

Thesis for the Degree of M. D.

Ankylostomum Dermatitis

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Ankylostomum Dermatitis

Parts of this Thesis might appropriately be considered under the disease, Ankylostomiasis, but as I think the dermatitis is in many cases the first manifestation of that disease I have selected the above title. The dermatitis is known under various names, water itch, water sore, pani-ghas, sore feet of coolies, etc.

The name, Ankylostomum Dermatitis, ^{has been} used in Manson's "Tropical Diseases" 4th Edit., I have adopted it, not that it is ever heard on the daily round of work or that it is ever likely to replace the common name, water itch, but because it suggests the view of the causation of the disease and the connection with Ankylostomiasis that I shall endeavour to support.

Further I shall try to show that this causative relationship has an important bearing on the nature and symptoms of Ankylostomiasis. These aspects will be mainly dealt with, simply stating the symptoms and treatment of the dermatitis.

Etiology: Water itch is prevalent during the rainy season and is most common

amongst coolies when their work causes them to stand in moist earth, contaminated with human faeces.

In 1901, my neighbour, Dr Dalgetty, attributed the disease to an Acarus which he described. (Journ. of Trop. Medicine, 1901, IV, page 73)

Dr Bentley, Assam, later ascribed it to the penetration of the skin by Onkylostoma larvae, thus, as Manson says, "hoos's" "experiment is unintentionally carried" "out on a large scale" (Tropical Diseases, 4th Edit. page 728).

I agree with the opinion of Bentley.

Symptoms; - the disease begins with itching usually along the inner side and dorsum of the foot, frequently between the toes. From eight to ten hours afterwards the itching is followed by swelling, dotted over with numerous raised red spots, sometimes the spots are in groups, these soon become vesicles which dry up and scale off in a few days, the swelling gradually subsiding.

These typical symptoms are usually changed by secondary inoculations, causing pustules and ulcers, these ulcers are

sometimes severe, and in weakly coolies I have seen extensive sloughing result.

Usually the disease is limited to the feet, but sometimes it attacks the legs just above the ankles, and it may occur on the hands and other parts of the body.

Treatment; complete prevention of the dermatitis can be secured if the feet are carefully washed immediately after soiling with the contaminated earth or if the feet are protected by wearing wooden sandals, perunnas the natives call them, or by coating the feet with tar. On all the tea estates in this district tar is liberally supplied, and many coolies regularly smear their feet with it as they go to work.

In this connection the prevention of the disease by prohibiting the soil contamination seems theoretically simple, but in practice on tea gardens it has so far proved impossible. The coolies will not use special places, they take the most convenient cover, so that the establishment of latrines seems well nigh hopeless. The only preventive

measure employed is the burying of the
faces of all patients under
treatment for any disease.

At the early stage, when itching has
set in, if the feet are washed with
carbolic lotion (1 to 40) or with ordinary
phenyle solution (1 to 40), and if the feet
are smeared with tar, the coolies may
go to work.

If swelling has taken place, or if vesicles
or pustules have formed, the vesicles
and pustules should be opened and
the patient made to sit for two hours
with the feet in the carbolic lotion;
afterwards the feet should be carefully
dried and dusted over with an
antiseptic powder. Usually healing
takes place in from three to five days,
but until the feet are quite healed
the patient must be treated as a patient.

If ulcers have formed, the treatment
is on general lines and is sometimes
a tedious ^{affair} matter.

Until recently, water itch was looked
upon as a disease only of economic
importance to the planter and of

little importance to the patient, but now it is considered of serious import to the patient and of even greater economic importance than was supposed, owing to the frequency with which it is followed by ankylostomiasis.

This opinion is supported by the observations of Bentley and the experiments of Hoos who has shown that ankylostoma larvae penetrate the epidermis causing a dermatitis and give rise to ankylostomiasis. (Manson's Tropical Diseases, 4th Ed. page 714).

The causal relationships between ankylostoma larvae and water itch is not universally admitted, but I think general agreement will be given to the fact that when coolies stand for hours in moist earth, contaminated with human excrement, containing larvae in abundance water itch will follow unless precautions are carefully attended to. I propose to support the opinion of the causal relationships between ankylostoma larvae and water itch

and that it is thus a frequent method of causing ankylostomiasis, by following the subsequent history of coolies who have suffered from water itch, and by bringing forward evidence to show that the prevention of water itch has a marked influence on the subsequent prevalence of ankylostomiasis.

My experience is confined to the Sylhet District of Assam, in Medical Supervision of a teagarden population, according to the latest returns, of thirtytwo thousand, four hundred and thirtyfour (32434).

In connection with this subject, I think it will be of interest to give the following short explanatory statement regarding coolies, the changes from their native country and how they live on teagarden.

Practically all coolies have been imported from other parts of India, such as Orissa in Bengal, Ganyam in Madras, Central Provinces and North West Provinces.

Many of these settle permanently on the gardens, some return to their country, others take up plots of land from Government, clear it and grow rice,

ultimately these supply local labour and in some districts where tea has been established many years, this source of labour supply is sufficient.

During six months of the year the rainfall is much higher in Sylhet than in their native districts, and though the actual temperature is lower, the air is heavily charged with moisture and the heat is more oppressive.

Malaria is prevalent and the propagation of many intestinal parasites is more prolific.

The total population on each garden, including labourers and all dependents, varies according to acreage ^{from} 600 to 2000 souls.

They are housed in huts, arranged in lines, one group to each garden.

Each hut usually contains three rooms in a row, it is built of sundried mud or of bamboo plastered with mud, the roofs are made of open bamboo work, thickly thatched with saingrass.

Many of these are roomy comfortable huts but the coolies are prone to keep out fresh air by closing all apertures and building low, shut-in verandahs.

There is ample space between the huts, broad pathways with small vegetable gardens on either side, cultivated by the better class of settled coolies.

Food consists chiefly of rice, fish, peas, vegetables, milk, with eggs and fowls occasionally. Many coolies own cows.

There is practically never famine in this district; if the price of rice goes up, much, the gardens provide it at a reasonable rate.

There are two classes of labourers, indentured, those who have entered into a contract to work on the tea estate for a fixed period of time, and those who are free to come and go.

Indentured coolies have several privileges, enacted by law, amongst these are maintenance during sickness and that rice must be supplied to them at three rupees (4/-) per maund (80 lbs.).

One month before confinement ^{in home} and one month after are treated as sickness but in these cases more leave is usually given.

Tea garden proprietors find that, saying nothing of humanity, it pays to give

similar privileges to all coolies. Many coolies especially Santal, and Kols, from time immemorial have drunk a coarse liquor (harra) made from rice, much of this is prepared illicitly. There are good wells, built of brick and cemented to guard against surface contamination.

There are no latines, the coolies go to the surrounding parts of the garden, they perform the toilet of the perineum with water carried with them or at the nearest stream.

On each garden there is a resident native doctor and a hospital, more or less equipped.

During the rainy season of 1898, my first in the district, water itch was prevalent and under its common name was well known to the European Managers and assistant native doctors.

The distribution of the disease was not uniform but on all the estates it was prevalent, during August and September, causing a daily absence from work of from 3 to 5

per cent. of the coolies.

The prevalence of the disease was a serious matter to the planter, at the busiest season it meant the loss of much valuable labour and to prevent this treatment such as making the coolies walk through shallow tanks filled with antiseptic fluid was in general use.

Many theories as to causation and treatment were suggested by the planters and native doctors, most of them fanciful, but there was general agreement on the following points.

1. Making the coolies walk through antiseptic fluids was too perfunctory and did little if any good.
2. The disease was only prevalent during the rainy season, about five months, 15th May to 15th October.
3. Coolies working on the garden adjacent to huts where they lived were specially prone to contract the disease. This part is polluted with faeces.
4. Those who were attacked by the disease were usually anaemic.

Medical literature gave little assistance, the disease was not mentioned in either Davidson's "Hygiene and Diseases of Warm Climates" published in 1893, or in the 1st edition of Manson's "Tropical Diseases."

The number of cases seen daily showed the prevalence, and also that the routine treatment then in vogue was useless.

The seasonal prevalence of the disease and the opinion that Coolies working on the faecal polluted areas more frequently contracted it than others did, were soon confirmed.

The opinion that the patients were usually anaemic seemed to be correct, but it was discovered that this applied only to cases shown to me at hospital, there only intractable cases were seen, and the majority of these were anaemic Coolies.

At general sick musters in many cases the sufferers were strong, healthy Coolies, and to arrive at a reliable conclusion with reference to this, a

record was kept of the number of cases of anaemia in 500 consecutive patients attacked by water itch, with the following result.

	Anaemia from Ankylostomiasis	Anaemia from other Causes	No Anaemia
500 cases of water itch	61	31	408
Per. Cent.	12.2	6.2	81.6

This dispelled the idea that the patients who suffered from the disease were usually anaemic.

The number of those suffering from anaemia, other than from ankylostomiasis, gives a percentage very similar to what would be found on examining coolies at work on a tea garden.

The cases of anaemia from Ankylostomiasis were recorded separately on account of the prevalence of that disease, not specially on account of water itch and an effort was made to obtain the history of these cases. Of the 61, two had died meantime, one from dysentery and one from pneumonia, and three had left the gardens; what afterwards proved of much interest was that of the

remaining 56 in every case there was a history of previous attacks of water itch, and amongst those who had been on the gardens for several years there was a history of numerous attacks.

During 1898 the treatment consisted mainly in getting the Coolies to wash their feet more thoroughly with antiseptics, and in encouraging the general use of kurums, wooden sandals. In 1899, a Manager, who had had much experience amongst horses and Cattle, suggested the use of tar as a protection to the feet, this was acted on and at the beginning of the rainy season tar for this purpose was supplied to the gardens. The treatment by coolies walking through tanks filled with antiseptics was stopped, it did little good if not positive harm, by giving an idea that something was being done to protect the feet. The wooden sandals gradually came into almost general use, with the result that the number of cases of water itch was less than during the preceding year, and this improvement has been

more than maintained. Cases of water itch are not of daily occurrence now, a tar bucket is a regular part of a garden equipment, and as the coolies go to work it is the exception not to see a pair of sandals being carried, ready for use.

I shall now refer to what ultimately led me to associate water itch with *Ankylostoma larvae* as cause and effect, and that thus ankylostomiasis was often produced.

Next to malaria, ankylostomiasis causes the heaviest loss on tea gardens by weakening the general health of coolies and raising the case mortality of diseases, such as dysentery.

To lessen, or, if possible, to prevent this loss, a record was kept of coolies arriving on the gardens from their country during the cold season of 1899-1900. The coolies were examined periodically so that any showing signs of ankylostomiasis might be treated promptly with thymol. These coolies were not selected in any

way, some came from Orissa, some from
 Bayam, some from Central Provinces,
 some were indentured labourers, some
 were not, all were living and
 working under the usual conditions
 on a tea garden.

The following two tables give the
 results for 1900.

	Contracted water itch	Did not contract water itch
463 coolies	105	358
Per. Cent.	22.7	77.3

The second table shows the large preponderance
 of cases of ankylostomiasis amongst
 coolies previously attacked by water itch.

	105 cases previously attacked by water itch	358 cases with no previous water itch
Suffered from Ankylostomiasis	88	11
Per. Cent.	83.8	3.07

These figures give strong evidence of the
 connection between water itch and
 ankylostomiasis.

During 1901 further evidence was given;
 32 coolies who had previously suffered
 from water itch and subsequent
 ankylostomiasis again contracted

water itch and all had a renewed attack of ankylostomiasis; 10 coolies contracted water itch for the first time and 8 had subsequent ankylostomiasis while during the year there were only 5 cases of ankylostomiasis with no previous history of water itch.

During this time, the protective treatment by tar and wooden sandals was coming into general use, old coolies had realised the benefits, with the result that the number of cases was yearly becoming less, and, moreover, the incidence of the disease was changing; previously it was quite common amongst old coolies, but now such cases were rare, new coolies were responsible for almost all the cases, due to the difficulty there has always been in getting them to attend to the necessary preventive treatment.

After collecting the 500 cases to test the opinion that water itch patients were usually anaemic, and it ^{having been} was ascertained that the cases of

ankylostomiasis amongst them had previously all suffered from water itch, and again during 1900 when it was found that of 105 cases of water itch, 88 subsequently developed ankylostomiasis, in seeking an explanation I thought that the water itch by incapacitating the coolies for work might have lessened their food supply, and by weakening them rendered them less able to withstand the drain due to the Ankylostoma parasites they might have been harbouring, Dobson stated that about 75 per cent of healthy immigrants to Assam harboured the parasites, I think this percentage is too high, but many coolies do harbour them and show no symptoms. Unfortunately I have no record as to whether or not the parasites were present in my cases previously to the attack of water itch, but by the end of 1900 I was quite convinced that in these cases a poor supply of food had nothing to do with allowing ankylostomiasis to show

itself, the sick coolies ^{being} ~~were~~ well fed.

During 1900, my neighbour, Dr Dalgetty was giving close study to the subject of water itch; ultimately he considered it was caused by the acarus previously referred to (page 2).

That this acarus was pathogenetic never appeared quite satisfactory, its presence was far from constant either in cases or in the soil where the disease was contracted, and, further, the acarus and the beetle that Dalgetty instanced as a means of spreading it seemed to be quite as prevalent during the dry cool season when there was no water itch as they were during the rains when it was prevalent.

Meantime Dr Bentley, Assam, showed that ankylostoma larvae applied to the skin produced a dermatitis similar to coolie itch and considered it to be the cause of the affection.

The moist hot earth, shaded by tea bushes where water itch is contracted, is an ideal place for the development of the larvae, and they can be found

there in large numbers.

This definite observation of Bentley's, added to the experience I had had, showing a close relationship between water itch and ankylostomiasis, confirmed me in the opinion that the larvae were the cause of water itch and that this was one way in which ankylostomiasis was produced.

In this connection I quote the following from Manson's "Tropical Diseases," 4th ed., page 714.

"In making some experiments with cultures of ankylostoma larvae, hoos inadvertently allowed the culture to come into contact with his hand. This was followed by redness and irritation of the skin of the part and, subsequently, by well marked ankylostomiasis; the sequence of events suggesting that the larvae in the cultures had penetrated the skin of the hand and so attained the bowel. Subsequently hoos repeated this experiment on a human leg an hour before its amputation. Section of the skin showed the larvae in the hair follicles and some had traversed the hair papillae and lay in the

"Connective tissue around the follicles. Again on page 728, "Looss also points out" "that the symptoms of ground itch do not" "tally with those caused by the penetration" "of ankylostoma larvae through the skin." So far as I can judge, at the early stage they correspond exactly, but amongst cooler symptoms of water itch are often quickly masked, secondary inoculations being common.

I shall here state some of the important points in connection with the parasite, *A. duodenale*. These are taken from Manson's "Tropical Diseases".

The normal habitat is the small intestine of man, particularly the jejunum. It attaches itself to the mucous membrane, from the blood of which it obtains a plentiful supply of nourishment. It is supposed to shift its hold from time to time, the abandoned site continuing to ooze blood for a short period.

The female ankylostomes produce a prodigious and never ending stream of eggs which pass out in the faeces. While in the body of the host the development of the

embryo does not advance very far; but on leaving the human host it proceeds, in suitable circumstances, so rapidly that in one or two days a rhabditiform embryo is born. This minute organism is very active, voraciously devouring what organic matter it can find and for a week growing rapidly. During this time it moults twice. After the second moulting it passes into a torpid condition, in this state it may live for weeks or months, but if the embryo is not supplied with a certain amount of air and earth, it soon dies.

Should chance so determine, it may finally be transferred to the human alimentary canal, either by penetrating the skin, or by the mouth, and there in a few weeks the permanent adult form is acquired.

I shall now deal with Corroborative evidence in support of the opinion that water itch and ankylostomiasis are closely associated as cause and effect.

During the cold season of 1904-1905, one of the gardeners imported 127 indentured coolies. During the previous years this

garden was about the average in health, but with the advent of these coolies a marked change soon showed itself, so that for 1905 there was a deathrate of 4.3 per cent of the total population, for 1906, 6.7 per cent and for 1907, 4.4 per cent while amongst the imported coolies it reached the terrible figure of 14.1 per cent per annum.

This was entirely due to ankylostomiasis and its many complications; its causation and propagation (were) ^{being} fostered by the following conditions.

The new coolies were of a type not far removed from animals in their habits, they defecated anywhere, in the paths between the huts and their immediate surroundings; they were amenable to no discipline; the result being that within three months after the onset of the rains, water itch followed by ankylostomiasis affected 57 of them.

Any attempt to insist on preventive treatment meant ^{that} the coolies left the garden.

Their filthy habits polluted the soil

between the coolie huts, so that amongst old coolies, also, water itch and ankylostomiasis increased rapidly; they had not been accustomed to protect their feet while frequenting these places and it takes time to change a custom in the East.

In spite of treatment by thymol, cases at the stage of marked anaemia became numerous; this was due to repeated reinfections through water itch and also by the mouth, owing to the dirty habits in eating and drinking that coolies suffering from chronic diseases are so apt to sink into.

The old coolies lost faith in the protective measures that had served them so well, they did not attend to the wearing of sandals and the smearing of their feet with tar, and thus water itch became as prevalent as in the years before active measures were taken to prevent it.

The records of this epidemic give corroboration of the relationship between water itch and ankylostomiasis. The following table shows this in

a marked way.

	Previously attacked by water itch	No previous attack of water itch
247 Cases of ankylostomiasis during years 1905 & 1906	202	45
Per. Cent.	81.7	18.3

I have seen it stated that penetration of the skin by the larvae is the only method of infection. (Indian Medical Gazette, July 1908 - page 267.) This does not seem to be in consonance with the above figures.

All of these cases were amongst coolies under observation and known not to be suffering from ankylostomiasis at the beginning of 1905, - by this I mean that none of them showed any of the symptoms, such as anaemia, digestive derangements, etc. that make up the picture of the disease, not that none of them harboured the ankylostoma. I think it would not be possible to take 247 coolies at random on any tea garden and find that none of them harboured the parasites.

The next table shows the high deathrate especially amongst cases in which

water itch had been the method of infection. The death rates in this table are much higher than usual owing to the utter disregard of treatment shown by the new coolies. The deaths are taken to the end of 1907 as the cases are often of long duration. The immediate causes of death were mainly dysentery, diarrhoea and cardiac dropsy.

	202 cases of ankylostomiasis with previous water itch	45 cases of ankylostomiasis with no previous water itch
Total number of deaths during ¹⁹⁰⁵ 1906 1907	63	7
Total percentage of deaths	31.18	15.5

These figures tell their own tale of the serious results of an epidemic of ankylostomiasis, and accentuate the importance of preventing water itch, the main channel whereby the parasites of the disease gain entrance to the host.

I shall now give two instances of the benefits resulting from the prevention of water itch both on the prevalence of ankylostomiasis and the death rate

on the gardens.

On both gardens the co-operation of the Managers was most cordial, this ^{being} ~~was~~ of great assistance in carrying out measures of daily routine and constant supervision.

The washing of the feet, the smearing with tar, and the wearing of wooden sandals with raised toe and heel pieces, were strictly enforced until the coolies realised the advantages and willingly attended to these measures. One Manager supplied wooden sabots, they gave good protection to the feet but they ~~proving~~ ^{being} too heavy and causing abrasions, these drawbacks militated against their general use.

For comparison I shall take the years 1899 and 1907. It is impossible to determine exactly the number of coolies who suffered from water itch during 1899, the daily sick records showing the coolies off work on account of water itch but ~~taking~~ ^{not} no account of the number of attacks to each coolie, many having several attacks. However the prevalence

can be seen from the returns for August 1899; 4.7 and 5.3 per cent respectively of the coolies were off work each day on account of water itch, whereas during the whole of 1907 there were only 23 and 41 cases of water itch on each garden, involving respectively 9 and 22 Coolies, this gives a percentage for the whole year of 1.9 and 1.7 of the coolies. Spread over the rainy season this gives an infinitesimal percentage of work daily, and on no single day was there one-half ¹⁰⁰ per cent off work.

During 1899, there was the usual prevalence of ankylostomiasis, but I cannot give an accurate statement of the number of cases; in the garden records the cases appeared under so many names, beri-beri of Ceylon, avacuma, general dropsy, etc but my own records of cases seen show that 11.2 and 9.8 per cent respectively of the coolies suffered from ankylostomiasis, and I am sure these did not represent all the cases.

During 1907, on one garden 2.7 and on the

other 3.1 per cent of the coolies suffered from ankylostomiasis and practically all had no previous history of water itch as of the coolies who suffered from that disease, on account of thymol treatment, only 2 and 3 cases respectively reached the stage of anaemia in ankylostomiasis.

This shows a marked improvement in the prevalence of the disease and the percentage of cases without previous water itch shows that the larvae of the parasites were still abundant, and allows of the reasonable conclusion that the diminished prevalence of the disease was not due to the absence of larvae.

In 1899, the death rates on these gardens were respectively 3.9 and 4.1 per cent, in marked contrast to 1907, when they were 2.2 and 2.4 per cent. Since 1900, on one occasion only has the death rate been over 3 per cent per annum, due to an outbreak of cholera.

I attribute these improved results to the preventive measures taken for water

itch and to the knowledge that the disease is often followed by ankylostomiasis leading to prompt treatment with thymol.

Passing on to the question of the route taken by the larvae to reach the intestine I quote the following from Manson's Tropical Diseases 4th ed. page 715.

"From the subcutaneous tissue they"
 "enter the blood vessels and lymphatics"
 "and by this channel are passively"
 "transferred to the lungs. Here they leave"
 "the capillaries enter the air vesicles,"
 "and thence along the bronchi and"
 "trachea pass into the esophagus"
 "and so to the stomach".

Upon the question of whether this is the exact route or whether many larvae reach the small intestine by passing through the wall of the bowel as stated by Sambon in the Journal of Tropical Medicine, Jan. 15th 1908, I have no criticisms to offer.

The above quotation is given to complete the connection between water itch and ankylostomiasis.

Before considering some aspects of Ankylostomiasis as they appeared in following the disease as it manifested itself after water itch, it will be of assistance to ascertain shortly what is meant when the name ankylostomiasis is used.

The name is not applied to every case where the parasites are present in the intestine. On page 719 of 4th Edit. of Tropical Diseases Manson says, "There may be dozens of ankylostomes" "in the intestine, without any appreciable" "anaemia or, indeed, symptoms of" "any description whatever."

Schubert in Diseases of Warm Climates 2nd Edit. English Trans., page 423, states "Many persons harbour a small or" "moderate number of ankylostoma" "and do not suffer from the" "slightest indisposition."

On pages 17 and 24 I have referred to parasites being present in apparently healthy coolies.

Shortly, the disease is a group of symptoms associated with and in

some way caused by the parasite, *A. duodenale*, present in the intestine.

Scheube in continuation of the quotation says "Anchyllostomiasis is" "attended by signs and symptoms of" "more or less severity. Anaemia is" "one of the most pronounced of the" "accompanying conditions, and with" "it marked disorder of the digestive" "organs". (The underlined are in italics in the text).

On page 720 of 4th edit. Tropical Diseases is the following "The essential symptoms" "of Ankylostomiasis are those of a" "progressive anaemia which is generally" "associated with dyspeptic trouble" "but which, in uncomplicated cases," "is not associated with wasting. If the" "progress of a case be unchecked, serious" "effusions in different organs and fatty" "degeneration of the heart ensue, and" "death may occur from syncope or" "from intercurrent complications."

Again in Allbutt's System of Medicine, 2nd edit. Vol II, Part II, page 899, "Considering the insignificant size"

"Of these parasites, it is unlikely, so long
 "as the numbers are small, that
 "serious inconvenience should result"
 "from their presence in the intestines."
 "But when these numbers mount up"
 "to hundreds and thousands, as is"
 "often the case, as a result of the "
 "constant drain of blood they keep up"
 "for months or years, the dyspepsia"
 "and malnutrition entailed by their"
 "presence, the wounds they inflict"
 "on the mucous membrane, and it may"
 "be the haemolytic toxin they secrete,"
 "a grave cachexia - the state known"
 "as ankylostomiasis - is produced and"
 "not infrequently leads to a fatal"
 "issue."

In the works quoted there follow
 descriptions of the disease, the
 symptoms, marked blood changes,
 digestive disorders, oedema etc, the
 diagnosis by examination of the faeces,
 differential count of the blood leucocytes,
 the degree of eosinophilia etc. - the
 pathological anatomy, the marked
 intestinal lesions and fatty degenerations

and finally the serious results due to the many complications that always arise. That these results are serious is shown by the high case mortality in the table on page 25.

Criticisms would be useful as to how many of these conditions are due to the parasites, how many to the diseases that are put down as complications, which the disease and which the complication, but I have not the temerity to enter into these criticisms.

I have given the foregoing quotations so as to bring prominently forward what are generally considered ~~to~~ be the leading symptoms of Ankylostomiasis.

I shall now endeavour to present some aspects as they have appeared to me.

These refer to some early symptoms of the disease its nature and the question of reinfections being the cause of the graver symptoms that arise.

The early symptoms are shown in the following clinical statement of a case that is typical of hundreds on tea-gardens.

"Druya woman, age 22, from Madras, contracted

water itch on 12th June, she had been on the garden three months. Strong healthy woman, had three children, all alive and healthy; the water itch disappeared in 5 days but as she persisted in not protecting her feet, on July 3rd she again had an attack. This passed off in a few days.

Routine thymol treatment was given with a negative result.

The woman had made a good start on the garden, worked regularly and did more than the average new Coolie does. After the middle of July she began to show disinclination to work, felt weak and was easily tired, this the manager ascribed to laziness. Her general appearance was good, no loss in weight and no apparent anaemia.

During August she had attacks of irregular fever, the temperature varying between 99.8 and 101.2 F. for a few days and then falling to normal or subnormal. This continued for over two weeks.

Towards the end of August, there were some symptoms of digestive disorders,

some pain and burning sensation relieved by taking food.

On September 3rd thymol was given, parasites were found in the faeces.

On September 15th thymol was again administered, from that date the parasites disappeared and under tonics and dieting the patient steadily improved, and by the end of October she was fit, and has remained so.

The following August she gave birth to a healthy child."

In that case, beyond the presence of the parasites, the only symptoms are the feeling of weakness, the irregular temperature and the slight digestive disorders. These are the usual early symptoms of ankylostomiasis when the larvae have entered through the skin as in water itch.

Further I think that almost every case of water itch is followed by these symptoms but unless looked for they are easily missed. In a district like Sylhet where a rise in temperature is put down to fever, meaning malaria,

by all non-professional Europeans and by most of the subordinate native medical men, no other diagnosis is sought for, and the cases are not submitted to further inspection.

The variations in temperature are referred to in accounts of the disease, sometimes as where Scheube in page 427, says "Eiles and Sandwith often observed fever, which, however, was only observable for a few days, at the commencement of the illness," the reference might be to the rise in temperature I speak of, but usually, when noted, it is given when the disease has advanced considerably as in Allbutt's System, page 901, "Temperature is usually subnormal, at times there may be transient flashes of fever," or on page 720 of Manson's Tropical Diseases, 4th edit. "Fever of an irregular, intermitting, or even of a sub-continued type is common."

Digestive disorders are usually given as the earliest symptoms of the disease, this is often true when the larvae have entered by the mouth, then these symptoms

may be very marked but in infection through the skin they are usually slight and follow the irregular temperature. In infections by the mouth, I have observed the irregular temperature I refer to, but my observations have been made chiefly in connection with infection in water etc. cases, and in these I have observed it occurring so regularly during the second month after infection that I look upon it as a constant early symptom of ankylostomiasis.

With reference to the nature of the disease, whether the anaemia and other symptoms are caused by the abstraction of blood or by the absorption of a haemolytic toxin, produced by the parasite, it seems difficult to account for these early symptoms by the mere loss of blood at the bites of the parasites; if it was so anaemia would be expected to show itself as one of the first symptoms, and any variation in temperature would follow, probably in a measure due to the anaemia, whereas the order of the symptoms is reversed.

Again the irregular temperature appears almost at once after the parasites have reached their adult form; the time from entrance until the adult form is reached is variously put down at from four to six weeks.

From Allbutt's System, page 898, I quote the following "Arrived at its final host, after moulting again at the end of five weeks (Heichtenstern), they acquired sexual characters and the permanent adult form."

Finally I quote the following sentence from page 897 of Allbutt's System of Medicine, Vol II, Part II "The two large head glands, which open at the base of the paired hooks, discharge, it has been conjectured, some haemolytic substance into the blood of the host."

I think these considerations weigh in favour of a toxic cause for the symptoms of the disease, and against direct abstraction of blood at the bites, at any rate in first infections through the skin, whatever influence this loss of blood may have later after

repeated reinfections or after an invasion by a large number of larvae by the mouth.

The question of reinfections being the means whereby grave symptoms are gradually set up is intimately mixed up with the length of time the parasites may live in the intestine.

Taking the latter point first, on page 715 of Manson's Tropical Diseases, 4th Ed., is the following, "The duration of the life of "A. duodenale in the intestine has not been determined, some state it in months, others in years (Bonisino) - one to three. On account of liability to reinfection, this point, an important one as affecting prognosis, is difficult to determine."

That the parasites live for a long time in the intestine is well known, and, after the early symptoms have passed off, cause no symptoms, and I believe that in great measure this accounts for the large percentage of natives who harbour the parasites and are classed as healthy. In fact I think that

every native of the Coolie class in this district has harboured them at one time or another.

Before it was recognised that ankylostomiasis followed water itch, it was quite a usual thing to hear of a good working coolie for some time being unable to work well, had difficulty in finishing an ordinary task, wanted leave frequently, and if fortunately no other disease arose to complicate, in a few months became fit again. In such cases no thymol treatment was given, possibly only some quinine or bitter tonic. In these cases there was sometimes a history of water itch, but so little importance was then attached to the dermatitis that its absence or presence was not noted. Looking back I think many of these cases must have been due to an infection by *Ankylostoma larvae*. I have tried to arrive at a definite conclusion as to the length of time the parasites live in the intestines, but I have not succeeded. It is not easy to keep coolies under observation in a

number large enough to give a reliable average and at the same time satisfy the following conditions.

1. Knowledge that parasites were present.
2. No treatment by thymol or other anthelmintics.
3. No reinfection.
4. Ascertain that the parasites have disappeared from the intestine without giving thymol. Often ova are not detected in the faeces and yet a course of thymol will bring away parasites.

However the following circumstances give some assistance. During the past ten years, old coolies, usually of a healthy clean class, have been clearing rice land in the neighbourhood of the gardens. At places they build a collection of bamboo and saung grass huts, making a small village; in each of these villages the same class of coolies, usually near relatives, live together to the number of 15 to 20; consequently they have the same customs and although there is no attempt at sanitation, so far ankylostomiasis

is not common there.

During the busy months, many of these village people work in the gardens, that is during July to October, when larvae are in abundance.

Frequently some of these coolies cease working either through contracting water itch, or simply through feeling weak.

The following season they return quite fit.

Again garden people at the stage of anaemia sometimes leave and live with relatives in the villages, and

the following season return in good health.

That may be bad for the new villages as these cases will pollute their surroundings.

What I wish to bring out is that in a number of these cases it has been definitely ascertained that parasites were present in August and September and were absent in the following June when the coolies returned to the garden.

Meanwhile no anthelmintic treatment had been given, and the chances of reinfections in the villages were small.

Although I am unable to state in reliable figures what is the duration

of the life of the parasite in the intestine, experience of cases in the circumstances just described has led to the opinion that in a single infection it is rare to find parasites in the host after six months. When cases were collected (page 12) to determine the number suffering from anaemia, it was found that those who were suffering from the anaemia of ankylostomiasis had had repeated attacks of water itch, that is reinfections. Again as the relative nature of water itch and ankylostomiasis manifested itself, it was always found that repeated reinfections had occurred in cases where marked anaemia and other grave symptoms have been present. Natives, even of the lowest castes have a certain amount of personal cleanliness which to some extent is a protection, but as disease weakens them they lose even this protection, they resign themselves to fate and amongst coolies sink into a condition of utter disregard of cleanliness. It is thus

easy to understand that infections by the mouth would become frequent, cause enormous loss of blood in the intestine, malnutrition and finally a fatal issue.

Parentetically I may remark that this increased liability to infection being common to coolies suffering from any chronic disease, it may give a partial explanation of the frequent presence of ankylostoma in post-mortem examinations of those who have died from diseases such as chronic dysentery, kala-azar and chronic malaria.

At this point the question of the microbic origin of the symptoms of ankylostomiasis would naturally fall to be considered, but I regret that I cannot offer any facts or criticisms that might throw light on this important question.

The production of ankylostomiasis by infection in water itch has an important bearing on prognosis.

In the table given on page 25 the percentage of deaths amongst coolies who suffered

from the disease following water itch is much higher than when it followed infection by the mouth. Owing to the coolies practically refusing treatment, the death-rate shown on that table is higher than is usually the case, but I think it indicates correctly the difference in the two modes of infection.

When through the skin, the onset is more insidious, there are no prominent symptoms to draw attention to the disease and call for early treatment, and, after several attacks of water itch have caused several infections, the patient is found to be suffering from anaemia, haemic bruits, palpitation, breathlessness, some cardiac dilatation, oedema; these alone may cause death, but usually death is due to the patient being so enfeebled that he quickly succumbs to the other diseases that coolies are exposed to.

Infection by the mouth usually produces marked symptoms of digestive disorders before anaemia is prominent, thus calling for treatment at an early

stage of the disease.

This difference in prognosis in the two methods of infection being due to treatment being more often delayed in infection through the skin than by the mouth, the early recognition of the disease following water itch practically abolishes this difference, but this only emphasizes the importance of recognizing the connection between water itch and ankylostomiasis.

If reinfections can be prevented, and thorough treatment with thymol or beta-naphthol is carried out at an early stage of the disease, the prognosis in all cases of ankylostomiasis is good.

The conclusions arrived at are,

1. Water itch is caused by the larvae of *Ankylostomum duodenale* penetrating the skin and marks the beginning of a frequent route for the larvae of the parasites to reach the intestine and set up the group of symptoms that constitute the disease, Ankylostomiasis.

Consequently the prevention of water itch causes a marked reduction in the

number of cases of ankylostomiasis.

2. The earliest symptoms of ankylostomiasis following water itch are a feeling of weakness, an irregular temperature, and slight symptoms of digestive disorders.
 3. That the loss of blood in the intestine at the bites of the parasites is not sufficient to cause these symptoms, and that the cause is probably a haemolytic substance derived from the parasite.
 4. The onset of the disease is insidious, more so than when infection is by the mouth.
 5. When infection occurs through water itch the grave symptoms of ankylostomiasis are due to repeated reinfections.
 6. Given early thorough treatment and no reinfections the prognosis is good.
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