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Since the anchylostomum was shown by Griesinger to be the cause of "Egyptian Chlorosis," and more especially since the St. Gothard tunnel outbreak, the harmfulness of this intestinal worm has been well known. It is, however, only within recent years that the very wide distribution of this parasite has been recognised by many workers, among whom may be mentioned Lutz in Brazil, Sir William Kynsey in Ceylon, Rudduck in Assam, Dobson in various parts of India, and Galgey in the West Indies.

Very different opinions are, however, held as to the exact degree of injury produced by the presence of this parasite in varying numbers. Thus Sandwith of Egypt and Thornhill of Ceylon write very strongly on the terrible amount of disease and death caused by this worm. On the other hand, Macdonald of Ceylon wrote that in a great number of cases the worm does very little harm, though capable under certain conditions of destroying life; Rudduck, who discovered this worm in Assam, is of the opinion that a healthy person can support a fairly numerous colony of them without damage, and the parasite only assumes importance when the patient is lowered by some other disease; and lastly Dobson, of the Indian Medical Service, after showing that upwards of 80 per cent. of the healthy inhabitants of most parts of India harbour this worm in numbers varying from units to hundreds, very pertinently asks, "At what stage does the parasite become injurious?"

In the course of my recent investigation of the epidemic malarial fever of Assam I had occasion to make some observations and experiments on this point, and I therefore propose in this paper to examine the evidence on both sides, and to see if the truth does not lie somewhere between the two extreme views quoted above.

In the first place it is certain that if these blood-sucking worms are present in very large numbers for a long period of time, they will cause a severe anæmia and other symptoms, which if not recognised and properly treated may cause death. In the St. Gothard outbreak as many as two and even three thousand of these worms were found in some of the cases. But if such a large number of the worms can be withstood for several months, is it not evident that the loss of blood caused by small numbers, such as from 20 to 50 will be repaired by the system, and no disease will result? Dr. Dobson's observations, as well as those of McConnel in Calcutta and Bilharz in Egypt, both of whom found this worm in the great majority of *post mortems*, after death from accident or disease, prove that this worm may be present in comparatively small numbers in the majority of a population without doing any harm. I was able to confirm this in Assam, for I found this worm in 66 per cent. of 50 healthy men to whom I gave thymol. In order to form some idea of what numbers are required in order to produce anæmia, I examined the blood of many of these men with the hæmocytometer and hæmoglobinometer, notes being taken of their condition and previous history with regard to malaria, &c. I found that in the case of men who passed 20 or fewer of the worms, their hæmoglobin averaged the same as healthy men who had none. Again one man, who passed 110 anchylostoma and 104 flukes (amphistomum hominis), had an average amount of hæmoglobin, and that although he had been more than three months in jail, where he drank only filtered water, so that he must have harboured this large number of blood-sucking parasites for more than that period of time without his blood having deteriorated. Another man with an average amount of hæmoglobin, who had been in jail for nearly three months, passed one anchylostomum and 42 flukes. It is evident then that the systems of these men had been able to completely repair the loss of blood caused by such large numbers of parasites acting for several months. Once more, 293 anchylostoma were passed by a man who had been in jail two-and-a-half months, yet he showed no clinical signs of anæmia, and his hæmoglobin was found to be only 15 per cent. below the standard of healthy Assamese people.

On the other hand it was found that in the blood of apparently healthy men who had suffered from malarial fever for one week or more within the previous two years, the hæmoglobin was below the normal standard, this being especially marked in all cases where the spleen was at all enlarged. It is evident then that a very small amount of malarial fever exerts a much more deleterious effect on the blood than does a fair number of anchylostoma.

Again Dobson found over 100 of these worms in seven healthy men, one of whom passed 230. It is, then, evident that from 100 to 300 anchylostoma may be present for upwards of three months without producing any evident anæmia. When then does the parasite become dangerous to man? No very exact line can be drawn, but the opinion of several writers on this subject that 500 of the worms must be present for from six months to a year in order to produce anæmia may be accepted as sufficiently near the mark for purposes of discussion. For an anæmia so produced, the term anchylostomiasis may be fittingly applied. On the other hand the mere presence of a few, or even a considerable number of these worms, does not constitute anchylostomiasis, which term means disease produced by this worm, for the loss of blood caused by them may have been fully repaired by the system, and no disease may have resulted.

Much of the confusion in which this subject is involved is due to this fact not being borne in mind, as a perusal of the present literature of the subject will show. To give an example, Dr. Ortho Galgey of St. Lucia has recorded "Short notes of 130 cases of anchylostomiasis." An analysis of these shows that 43 of them were admitted for diseases other than anæmia or malaria, many of them not showing any signs of anæmia. Another 31 were admitted for malarial diseases, while 19 more had malarial symptoms. The number of anchylostoma passed after thymol by these cases was recorded as follows. In one case "hundreds" and in another "enormous quantities," in two "very large quantities," in six "large quantities," in 26 "quantities," in 79 "many," and in 16 "a few." A clue to what these terms mean is afforded by the fact that in several of the cases in which "a quantity" were passed, none were obtained after the administration of the first two doses of 20 grains each, and it was only after a second similar treatment that "a quantity" came away. Now it is quite certain that if as many as 50 of the worms had been present, some of them would have come away after the first administration of the drug, so that we may safely take this term to mean something less than 50, while many probably means about 20. It appears then that in this series only eight cases passed more than 50 worms, while certainly in 95, or more than three quarters of them, less than 50 worms must have been present. I feel sure, from my experience in Assam, that if Dr. Galgey would give thymol to a series of healthy people, he would find either "a few" or "many" of the worms in as large per centage of them. Now the diseases for which many of these cases were admitted to hospital ranged from measles to locomotor ataxy, yet they are all included under the head of anchylostomiasis, simply because they passed a certain number of these worms after thymol! If the term is to be used in this sense, three-quarters of the healthy people of India suffer from "anchylostomiasis," which is absurd. Moreover, I have proved that small numbers of this worm have no effect in reducing the hæmoglobin, while one of the strongest advocates of the extreme harmfulness of this parasite acknowledges that 50 of them is a number altogether too small to have any deleterious effect.

It is evident then that the presence of the anchylostoma in many of Dr. Galgey's cases was purely accidental. I would not be understood to wish in any way to disparage Dr. Galgey's work, as his discovery of the frequency of this parasite in the West Indies is most important, and has led to the saving of life, and doubtless many of his cases benefited by the thymol. The abuse of the term "anchylostomiasis" might be thought to be of more theoretical than practical importance, but the following instance of the disastrous results of looking on the presence of a few anchylostoma as evidence of anchylostomiasis, and the consequent abuse of thymol, will be suffice to show that this is not the case. In a certain dispensary in Assam, a very experienced hospital assistant counted the anchylostoma passed after thymol in a series of 72 cases of anæmia which he treated with this drug. An analysis of the notes shows that in 58 of them the spleen was enlarged, reaching three or more fingers' breadths below the ribs in 40 of them, while in 13 cases it extended to eight fingers' breadths. In 17 of them there was no dropsy, and in 17 more only slight œdema of the feet, and in the rest more extensive dropsy. The great majority of these cases were then obviously suffering from malarial cachexia with anæmia, while in some of them anchylostomiasis might fairly have been suspected. All were treated with thymol, and many of them repeatedly, with the following result. In no single case were more than 50 anchylostoma passed after the thymol, and in 57 of them less than 20 came away, yet there were 17 deaths, no less than eight of which took place within six days of the last dose of thymol. The largest number of anchylostoma passed after any of these last doses was ten, while the average was five. The removal of such small numbers could have done the patients absolutely no good whatever, while there can be little doubt that the use of such a drastic measure in cases of extreme malarial cachexia (all 17 fatal cases had enlarged spleens, and 13 diarrhœa or dysentery) must have hastened the end of some who might very possibly have recovered under milder and more rational treatment.

We see then on the one hand that if about 500 anchylostoma be present for from six months to a year, they will produce anchylostomiasis, while on the other hand in all districts infected by this worm a large number of both healthy people and those affected with all kinds of diseases, will harbour the parasite in smaller numbers without any harm resulting, for the drain caused by them is repaired by the system. Intermediate between these extremes is a class of cases in which some 100 to 300 of the worms are present, the action of which might be withstood for a very long time in a healthy person, but if at the same time some other debilitating or anæmia-producing disease is also at work, such as malaria, dysentery, syphilis or bad feeding (especially a deficiency of nitrogenous foods), then such a number of the worms will play an important part in producing anæmia. These cases are not, however, pure anchylostomiasis, but malaria, &c., complicated by the action of the anchylostomum, and should be so classed. Such cases are, in my experience, much more commonly met with on tea gardens in Assam than pure uncomplicated anchylostomiasis, and thymol will be a necessary pre-

liminary in their treatment, that of the primary condition being afterwards attended to.

It is evident both from the Assam dispensary cases, and those of Dr. Galgey, that it is cases of malarial cachexia which are most frequently confused with anchylostomiasis, and as it is just in these cases of advanced malarial cachexia that thymol is so dangerous, so that the differential diagnosis of these two forms of anæmia becomes of great importance. The clinical differences are well known, and I do not propose to repeat them here, more especially as I have published a table of them elsewhere. I wish, however, to refer to a method of differentiating them by means of an examination of the blood. It occurred to me that as the anæmia of anchylostomiasis is caused by long continued small losses of blood from the intestinal mucous membrane, while that of malaria is brought about by the destruction of the red and white corpuscles of the blood by the plasmodium malaria, the hæmoglobin being retained in the system in the form of pigment, that the type of the anæmia in the two diseases might be expected to differ considerably. I therefore made a full examination of the blood in both diseases, with the result of finding that the differences were so great as to be of diagnostic value. As a full account of this research will appear elsewhere, I need only refer briefly to the main points established.

Firstly: in the anæmia of malaria the percentage of hæmoglobin and of the red corpuscles are equally or nearly equally reduced, so that the amount of colouring matter in each corpuscle, or the colour index, is about the normal (1·0). On the other hand, in anchylostomiasis the percentage of hæmoglobin is reduced about twice as much as the number of the red corpuscles, so that the colour index falls to one half of the normal (0·5). Secondly: in malarial anæmia the number of white corpuscles are proportionally more reduced than the red, so that only 1 white to 1,000 red, or even, in extreme cases, 1 to 2,000 are found. In anchylostomiasis, on the contrary, the white corpuscles are increased in numbers relatively to the red, 1 to 300 or 400 being commonly met with. Thirdly: the specific gravity of the blood is more reduced, relatively to the degree of anæmia, in anchylostomiasis than it is in malarial anæmia. These differences I have found to be so great, that the extreme figures met with in pure cases of the one disease did not overlap those of the other, so that they are of absolute diagnostic value. Moreover, I found that in cases where the two diseases complicated each other the blood changes were intermediate between those of the two primary conditions, so that in any case of malarial anæmia in which the colour index is unusually low, the presence of anchylostoma in harmful numbers may be rightly suspected. To give an example: in a case of chronic malarial fever in which I examined the blood, I found an unexpectedly low colour index. Thymol was given, and 159 of these worms were passed.

This difference of type of the anæmia is also of practical importance in furnishing a guide to treatment, for in malarial anæmia arsenic is indicated in order to increase the output of corpuscles by the bone marrow. It is worthy of note that I have found the marrow of the shafts of the long bones to be constantly converted into red marrow in malarial cachexia, just as it is in pernicious anæmia. Iron is of much less importance in the treatment of malarial anæmia, for there is plenty in the system in the form of pigment. In anchylostomiasis, on the other hand, iron is the essential drug, and can best be given in the form of dialysed iron or the sulphate of iron, which interfere least with the already weakened digestive powers.

It must also be borne in mind that in some advanced cases of undoubted anchylostomiasis very few or none of the worms may be present in the intestines at the time the patient comes under observation, owing to most of them having dropped off. In such cases thymol can do no good, while by irritating the already sorely tried intestinal mucous membrane, fatal diarrhœa may easily be set up by this powerful drug. An examination of the fæces should, therefore, never be omitted in advanced cases. The simplest method is to spread a small piece of fæces out in a drop or two of 1 in 20 carbolic acid (which removes all odour) under a $\frac{7}{8}$-inch coverslip, and to systematically examine the whole specimen under the microscope. I have found by experiment that in this way the ova of the worm will be easily detected if as many as twenty of the worms are present, while the number of ova found will serve as a rough test as to the probable number of worms present. If no ova are found by this method, if any worms are present they will be so few that they may safely be neglected. As these worms cannot increase in numbers within the body, but each must be introduced from without, it is obvious that there is no necessity to remove the very last worm by repeated doses of thymol. Much harm may be done in the attempt to do so, when the patient is in a very debilitated state, while no appreciable good can result from the removal of the few worms left after one or at most two efficient administrations of thymol. In some extreme cases it will indeed be advisable to treat the patient with strychnine and digitalis for a week or two before giving thymol at all.

Summary.

Firstly: it has been proved by Dobson and myself that from 60 to 80 per cent. of the inhabitants of Assam, Bengal, and many other parts of India, harbour the anchylostomum in numbers varying from a very few to 100 or even more. The mere accidental presence of such numbers of these worms does not, however, constitute anchylostomiasis, for I have shown that the loss of blood caused by them is fully repaired by the system, and no disease results.

Secondly; in anchylostomum-infected districts, in addition to the first class, cases will be met in which some debilitating or anæmia-producing diseases are complicated by a considerable number of these worms, say from 100 to 300, the drain caused by which might be withstood for a very long time by a healthy man, but which when added to such diseases will play an important part in the production of anæmia and cachexia. In my experience on tea-gardens in Assam, this class of cases is far more commonly met with than pure, uncomplicated cases of anchylostomiasis, and they should be returned under the head of the

primary disease, and stated to be complicated by the presence of the anchylostomum.

Thirdly: we have cases in which some 500 of the worms have been present for upwards of six months, and have by themselves produced distinct anæmia and other well-known symptoms. These constitute true anchylostomiasis.

In both the last two classes of cases thymol is indicated to remove the worms as a preliminary measure to the treatment of the anæmia, but it must be used with caution in advanced cases, and especially in those which are complicated with malaria or dysentery. In cases of other diseases in which these worms are accidentally present, thymol may also be given if not otherwise contra-indicated, but such cases should not be classed as anchylostomiasis.

Lastly: the mere presence of anæmia in a tropical climate should not be considered as an indication for dosing the patient with thymol, without first examining for the ova of the worm, and studying the type of anæmia met with, and all possible causes of the anæmia other than anchylostomiasis. Such a rule of treatment is both unscientific in its inception, and, as I have shown above, may also prove disastrous in practice.

I had intended to have discussed the way in which this worm causes disease, in the light of some microscopical work that I have done on this part of the subject, but as this paper is already a long one, I must leave this part of the subject for another communication.

LEPROSY IN THE CANARY ISLES.

By Stanford Harris, M.D., M.R.C.S.

The inhabited islands of the Canary group are:—Teneriffe, Grand Canary, La Palma, La Gomera, Hierro, Lanzarotte, and Fuerteventura. They lie in the North Atlantic between 27° 4′ and 29° 3′ N. lat. and 13° 3′ and 18° 2′ W. long. The most easterly—Fuerteventura—is 50 miles distant from the coast of Africa. Politically they form a sub-province of Andalusia, in Spain. In Las Palmas, the capital of Grand Canary, there is an asylum for lepers, which admits sufferers, as voluntary patients, from the seven islands. These are free to come and go at will, the inhabitants having no fear of catching the disease. The remark made by Dr. William Robinson in his interesting address on Consumption and the Means to Avoid Contagion (see *British Medical Journal*, July 23, 1898), to the effect that "there is no need to treat the sufferer as a leper," would have to be transposed to express the Spanish feeling in the matter, into such a statement as this: "There is no need to shun the leper as a consumptive." Here the fear of phthisis is far greater than of leprosy. All articles which can be burnt are so destroyed which have been used by a tuberculous patient, and the rooms which have been occupied by him are disinfected. This view as to the slightness of the danger of becoming infected by leprosy appears to be justified in these islands. There is no record of any nurse or attendant at the hospital having contracted the disease, although certain histories of patients point to the likelihood of their having acquired the disease by very close intimacy, such as eating and sleeping with those affected.

I propose to give an epitome of 15 selected cases, now in the asylum in Las Palmas, and to briefly comment upon their histories afterwards.

I may premise these by the statement that the register of admissions to the hospital dates from the year 1845, since when 544 lepers have been admitted, making an average of a little more than 10 per year. Since July, 1890, the register has been kept under a rather different system, which enables me to give the following details:—From 1890 (July) to 1898 (July) 42 males were admitted and 35 females.

The 42 men are accounted for as follows:—13 have died, 18 are still in hospital, and 11 have left the asylum. Of the 35 women, 11 have died, 15 are still in hospital, and 9 have left.

The islands supplying the 42 males are as here given:—Teneriffe, 15; Grand Canary, 12; La Palma, 7; La Gomera, 6; Fuerteventura, 1; Hierro, 1; Lanzarotte, 0. Of these males one was married, one a widower, and the rest unmarried.

I. — José Amador, aged 22, native of Fuerteventura, now in the hospital of San Lazaro, Las Palmas. Parents alive and well. Has had 12 brothers and sisters. No relations have ever been affected by leprosy. (In all cases the relations are asked about as far back as the grand-parents, and collaterally as to uncles, aunts, and cousins.) He never lived in association with lepers, but there were three lepers in his native village, an inland one. His food was gofio (a native meal, made by grinding and roasting maize, to which a little salt is added), potatoes, fish (fresh and salt). Parents' food had been the same, except that, having lived nearer to the sea for most of their lives, they had eaten more fresh fish.

The disease commenced, as well as he can remember, seven years since. He slightly burnt the calf of his left leg over a brazier (there is no cicatrix now visible), and after that a swelling followed, which he says has remained the same ever since (it is a soft, slightly discoloured swelling about the size of a large cherry). Other swellings followed on both lower limbs, and he lost sensation over the right elbow and adjacent parts.

Present Condition.—His face is covered by tubercles (in size averaging a large cherry). Some of them are broken—he scratches them, owing to their itching a great deal. There are translucent swellings on the outer sides of each cornea, at its junction with the sclerotic. The lower limbs have numerous tubercles, the original one on the left calf not being more advanced than the rest. There are patches of anæsthesia here and there on the lower limbs and over the right elbow. The hands are almost completely covered by tubercles. Beyond the itching there is little discomfort or pain. A bit of tubercle cut from the face, and examined under the microscope with a $\frac{1}{12}$ Zeiss oil immersion and with Abbe's condenser, showed bacilli about two-thirds the size of the tuberculous bacillus of Koch, lying within the large