to be infected. If the periodical examination and treatment of the men were now relaxed, there is no guarantee that in a short time the infection would not spread from these few remaining carriers and again become prevalent. The failure of this attempt may be in part due to the impossibility of making sure that every man who is treated is really quite free from worms. It is however doubtless more dependent on the longevity of the adult larvae and the difficulty of attacking the infection of the mine. We have found that the encapsuled larvae will live in the laboratory for more than a year. Their resistance to disinfectants has been much exaggerated (this *Journal*, IV. 1904, p. 85), but there are obvious difficulties in the way of efficiently permeating all the mud and water, along perhaps miles of underground roads, with any antiseptic in sufficient concentration to kill them. It is however a very long business to disinfect the men and wait for the larvae to die out. If the eradication of the parasitic phase of the worm is to be effective, it is necessary that its saprophytic phase should be also attacked. That this is possible, though necessarily troublesome and expensive, is, we think, indicated by the history of Levant Mine (see this *Journal*, IV. 1904, p. 447). *Ankylostoma* has never gained any foothold in this mine, where the circumstances of temperature, moisture, faecal contamination and the presence of infected persons are all very favourable for its spread. The immunity is certainly due to the fact that sea water leaks into the mine so that the salinity of the mine water varies, in different places, from 0.9 to 3.0 p.c. Our observation that less than 2 p.c. sodium chloride will kill young *Ankylostoma* larvae in the laboratory has been confirmed by Calmette<sup>2</sup>; and the fact that

<sup>1</sup> The simple blood examination is of course not applicable under these circumstances.

<sup>2</sup> *Lancet*, Vol. III. 1905, p. 490.

the infection does not gain any hold in mines with saline waters has subsequently been fully established by Manouvriez<sup>1</sup> and Tirelli<sup>2</sup>. If any method of disinfection is likely to be successful, it seems to us that chief attention might be paid to salt which has naturally proved so efficacious.

As far then as the infected mine itself is concerned, it does not seem to us that the benefits which have been gained in Westphalia are greater than those in Cornwall to a degree at all commensurate with the enormous sums of money which have been spent on medical examination and treatment and the payment of wages to men under treatment. But the German system has this great advantage—that it has, within a few years, very largely reduced the number of men who were capable of carrying the infection to fresh places. This result could not be obtained by the Cornish system except after a very long time. Any dozen men from Dolcoath are at the present time not much less likely to infect any suitable mine to which they might go than they were five years ago, except in so far as their habits of defaecation have improved.

So far as this country is concerned, there seems to be no very great danger of serious infection becoming general among miners. In this matter the experience of the mines in the neighbourhood of Dolcoath is not without interest. There has always been a very free interchange of men between Dolcoath and these other mines. But even before the nature of the disease was recognised, there was much less illness in them, and the disease never caused the trouble that it did at Dolcoath. This is doubtless due to the fact that they are, on the whole, not so deep, cooler, and in some instances drier than Dolcoath. In 1903, 42 p.c. of the men at East Pool Mine were infected, and 12 p.c. of those at South Crofty, men who had worked at Dolcoath not being reckoned in each case. In 1908, 15 p.c. of the men at Grenville Mine who had never worked elsewhere and 24 p.c. of all the men were found to be infected: for Tincroft the corresponding figures were 9·5 p.c. and 25 p.c. At these last two mines 48 p.c. of the men who had previously worked at Dolcoath were found to be infected: in a number of cases they had not been in Dolcoath for several years. We could only find one instance of illness at these mines. These results show clearly that, despite very free interchange of infected persons, the disease may cause no

<sup>1</sup> *Mines rendues réfractaires à l'ankylostome par des eaux salées de filtration*, par A. Manouvriez, Valenciennes, 1905.

<sup>2</sup> *Lancet*, Vol. i. 1908, p. 102.

practical inconvenience in places which are moderately unsuitable for the development of the larvae.

It appears that there are in this country not many mines where the general conditions of temperature and moisture are suitable for *Ankylostoma*. Most of the hot mines are, except in limited areas, too dry, and most of the wet mines are too cool. Careful enquiries on this point were made recently by Prof. J. Cadman for the Mines Commission. He found very few hot wet mines. A number of the men working in those where favourable conditions prevailed in different parts of England and Scotland were examined by one of us (A. E. B.) by means of the blood film method<sup>1</sup>; no evidence of the presence of *Ankylostoma* was obtained, even in a pit where men from infected mines in Germany had been working. The realisation of the possibility of *Ankylostoma* gaining a foothold in this country has, however, been most beneficial in directing attention to the unsanitary conditions which often prevail underground, and in bringing about a much-needed reform in these matters. There is every reason to believe that when the reforms recommended by the Mines Commission are carried into effect the coal mines of this country will be proof against any appreciable *Ankylostoma* infection.

This enquiry showed once more the usefulness of the blood film method in searching for *Ankylostoma*. Since some misapprehension has arisen as to its scope and accuracy, we may take this opportunity of briefly stating the data which have been obtained. We ascertained in Cornwall in 1904 that of 148 men infected with *Ankylostoma*, 94 p.c. showed more than 8 p.c. of eosinophiles in a differential leucocyte count made on a dried blood film, while only 3.5 p.c. had less than 5 p.c. of eosinophile leucocytes. On the other hand, of 158 miners not infected with *Ankylostoma* in Cornwall, Staffordshire and Shropshire, 91 p.c. had less than 5 p.c. and only 2 p.c. more than 8 p.c. of this variety of leucocyte. In 1907-8 we examined films from 642 men in hot wet coal and metalliferous mines in Scotland, Lancashire, Yorkshire, South Wales and the Isle of Man: only four (0.6 p.c.) showed more than 8 p.c. eosinophiles. In 800 non-infected miners therefore we had seven cases of eosinophilia: in one the man had left the district and his faeces could not be obtained, in two *Ascaris* eggs were found, in the four others *Trichocephalus* only. An incredible amount of time would have been consumed in obtaining and examining samples of faeces from these 800 working men. As an illustration of the rapidity with which the blood method may be carried

<sup>1</sup> See *Second Report of the Royal Commission on Mines*, Parliamentary Paper, 1909, p. 182.

out we may note that 183 films were obtained by us from two pits in Scotland and examined in London in four days: one case with 15 p.c. eosinophiles was found and *Ankylostoma* was definitely excluded by an examination of his stools during the next week. In this country therefore the method works admirably. But this is so only because other intestinal worms which cause eosinophilia are quite uncommon. The ordinary hospital population in London only harbour worms to the extent of 5 p.c.; and practically all these are *Trichocephalus*, which very rarely produces a definite eosinophilia<sup>1</sup>. This method could not be applied with the same success to, for example, an ordinary Swiss population where *Ascaris*, a frequent cause of a high degree of eosinophilia, is found in 48 p.c. of people<sup>2</sup>: still less in the tropics where most natives have more than one cause of eosinophilia in their persons besides *Ankylostoma*. No suggestion has however ever been made by us that it should be used under these circumstances. Nor has it been proposed that the examination of blood films should replace the search for eggs in the faeces in persons in whom a *prima facie* case for the presence of *Ankylostoma* has been made out. The ultimate diagnosis, which is preliminary to treatment, must rest on the examination of the faeces; a preliminary examination of the blood will however save a great deal of trouble in cases, as in English miners, where other causes of eosinophilia are practically absent.

<sup>1</sup> French and Boycott, *This Journal*, Vol. v. (1905), p. 274.

<sup>2</sup> B. Galli-Valerio, *Centralbl. für Bakteriol. Orig.* Vol. XLIV. (1907), p. 531.