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Preface.

When a boy, I used to observe that in certain parts - of my native country i.e. Travancore, many people ----- suffered from anaemia. But I could not then connect this circumstance that in those parts my country was damp and covered with thick vegetation and that the atmosphere - was markedly warm and moist as a whole. When I had -- occasion to travel, I observed that on the Coromandel - coast of South India, the phenomenon of anaemia was not so marked as in my own country. I did not think there was any connection between this circumstance and the -- dry soil and warm and dry atmosphere of the Coromandel - coast where vegetation is generally sparse and does not attain to much development. I was half inclined to put down the anaemia as a racial instead of a local peculiarity. Later on, while attending the Medical College, Madras, South India, I came for the first time to learn that medical men were coming to think that certain ---- diseases were peculiar to the tropics and that they would -- occur in the temperate zone only if the tropical ------ conditions of climate and other incidental circumstances were fulfilled. I well remember what an effect this-- knowledge produced on my mind. I very much wished to - take a special course in Tropical diseases. This ---- wish remained unfulfilled for several years till I ----

I proceeded to Edinburgh and took the degree of Bachelor of medicine. At that time, I took a special course in Tropical diseases. I followed up this subject by proceeding to London and attending the school of Tropical medicine in that city. On the completion of my studies, I returned to my own University and took the Diploma in Tropical medicine and Hygiene. Tropical diseases, have, since that time, had great attraction for me and my special studies have been of use to me in practice in my own country. I have chosen "Ankylostomiasis in Travancore" as the subject for mythesis as this disease has affected a great number of people in many parts of Travancore.

K. R. Tampi.

Contents.

Introduction.

During the past decade, tropical diseases have come to occupy a prominent place in the field of medicine At one time, the classification of diseases on a climatic basis was not considered to be of any value. But gradually it came to be recognised that there were certain diseases peculiar to the tropics and which only occurred in temperate climates when the requisite condition as regards temperature was accidentally satisfied. Certain diseases as Scarlet fever, were found only in temperate climates, while several diseases as syphilis cancer tuberculosis were found in all climates. Diseases produced by parasitic worms are essentially tropical, as eggs of the worms will hatch only when a high degree of warmth and moisture are available. That diseases caused by worms are extremely common in India, is borne out by the fact that nearly 75% of its inhabitants suffer from worm-infection. Of the various forms of worm infection, the most important, on account of its severity and the great economic consequences, is ankylostomiasis. In Ceylon, the mortality from it, has been estimated to be greater than that from cholera (vide Ankylostomiase in Brouardel-et Gilbert nouveau Traitede medicine 1906 IV).

Travancore is an agricultural country. Geologically, many portions of Travancore, were originally under the sea.

As a result there are many marshes and sandy areas in different parts of the country. The country is covered by luxuriant vegetation. The conditions are favourable to the spread of ankylostomiasis. As the main feature of ankylostomiasis, is anaemia, it may be well classed under the great group of anaemias. The two recognised groups of anaemia found in temperate climates, are chlorosis and pernicious anaemia. They are not considered of much importance, owing to their comparative rarity. In the tropics, anaemia is very common. Of the forms of anaemia, that produced by worms, is the commonest. Among the worms which produce anaemia in the tropics, the most important is the ankylostoma duodenales.

What is ankylostomiasis?

Ankylostomiasis in Travancore.

Definition of Ankylostomiasis. A wasting disease which comes on imperceptibly, characterised by digestive, nervous and circulatory disturbances, in the latter case, being -- accompanied by anaemia and palpitation and pain over the region of the heart.

It is found usually in labourers in warm climates - who work in dirty soil and who are not clean in their --- habits. The disease is due to the entrance of the Ankylos- -toma or Necator into the duodenum and jejunum and the - subsequent formation of toxic products by them which be-- -come absorbed into the blood of the host, giving rise to characteristic symptoms.

If the disease be allowed to progress unchecked, it may end fatally. On the other hand, it can be overcome in most cases by efficient treatment. Scrupulous personal -- cleanliness ensures protection from the disease.

Synonyms.

"Agchylostomiasis", "Tunnel anaemia", Miner's anaemia, "Ceylon anaemia", "Uncinariasis", "Hook-Worm disease", - "Negro Consumption", Dirt-eating disease, Dochmiasis, "Ca-

Cachexie Africane", "Egyptian Chlorosis", "Anemie des--- pays chauds", Tropical Chlorosis", Mal de coeur", ------ "Mald'Estomoe", "Nausea of Negroes", sufra", Opilicao, - tuntun &c.

History.

The disease was probably known in ancient Egypt. In the medical papyrus supposed to be written about 1550 B.C. the worm causing the disease was called "Heltu", -- and the disease was called A.A.A. 1. This papyrus was--- translated into German by Professor Ebers at Thebes in - 1873. The symptoms of the disease as mentioned in the papyrus were heart-weakness, palpitation and stabbing -- cardiac pain, constipation, Oedema of legs, and a sen---- sation of heaviness in the body, along with digestive -- troubles. Dr. Castellani thinks that the disease was - probably recognised in ancient India as "Pandu Roga", -- mentioned in the "Harita Samhita". "Pandu Roga" was ---- supposed to be caused by eating clay. In the ancient - Hindu medical sanscrit work called "Ashtanga Hridaya", -- the symptoms of Pandu Roga are given as puffiness of ---- face, great weakness of body, palpitation, singing in the ears, profound anaemia, along with digestive troubles. It is also stated that the

1. Castellani and Chalmers Manual of Tropical Medicine second edition page 9.

2. Sand with's medical diseases of Egypt Vl. .1.

the worms are discharged through the faces (vide appendix on Hindu medicine) To make myself certain that "Pandu-- Roga and "Ankylostomiasis" were the same, I devised an - experiment. In the course of my investigation of the-- diseases I once asked a doctor who had no knowledge of - English, but who was well versed in Hindu Medicine, to -- show me by way of identification a few of his patients who were suffering from"Pandu Roga" I examined them, and not only did I find Ankylostoma ova in their faces, but they- presented the typical clinical picture of ankylostomiasis I am therefore certain that the disease has been ------- recognised in Ancient India.

In the New World, a fatal disease, the cause of-- which was not known, was described by many writers. In 1648, Piso described a disease "Oppilatio"(or Oppilacao) in his Historia Medica Brasiliae". The symptoms ------ described point to the disease as having been ankylostomiasis. The same disease was described by Labat in Guadeloupe --- in 1742. Chevalier found it in St. Dominique in 1752. Desportes also found it there in 1770. In 1780, Bayon -- described it as having occurred at Cayenne. In 1796, Hunter found it in Jamica, and in the same year, Rodschield found it in British Guiana, In 1799, Byron Edwards again described it as occurring in Jamica. Pitt found it in 1808 in the United states. Moreau de Jones found it again at Guaudeloupe in 1816. Chabert gave a very good account of the disease in

in 1821. In that year, Castelnau found it in Peru. Johin found it in Brazil in 1835. Clarke found it in West Africa in 1860. In Europe, in 1786, a peculiar anaemia was noticed among miners, first in Hungary and then in France Belgium, Germany and Cornwall. Dubini in 1838 discovered that the disease was due to a worm which he named Agchylostoma (αγκύλος, bent and στόμα, mouth) Pruner found the parasite in Egypt in 1846, Bilharz -- found the worm in nearly all the post-mortem examina---- -tions he made in Egypt. In 1851, Griesinger showed that- this worm was the cause of Egyptian anaemia. He further - discovered that the worm caused wounds in the mucous --- membrane of the small intestine. In 1866, Wucherer found the disease in Bahia and called it Opilicao. In 1867,-- Grenet and Morestier discovered it at Mayotte. They ---- thought that this worm was the cause of watery cachexia or nausea of Negroes. In 1871, De'liou & Savagnac dis-- -covered the worm in most of the cases of tropical anae- -mia. In 1872, Rodriguez de Moure stated that ankylostoma caused intertropical hypohaemia. In 1878, Grassi found - ova of ankylostoma in the stools mostly of anaemic work- -men. In 1880, there was a virulent outbreak of anaemia in St. Gothard's tunnel. Perroncito proved that the anae- -mia was caused by ankylostome. He also gave a full ac-

-count

account of the disease. In 1881, Binz found that ankylostoma was the cause of miner's anaemia at Schemnitz. In 1898, Looss found that the mode of infection was by the skin, the lungs & trachea. Later, Sambon, Fulleborn and V. Schilling Torgau found that there was another route of infection: viz. from the lungs through the blood stream into the alimentary canal.

In 1899, Ashford noted that Eosinophilia was well marked in this disease. In 1902, Stiles described Necator Americana, Boycott and Haldane in the same year, found the disease in the mines of Cornwall.

Geographical distribution.

In Europe, ankylostomiasis has been found in the North of Italy, Sicily, Sardinia, Germany, Spain, Belgium and Netherlands and parts of France. It has not yet been found above a latitude of 52° N. Even in countries such as England which is about Latitude 47° N, it occurs only in mines where there is sufficient warmth for the development of the parasites. In Asia, the disease has been found in Japan, Borneo, the Malay Archipelago, Ceylon and several parts of India. In India, the disease has been found in Calcutta, lower Bengal, Assam, Burma, Cochin and Travancore. In America, it has been found in Southern --

Southern United States,Mexico,Central America,Guiana,Ve--
-nezuela,Brazil,Bolivia,Peru and Porto Rico. In Porto --
Rico,287,568 cases were treated between 1904-1910. In -
Africa,the disease is very common,especially in Upper -
and Lower Egypt.

Variations of the disease according to climate.

It has already been noticed that the disease does not appear above Latitude 52°-N. In temperate climates -- the disease is found to occur only in persons who work - in the mines. As the parasite requires warmth for its de--velopment,its virulence is greatly diminished in a cold climate. Boycott,who has thoroughly investigated the oc--currence of Ankylostomiasis in English Mines,is of opi--nion that in England the infection is limited to about-6000(Six thousand)miners. Of these,not one has died of - pure ankylostomiasis.[3.] This conclusively proves that the disease does not assume there so serious a form as it --- does in the tropics. Recovery from the disease is also - comparatively easy in temperate climates,as,once the ---- worms are thoroughly expelled,the chances of re-infection are far less than in the tropics. The chief tropical ---- countries in which the disease is found,are Egypt,India-- and Ceylon. In India,the parasite has been estimated to--

3. Boycott's Milroy lecture on ankylostoma infection -- (Lancet,25th.March 1911.)

to occur in nearly 75 % of the population. In Ceylon, the mortality from ankylostomiasis has been said to be greater than that from Cholera.[4]

Spread of the disease in Travancore and factors which help it.

In Travancore, the disease is widespread. It is more abundant in the North than in the South. It has been found as the result of careful examination of anaemic patients in different parts of the country, that the disease has a tendency to attack persons living in sandy areas. The temperature of the soil is favourable to the development of the eggs of the parasite.

Another factor which helps the spread of the disease, is the method of disposal of the faeces. There is no proper system of collecting and disposing of night soil.

In towns, there are Cesspits in which the parasite can thrive.

In villages, especially in sandy areas, the inhabitants squat themselves on the ground for purposes of defoecation. The faeces are left exposed to the sun and there getting thoroughly dried, become converted into fine powder. The latter is easily blown from one place to an-

4. Ankylostomose in Brouardel et Gilbert Nouveau Traite' de Medecine 1906/IV.

another by violent winds which are very common. Again, the bulk of the inhabitants devote themselves to agriculture. They work in the fields bare-footed, thus giving great --- facility for the entrance of the parasite. Vegetables --- form an important part of their dietary. There are vari--ous possibilities of contamination of vegetables, for --- example, using infected earth as manure and watering with water in which there has been faecal contamination.

There is yet another factor to be taken into ac----count. Food is eaten with the help of the fingers. It is not at all unusual for those who work in the soil, to eat their food with dirty fingers. Infected earth can easily collect under the finger nails.

Varieties of parasite.

In India, till recently, only two kinds of ankylos---tomes were known to infect man, viz-Ankylostoma duodenale and Necator Americanus. Of these, ankylostoma duodenale -- is a purely human parasite, while Necator Americanus has -been found to infect gorilla as well as man. In the In---dian Medical Gazette for June 1913, Major Lane Calls at--tention to a third variety of ankylostome which he found infecting a few prisoners in Berhampore gaol. Out of a -- batch of thirty prisoners examined for ankylostoma, in the stools of three, he found Ankylostoma Ceylanicum which was first described by Looss in 1911. Looss found it only as a

a parasite in Civet Cat. Major Lane found this parasite in the cat, dog, lion &c. The three varieties of the parasites will now be considered.

Ankylostoma Duodenale.

This is the commonest variety found in Travancore.

When alive, it is of a pinkish colour. After death, it becomes white or grey in colour.

Measurements. Dubini, Bilharz & Von Siebold give the length as 9-11 Millimetres. Schneider gives it as 10-12-M.M. Leuckart gives the maximum length as 18 Millimetres. According to Blanchard, it is 15-M.M. Professor Looss, as the result of examination of hundreds of living specimens has come to the conclusion that the maximum measurement of the male, is 9-M.M. and that of the female, 12-M.M.[5] In his opinion, Leuckart's observations were confined only to dead and swollen specimens and in them, there was stretching of worms due to long immersion in water. He also considers that the preservatives used for the worms may in some cases, produce stretching.

Thickness. Professor Looss found that the thickness in the male, varied from 0.4-0.5 M.M., and in the female, the maximum thickness was 0.6 M.M.

Body wall. [vide appendix. Figures 1.2.3]. The skin is thick and resistant. Under the skin, there are four longitudinal bands- a dorsal band, a ventral band and two lateral bands. The dorsal band reaches

5. Records of the Egyptian Government School of Medicine- Vol. III. page 31.

reaches only up to the arms. The ventral band is well -, developed near the tail. The lateral bands alone extend to the whole length of the body. These take part in the formation of rays of the bursa, in the male. The head - glands are closely applied to the lateral bands. Besides the ordinary muscles in the body wall, there are special muscles which are used for special purposes. Thus there are Cephalo-Oesophageal muscles, which move the head and the Oesophagus. There are also intestinal muscles. These two sets of muscles belong to both sexes. In the female, there are the anal muscles and the vulvar muscles. The - muscles of the bursa are peculiar to the male. The worm is cylindrical, with slight forward thinning. The head -- end which is slightly pointed, contains a large mouth -- capsule. [vide Appendix · Fig · 4a] This capsule is bell-shaped, and has a horny --- wall. The capsule is bent backwards almost at right an- -gles to the body. The capsule has given the name to the worm (Ankylostome-αγκύλος, bent, στο μα, mouth.) The name uncinaria is given as the mouth is armed (Uncinus hook). The capsule has two hook-formed teeth. The inner of the two has an accessory tooth. The head gland is situated - near the outer tooth. It consists of a single cell. It - runs through half the length of the worm and opens on -- each side. In the female, it runs nearly to the Vulva. - The head gland secretes an irritant liquid which can get

get into the wounds made by the teeth. There is another gland situated in the oesophagus. It opens in the middle of the mouth capsule. Its secretion is supposed to have the power of dissolving the mucous lining of the intestines of the host. There are two inner teeth rising from the ventral wall of the buccal capsule. These are situated near the floor of the mouth. The wall of the mouth capsule is made up of a number of pieces which move against one another. The advantage of this arrangement is that the worms can easily release themselves from their hold and attach themselves to fresh spots. The opening of the mouth capsule has three ridges or prolongations, into which strong radiating muscles are attached. These muscles contract the pharynx and cause suction on parts in contact with the mouth. The back part of the pharynx is fixed in the intestine, thus forming a valve preventing the return of food. The intestine is usually straight and very wide and floats freely in the Visceral cavity. The tail end of the ankylostomum is blunt in both sexes. (The tail of the female Oxyuris is tapering). The anus has a Ventral opening at the base of the tail in the female. In the male, it unites with the genital duct and forms a cloaca which opens into the copulating sac. In the male, there are two anal glands which open into the cloaca.

Generative apparatus. In the female, there is the uterus which is a large tube situated ventrally. It communicates with the Vulva by means of a short Vagina. ---- There are two ovaries which open into the uterus. These ovaries are very long tubes(nearly five times as long -- as the animal). In the male, there is a long testicular - tube, which is made up of many coils, ending in a pouch, - the seminal vesicle, which runs on into a discharging --- canal. This canal reaches the cloaca and unites with the rectum at the bottom of the copulating sac. Two pouches - situated on the dorsal aspect of the intestine, open into the cloaca. There are two spicules each 2-M.Ms. long at - the bottom of these pouches. They serve to open the Va- -gina during copulation. The copulating sac is a sort -- of tent. [vide appendix. Fig 8] It is formed of a circular fold of integument- divided into four unequal lobes by shallow notches. Of - these, the dorsal is the smallest, the Ventral, intermedi- -ate in size, and the lateral ones are the biggest. In - the wall of the sac, run eleven branching ribs. The dor- -sal or posterior rib is uneven, all the others being --- symmetrical. Its extremity bifurcates, each branch having three fingers. From each side of the dorsal rib, springs another rib, the first lateral, which runs into the pos-- -terior part of the corresponding lateral lobe. Through the middle of the lateral lobe, run three big ribs, viz.-

viz. the second, third and fourth lateral, diverging from a common stem. This stem sends out at its base a fifth lateral rib called the Ventral rib ending just near the notch between the Ventral and lateral lobes and deeply notched at its own extremity. The ribs are prolongations of the longitudinal muscular bundles and enable the animal to open and contract the copulating sac, so as to fix it for copulation. It is a kind of cupping glass for fixing the male firmly on the vulva of the female. Copulation probably lasts for several days. The Genital opening in the female is situated just beyond the middle of the body, far away from the anus. Copulating pairs therefore have the shape of Y .

Eggs of -- A-Duodenule. They measure between 0.056 & 0.061 M.M. in length and in thickness between 0.034 & 0.038 M.M.[6] They are fairly oval in shape, with rounded poles. Under low power, the shell appears as single, but under high power, it is seen to have a colourless double layer. The contents of the egg appear granular under the microscope. The interior of the eggs as found in fresh faeces, seems to consist of four-eight, or sixteen segments.

6. Looss Article abridged in Sandwith's Medical Diseases of Egypt-Vol.I.

Necator (Uncinaria Americana).

Americanus. This species was discovered by Stiles in the United States in 1902. This worm is - more slender and smaller than Ankylostoma duodenale.

Measurements. [vide figures 12, 13, 15, 18].

Female - 9 to 11 M.M.long & 0.5 M.M.broad.

Male. 7-9 M.M. long & 0.35 M.M. broad.[7]

It is easily distinguished from Ankylostoma duodenale with the naked eye,as the head is abruptly bent backwards in both sexes. In the male,the copulating bursa is not - median,but directed to one side. [vide fig 9&10] The buccal capsule is - smaller but more circular. It has a dorsal and a ventral pair of lips at the mouth. It has a prominent dorso-me-- -dian buccal tooth and four buccal plates.[8] In the male, - the dorsal ray of the copulating bursa divides at the -- base and each branch possesses two lips. In the female, the Vulva is situated in the anterior half of the body.

Eggs of Necator Americanus, are thin-shelled. 64 to 72 - Micromittimetres long & 36 to 40 micromittimetres broad They are slightly larger and taper more at the poles --- than those of Ankylostoma Duodenale. [vide fig 21]

Agchylostoma Ceylanicum.

This was first described by Looss in 1911. He --

7. Daniel's Tropical Medicine & Hygiene-Vol.II.Page 130.
8. Stiles' Article in Osler and Macrae's System of Medi- -cine.

He found it as a parasite in a civet cat sent to him by - Dr. Wolley of Colombo. He therefore gave the name Agchy-- lostoma Ceylanicum,to the parasite. Later,the parasite was found to infect cats and dogs at Berhampore. Major - Lane found it also in a lion which died in the Zoological gardens at Calcutta. While examining the faeces of prison--ers at Berhampore,Major Lane came across this parasite -

9.

Chief features of Agchylostomum Ceylanicum.

It is smaller than A-Duodenale. In Loos's specimens from the civet cat,the measurements were 5-M.M.for males- & 7-M.M.for females. The worms obtained by Major Lane --- from the prisoners,measured 8.5-M.M. & 10-M.M.for males - and females respectively. The head is transparent except at the oesophagus. The rest of the body is opaque.

[Figs 19, 14, 7.]

Specific characters There are two pairs of ventral --- marginal teeth. In the copulating --- bursa of the male,there are special clefts separating the dorsal from the lateral lobes. The dorsal ray bifurcates. Each branch thus formed,again bifurcates. The lateral --- lobes are long and rounded. [vide Fig. 11, 17]

Tabular statements regarding the three parasites, are given in the next two pages. 16 & 17.

Development of Ankylostomum Duodenale. (To come after page 17).

The female lays the eggs in the intestine of the -- host and these eggs escape from the host through the ---

9. Major Lane's article on Agchylostomum Ceylanicum-in - Indian Medical Gazette--June 1913.

Le

MORPHOLOGICAL CHARACTERS OF THE THREE KINDS OF PARASITES .

Name.	A. Duodenale.	N. Americanus	A. Ceylanicum .
General description.	Pinkish worm nearly straight.	Smaller and slender than A Duodenale.	Smaller than A. Duodenale.
Mouth capsule	Bell-shaped.	Smaller and more circular.	Mouth cavity is deeper than that of A Duodenale.
Teeth or Plates.	Two pairs of teeth. One pair dorsal. One pair ventral.	One prominent buccal tooth and four buccal plates.	One pair of teeth. Outer - long and superficial. Inner - short and deep. Two pairs of Ventral marginal teeth.
Oesophagus.	Muscular - connects mouth capsule with the intestine. It has chitinous lining.	Similar to that of A.Duodenale.	Oesophagus is opaque.
Bursa in the male.	Four un-equal lobes. Lateral lobe not long. Lateral rays are short and stout.	Two large lateral lobes joined to a dorsal median lobe.	Lateral lobes long and rounded. There are special clefts separating the dorsal from the lateral lobes.

Name.	A. Duodenale.	N. Americanus.	A. Ceylanicum.
Dorsal Ray.	Each dorsal ray ends in three points.	Dorsal ray divides into two and each branch has two tips	Dorsal ray bifurcates each branch thus formed, again bifurcates.
Genital Pore.	Situated beyond the middle of the body, far away from the anus.	Situated in the anterior half of the body.	Situated as in A. Duodenale.
Eggs.	Shape:- Oval with rounded poles.	Slightly larger and taper more at the poles than those of A. Duodenale.	Space between the Yolk and shell is slight.[10]
	Size:- 52 - 60 μ	Above 60 μ in length.	Less than 52μ in length.

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10. 'Lane on' Ankylostome infections'. Indian medical Gazette Nov. 1913)

the foeces. The number of eggs laid by the female is enormous. Leichtenstein has counted nearly 20,000(twenty thousand) in a gramme of foeces. If the eggs be left exposed to the air, their rate of development varies according to temperature. When fully developed, they become larvae. The larvae get out of the shells, feed on the foeces and grow. As a rule, larvae escape from the foeces from the third to the tenth day. At first, the appearance of the larvae is rhabditiform(rodlike). The oesophagus is narrow in its lower half and there is a swollen bulb at the end of the oesophagus(rhabditiform oesophagus) Three small valves are situated inside this bulb. The valves have the appearance of [illegible]. The tail has a thread-like point. Another peculiarity of the larva is the shape of the mouth cavity. It is long and cylindrical and has a highly refractile membrane. By feeding on the foeces, the larva grows. As soon as it escapes from the egg, the larva measures from 200 to 210 Micromillimetres in length and 14 micromillimetres in width. It grows very rapidly, becoming each day 80 to 100μ longer & 2 μ wider. [vide Figs. 23, 24].

Gradually a new skin begins to form under the old one. When the formation of new skin is complete, the old one is cast off. This process is called Ecdysis. The time taken for shedding of the skin also depends on the temperature of the atmosphere. As a rule, the first shedding

shedding takes place on the third day. After its ecdysis the larva becomes thinner and the oesophagus loses its -- sharp division into three parts. The extreme point in the tail is lost by the first ecdysis. The second ecdysis be--gins when the larva is ready to leave the foeces. The -- sheath becomes loose and the embryo can move within it. - It retains the sheath while leaving the foeces,and climb--ing grass poles,stakes,walls &c. The third is the en---cystment stage. The second ecdysis is not completed un--til the larva is ready to and is actually penetrating -- the skin when it completes the moult. The larva then tra--vels by the connective tissues and lymphatics,to the --- lungs and from there,to the oesophagus by the bronchi and trachea. Thence it goesto the stomach and intestines,and before entering the walls of the latter,it completes a -- third ecdysis or moult. In the submucous wall,it becomes-sexually mature,and,acquiring sexual organs & differences and again moults. With the fourth ecdysis,it comes into - the body of the intestine for purposes of feeding. It has been found experimentally that man cannot be infected by swallowing material containing eggs and immature larva.-- Only mature larva can infect man. Direct infection from - man to man is impossible. Dr.Haldane examined a number of the wives and children of infected miners in Westphalia. Not even one of them was found suffering from ankylostoma

Ankylostoma infection.[11] Giles has stated that Ankylosto--ma larvae may become sexually mature and multiply out---side the body. Dr.Boycott has tried to cultivate sexual - forms of the parasite in the foeces,but has not been able to do so.[12] Professor Looss also has failed to cultivate -- sexual forms in the foeces.

Life conditions of the eggs and larvae.

Air,moisture and warmth are absolutely necessary -- for the development of the eggs. A free supply of Oxygen is necessary in order that eggs may hatch into larvae. --- Hence it is impossible for the eggs to hatch while in the intestine of the host. They don't hatch even if kept in - a small open dish with water,one inch deep.[13] In the ab---sence of oxygen,they may live for about ten days. Young-larvae also require a good supply of oxygen even though - they can thrive well in water. When the larvae have deve--loped and reached the encapsuled stage,they can exist -- without oxygen for some weeks.

The condition of the foeces also influences deve---lopment.

11. Report on Ankylostomiasis in Westphalian Collieries, by J.S.Haldane M.D.F.R.S.
12. Boycott's lecture on Ankylostoma Infection(Page 5--- Lancet-March 18',1911.)
13. Boycott's lecture on Ankylostoma infection.(Lancet -- March 25',1911.)

, In hard faeces, it is found that ova on the surface de--
-velop more rapidly than those in the interior as air --
has free access to the surface. Unless scybala be broken
up, the ova in the interior do not develop, but die owing
to want of air. If the faeces becomes watery, either by -
the motions becoming diarrhaeic, or by the addition of ---
water, the eggs die. It has also been found that if acid
fermentation takes place in the faeces, the eggs and lar-
-vae are all destroyed. Eggs develop better in faeces ---
from a mixed diet than in faeces, from a purely vegetarian
diet. The best medium for culture of eggs has been found-
to be a paste made of faeces, animal charcoal and a little
water. I have tried this medium for cultivation of the --
eggs in several cases and found it quite satisfactory.

Moisture. Complete drying will kill all eggs & larvae.
It has been found that mature larvae require less mois---
-ture than the eggs or immature larvae. The influence of
moisture on spread of infection has been well shown in --
mines. In Westphalian coal pits, there was a virulent epi-
-demic of ankylostomiasis after introduction of the cus--
-tom of watering the roads to prevent dust explosions. --
Dr. Boycott has thus tabulated the figures to show the in-
-crease of infection. Watering in the coal pits was in---
-troduced towards the close of 1899.

Year.	No.of Collieries.	No.of cases reported.	Cases per --- 10000
1896. ..	15 ..	107 ..	6.4
1897. ..	31 ..	113 ..	6.2.8
1898. ..	23 ..	99 ..	4.9
1899. ..	26 ..	94 ..	4.4
1900. ..	40 ..	275 ..	11.7
1901. ..	63 ..	1030 ..	40.6
1902. ..	66 ..	135.5 ..	52.9

Temperature. In Egypt, it has been noted that the eggs develop best between 30° & 35° C, but in Europe, the optimum temperature is 25° to 30° C. Development is retarded under lower temperature. Larvae can stand far lower degrees -- of temperature. They don't die till the freezing point - is almost reached.

In Egypt, experimentally, larvae have been seen to emerge from the eggs within twenty four hours and become mature on the fifth day when temperature was between 30° & 35° C. In Egypt, development is not prevented even by a temperature of 45° C. In Europe, it was found that eggs -- & larvae, when kept in an incubator at 37° to 40° C, did not develop properly. Haldane found that at 15° C, the eggs -- took a week to hatch. For reaching the encysted stage, -

the

the larvae require a temperature higher than 20° C. Bruns, working in the bacteriology laboratory at Gelsen kerchen, as the result of numerous experiments, found that 20° to 21° C was the lowest temperature at which he could observe any larva developing to the encapsulated stage and at about 20° C, hardly any larva developed.

The most favourable temperature he found, was between 25° & 30° C. He also found that the average duration of life of the larvae was at least six months.

Action of antiseptics on larvae.

In 25% Sulphuric acid, larvae died in a little more than half an hour. 2% corrosive sublimate took six hours to kill them. 1 in 1000 corrosive sublimate will kill eggs and encapsuled larvae. These are also killed by ½% lysol.

Action of Salt. Salt water was found to destroy larvae. In the Levant mine in Cornwall, though the underground temperature was favourable for development of the parasite and though there was faecal contamination, it was found that the men working there were immune from the disease. On enquiry the immunity was found to be due to the nature of water in the mine. Dr. Boycott undertook a series of experiments to test the effects of different strengths of salt solution on larvae. He first experimented

experimented with encapsuled larvae which he kept in salt solutions of varying strengths at a temperature of 20° C.

..	3 hours.	18 hours.	2 days.	9 days.	18 days.
0.8%.	Lively.	Lively.	Lively.	Lively.	Lively.
2 %.	..	Some dead some live--ly.	A few - lively.	A few - lively.	A few- lively.
4 %.	Motion--less.	None mov--ing.	Dead.	..	..
6 %.	..	..	..	..	..
10%.	..	..	..	..	..

He next experimented with eggs by placing freshly infec--ted faeces in an island of filter paper surrounded by -- salt solution at 20° C. His results are as follows:-

..	After 7 days.	After 12 days.
Tap water.	Lively large larvae.	Very hearty, encapsul--ed larvae.
0.8% NaCl.	Do.	Do.
2.0%.	A few dead first day larvae.	Many first day & a --few second day lar--vae all dead.
4.0%.	Eggs ready to hatch no larvae.	No free larvae, eggs dead.

6.0%.	A few embryos in eggs.	No larvae eggs dead
Water from Levant mine containing 2.42% Nacl.	A few first day lar--vae not all dead.	A few dead larvae--eggs dead.

Modes of infection. There are two ways in which man can become infected-namely,by the skin and by the mouth.

Infection through the skin. Professor Looss discovered this method of infection [illegible]. Once,while he was working in the laboratory with cultures of ankylostoma duodenale,a drop pf culture containing more than one thousand larvae fell accidentally in the cleft between two fingers of his left hand.[14] He noticed that this was followed by a burning sensation at the point of contact and that the part became inflamed. He then repeated the experiment on another spot with the same result. He next examined the drop of fluid left in the hand after it had remained for a long time in contact with the skin. He found that many larvae had disappeared,leaving empty sheaths behind them. After a few weeks,he began to suffer from debility and anaemia,and on examining his faeces,he found numerous eggs of ankylostoma duodenale.

Experiment No.2. This was performed on the leg of a boy

14.Sandwith's Medical diseases of Egypt-Vol.I.

boy,aged 13 years. The limb was to be amputated. The ex--periment was undertaken an hour before the amputation of the limb, The leg was well washed with soap and water and dried. Then one drop containing numerous ankylostome lar--vae,was dropped at one spot. The drop was allowed to dry on the skin. There was no redness at the experimented - spot. An hour later,the limb was amputated. The skin area which had come in contact with the larvae,was carefully-- excised,and hardened in alcohol. It was then cut into --- Sections and examined. The larvae were found to have pe-- -netrated through the hair follicles in the skin. Having entered the hair follicles,they were found progressed by boring.

Experiment No.3. This was made on a volunteer. He was -- previously informed of the risks of the experiment. His - faeces were examined for five weeks in succession and de- -clared to be free from ankylostoma ova. Next a few drops containing a culture of ankylostome larvae were poured -- over his forearm and allowed to dry. His faeces were then periodically examined. On the 71st.day after experiment ankylostoma eggs were detected in the faeces.

Other experiments. Dr. Boycott produced an infection on

15.Boycott on Ankylostoma Infection.(Lancet-March 18'1911)

on Professor Leathes by applying a culture containing --
Ankylostome larvae to the forearm and allowing it to re--
-main in contact with the skin for two hours. The skin of the infected part became red. There was also slight itch-
-ing. On the 50th.day, eggs were found in the faeces of -
Professor Leathes. Dr.Pieri in Italy, allowed eight drops-
of a culture of larvae to drop on his hand. He found eggs in his faeces on the seventy first day after infection.

Dr.Looss's experiments on puppies. [vide Fig. 25].

He examined faeces of puppies for several days to -
make sure that there were no eggs of ankylostome. He then made a paste of charcoal and faeces containing larvae and rubbed the paste on their backs. The animals died on the-
tenth day. On post-mortem, many immature worms were found-
in the jejunum. Looss worked out the mode of passage of -
the worms from the skin to the alimentary canal, by nume--
-rous experiments on puppies. He found that the larvae -
bore through the skin into the lymphatic vessels and cu-
-taneous veins. From these veins, they reach the right ---
side of the heart by means of circulating blood. From the right heart, they get into the lungs, also by way of the --
blood stream. From the lungs, they pass through air cells

16. Sandwith's Medical Diseases of Egypt. Vol.I.

qells and thence to the bronchial tubes,trachea and lary- -nx. From there,they pass to the oesophagus,and gradually reach the intestine. Looss found that very young animals- were far more susceptible to infection than old animals.-

Sambon's view.[17.] Sambon thinks the worms penetrate the --- skin and gradually get to the lungs. Having entered the - lungs,they reach the pulmonaryartery and thence reach the pulmonary veins. They thus get into the general blood --- stream and reach the jejunum. He does not think that the- worms get to the trachea larynx and then into the stomach via the oesophagus. In support of his view,he says that - only rarely have larval forms of ankylostoma been found - in the stomach; they are always absent in the duodenum -- and that they are found in the left heart,pulmonary and - azygos veins,in thoracic duct,peritoneum and lymphatic -- glands. Sambon also thinks that when larvae are swallowed they pierce the oesophagus,enter the blood stream, and -- through that channel,reach the intestine.

Fulleborn & VonSchilling Torgau's experiments.

They performed tracheotomy on dogs and inserted a - canula to prevent larvae from passing into the oesophagus

17. Castellani & Chalmers' Manual of Tropical Medicine -- 2nd. Edition-Pages 558 & 559.

oesophagus from the lungs. They then infected dogs with - ankylostoma Caninum and found that secretion from the --- trachea contained larvae. In another series of experiments they divided the oesophagus and stitched both ends to the skin and infected the animals. After some time, the larvae were found in the upper cut end of the oesophagus. All -- the same, a few parasites were found in the intestine in - both of these experiments. These experiments tend to show that a few worms do take the route suggested by Sambon, -- but that the majority adopt the route suggested by Looss.

Schaudinn's experiments on Monkeys.

He examined foeces of young monkeys and satisfied - himself that they were free from eggs of ankylostomes. He then selected a monkey, cut off hairs from a small patch - on its back, cleansed the patch thoroughly with absolute - alcohol and applied five or six drops of a culture of ankylostome lar- -vae over the patch. These were allowed to dry on the --- back. This experiment was made on May 28', 1904. The mon- -key died on June 10th. Thirty six living ankylostomes -- in various stages of development were found in the upper- third of the small intestine. Another experiment was made by infecting a monkey with a culture on three successive- occasions, and killing and examining the animal six hours- after the last infection.

Schaudinn found many worms in the intestine and some - larvae in the skin.

Castle Smith[18] experimented with Necator Americanus. He was able to produce infection through the skin. He -- found that at the site of infection,local itching and a-macular eruption followed. The day after infection,there was a vesicular rash and swelling of the infected part.- On the fifth day,the lymphatic glands near the infected-area,were found enlarged. By the twelfth day,the skin -- affection disappeared. There were sore-throat and sto---mach derangements for a few days. Ova were found in the faeces about the middle of the seventh week.

The possibility of skin infection is also borne out by the fact that there is a disease called 'Ground-itch' which occurs among coolies in many parts of India and - in other tropical countries. The disease occurs during-the rainy season. It has been supposed to be due to in--fection by ankylostome larvae. It has been found that - wearing boots,while working in the fields,is a sure pro--tection against ground-itch. Ground itch occurs only -- in the feet and ankles. It has been found that in places where it is very common,ankylostome larvae also occur in the soil. Cutaneous eruptions have also been noticed in

18. Castellani & Chalmers' Manual of Tropical Medicine--- 2nd.Edition-Page 1305.

in miners in Cornwall and in French mines. In Cornwall,-- these are called 'bunches',while in France,these are ---- known as 'Gourmes'. In some cases,catarrhal bronchitis -- also occurred in persons with gourmes. Both of these pre-
19.
-ceded the onset of anaemia.

In Egypt,skin eruption has not been a prominent --- feature of ankylostoma infection. In Travancore also,skin eruptions have not been found even in persons suffering - from severe forms of ankylostomiasis. Probably,the pa---- -tients in these parts,who always walk bare-footed,may -- have developed toughness of skin which may make it diffi- -cult for ankylostoma larvae to pierce.

Infection through the mouth.

Perroncito proved this to be the common source of - infection when he investigated the St.Gothard epidemic.-- Thus,workmen who have handled infected soil,and eat with- -out washing their hands,or who put their food,pipes and- water-bottles on the ground,where the larvae can gain ac- -cess,are liable to infection. In these cases,the larvae can easily get into the mouth and thence reach the intes- -tine,where they develop and become adults. Leichtenstern
20
conducted numerous experiments on human beings. His con-

19. Ankylostomose in Brouardel et Gilbert Nouveau Traite de Medecine.
20. Braun's Animal parasites of Man-Page 330.

conclusions were, that men were infected by the direct-introduction of mature larvae into the alimentary canal Stiles also is of opinion that, in many cases, the infection has taken place through the mouth. This has been found to be a common source of infection in this country because people generally eat food with the help of their fingers. Alessandrini has demonstrated another means by-which the larvae may gain access to the mouth. He found that flies which settle on foecal matter, can convey the larvae, by depositing them on food or even by dropping them into the mouth of persons who sleep in the open air. He has shown that larvae can pass through the digestive tract of flies and escape in the excrement without being killed. Thus flies can also spread ankylostoma infection just as they spread typhoid fever and cholera. In this country, contamination of food by flies is a common occurrence.

I shall now consider the causes influencing the frequency of infection by the parasite. The disease is found only in places where there is no proper provision for the disposal of faeces. It is frequent in localities where the climate is damp. The larvae are found in the mud by the side of streams in which places, the people deposit their faeces. They are also found under low bush in the vicinity of houses. In this latter locality, the -

the inhabitants defaecate. It is not a disease of towns. Generally it is found in rural areas. As regards frequency according to sex and age, opinions vary. Thus Ashford King and Gutierrez in their report on anaemia in Porto-Rico, state that, of 5490 patients, 3259 or 59.34 % were males and 2231 or 40.66 % were females. Dr. Sandwith on analysis of 1000 cases, found the number of females affected to be only 1 %. Stiles found that it was more common among women and children than among men. In mining districts, the disease is chiefly found among men. I am inclined to agree with Stiles in thinking that the women who are affected, must be numerous, but that they do not so readily come in for treatment as the men. As regards age incidence, the Porto Rico Commission found that out of 5490, 1027 were between the ages of five and nine. Dr. Sandwith found that the disease was most frequent in the prime of life, i.e. between twenty and forty. It was rare above sixty. My observations lead me to agree with Dr. Sandwith in his remarks regarding age incidence in this disease.

As regards occupations, Dr. Sandwith analysed 200 cases. He found that those who work in the fields were most frequently attacked. (More than 75 % of the total number). Next came masons or brick-layers who had to build

build walls with mud. Thirdly came scavengers of street-refuse and cesspools,and fourthly,pedlars of unwashed -- vegetables as onions and radishes. In this country I -- have found that the disease mainly affects farm labour-- -ers and coolies engaged in the construction of mud ---- walls. As regards locality,the disease has been found to be more prevalent in sandy areas than in clayey soils. - But sand from the banks of running streams contains no- larvae. The disease has been found especially in places- where the sand is fine as it can then hold moisture eas- ily. Stiles found the disease also in piney forests --- where trees effectually protected young worms from heat. The disease is found far more among the poor than among- the rich.

The main symptoms produced by the parasite may next be considered. The symptoms are generally mild in tem--- -perate climates,but in the tropics they can become very grave. Stiles classifies all cases of ankylostomiasis - under four groups.[21]

1. Light cases. These include patients who have eggs in their faeces,but who do not present any symptoms which - would attract attention. Even these patients have to be- treated properly,as otherwise,they may become carriers -

21. Stiles. In Osler & Macrae System of Medicine.

of disease.

2. Medium cases. These patients have anaemia as the chief symptom. The anaemia will not be severe enough to make the patients resort to treatment. Only physicians who have a special knowledge of the disease, will be able to say that the anaemia is due to parasites.

3. Severe cases. These include patients who may eat dirt and whom even laymen will be able to recognise as suffering from worm infection.

4. This includes patients with profound anaemia and extreme debility, who are likely to die at any moment.

The symptoms of the disease may be considered under the following headings.

i) Symptoms affecting the digestive system.
ii) .. circulatory system.
iii) .. respiratory system.
iv) .. Nervous system.
v) .. Muscular system.
vi) .. Urinary system.
vii) .. Genital system.
viii) Temperature.
ix) Symptoms referable to skin & mucous membrane.

i) Symptoms affecting the digestive system. [vide cases 1, 2, 3. appendix]

The appetite is greatly increased in the initial stages

stages of the disease, but when the disease has advanced there is complete loss of appetite. At first the patient becomes extremely fond of sour things as lemons, pickles, buttermilk &c. Later, the appetite becomes perverted. The patient eats charcoal, chalk, mud, clay &c. Stiles has mentioned the case of a boy who had eaten three coats ---- thread by thread within one year. In some cases, the perversion is so great that patients eat even mice and --- young rats. I have found that patients relish dirty sand bits of broken earthenware pots & ashes. Nausea is another common symptom. Flatulence and heart burn are also present. Pain and tenderness in the region of the epi--- gastrium are very common. I have come across a patient A. A. aged 25, [vide appendix Case i] in whom there was much tenderness in the epigastric region. She was not markedly anaemic. She --- felt as if something was biting her from inside. She was treated for dyspepsia for a long time, but to no purpose. Examination of the faeces showed many ova of ankylostoma. A three months' course of treatment for ankylostoma infection completely restored her health. Constipation is fairly common. Occasionally there is diarrhaea, Blood -- and mucus are found only very rarely in the faeces. --- Ashford has noted blood in 6 cases and blood & mucus in five cases out of over 22000 examinations of faeces. According to Leichtenstern, the appearance of blood in the

the stools indicates that the worms are copulating.

Symptoms affecting the circulatory system. [Vide Cases 5, 6, 7, 8].

In slight cases, the apex-beat is heard louder than usual. In more advanced cases, the apex is found displaced downwards and to the left. In very advanced cases, the --- apex beat ceases to be distinct, but in its stead, there is pulsation over the epigastrium. In these cases, there may be cyanosis of the lips. The area of the heart becomes -- enlarged, owing to hypertrophy of the left ventricle. Presystolic thrill is found in moderate cases. Palpita--- -tion is a very early and constant symptom. Along with -- this, there is usually pain over the region of the heart. Sandwith considers cardiac pain as a prominent symptom. I have noticed it in several cases.

Pulse. In this disease, the pulse rate is quickened. It- may vary from 80 to 120 or more. In advanced cases, the -- pulse becomes weak, irregular and intermittent.

Blood. Ashford and others working at Porto Rico, found on examination of 590 patients, the average percent of --- Haemaglobin was 45 % in Whites and over 44 % in Mulattoes and 49 % in Negroes. Males had an average of 41 %, and fe- -males 48 %. In extreme cases, they found only 8 %. In a - few, the hoemoglobin was 101 %. In some special cases, the haemoglobin varied from 6 to 65 per cent, with an average of 24.38 %. Under treatment, they found an average increase

increase of haemoglobin of from 21 to 34 %. In some cases they got even an increase of 20 to 30 % every week. They found that reduction of red corpuscles was not in proportion to reduction of haemoglobin. In many cases, the red corpuscles were not affected till the amount of haemoglobin was reduced to 30 %. Sandwith's average was 26 %. -- In Travancore, it has been found that the haemoglobin average in patients suffering from ankylostomiasis is very low. Many of the patients I examined had only from 15 to 25 % of haemoglobin. Only in one or two cases, did the --- haemoglobin rise above 50 %. I have found that under suitable treatment, increase in haemoglobin becomes very evident.

Thus, K-aged 39 had on admission

on 30-8-12, only 10 %.
On 12-11-12, haemoglobin was 35 %
On 15-12-12, 45 %.

K.A.(Female) aged 25 had, on admission

On 30-7-12 only 20 % of Hb.
On 31-10-12, the Hb was 55%

Red blood corpuscles. These become considerably reduced in ankylostomiasis. In severe cases, they may even go down to 750,000 per c.m.m. Generally they vary from 1 to 3 millions per Cubic Millimetre.

White corpuscles. When the disease is in its early --- stage, there is leucocytosis, but when it is very advanced there is leucopaenia. Sandwith has summarised the blood changes in the following table.

Count.	Normal.	Ankylostomiasis.
Red blood corpuscles.	$4\frac{1}{2}$-5x10^6.	1 - 3x10^6.
Haemoglobin.	90-100%.	10-54 %.
Colour index.	.9-1	0.5
White blood corpuscles.	6000-10,000.	9000-12,000
Eosinophiles.	2-4 %	23 %.
Eosinophiles. (absolute number)	225.	3000.

The great increase of eosinophiles is supposed to be -- diagnostic of parasitic infection. (especially helminthic infection). This is only useful in countries, where other parasitic worms are not found.

Symptoms referable to the respiratory system. [vide Cases p.10].

There may be Dyspnoea on exertion. The larvae may - irritate the mucous membrane of the bronchi and set up - bronchial catarrh. In some cases, constant irritation of the bronchi may lead to the development of emphysema of the lungs.

Symptoms-

22. Sandwith's Diseases of Egypt. Vol.I

Symptoms referable to the Nervous System. [vide Cases 11,12,13].

The mental condition of the patients is greatly af--fected by this disease. School Children, when affected, find it very hard to keep up their studies. They become dull and stupid. I have noticed the case of a boy V aged 9, who was brought to me by his uncle with the complaint that he had become dull and indifferent to his studies. On carefully examining the boy, I found he had marked --- anaemia due to ankylostomes, and by suitable treatment, -- his mental condition showed decided improvement. Other - brain symptoms are a feeling of weariness, headache, diz-- -ziness and sleeplessness.

I have had two patients in whom, head-ache and sleep -lessness were very prominent symptoms. In one, P.P. aged 28, a clerk, these symptoms were so troublesome that he -- was obliged to give up work for some months. The ordi---- -nary pain relieving remedies had no effect on him. As - he was markedly anaemic, I examined his stools and found- numerous ankylostoma eggs. After the expulsion of anky- -lostomes, which took about six weeks, he was completely - restored to his former health. In the other case, K.A.- a lady aged about 45, the head-ache was so persistent --- that she was suspected to suffer from brain disease. She was very sleepless, often being without a wink of sleep-

for

for nearly a week. After two courses of treatment with -- thymol, she improved considerably.

Symptoms referable to the Muscular System. [vide Case 14]

Muscles become soft and flabby. Patient is obliged to rest even after slight exertion. Deficiency of Haemo-- globin and red blood corpuscles tell on the vigour of the patient.

Symptoms referable to the Urinary System.

The specific gravity of the urine is usually from - 1010 to 1015. Colour is pale. Reaction is neutral or al- -kaline. The quantity of urine passed is increased in --- amount.

Symptoms referable to the Genital System.

Development may be delayed. There may be great de- -lay of the onset of menstruation. The disease may pro--- -duce abortion or miscarriage in the case of pregnant --- women. In advanced cases, sterility and impotence may -- result. [vide Cases 15. 16.].

Temperature. In some cases, the illness may be usher- -ed in by an attack of fever. I have not noticed fever as a common accompaniment of ankylostomiasis. In one of my - patients, Espie. aged 19, [vide case 17] the attack started with a tempera- -ture

temperature of 103° F. She had irregular attacks of fever which yielded to treatment for the worms. Castellani --- mentions three types of fever.[23]

1. The low intermittent type.

Here the temperature rarely rises above 100° F.

2. An irregular type, at times intermittent and at ---- times sub-continuous.

3. An undulating type. This is very rare. Castellani-- believes that the fever when present, is due to infection by intestinal bacteria, which enter the general circula-- -tion through small wounds produced in the mucous mem--- -brane of the intestine by the bites of the worms.

Symptoms referable to skin and mucous membranes.

I have already referred to 'Ground itch', which oc-- -curs as a dermati tis between toes, and on the sides and top of the foot. The colour of the skin in patients suf- -fering from ankylostomiasis may vary from yellowish --- white to dirty yellow. The skin becomes dry. There may - be severe itching. In chronic cases, the skin becomes --- atrophied.

Hair. If a person be attacked before puberty, there is - an arrest of growth of hair.

23. Castellani & Chalmers' Manual of Tropical Medicine- 2nd. Edition-Page.1309.

Oedema of the face is a very common symptom, especially - in advanced cases. Sometimes there may be oedema over -- the feet and ankles, or the whole body may be oedematous. In one of my cases, H.A. aged 42, [Case 18] there was oedema all over the body. As a rule, the face has a stupid expression. -- Pulsation in the neck is found in advanced cases. Ascites is also found in some cases.

Visible mucous membranes.

They may vary from their natural colour to pearly - white, according to the degree of anaemia. This is espe- -cially seen in the conjunctiva. In many cases, the con-- junctiva becomes pearly white. There may be pigmented -- patches in the tongue in some cases. In advanced cases, - the tongue becomes white.

The subjects of ankylostomiasis are very liable to other tropical complaints as a result of debility. They are specially liable to attacks of dysentery or typhoid. Other worms are often found in association with the ankylostome.

I shall next say a few words on the pathology of the anaemia produced by ankylostomiasis.

Pathology of Ankylostoma - anaemia. It has already been noted that the --- amount of haemoglobin is considerably re- -duced. The total volume of blood is increased. Haldane

Haldane and Smith have worked out the quantity of haemo--globin and the total volume of blood in three patients working in Cornish mines, and have compared them with --- those obtained from patients suffering from chlorosis, pernicious anaemia, anaemia from haemorrhage and polycythaemia. Their results are given below.[24]

	Haemoglobin per cent.	Total haemoglobin in grammes.	Blood Volume (Cubic centimetre).	Relative No. of redcells in whole blood.
Normal.	100	400	3000	100
Ankylostoma	44	311	5160	102
No.(1)	(47	357	5520)	106
No.(2)	(41	331	5880)	
No.(3)	49	316	4620	128
Chlorosis.	40	354	6480	173
Pernicious anaemia	26	179	5160	32
Anaemia from haemorrhage.	33	175	3900	73
Polycythaemia	162	1360	6000	400

*24 Boycott's lecture on Ankylostoma Infection. (Lancet. March 18 - 1911.)

Boycott believes that the anaemia is similar to that of chlorosis. As the result of my own observations on numerous cases of ankylostomiasis, I agree in this view. In both chlorosis and ankylostomiasis, there is increase in blood plasma. There is another point of similarity between these two conditions. The sufferers from both these diseases can do muscular work, even though there be great reduction in the amount of haemoglobin.

There have been various theories regarding the anaemia of ankylostomiasis. At first, it was thought that the anaemia was due to loss of blood through bites of the worms. In 1890, Lussana made an extract from the urine of an ankylostoma patient and injected it subcutaneously into rabbits and produced anaemia in those animals.[25] He next got rid of the worms from the patients by medicines. He then made an extract of the patients' urine and injected it into rabbits as in his previous experiment. The rabbits were not at all affected by the injection. He therefore thought the anaemia was due to poisoning by toxins secreted by the parasites. In ankylostomiasis there is always catarrhal inflammation of the small intestine. Some believed that the anaemia was partly due to some colic bacilli entering the circulation through

25. Ankylostomose in Brouardel et Gilbert's Nouveau Traite' de Medicine

through wounds in mucous membrane and then excreting -- toxins into the blood. Charleton inoculated the perito--neum and veins of a rabbit with repeated doses of Baci--llus coli. After some time, the corpuscles in the blood became reduced to 25 % of their original number. He ---- thought that ankylostoma anaemia could be partly explain--ed in this manner. Castellani thinks that the anaemia -- is due to three causes operating at the same time-viz. -- i). The toxins secreted by the parasites which have the -- power of destroying the red blood corpuscles, ii) The -- actual loss of blood caused by bites of the worms.---- iii) Secondary infection due to microbes.[26]

It has been already stated that eosinophilia is --- well marked in ankylostomiasis. Owing to the presence of toxins, the bone marrow is stimulated to produce eosino-- phils. The toxins also prevent the formation of haemo-- -globin and thus help in the production of a watery con- -dition of the blood. As a result of the diminution in -- haemoglobin, the amount of iron in the liver is diminish- -ed.

Morbid anatomy of ankylostomi--asis.

On postmortem, the swollen appear-- -ance of the body is seen to be -- due partly to fat and partly to -- general oedema. As a rule, there is some fluid in the ---

26. Castellani & Chalmers' Manual of Tropical Medicine- 2nd. Edition-Page.1308.

the peritoneal cavity. There may be fluid in the other - serous cavities. Many of the organs show fatty degenera--tion. The heart is pale and fatty. Usually the cavities are dilated. Sometimes the left ventricle shows some --- hypertrophy. Sandwith has noticed changes in Mitral --- Valve in 12 % of his cases.[27] Muscles are pale. Lungs are oedematous. Liver is pale and fatty. Kidneys also show- fatty degeneration. Spleen may be enlarged. Panereas & - suprarenals are usually normal.

Stomach often contains indigestible substances which -- were taken in as the result of depraved appetite. Its -- mucous membrane presents the appearance of chronic in--- -flammation.

Small Intestine. If the postmortem be made within an hour or two after death,according to the degree of in--- -fection,ankylostomes will be found adhering to the mu- -cous membrane of the third part of the duodenum or in - the jejunum or sometimes even in the ileum.

Later,i.e.after thirty hours,the worms will be found -- floating in the intestinal contents. On washing the je-- -junum and ileum,the mucous membrane is found contract-- -ed. There will be numerous spots of haemorrhage in the- mucous membrane caused by bites of the worms. Microsco-- pic

27. Sandwith's Medical diseases of Egypt-Vol.I.

Microscopic examination of the mucous membrane of the small intestine, shows infiltration with lencocytes, especially eosinophiles.[28] [Please refer to Case 19 · appendix].

Diagnosis of Ankylostomiasis.

Definite diagnosis depends on the detection of the ova in the faeces. The worm is not found in the faeces unless a medicine for expelling the worms from the intestine has been previously given.

There are several methods of detecting ankylostoma infection. These will be discussed in detail.

Methods of detecting the eggs in the faeces.

1. Ordinary method is to make a thin film of faeces on a glass slide and examine under a low power. When the infection is severe, the eggs can easily be found in this manner.

2. Bass's Method[29]. First take a fragment of faeces. Wash with water two or three times to remove some light particles of dirt. Next wash with a solution of calcium chloride of Sp.gr.1050, two or three times. Then add Calcium chloride solution of Sp.gr.1250. The eggs will float on the top as their Sp.gr.is only 1100. The eggs -

28. Ankylostomose in Brodardel et Gilbert's Nouveau ---- Traite'de Medicine.

29. Boycott's Diagnosis of Ankylostoma Infection- Lancet March 25-1911.

eggs can then be separated from crystals and heavy deb-
-ris by centrifugalising. I have found this method use-
-ful in cases of mild infection.

3. Method of culture.[30] Take a small petri dish,4 inch --
deep. Put circular bits of blotting paper about 2½ inch-
-es long and ½ inch high. Fill the dish with water near-
-ly to the level of the top of the paper and cover the --
paper with a thick layer of faeces. Incubate at 30° C to
36° C,for from five to seven days. After this period,the-
larvae will have hatched out of the eggs and swim in the
clear water. They can easily be found by centrifugalis--
-ing the water. Bruns,who has investigated ankylostomia-
-sis in Westphalia,has stated that by the method of cul-
-ture,eggs were found in 99 % of infected persons,where-
-as by ordinary methods,eggs were found only in 40 % of
infected persons.

Pepper's Method.[31] The principle of the method is that -
the ova of ankylostoma are more sticky than those of ---
other parasites. Take a fragment of faeces which has ---
been sedimented. Place it on a slide for a few minutes.
Gently immerse the slide in water. As the ova are sticky

30.Boycott's lecture on 'The Diagnosis of ankylostoma --
infected. Lancet-March 25.1911.

31.Castellani & Chalmers' Manual of Tropical Medicine-
2nd.Edition-Page 1310.

sticky, they adhere to the slide. Eggs of Ascaris, tricho--cephalus dispar, if present in the faeces, are washed away in the water. I have found this a reliable method.

Telemann's Method. Take a small portion of faeces and shake it up with equal parts of ether and hydrochloric Acid. Filter. Centrifuge & examine the bottom deposit.

Blotting paper test. This was introduced by Stiles.[32.] The test may be made with blotting filter or ordinary -- paper. It is as follows:-

Fold an ounce or so of faeces in paper and allow to stand for several hours, then unwrap and examine the pa--per for blood stains. Stiles believes that in many ---- cases, owing to bites of the worms, traces of blood will-- appear in the faeces.

Examination of the blood. Boycott has attached great - importance to the examination of the blood. He thinks -- that in mines the examination of the faeces is not easi--ly conducted. In some cases, he has noted that infected miners, in order to evade the doctor, have given healthy - faeces for examination. He finds that if on examination of the blood of any patient suffering from anaemia, the - percentage of eosinophilis is above 10, there is a very -

32. Stiles' article in Osler & Macrae's system of -- medicine.

very strong probability of his being subject to ankylos-
tomiasis.[33] Blood examination can be conducted easily. ---
There is little chance of deceiving the doctor,as every--
specimen of blood required for examination can be taken -
by him. Boycott's conclusions with regard to the relation
between eosinophilia & ankylostomiasis are as follows.[33] /
Increase in eosinophilia begins to show itself so early -
as three weeks after infection. Eggs usually are not ----
found in the faeces till at least seven weeks after in---
-fection. Boycott examined 148 infected men in Cornwall.
The percentage of eosinophils in a differential count.of-
500 lencocytes on a strained film,varied between 3 & 73 %
5 has less than 5%. 4 between 5 & 7 percent & 139 showed more-
than 8 % of whom 123 had more than 10 % and 49 more than-
20 %, the average of the whole number was 18.2[34] %. The ---
most marked reaction seems to occur in young people who -
have been only recently infected and may not have become-
anaemic at all. In cases of longer standing,the number of
eosinophils may be much less & in cases which have reach-
-ed a severe degree of anaemia,may be even less than nor-
-mal. Ashford has shown clearly that the responsiveness -
of the marrow may be depressed or almost destroyed by ---

33.Boycott's Report to the Secretary of State on Diagnosis of ankylostomiasis by examination of the blood.
34.Boycott's Diagnosis of Ankylostomiasis Infection-Lancet March 25.1911.

by long continued severe anaemia. Absence of eosinophilia was found in Porto Rico to indicate a bad prognosis. The effect of treatment on eosinophilia is very irregular. In the majority of cases, starting with a marked eosinophilia the leucocytis gradually comes to normal or thereabouts as the worms are expelled and the patient recovers. In very anaemic persons, treatment may produce an eosinophilia - which subsequently declines. Eosinophilia is of no value in gauging the results of treatment-or in ascertaining -- whether the worms have died out from an infected person. I think that diagnosis by examination of blood alone is - not of use in tropical countries, as other parasites than- Ankylostoma commonly infest man and they also induce the- production of eosinophilia. I have noted several instan-- -ces, in which ascaris lumbricoides, and trichocephalus dispar have been present along with Ankylostoma duodenale.

Differential diagnosis. Ankylostomiasis has to be diffe- -rentiated from a) pernicious anaemia, b) Beriberi, c)-- Kidney disease, d) Kala Azar. e) Anaemia due to malaria. Each of these will be sepa- -rately considered.

a) In pernicious anaemia, the patient becomes extremely - weak and helpless. In ankylostomiasis, the patient is not- confined to bed even when he has a high degree of anaemia. In pernicious anaemia, no benefit is obtained by the pa--- -tients

patient's removal from one place to another. In ankylos-
-tomiasis,change to a non-infected area tends to produce
a cure,combined with specific treatment.

Examination of the blood. In pernicious anaemia,the co-
-lour index is 1 or about it. In ankylostomiasis,it is -
low and becomes lower in proportion to the fall in hae-
moglobin. Again,eosinophilia is markedly present in ---
ankylostomiasis,but not so in pernicious anaemia.
Poikilocytosis,normoblasts and megaloblasts are more ---
marked in pernicious anaemia than in ankylostomiasis. --
Again,the volume of blood in ankylostomiasis is twice --
that of the normal. The anaemia is due to the diluted --
condition of the blood and not to a real deficiency of -
the haemoglobin and red blood corpuscles,whereas in per-
-nicious anaemia,there is real deficiency of haemoglobin [35]
Ankylostomiasis is found in hard-working peasants,where-
-as patients suffering from pernicious anaemia are not -
fit for any kind of work. In pernicious anaemia,neither
the eggs nor the adult worm ankylostoma will be found on
examination of the faeces.

b) From Beriberi. In Beriberi,muscular feebleness is -
well marked,but not so in ankylostomiasis. Again,in Beri
beri,there is hyperaesthesia of calf muscles together --

35. Anaemia in ankylostomiasis by Boycott-B.M.J. Nov.
9-1907.

together with absence of kneejerk. In ankylostomiasis,-- the kneejerk is normal and there is no hyperasthesia of- the calf muscles. Thirdly,in Beriberi,there is numbness, especially in front of the shins,,whereas numbness is -- entirely absent in ankylostomiasis. In Beriberi,examina- -tion of the faeces does not reveal any infection by --- ankylostoma.

From Kidney disease. In ankylostomiasis,the patient --- passes urine freely. In kidney disease,the excretion of- urine is deficient in quantity. Again,the urine is pale and clear and free from casts in ankylostomiasis,whereas the urine is cloudy and contains numerous casts in kid-- -ney disease. In kidney disease,no characteristic ova - are found by examination of faeces.

d) From Kala Azar. The anaemia of Kala Azar is a sort - of Cachexia. In Kala Azar,there is enlargement of liver- and spleen. Fever is also a very constant symptom in --- Kala Azar,but it is not commonly found in ankylostomias- is. Prostration is a well marked feature of Kala Azar -- but not at all pronounced in ankylostomiasis. In Kala -- Azar, Leishman Donovanbodies can be found in splenic juice or even in peripheral blood. In Kala Azar,ankylos-- -toma,either as ova or as worm,is absent in the faeces.

~~Prognosis. In very old persons,the prognosis is grave.~~

e) From anaemia due to Malaria.

In anaemia due to malaria, there is usually ---- enlargement of spleen. There will be periodical attacks of malarial fever. During the attack of fever, if a -- drop of blood be taken from the patient and examined under the microscopes malarial purasites will be found. Mononuclear lucoytosis is found in Malaria, where as --- eosinophilia is a marked feature in ankylostomiasis.

In malaria, the loss of haemoglobin is only in -- proportion to the loss of red blood corpuscles, where as in ankylostomiasis the loss of haemoglobin is far ------ greater. In ankylostomiasis, the characteristic ova- will be found in the faeces.

36. Sir Patrickmanson's manual of Tropical diseases. Fourth Edition. 1911- Page 722.

Prognosis. In very old persons, the prognosis is grave. Complications due to the coexistence of other diseases, increase the gravity of the case. Prognosis is very grave in parturient women. Even a small loss of blood during delivery, is very badly borne by patients suffering from a high degree of anaemia Besides, the strain and exertion of labour may bring on heart failure.[36] Patients may die soon after the child is born. Postpartum haemorrhage is not common. Premature delivery is common. Children may be still born or may be born healthy. Sandwith says that in old people, the outlook gets worse every year after 50. In hot countries, the prognosis is also rendered serious as patients are apt to neglect their health. Again, the chances of reinfection are very great in warm countries. Prolonged illness leads to fatty degeneration of the organs. Patients suffering from ankylostomiasis have very little power of resistance and so they become easily susceptible to other diseases, such as bronchitis, pneumonia, tuberculosis and rheumatism. As intestinal mucous membrane is always injured in ankylostomiasis, other pathogenic bacteria, as for example, those causing enteritis and typhoid fever, gain access to the intestine easily.

In cold countries, the disease is found usually among

[36]. Daniel's Tropical Medicine & Hygiene, (1st. Edition) Vol. II-Page 138.

among miners. The prognosis is favourable as they are -- easily brought under treatment and the chances of rein-- -fection are also remote.

Treatment. This may be dealt with under two heads- --- prophylactic and Curative.

Prophylactic measures.

Dr.Castellani,in his Manual of Tropical Medicine,- thus sums up the preventive measures against ankylosto- -miasis.[38]

Summary of preve ntive measures.

Educational.

Instruction of rich & poor with regard to the methods - of infection,symptoms,treatment & prophylaxis.

Personal Prophylaxis.

1. Protection of the feet.
2. Protection of the hands.
3. Immediate treatment of the eruption on feet or hands.
4. Necessity of early treatment.

Public prophylaxis.

1. Search for and treatment of carriers.
2. Search for cases of the skin eruption and treatment - of the same.
3. Search for cases of anaemia & treatment of the same.
4. Provision of sanitary conveniences kept in good con- -dition and associated with a good system of conser--- -vancy.

These methods will be discussed in detail.

38. Castellani & Chalmers' Manual of Tropical Medicine- 2nd.Edition-Page 1316.

Educational measures. At Porto Rico, the patients were given medicines and a card with instructions. On the card were printed the following

1. Take one of the two purgatives given to you tonight (sodium sulphate).

2. Take at 6 A. M. tomorrow half the capsules (all the capsules equal 45 to 60 grs. of thymol or 23 to 45 grs. of B naphthol).

3. Take the other half at 8 A. M. the same morning.

4. Take the other purgative at 10 A. M.

5. You should neither drink wine nor any alcoholic liquor during the time you are taking these medicines.

6. Come for more medicines until the physician says you are cured.

7. Have a privy in your house. Do not defaecate on the surface of the ground but in the privy.

8. Do not walk bare footed so that you may avoid catching mazamorra in your feet. Wear shoes and you will never suffer from anaemia.

Much good can also be done by delivering

illustrated popular lectures giving in detail the main signs of the disease the great suffering induced by it and also the results of successful treatment.

Sir Patrick Manson outlined a sanitary scheme to stamp out this disease.[39] The details of the scheme were

(1) In villages or districts infected with the disease, a headman should be elected who would be responsible for carrying out local measures.

(2) The headman should be made responsible to the Surgeon who in turn should be responsible to the Surgeon General of the colony.

(3) There should be a Special Inspector General to deal effectively with sanitary methods to be employed in warding off the disease. He should supervise a group of colonies and be responsible to the Secretary to State.

Personal Prophylaxis.

1. Protection of the feet. Wearing boots is a very efficient protection for the feet. For coolies, this is not possible. By dipping their feet first in a bucket of

[39] Medical Annual- 1910.

tar and then into a bucket containing fine sand, they get a good coating of tar on the feet which serves as a protection against the entrance of larvae.

Protection of the hands. Hands should be thoroughly cleansed with soap and water before they are used for partaking of food.

Immediate treatment of the eruption on feet or hands. Early treatment will check the progress of the disease. As soon as an eruption has appeared, it should be painted with a solution of Salicylic acid in collodion (1 in 6). If patient be seen only a few days after the commencement of the eruption, he should be ordered to wash the affected part with weak carbolic lotion (1 in 100). The vesicles and ~~particles~~ pustules should be incised and cleaned with (1 in 40) carbolic lotion. Next the whole part should be dressed with lint soaked in carbolic lotion. For itching Dr. Castellani recommends the following ointment:--

Acid salicylic	gr. V
Zinc oxide	3 II
Vaseline	3 I

The affected part should be dressed twice daily. Internal treatment should also be ~~reverted~~ resorted to at the same time, in order to expel the worms.

Public prophylaxis.

1. Search for & treatment of carriers. This is very important as the carriers if left untreated will serve to transmit the disease to healthy individual.

Search for cases of skin eruption and treatment of the same. In some places, many of the patients suffering from the disease give a history of skin infection. Hence early recognition and treatment of skin eruption will check the spread of the disease.

Search for cases of anaemia and treatment of the same. Prompt measures for dealing with all cases of anaemia will tend to root out ankylostomiasis.

Provision of sanitary convenience kept in good condition and associated with a good system of conservancy. This is the most important prophylactic measure. By attention to this, the disease has greatly been checked in various countries.

General prophylactic measures adopted in mines.[40] The principles to be observed are to disinfect the mine, to prevent their reinfection, to cure those who are ill and to protect the healthy from contracting the disease.

40. Ankylostomose: in Brouardel et Gilbert. Nouveau Traité de medecine

Disinfection of the mines. At least some parts of the mine can be thoroughly disinfected. The substances used for disinfection are, Whitewash, 5% solution of lysol or a solution of ferrous sulphate. Dilute solution of sulphuric acid is useful. It is found naturally in some mines. Ex. Kremnitz. These are free from ankylostomiasis. By lowering the temperature of the mines and reducing moisture, much good can be effected. In damp mines, there will be water-pools and accumulations of mud. Mud should be removed in buckets. Water from pools should be collected by means of channels and pumped up and emptied.

Improved methods of ventilation will lower the temperature. Miners should not be allowed to defaceate underground. There should be good latrines above ground containing receptacles with lids. Near these, whitewash should be kept ready. Special men should be employed to see that the whitewash is put into the faeces soon after defaceation. Workmen should be given pure drinking water and also sufficient water for washing their hands before eating. Guiart suggests that there should be dressing lavatories. In each lavatory, there should be a big hall with several cords hanging from the roof with hooks to be let up or down by pulleys. Going down, the miner puts

off his clean clothes, hooks them to his cord, pulls them up to the roof and puts on his working clothes. Leaving work he takes these off, goes into washing room, cleans himself quickly by a douche and puts on his house clothes in the dressing room. The advantage of an arrangement like this is that the chances of the workman carrying contagion when he goes out of the mine are small. Attached to mines, there are special dispensaries for treatment of ankylostomiasis. All the men who are ill are sent there. Before they return to work, they have to produce a certificate that their faeces had been examined microscopically and that there were no ova in the faeces.

General prophylactic measures. I have already mentioned that the main source of infection is the indiscriminate deposition of contaminated faeces. Persons should not be allowed to defaceate on open ground. Deposition of faeces in shallow cesspits is not very objectionable. In these cesspits, some flies (for example, Sarcophagidae), deposit larvae. These larvae eat up the eggs and larvae of ankylostomes. If cesspits be made of brick or cement, owing to the impervious nature of the material, larvae cannot develop and they die. In places where the faeces are conveyed to septic tanks, the

larvae are killed by the bacilli which abound in the tanks. In the process of making pondrette from the faeces, the eggs and larvae of ankylostomes are completely destroyed. A pure water supply is necessary in places where ankylostomiasis is prevalent. It is a safe rule to use only boiled or filtered water. Farm labourers, brickmakers, miners and all those who, by the nature of their occupation, are likely to get their hands and feet contaminated by soil or clay, should wash thoroughly before partaking of food. Whenever possible, those who work in the fields should wear boots and puttees. Night soil should not be left exposed, but should be collected in privies or trenches and properly disinfected. The measures adopted for combating the disease in various countries with the results obtained will now be described.

Measures adopted in Westphalia. The disease was imported into Westphalia by miners from Hungary. In 1897, Government passed a regulation by which all foreigners who applied for work in Westphalia were examined for ankylostomiasis. Those who were found suffering from the disease were excluded. In 1900, another regulation was passed forbidding employment of miners from Belgium and Hungary. On investigating the disease, the causes were found to be

(1) Soiling of the ground by human faeces which

contained ova. (2) Range of temperature of the mines. (3) Moisture of the ground.

Measures adopted to check the disease.[40a] Periodical examinations of all the workmen employed in the mine were made on pay days. Those who were found to be suffering from anaemia, were sent to hospital for treatment. Ventilators were introduced. These served to lower the temperature of the mine and thus retarded the development of larvae. A few good privies were constructed underground and men were enjoined not to pollute the ground. Instead of a common tank at the surface of the mine in which all the workmen washed themselves shower baths were introduced. The receptacles used in the privies were vessels of galvanised iron and provided with a lid. The disinfectant used was milk of lime (1 in 4). Another plan of disinfection adopted was to keep some water in the receptacle. Floating on the top of the water was an oily disinfectant, so that as soon as the faeces were passed, they were covered on the surface with a film of the disinfectant. This plan destroyed the odour of the faeces and also destroyed the ova. General disinfection of the mines was also attempted. Milk of lime

40a. Report on Outbreak of Ankylostomiasis in Westphalian Collieries - page 7, by J.S. Haldane.

was pumped from a large iron vessel through a hose. Precautionary measures, together with effective treatment, caused a marked improvement in the health of the miners in Westphalia.

The following table shows this conclusively.[41]

	No. of infected men.	Per cent.
May - October 1903.	14548	100.0
February 1904.	3663	25.3
November 1904.	3288	22.6
October 1905.	2352	16.2
December 1905.	2103	14.5
January 1907.	1366	9.4
August 1907.	1111	7.6
April 1908.	895	6.2
March 1909.	749	5.2

~~Measures adopted in Cornwall.~~

Measures adopted adopted in Cornwall. The men who were actually sick, were treated by doses of thymol. When they improved in health, they returned to duty to the infected mine. In some cases, there was re-infection,

41. Boycott on Ankylostoma Infection Lancet - April 1, 1911.

Whenever there was re-infection, the treatment was repeated. Sanitary reforms were also introduced into the mines. The Home Secretary for Mines passed the rule 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.' In 1904, new pails which could be easily taken out and cleaned, were introduced. In four years, the number of men who were disabled by ankylostomiasis became very few.

In some mines, the want of moisture and suitable temperature prevents the spread of ankylostomiasis . Ex. In West Kitty Mine at St. Agnes owing to cold and dryness of the mine, the larvae could not thrive. On examination of the miners,Boycott found only one man infected. He was a man who had just returned from gold mines in Mysore. Some mines contain salt water which kills larvae. Thus the immunity of the Levant Mine at St. Just, in spite of its having the required temperature and moisture is said to be due to the salinity of the water. In the Transvaal, the water in the mines contains

acid water (sulphuric acid from decomposing pyrites).

The larvae of ankylostoma are killed by 1% sulphuric acid. The water in the mines contains more than this quantity of acid and so the mines are free from this disease.

Measures adopted in Porto Rico. Ashford who investigated the cause of anaemia in Porto Rico, discovered that it was due to Ankylostoma infection. In 1904, a commission was appointed to investigate the extent to which ankylostomiasis prevailed in Porto Rico. On examination it was found that at least 90% of the peasants were infected. The peasants were mainly exployed in coffee plantations. They used to defaceate in the open space near their houses. They never used boots. The soil near their houses was found permented with the ova of the worms. The commission treated 5490 patients in 1904. Of these, 48% were cured, 31% improved, 1/2% died and the remainder could not be traced. They next started dispensaries in different parts of the island. Patients were examined at these dispensaries, they were given suitable medicines and a printed card containing instructions. The instructions contained in the card have already been referred to in this paper. The patients

continued to visit the dispensary till ~~x~~ eggs were absent - in their faeces. The work done during the years 1904-09 is summarised in the following table.[42]

	New patients visited.	No. of visits.	No. of deaths.	Amount spent. £
1904-05	5490	22000	27	991
1905-06	18865	76896	67	2162
1906-07	89233	425131	193	9823
1907-08	81375	472407	93	11390
1908-09	54725	305598	46	6472
Total.	249688	1302032	426	£30838

[42] Boycott on Ankylostoma Infection- Lancet-April 1,1911.

In Ceylon infected faeces are mixed with coir fibre and burnt in small incinerators.

Curative treatment. The drugs used are Thymol, B naphthol, extract of male fern, euculyptus and chloroform mixture. [for treatment according to Hindu medicine, please see appendix. page 4].

Thymol is the drug which has been used on a very large scale for the treatment of ankylostomiasis. Bozzolo introduced thymol in 1880, for the treatment of this disease. There are several methods of administering thymol.

Guiart's method. Put the patient on milk diet for one or two days, then for three consecutive days, give him two to three cachets each cachet containing one gramme of thymol. He has to take these early in the morning, on an empty stomach. An hour's interval should elapse between taking each cachet. If his bowels have not moved, he should be given a purgative five or six hours after taking the last cachet. This treatment should be repeated on three successive days. The faeces are examined for ankylostomiasis on the days in which he takes medicine and also on the fourth day. If at the end of a week, faeces should contain ova, the treatment should be repeated .

Treatment adopted at Porto Rico.[43] 30 grammes of magnesium sulphate are given in the evening. Next morning, patient is made to rest in bed and at 8 A.M., he is given 2 grammes of thymol in capsules on an empty stomach. At 10 A.M. a second dose of two grammes is given and at 12 noon, a second dose of salts (30 grammes of magnesium sulphate) is given.

Schultz's method.[44] In the evening, a dose of magnesium sulphate is given to the patient, on an empty stomach, 60 grains of thymol, divided into two portions and mixed with one third the quantity of milk sugar. The mixture is given in two doses, with an interval of two hours between each dose. Another purgative is given two hours after the last dose.

Nicol's method. He advises three doses of thymol of 30 grains each, at two hourly intervals. He found this method most effective in getting rid of the worms. He found that after the first treatment 97.87% of the worms were expelled and after the second treatment, all the worms were expelled.

43 Ankylostomiasis in Medical Annual, 1909.

44 Do. Do. 1913.

Stiles' method.[45] The evening before the thymol is given to the patient, a dose of magnesium sulphate or soda sulphate is given. This is to remove the mucus which serves to fix the worms to the walls of the intestine and which serves to protect them. Next morning, the patient is given 30 grains of finely powdered thymol in capsules and the dose is repeated two hours after. A dose of salts is given two hours after the last dose of thymol.

Sandwith's method[46] Patient is given 1 gramme of thymol at 6 P.M. when he is in bed. Next morning at 6 A.M., he is given another gramme and at 8 A.M., he is given 30 grammes of magnesium sulphate. For the rest of the day, he is kept absolutely at rest. At first, Dr. Sandwith used to give a preliminary purge, but he found this tended to exhaust the patient.

I have tried this method in over fifty cases, with very satisfactory results.

Treatment adopted in Cornwall. A purgative of calomel was given in the afternoon to the patient. Next morning, he was given three successive doses of 30 grains each of

[45] Stiles's article in Oslen & Macrae's system of Medicine.
[46] Sandwith's Medical Diseases of Egypt, Vol. I.

thymol, as emulsion or in capsules at intervals of two hours. Patient was kept in bed and had no food except tea or coffee. After the last dose of thymol, another purgative was given.

Dosage of thymol. This should be in proportion to the age of the patient. The Porto Rico Commission, who treated cases of ankylostomiasis, fixed the following doses.

Age.	Amount of thymol.
For children under 5 years.	7.5 grains.
Between 5 & 10 ,,	15 grains (one gramme).
,, 10 & 15 ,,	30 grains (2 grammes).
,, 15 & 20 ,,	45 grains (3 grammes).
,, 20 & 60 ,,	4 grammes (60 grains).
Above 60 ,,	2 or 3 grammes.

Contraindications for thymol. Thymol should not be given to patients who are weakened by exhausting diseases. Pregnancy, advanced cardiac or other organic disease, a tendency to vomit, anasarca, chronic diarrhaea and dysentery are also contraindications.

Precautions to be observed while administering thymol. Patient should be kept in bed quite at rest. Castor oil,

alcohol, ether, chloroform, glycerine, turpentine and oils generally are solvents of thymol and so they should not be administered soon after thymol. If a patient becomes collapsed soon after taking thymol, he should not be given brandy. Strychnine may be given hypodermically. Coffee can be given by the mouth and hot water can be injected through the nectum.

Symptoms of thymol poisoning. Temperature is lowered by 1 °c or 2 °c. Both pulse and respiration are slowed. Patient becomes giddy and faint. He may be collapsed. As a rule, if kept in bed for a few hours, these symptoms pass away.

Treatment by B naphthol.

Castellvi's method.[47] Patient is first given a saline purge. He then fasts for 3 hours. Eight or nine hours after the purge, two doses of 1 gramme each of B naphthol are given to the patient. The last dose of B naphthol is followed two hours later by a purgative (senna infusion with 30 grammes of sodium sulphate and 30 grammes of rhubarb infusion). The treatment was repeated at the

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expiry of a week. Castellvi treated 33 cases. His results were

Two were cured after one treatment.
Nine ,, two treatments.
twelve ,, three treatments.
six ,, four ,,
Four ,, five ,,

Nicol's method.[48] He gives three doses of B naphthol (30 grs. each) at interval of two hours. He also gave a purge before and after administration of B naphthol. B naphthol has been used on a large scale among the Indian coolies to free them from parasites before they enter Natal. It has been found that 90 grs. of B naphthol had the same effect as an equal dose of thymol as regards expulsion of the worms.

I have tried B naphthol in small doses, but I have not employed it in large doses as advised by Nicol. As regards the power of expelling worms, I have found it to be inferior to thymol.

Manson's method. Sir Patrick Manson first introduced

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the eucalyptus, chloroform and castor oil mixture for treatment of ankylostomiasis. The formula is as follows.

Eucalyptus oil eucalyptol	~~ʒ~~ ʒfs
Chloroform	M 45
Ol. Ricnii	~~ʒ~~ 3ˣ

This is divided into two doses. The first dose is given early in the morning and the second dose is given half an hour later. Sir Patrick Manson has found this mixture to be far safer than either thymol or B naph -thol. I have tried this mixture in many cases where owing to extreme debility, I could not give thymol. I have also found it very useful in treating patients who have disease of the kidneys as a complication.

According to Sir Patrick Manson, the essential ingredient in the mixture is chloroform. Some patients cannot tolerate this mixture. The action of this mixture is facilitated by giving a dose of magnesium sulphate an hour after the second dose of the mixture.

Extract of male fern. This drug is used on a large scale on the continent of Europe in treating ankylostomiasis.

The best way of administering it is as follows:-

M.M. Molvoz and Lambinet's treatment at Liege.[49]

In the evening the patient takes a cachet containing

Jalap.	..	aa 0.25 gr.
Calomel.	..	

The second day, in the morning he swallows eight capsules, each containing 0.50 gr. of extract of male fern, and after one hour, another eight of the same kind.

The patient must take care to stay in bed to avoid nausea, vomiting, giddiness, &c.

During the morning, he will take some very strong tea or coffee and at 2-P.M. a light but substantial meal of soup, beefsteak, eggs or vegetables. After a day's rest he swallows, fasting, the following draught, which he will take at two times with an hour's interval.

Ethereal extract of male fern.		4 grammes.
Pure chloroform.	..	2 ..
Glycerine, neutral.	..	40 ..

He stays in bed till 2-P.M. and then can breakfast. This treatment has to be repeated generally two or three times at intervals of a week or a fortnight.

[49] Ankylostomose: in Brouardel et Gilbert Nouveau ----- Traite' de Médecine 1906. iv. p.

'Izal' has been tried in large doses and found effective in expelling the worms.

Treatment by Coliform Vaccine.[50]

Captain Archibald has treated one case of acute --- Agchylostomiasis by means of an autogenous vaccine of a - coliform organism which he isolated from the faeces of - the patient. The patient received an injection of 500 --- million organisms. Five days later, he was given an in--- -jection of 1000 million. He was given a third injection after another week. The patient showed improvement soon-- after the first injection. The conclusions arrived at by- Captain Archibald are that, in some cases of severe anky-- lostomiasis, symptoms may be due to absorption of intesti- -nal organisms and their toxins, and that in such cases,- injections of vaccines of the coliform organism are at--- tended by highly beneficial results.

In all these, after expulsion of the worms, some prepa- -ration of irom should be given to combat the anaemia, My own experience has shown me that of all iron salts, Ferri- et Ammonii citras is the best and most agreeable to the -- patient.

But the treatment of this disease has recently taken

[50] Journal of Tropical Medicine & Hygiene--September 1 ---- 1913.

taken a new turn, suggesting brilliant possibilities for the future. After the immortal Pasteur had revolutionised the medical world as to the causes of putrefaction, the famous exponent of his theory. Professor Metchnikoff, by his laborious researches, proved that intestinal putrefaction had a great deal to do with the causation of diseases in general. It is well known that his advocacy of the sour milk treatment to combat intestinal putrefaction was the direct outcome of his researches in this direction.

Later, William B. Hunter showed by his researches, that intestinal toxaemia played a material part in the causation of anaemias in general. He accordingly proposed strict attention to hygiene of the mouth as a preliminary treatment of all kinds of anaemia.

Captain Archibald, following up the line of investigations suggested by Hunter, came to the conclusion that intestinal toxaemia was a material factor in the production of ankylostomiasis. In the course of his researches he succeeded in isolating a coliform organism from the faeces of a patient who was suffering from acute ankylostomiasis. On making an autogenous vaccine of this organism and injecting the patient with gradually increased doses, he was able to afford material relief to the patient.

(Vide Journal of Tropical Medicine & Hygiene-September 1,1913.)

Besides Vaccine therapy, which has been, before the Medical World for some years, there is another new branch of the Science which is also fraught with much promise -- for the relief of suffering humanity. I refer to organotherapy.

The markedly beneficial action of Kinazyme, and Lymphoid compound and Ovamnoid compound, in the treatment of-tuberculosis, goitre and disorders of menstruation, is now-a-days very well known to every practising physician. In the present state of our knowledge, there is reason to --- hope that further development of organo therapy will lead to the discovery of some remedy for combating ankylosto--miasis, the serious economic consequences of which is en--gaging the attention of political and medical authori---ties in several parts of the world.

Summary of Thesis.

An investigation of this disease is important, as this is one of the most common causes of anaemia in the tropics.- This observation applies with special force to Travancore which is an agricultural country and which, geologically, is of a nature favourable to the prevalence of the di----sease. This disease has been recognised by Medical men- from ancient times, in Egypt and India.

It is now found to be prevalent in Central & Sou---thern Europe(Vide Page 5.), but not found above 52° N.- Lat. In Asia-Cases have occurred in Japan, Burmah, Malay - Archipelago, Ceylon and several parts of India, including-- Travancore.

In temperate climates, the disease is found only in- Mines. The colder the climate, the less virulent the at--tack of the disease. There are three kinds of parasites belonging to the species Ankylostomum, which produce the - disease. Of these, Ankylostoma duodenale is the commonest in Travancore and other parts of India. Necator America---nus has been observed in different parts of India, but -- only very rarely in Travancore. Ankylostoma Ceylanicum - was first recognised in 1913.(Vide para Tabular State--ment-Pages 16, 17)

~~was first recognised in 1915. (Vide para Tabular State-~~
~~-ment-Page).~~

Development of the parasite is briefly thus:-

The female lays the eggs in the intestines of the host which develop into larvae. These larvae undergo four successive ecdyses. (Vide Page 18,19).

For infection of man, the larvae should have at --- least passed the second moult. Experiments have shown --- that direct infection from man to man is impossible. Air, moisture and warmth are necessary for the development of larvae. Hence it is impossible for the eggs to hatch-- while in the intestines of the host. Some antiseptics --- readily destroy larvae. Common salt is one of the common- est things that has this action.

Infection may be in two ways; i) by the skin, ii) by the mouth.

Infection by the skin is by far the commoner. This fact accidentally discovered by Professor Looss ~~in 1914~~. His experiments have gone to determine the mode of infec- -tion. (Vide Pages 25.26).

The possibility of skin infection is confirmed by - the analogy of ground itch, common in several parts of --- India. Skin eruption caused by this parasite is common -- enough

enough in mines in Europe, but not common in Egypt or --- Travancore. Probably this might be due to the fact that common people and coolies walk about bare-footed and so develop hardness of skin. Originally, infection by the -- mouth was considered to be more common than infection by the skin. It was this kind of infection which Perroncito observed in St. Gothard Tunnel.

This kind of infection is common enough in Travan--core. Infection is generally carried by eating with --- dirty hands. Flies may also carry infection. The disease is found only in places where there is no proper provi--sion for disposal of faeces and in localities where the climate is damp. Luxuriant vegetation, especially shrubs protects larvae.

Opinions vary and are sometimes contradictory in -- regard to the frequency of the disease according to the age or sex.

In Travancore, the disease mainly affects farm la---bourers and coolies engaged in the construction of mud walls, which usually surround homes in many localities.-

Symptoms produced by the parasite vary according to climate being mild in temperate climates and more grave-- in the tropics. The disease develops characteristic symp--toms

symptoms when it affects various organs of the body.(Vide Pages 35-42). Puffiness of faces, oedema under the eye-lids-and pearly white conjunctiva,are among the common signs--of the disease. Different views are held by different au--thorities as to the causation of the anaemia by ankylos--toma. Dr.Castellani's view appears to be the most accep--table.

Diagnosis is commonly made by recognition of the --ova,as worms appear in faeces only, if expelled by medi--cine.

Ankylostomiasis is sometimes confounded with perni--cious anaemia,beriberi,kidney diseases and Kala Azar, but anaemia due to malaria. the ova,if observed,decide the case.

Prognosis is bad in old people and pregnant women. Generally,prognosis is graver in tropical countries,as --the people have less power of resistance.

Treatment of the disease may be considered under --two heads:-

i) Prophylactic, ii) Curative.

Prophylactic measures fall under 3 classes:-

i) Educational.(Instruction of the poor in regard to the nature of disease and conditions of infection).

ii) Personal. (For example,protection and cleanliness as regards hands,feet &c.)

iii) Public. (Precautionary measures to be adopted, for example, against faecal contamination.) Different -- measures have been adopted in different countries, for -- combating the disease, with varying results-(Vide Pages 62-68.)

ii) Curative treatment.

Several drugs have been used in treatment. Of these, thymol has been found to be the most useful in --- practice for expelling the worms.

The treatment by Coliform Vaccine is still on its-- trial. When the worms have been expelled, anaemia has - to be combated by some preparation of iron.

Ferri et Ammonii Citras has been found in practice to be the best and most agreeable to the patient. But -- apart from all this, the treatment of the disease has a -- brilliant future in the new possibilities suggested by -- the researches of Captain Archibald, (Journal of Tropical Medicine & Hygiene. Sep. 1. 1913) who, no doubt, must have --- been benefited by the views of Hunter on the causation - of anaemia, through intestinal toxaemia.

Appendix on Hindu medicine.

1. The Ashtangahridaya by Vagbhata is one of the --- authoritative works on Hindu medical science. It is --- one of the mementoes of Indian Buddhism and must therefore be more than ten centuries old.

According to Vagbhata, the disease is called ---- "Pandu" because as a result of it the skin assumes a --- pandu (pale) yellowish or greenish colour, and in any -- case paleness will dominate all these texts.

Verse 3, Chapter XIII
Ashtangahridaya.

Symptoms.

Tato-lparaktamedasko nihsarah syac.chlathendriyah
Sunakshikutah vadanah kopanah shthivanolpavak
Annadvitsiradveshi sirna roma hatanalah
Sannasaktho jvari svasi karnakshvedi bhrami srami

Verses 5 - 7 ch: xlll

Translation.

As a result of this disease the patient becomes - emaciated and blood-less, weak and feeble in action ---- (mental as wellas physical)having his eyelids swolen;--- indolent,always inclined to be angry (or peevish) fond- of spitting often, reticent, not relishing his food, ---

food, hating cold, with his hairs falling out, ---------
digestion impaired, tired in the thighs, feverish, -----
breathing hard, attended with singing in his ears, -----
giddiness and exhaustian .

First symptoms (or prâgrûpam) observed before---
actual identification of the disease by standard -------
symptoms.

Prâgrûpamasya- hridayaspandanam rûkshiatâtvachi
Aruchih pîtamûtratvam svedâbhâvo-gra vahnitâ

Verse 8, Chapter Xlll.

Translation.

The first symptoms of the disease are:-
Palpitation of the heart, roughness of the skin, loss of-
appetite, yellowness in the urine, obstruction of ------
perspiration, weak digestion.

Vagbhata says that this disease may arise from --
among other things, eating earth.

Verse 7 Chapter Xlll

2. Charaka, who lived in the first century A. D. is the most ancient authority in Hindu medical science. -- His views as to the symptoms of the disease are given in

in verses 10 to 14 chapter 20 Chikitsitasthanam -------- charakasamhita. There is a general agreement between -- his views and those of vagbhata. Both agree also in -- thinking that eating earth is a cause of the disease.

3. Susruta who cannot be placed later than the fourth- century A. D. considers eating earth as one of the ----- first symptoms (pragrupam) of the disease and not a ---- cause.

Verse 3 ch: XLIV.

Uttarasthanam, Susruta samhita.

Treatment of ankylostomiasis according to Hindu medicine.

Boil galls in cow's urine till the urine has----- completely evaporated. (for 100 galls, 48 ounces of--- cow's urine are required). Take the kernel out of the gallnuts. The covering of the gallnuts which has a --- layer of solid constitents of cow's urine, is finely ---- powered. for adults, the dose of powder given is 37 ----- grains. The powder is adminstered in warm butter milk twice a day, for a fortnight. Galls have the power of --- expelling worms. Purified sulphate of iron, or oxide of iron is given - afterwards to combat the anaemia. The preparation of -- iron is given for a fortnight.

Illustrative cases.

Case. 1. A. A. 25, nair, mother of three children, one of whom is suffering from ankylostomiasis. Has a ----- comfortable home. She lives in an unhealthy locality. She had been suffering from pain in epigastrium. Her power of digestion was very poor. She had a feeling as if something was gnawing her inside. First came for -- treatment on 15-8-12. On examination she was not ---- markedly anaemic. She had only digestive trouble. She was treated for dyspepsia but did not derive any benefit Examination of faeces revealed many ova of A. Duodenale. She was given four doses of β naphthol of 1 gramme each. -- followed by a purgative. ~~Each~~ were given at intervals of a week. At the end of a month she felt much better, and there were no ova in the faeces. In another two months, she was -- completely restored to health.

Case 2. M. I. 20. Brahmin, student, Patient contracted the disease while residing in an unhealthy locality. He had mainly digestive troubles. He was admitted on 25-10-12 He was given two courses of thymol, at -------- intervals of a week which expelled all the worms. The anaemia was not severe. On admission he had 50% H.b. After treatment for seven weeks the haemoglobin rose to 75%. There was also great improvement in his general health.

Case 3. Ouseph- 32. Admitted on 31-12-'13 came for treatment on account of anaemia along with digestive --- troubles. He was living in an unhealthy locality and w working in the fields. At first he had deprved ----- appetite, but later on, he found he was not able to ---- digest food. He got three courses of thymol treatment from which he derived great benefit. Errors of --- diet were attended to. He was given medicine with the object of promoting digestion. Now at the expiry of two months, he has shown great improvement. For combating the anaemia Hommel's Haematogen was found useful.

Case 4. Abdullah. 35. Mahomedan. Came in for treat ment for anaemia and palpitation on 16-9-12. He noticed he was getting pale about 6 months ago. Gradually he became weak and unable to do work. Previous to this, he had been in sound health.

Social condition and habits. He lives in a sandy -- locality. The soil is dirty. He has built mud walls. He has also done cooly work. Family history is ------ satisfactory. On examination he is fairly well ------- built . Skin has a yellowish tinge. Conjunctivae ----- pearly white. Lips and gums very pale. Appetite ---- very great. He used to eat sand and broken bits of --- earthenware. Blood watery. Haemoglobin 15% He had ---- palpitation on slight exertion, but no bruit. After -- four doses of thymol at intervals of a week, ankylostoma

disappeared from the faeces. He was also given iron and digitalis. In two months he was greatly improved in -- health.

Case No. 5. K. 39. Admitted on 30-8-12. Cooly complaint palpitation and anaemia. State on admission. patient poorly developed. Has puffiness under eyelids. Some swelling on the dorsum of both feet. Face very pale Lips and gums white Tongue white. Ravenous appetite, feels gnawing pains round unbilicus.
Circulatory system. Blood watery H. 10%.
R.B.C. 7,50,000, pain over praecordia.
Pulse 82. Nervous system. Patient has slight headache numerous ova of ankylostome found in the faeces. He was given two courses of B-naphthol one gramme each and two ~~coats~~ courses of Thymol two grammes each. He remained in Hospital till 15-12-12, during which time he gained in weight , The H. rose to 45 % and the number of R.B.C to 3 millions.
Case No. 6. K. K. 49. Admitted on 15-11-12. Complaint Palpitation and anaemia.
Family history. His mother died of Anaemia with dropsy one sister alive she was also very anaemic. He lives in a sandy unhealthy area. He is a labourer in the fields He has pigmented areas in the tongue. Has palpitation on slight extertion but no bruit.

Case 7. K. P. 63. Admitted on 10-3-13.

Complaints.(similar to case 6).

Family history. Two sisters elder one died of anaemia with dropsy. The younger one has been under my treatment for Ankylostomiasis.

Social condition and habits. Patient has a fairly - comfortable home in a sandy locality. No special - precaution taken regarding disposal of faeces.

Patient is a farmer working barefooted in the fields with spade. He was under treatment for two months. Drug used for expelling the worms was thymol.

Case 8. V. 42. Admitted on 18-11-12. Complaint: Anaemia and palpitation.

History. Three years ago patient noticed he had ---- palpitation on exertion. He had also giddness. He felt he was growing pale.

Social condition. He is a labourer working in the fields has not good home and lives in a sandy locality.

State on admission. Patient is very anaemic skin ---- lemon yellow gums pale conjunctivae pale. Tongue very - white.

Circulatory system.

Systolic bruit most pronounced at the apex. Heard in

in all the areas.

He was given four doses of eucalyptus, chloroform and castor oil mixture at intervals of a week. He was also put on a mixture containing digitilis and ferrietammoniicitras. He was discharged relieved on 20-1-13.

Case 9. M. 29. admitted on 15-12-13.

Complaint Anaemia and cough.

History of present illness.

For the past three years patient had loss of ---- appetite. He had epigastric pain. He felt unable to do any work. Latterly, he noticed that he was getting --- very pale. For the past four months, he had been ----- troubled with a bad cough.

Social condition. Patient lives in a small house. surroundings are unhealthy He is a farmer and has to work in the fields.

state of admission. Patient is poorly nourished. Very anaemic. lips, gums and conjunctivae very white .

Circulatory system. Patient has palpitations and a --- quick pulse.

Respiratory system. Right lung shows evidence of tuberculosis. This was confirmed by the detection of tubercle bacilli in the sputum.

Patient was given three doses of thynol.

After the first dose he expelled 205 worms of which

120 were necator Americanus. He was also treated for lung trouble. He has been under treatment for over two months with considerable benefit to himself.

Case 10. Poovan 10. Pulaya Admitted on 5-1-14.

complaint.- palpitation and cough.

History of present illness. For over a year he has been getting anaemic. He has eaten sand. For the past two months he has been troubled with cough. He has also been unable to work owing to palpitation.

Social condition. Patient is very poor. He has to -- assist his father in his work in the fields and has to carry bucketfuls of mud. He lives in a sandy locality.

State on admission. Patient is very anaemic.

circulatory system. Patient has pain over the praecordâ no murmurs. pulse quick.

Respiratory system. Both lungs show evidence of ------ chyronical bronchitis. He was treated at first by ---- thymol to expel the worms and then his lung complaint received special attention. In six weeks he has made - great improvement.

Case No. 11 V. Age. 9 Nair. Was brought to me with a history that the boy had become dull and that he was not able to keep up his studies. He was not markedely ---- anaemic(had 50% haemoglobin. He was given thymol on two occasions and this was followed by tonics. He came for treatment on 17-10-12. By the end of November he

he showed considerable improvement. His physique also improved.

Case 12. P. P. 26. Clerk. Came for treatment on 15-6-13. His main trouble was severe neuralgia which --- disabled him. I found him very anaemic. Numerous Ova- of Ankylostome were found in his faeces. He had four doses of Thymol which effectively got rid of the worms. After the first dose of thymol he noticed ~~this~~ improvement as regards his neuralgia. He was put on a mixture containing iron for a month. For another month he was given Blaud's pills. At the end of three months he was quite cured.

Case 13. K. A. 45. Came for treatment on15-9-13
Her main complaints were severe headache and sleeplessness
She noticed that for over a year she had been getting pale, appetite was very poor. She was given thymol 5 times to completely get rid of the worms. She was also given tonic containing iron. In four months she has been completely restored to health.

Case No. 14. Hussain 25. Mahomedan.
Admitted on 25-11-13.
History. About four years ago he noticed he was getting pale. Lately he has been feeling great weakness in his muscles

State on admission. Patient is an anaemic. His muscles are flabby. Visible mucous membranes are white mouth unhealthy gums decayed

Circulatory system. There is palpitation.

Haemic bruit is present. Examination of feaces showed numerous ova

Treatment. He was given 3 doses of eucalyptus mixture. which got rid of the worms. He was also given tonics. He got great relief by being under treatment for a month

Case 15. K. Aged 28. Came for treatment on 7-5-13. patient lived in a sandy area where there was every chance of faecal contamination. She had been growing anaemic for the past three years, during which time she had two abortions.

State on admission. Body slightly emaciated. Easily tired. Conjunctivae white;lips and gums white;appetite deprived. Blood watery. H.B. 25 % She was given 3 courses of thymol. After the worms were expelled she was put on iron. Later she was given haematogen. In two months she recovered completely.

Case 16. K. K. Aged 25. Came in for treatment on 30-7-13. Patient had been suffering from severe anaemia for over four years. She used to eat raw rice, broken bits of earthenware etc., She had three miscarriages.

She lived in an unhealthy locality. She had a -----
comfortable home.
State on admission. Patient very anæmic complains of
palpitation and pain in the ~~reign~~ region of the heart. Conjunctivae pearly white, tongue white, skin dirty yellow --
colour. Blood watery contained only 20 % H. B.
Numerous Ova wereffound in the faeces. She had three ----
doses of thymol. With the first dose more than 150
worms escaped through the faeces No. ova could be ------
found in the faeces after the third dose. She ~~had~~ was put on
blaud's pills for two months. She discharged cured on
31-10-13. At present she is in excellent health and is
pregnant
Case no 17. /E.S.P.I.E. 18 admitted on 24-9-12. complaint
anaemia and palpitation.
History. A year ago she noticed she was getting anaemic
She lives in a marshy place in a small house. In that
house there is another woman suffering from severe anaemia
Latterly she has been unable to do any work. State on
admission:- Patient poorly developed. Appetite poor.
On examination of the faeces many ankylostome ova were
found. Soon after admission she got a sudden attack of
fever without any apparent cause. The worms were expelled
by three doses of Bnaphthol one gramme each. The fever
subsided after this. There was no recurrence of the --
fever.

she left hospital at the expiration of a month.

Case No. 18. H. A. 42. Brahmin Clerk. Came for treatment on 5-1-11. Complaint palpitation and swelling all over the body

History:- Patient had anaemia for the past three years. During the past six months he was feeling short of breath on slight exertion. A month ago he had swelling on the dorsum of both feet. Gradually he developed ~~sss~~ ascites

Social condition. Patient lives in a sandy area. He has to walk barefooted over unclean soil.

Habit:- Patient had craving for eating ash sand, etc.,

State on admission:- Patient is very pale and weak There is oedema all over the body.

Circulatory system. There is a systolic murmur at the apex.

Digestive system:- Appetite very poor. There is ascites. He was under treatment for three months, during which time he was given four doses of thymol to expel all the worms. He was also given Cardiac Tonics and ------ diuretics. He was discharged cured at the end of three months.

Case No. 19. Samuel. Admitted on 16-10-12.

Complaint :- Severe anaemia with swelling all over the body.

State on admission. Patient very anaemic.

Heart sounds very weak.

He expired on 18-10-12.

Postmortem On opening the thoracic cavity pleurae contains a good deal of fluid. Lungs oedematous.

Pericardium. Also contains fluid.

Heart. Fatty. Left ventricle. Hypertrophied

peritoneal cavity contained a good deal of fluid.

All organs were very pale.

Stomach. Mucous mbrane thickened, there was evidence of chroniccatarrh.

Liver. Extremely fatty.

Kidneys. Fatty.

Spleen:- Shrunk.

Small intestine. Mucous membranes of jejunum and ileum showed haemorrhagic spots. Many ankylostoma worms were found adhering to the mucous membrane.

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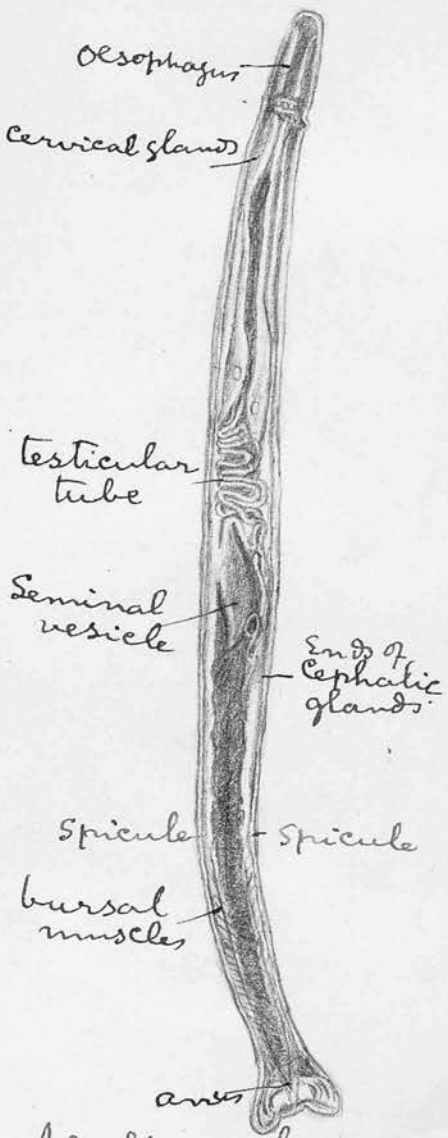
Fig I



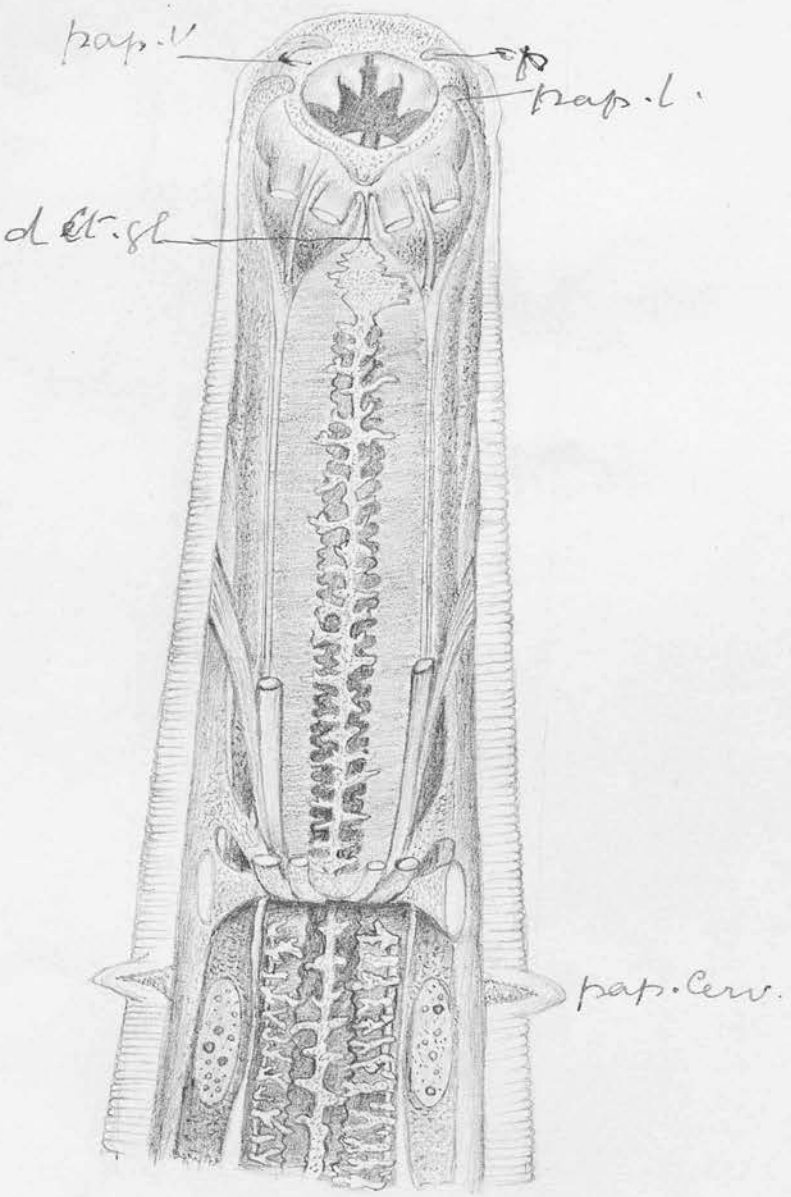
Adult male. preserved in alcohol and cleared in glycerine [from the ventral side].

Fig 2.

[From records of the Egyptian Government School of Medicine. Vol III]

Fig 3.

Anterior part of the body of A. Duodenale (viewed from ventral side).



pap. V - ventral head papillae
pap. L. lateral " "
pap. cerv. Cervical papillae
d. ct. gl - Excretory duct of gland.

[Term Report of Egyptian School of Medicine. Vol III

Lateral section of
Fig. 5a. head of N. Americanus.

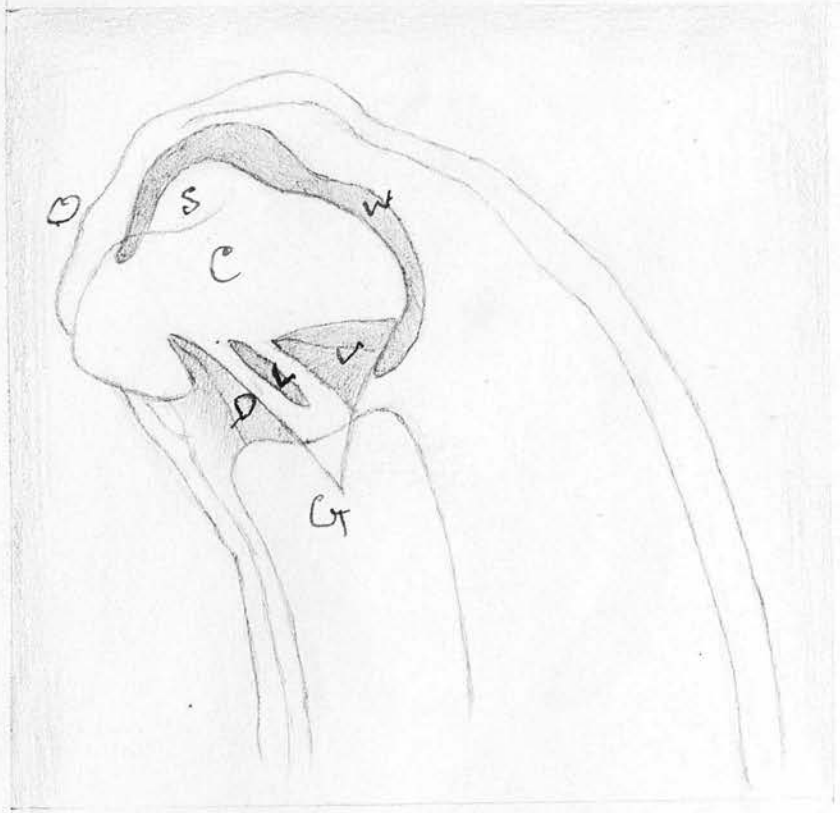


Fig. 5.

Head of
A. Duodenale.

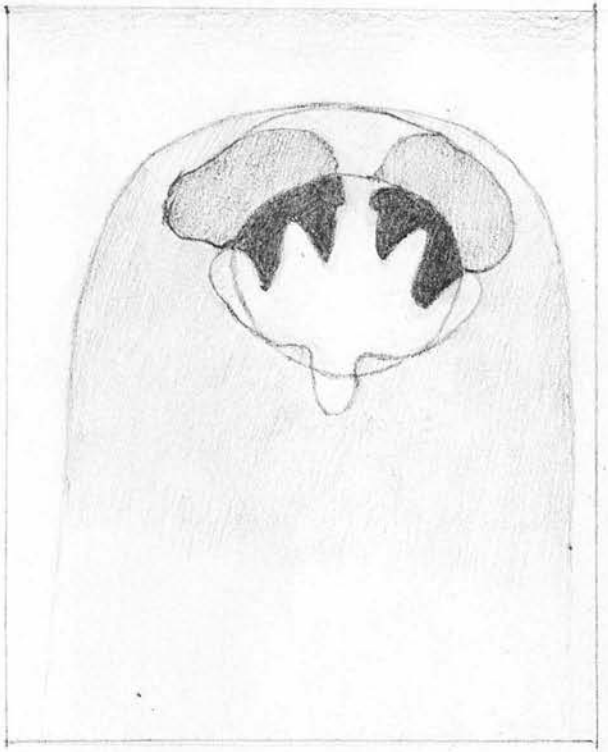
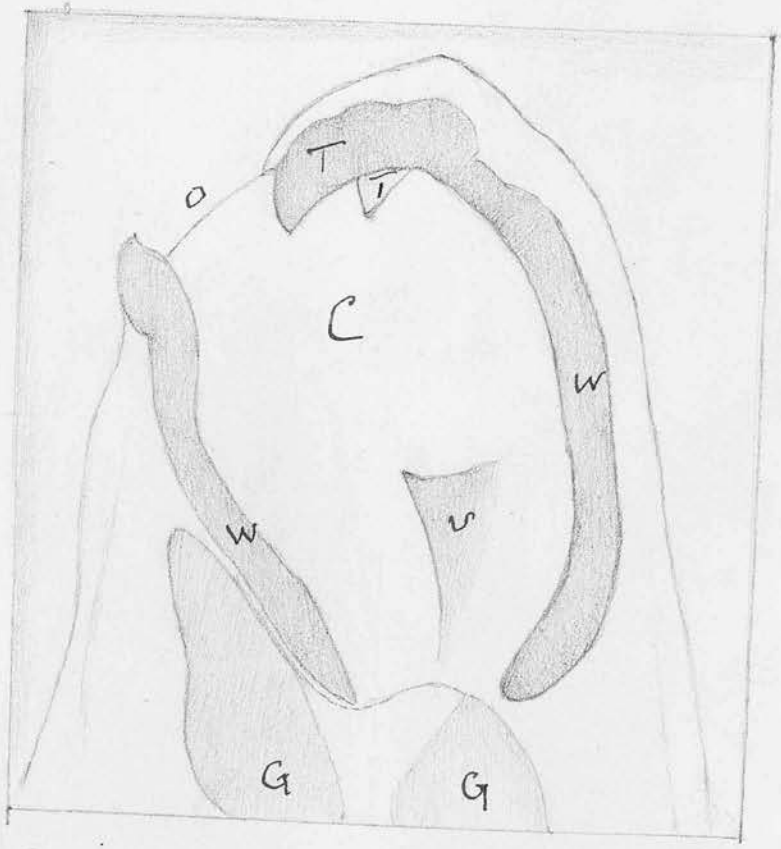


Fig. 4.

O - oral opening.
C - Coral Cavity.
S - Ventral Semilunes.
V - Ventral triangles.
D - Median dorsal tooth
L - Lateral lancets.

[From Major Lane's article in the Indian Medical Gazette. Nov. 1913.]

Fig 6.
Lateral section of head
A. Duodenale



O - Oral opening.
C - Oral Cavity
W. Chitinous wall of oral cavity
T. Ventral teeth.
V - Ventral Triangles.

Figure 7
Lateral section of head
A. Ceylanicum

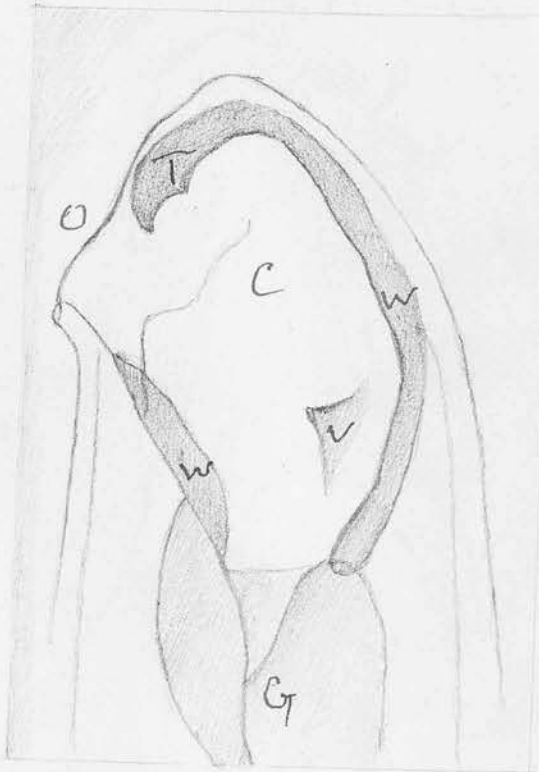
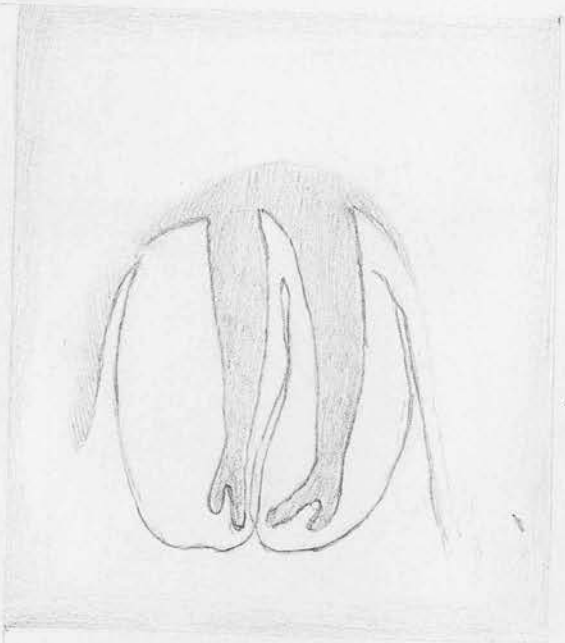


Fig. 7.

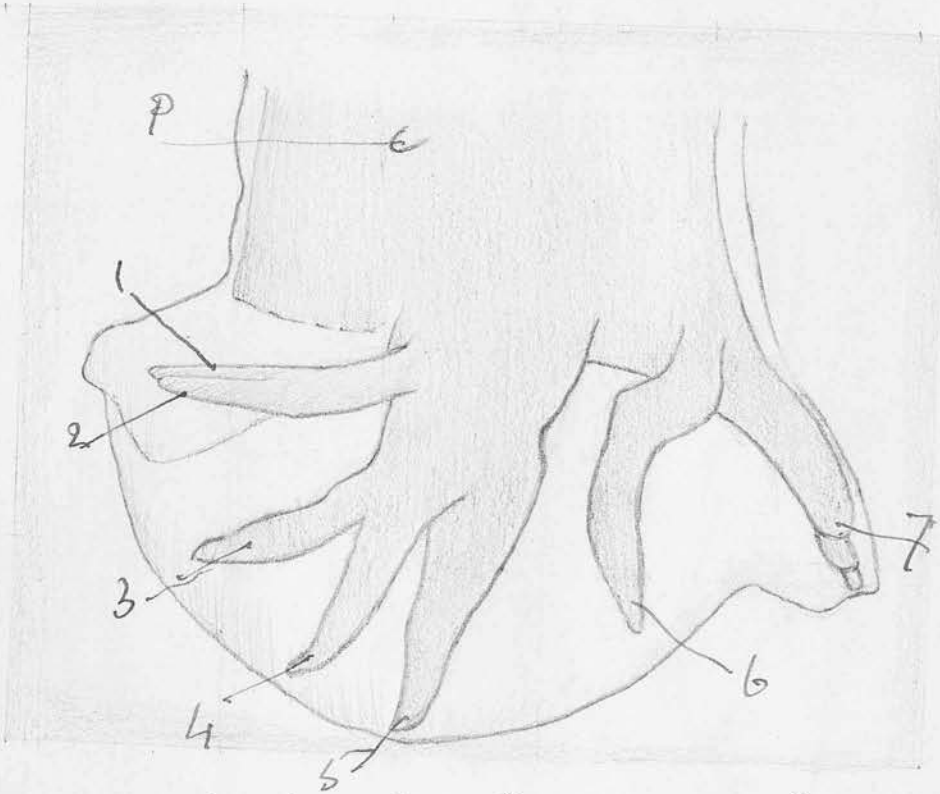
[From Major Lane's article in Indian Medical Gazette - Nov. 1913].

Fig 4.



Dorsal lobe
of male of
N. Americanus

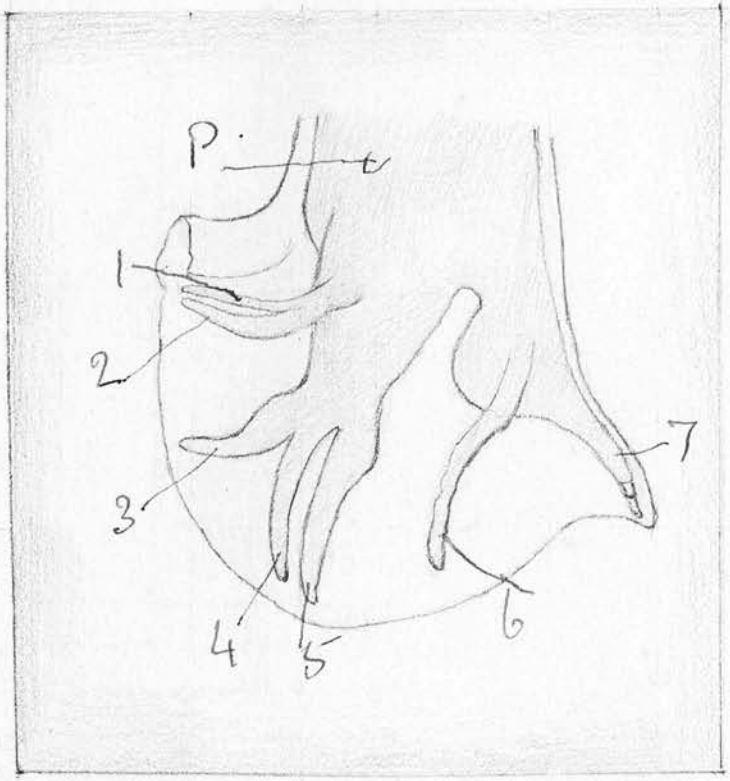
Fig 8



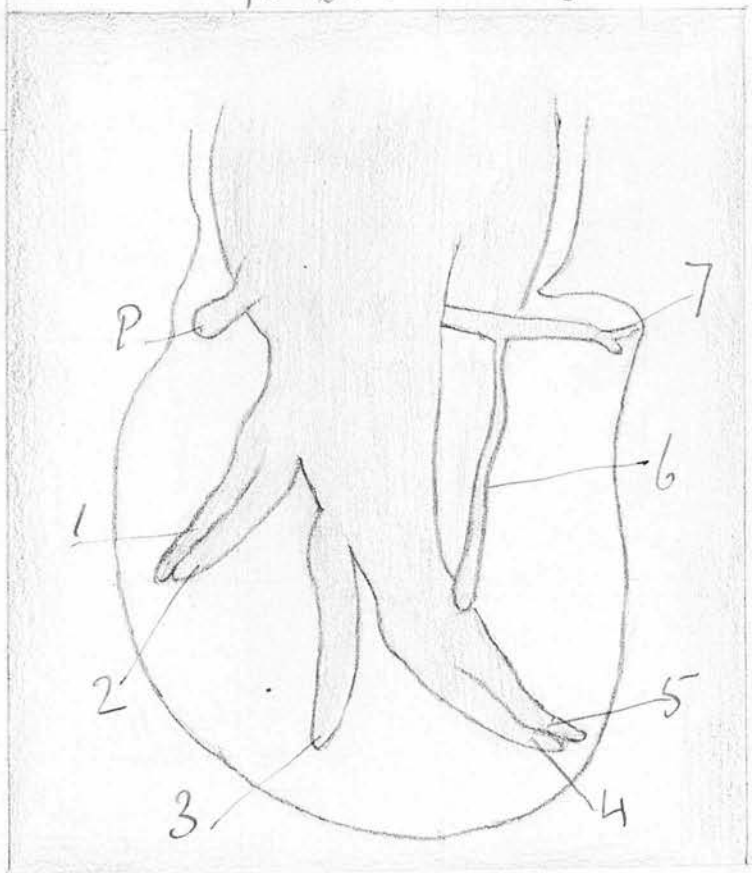
Lateral view of male
bursa of A. Duodenale
P - Preburseal papillae.
1 & 2 - Ventral rays
3 - Externolateral ray
4 - Mediolateral ray
5 - Posterolateral ray -
6 - Externodorsal -
7 - Dorsal ray

[From Looss's article in Indian Medical Gazette Nov. 1913]

P. Prebursal papilla.
1 + 2 - ventral rays
3 - Extero lateral ray
4 - Medio lateral ray
5 - Postero lateral ray.
6 - Extero dorsal
7 - Dorsal ray.



Lateral view of male bursa of A. Ceylanicum.



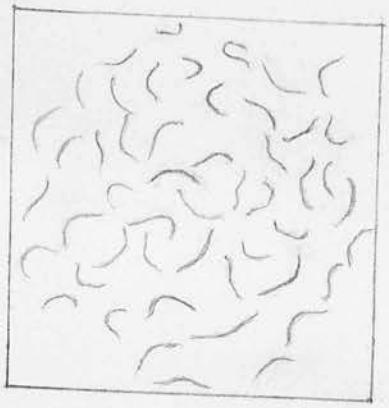
Lateral view of male bursa of N. Americanus

[From Major Lane's article in Indian Medical Gazette - Nov. 1913].

Figure 40

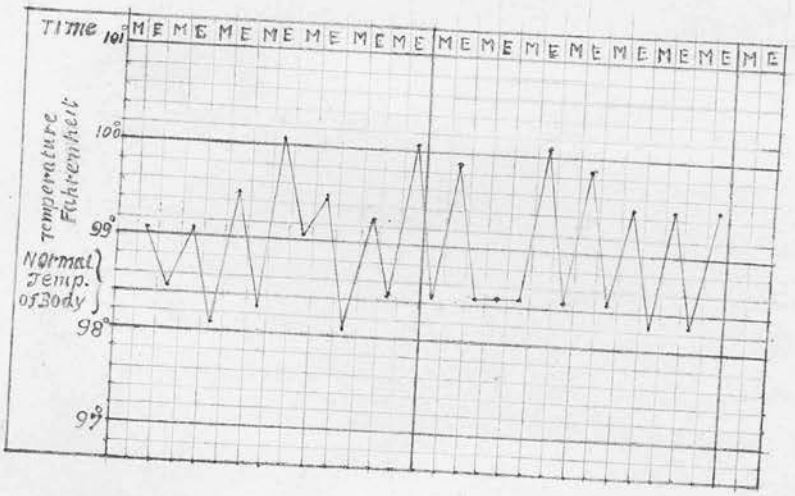
Figure 41

Fig. 12.



Necator Americanus.
(natural size).

Fig 13.



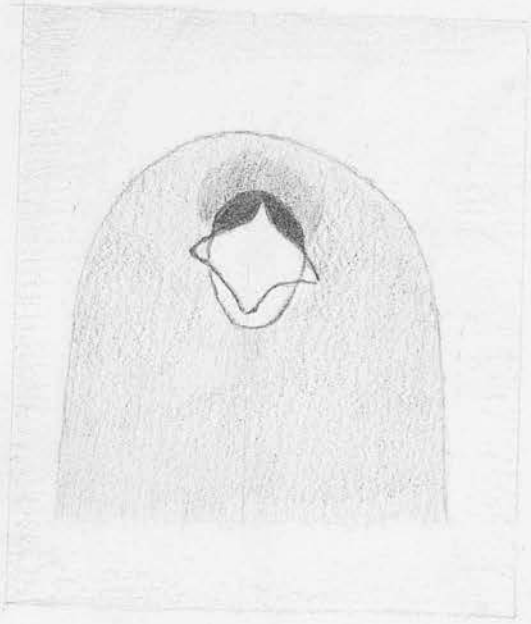
Temperature chart of a case
of Ankylostomiasis fever.
[From Castellani & Chalmers' 'Manual of Tropical Medicine'.

Fig 14

Head of A. Ceylanicum

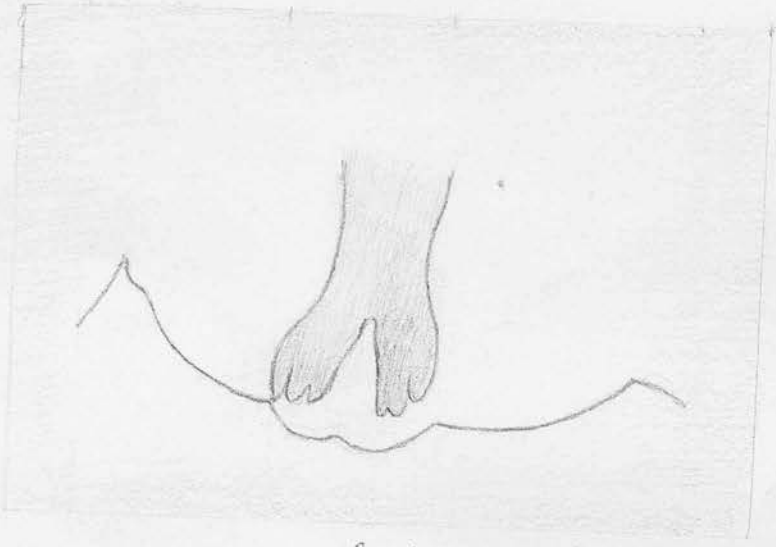
Fig 16.

Fig 15

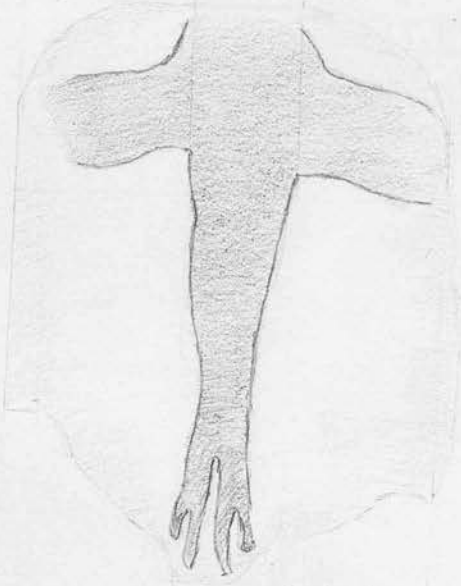


Head of N. Americanus.

Fig 17.

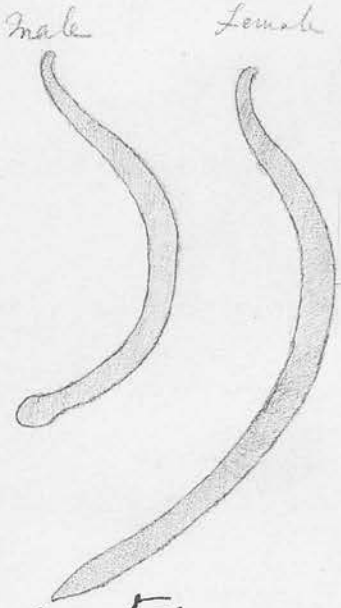


Dorsal lobe of the male bursa of A. Duodenale.



Dorsal lobe of male bursa of A. Ceylanicum.

[From Major Lane's article on Ankylostomes & Ankylostomiasis in Bengal. Indian Medical Gazette. Nov-1913].



Necator Americanus

Fig 18.

Agchylostoma Ceylanicum

Fig 19

Agchylostoma Duodenale.

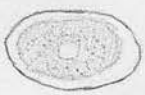
Fig 20

Fig 21

Ova of N. Americanus

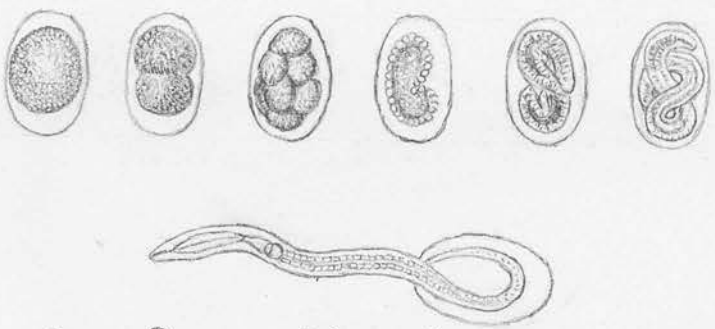
Fig 22

Ova of A. Ceylanicum.



[From Lane's article on Ankylostomes & ankylostomiasis in Bengal - Indian Medical Gazette - Nov. 1913].

Fig 23



A. Duodenale -

Development of the rhaboritiform embryo -

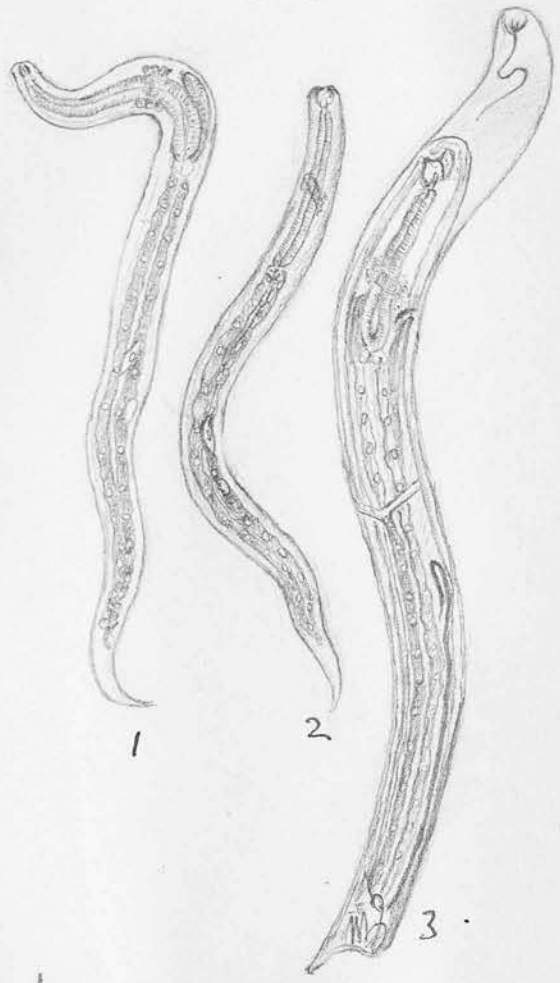
[From Castellani & Chalmers' Manual of Tropical Medicine - Second Edition. Page 558.

Fig 24

Successive stages of development of A. Duodenale.

[From Castellani and Chalmers' Manual of Tropical Medicine 2nd Edition P 578].

Fig 25



1. Four days after transmission into the dog.
2. At the commencement of the Second Stage of development.
3. Fourteen to fifteen days after infection

[From Braun's Animal parasites of man].