

I hereby declare that the following Thesis entitled  
 Common Helminthes  
 of the Human Intestine  
 with an Application to  
 the Duties of a Medical  
 Inspector of Schoolchildren  
 has been composed  
 by myself.

Signed John Lloyd Owen

(M.B., B.S., 1893)

Old Regulations

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Common Helminthes of the Human Intestine with an  
 application to the duties of a Medical Inspector of  
 Schoolchildren.

After a post-graduate practice of fifteen years  
 mainly amongst the artisan class, and having latterly  
 made a special study of the above subject, I shall now  
 endeavour to embody some of the results attained. I  
 can heartily corroborate the opinion of others that  
 an enormous number of diseases are traceable to the  
 presence of *Vermin* in the bowel. These are permanent

parasites. They illustrate true Parasitism, not Commensalism. These common helminthes are the most general form of entozoa infesting man and are for the most part visible to the naked eye. They can be assigned to two distinct orders (1) Cestoda (2) Nematoda. These orders have little in common but their parasitic habits. It is my purpose to discuss first three of the commoner species of the order Cestoda or Tapeworms. I agree with those who look upon a complete tapeworm as a Colony consisting of numerous individuals, temporarily connected for the common good, but each capable of leading a distinctly separate existence - at least for a time. I can confidently confirm the general opinion that tapeworms have two phases of existence the (1) adult or strobila (2) ~~the~~ larval or cysticer<sup>ca</sup>as. Küchen<sup>er</sup>Weister and Len<sup>ch</sup>art did much experimentally in evolving this opinion. Generally speaking, the name tapeworm or cestode implies the mature, adult or strobila form, which may be described as long, flat, segmented whitish ribbon-like organisms. Morphologically speaking each worm is divisible into a head and neck, scolex and a string of segments - proglottides. The head is small with two or more suckers to attach it to the mucous membrane of the gut of the host and absorbs

alimentary <sup>ent</sup> juices for its nutrition. The three tapeworms I have made a special study of are clinically the most important, and are very common. Two, the taenia solium and taenia saginata, belong to the family taeniada, the third - bothriocephalus latus, to the family bothriocephalida.

The taenia solium or more correctly taenia sola and taenia saginata <sup>in</sup> occur in my opinion with equal frequency. In statistics as to the geographical distribution of persons infected by the former, it is found to coincide with that of the common pig. It is most frequent in North Germany, but often occurs in these islands, France, Italy etc., In Asia & Africa its occurrence <sup>re</sup> is rare on account of the religious observances of the majority of the inhabitants. In the <sup>is</sup> country, amongst the working classes, one would expect to find the pork tapeworm more often than the beef tapeworm. Amongst the middle and upper classes the reverse is found to be the case. The taenia solium <sup>is</sup> was so named under the erroneous impression that only one could infest a *host* at a time. It is also known under the names taenia cucurbitina (from the *proglottides*), taenia dentata & taenia armata (from the presence of hooklets). The French name "ver solitaire" implies the same mistaken notion <sup>as</sup> which is taenia solium <sup>is</sup>, though Manson (in Allbutt's System (1897) Vol II p. 1013) erroneously gives the name

to taenia medi~~an~~<sup>oc</sup>anellata.

*Blair* Sutton (in ~~Brain's~~<sup>2u</sup> Diet: of Med: 1894 p. 580) says that the T. Sol~~im~~<sup>it</sup> when fully developed may attain a length of from 2 to 3 feet. He might better have said 20 to 30 feet. Its usual length is 10 feet. Its head is very small, somewhat globular, with a slightly prominent rostellum in front surrounded by a double row of curved silicious hooks, 12 to 15 in each row, and further back 4 suckers symmetrically arranged. The head is often black from the presence of pigment. The neck is extremely slender, from  $\frac{1}{2}$  an inch to nearly an inch long, transversely marked. The proglottides in their earlier stages are small and much broader than long. They appear almost structureless. They gradually increase in breadth, and still more in length, so that at about a yard from the head, they are square and towards the distal end of the strobila, their length is considerably greater than their breadth. This is accounted for by the fact that the new joints are formed near the head, and so, as the development of the new segments goes on, these, as they are formed separate the scolex further and further from those which ~~pre~~<sup>e</sup>ceded them. Thus towards the distal end, they are fully developed. Each joint is furnished with a hermaphrodite apparatus. The worm attains its full growth in from three to three & a half months, after which the segments are detached and appear

either singly or in chains in the faeces of the host. The ova contained in the now free ~~proglot~~<sup>ti</sup> escapes, not through the genital canal but through a rupture in the segment. Having reached the external world however, the ~~proglot~~<sup>ti</sup> may creep about for a time & may remain alive for some days if favoured with warmth and moisture. It, or the liberated ova, may be swallowed by a pig, any other animal or by man himself.

These ova are nearly globular & measure .03 m. m. in diameter. They have a firm, thick, brownish shell and are covered with rod shaped projections. The enclosed ~~embryo~~<sup>embryo</sup> is furnished with six boring spines arranged in three pairs. As soon as the egg reaches the stomach of the intermediate host either in food or drink, its ~~men~~<sup>men</sup> ~~snous~~<sup>snous</sup> ~~membranous~~ shell is dissolved by the action of the gastric juice, and the six hooked embryo escapes. By means of its hooks, it bores through the walls of the stomach, and finally comes to rest in the liver, lungs, brain or ~~tissues~~ and thereby undergoes another ~~phase~~<sup>phase</sup> of existence.

It loses its six hooks and becomes surrounded by a layer of exudation from the tissues of its host. and finally develops into a bladder-worm. It separates muscular bundles and is disposed in the same direction. This cyst is incapable of further development, but assumes a

resemblance to the head of a pork tapeworm or rather to the head and neck, as it would appear if it were withdrawn into its own body. Pork infected by these bladder worms is termed measled, and if eaten by man, the scolex<sup>x</sup> retracted into the centre of the cyst extends. The cyst is dissolved in the stomach of the definit<sup>ive</sup> host. The head attaches itself to the alimentary lining membrane. The segments grow upon it, till an adult tapeworm is formed and the cycle is then completed. ~~Man then~~ Man then is liable to be attacked by the larval & adult form of this cestode. In my opinion the cystic form is fully more dangerous than the *strobila*, occurring as it does so frequently in such a vital centre as the brain. Cobbold (in "Animal Parasites of man") states that *C. cellulosa* occurs less frequently in the brain & eye than in the subcutaneous, areolar and intermuscular connective tissue. Manson, on the contrary, says (Allbutt's System p. 1014. 1897. Vol II) they occur more frequently in the brain and eye than in these tissues. My research in this connection leads me to consider that neither is correct on this question. It is my opinion that the *cysticerci* have no special predilection for any part of the body. Manson points out that the concurrence of subcutaneous nodules or of a cysticercus in the eye with cerebral symptoms is a valuable point in determining the diagnosis

of obscure brain disease. Griesinger has collected over sixty cases of death from *cysticerci* of the brain and further states that as the epilepsy attendant on this condition and psychical disturbances have nothing characteristic about them, it is practically *life from symptoms alone*. When we consider the impossible to diagnose during dangerous results that follow the entrance of the ova of this tapeworm into the human body, the *prophylaxis* is important, and consists in the avoidance of all doubtful fruits & vegetables. Salads prepared elsewhere than by a reliable person may harbour ova. Vegetables may have been manured with night-soil containing hundreds of cestode eggs, or may have been watered with fluid filth into which eggs have entered. Fallen fruits, edible plants, pond, canal & even river water may harbour *embryos* which may eventually enter the human body. Apart from infection in these ways, there is a two-fold risk of *autoinfection* ~~ants injection~~ run by a person already harbouring a taenia. Such a person does not derive *cysticerci* directly from its ova, while in the intestine. They must first pass into the stomach where the shells are acted upon by the gastric juice. They may reach the stomach by being carried from the anus to the mouth, or by frequent and prolonged retching enter the stomach in a proglottis. Dr Fagge (in his Text Book of Medicine- 1902. p. 452) remarks on the infrequency of this *autoinfection* ~~injection~~. I now come to the consideration of

the symptoms produced by the adult worm. The first intimation of the the presence of *T. Soliman* is often the appearance of segments in the stools, but in the majority of cases, in my opinion, other decided symptoms manifest themselves - such as abdominal discomfort, irregualr action of the bowels, nausea, eructations, flatulence & and other dyspeptic syptoms, especially when fasting. Mal nutrition makes its appearance, a state of grave anaemia supervenes *sometimes*.

In not a few cases there may be alarming nervous disturbances, vertigo, hystero-epilepsy, chorea, illusions, and other neuroses. e.g. melancholia. To these symptoms may be added abnormal action of the heart, irritability of the bladder & stricture of the urethra & tumidity of the abdomen. The presence of tapeworm may also cause foulness of breath, irregular & craving appetite, salivation, itching of the *anus* arms & nose & grinding of the teeth.

A woman came to my surgery recently to consult me. She had marked tumidity of the abdomen, suggesting *preg-*nancy to her. I diagnosed the case rightly to be one of tapeworm. It can readily be supposed that some symptoms, especially reflex, may be exaggerated in persons of a hysterical tendency. Patients of a hypochondriacal temperament have been known to persist in the belief that a worm was present, even when no worm has been proved to

exist or when it has been completely expelled. An interesting case<sup>is</sup> related by Graves, of a young lady who was attacked by alarming symptoms of bronchitis, accompanied by a dry hollow cough. The usual remedies were tried in vain, finally she had a sudden attack of colic for which an old servant administered a full dose of oil of turpentine with castor oil. She passed a large piece of tapeworm and from that moment every pulmonary symptom disappeared. "This is an instructive case of hysteria occasioned probably by the consciousness of the movements of the strobila - the continual play of its suckers & the bendings of its neck."

Women<sup>e</sup> suffer more frequently from this worm <sup>than</sup> ~~man~~<sup>men</sup>. Usually the persons affected are ~~xxxxxx~~ between 16 & 40 years of age. Cooks & butchers are especially liable.

The prophylaxis is well summed up by Oster<sup>e</sup> under three heads (I) The burning of all tapeworm segments. These should never be thrown into the water-closet or outside.

(2) Careful inspection of meat abattoirs.

(3) The cooking of meat sufficiently to kill the cysticerci.

The last precaution is perhaps the most important. The degree of heat necessary for the destruction of these <sup>cysticerci</sup> ~~cysterci~~ has been determined by reliable experimenting. The experiments were carried out in connection with the "Measles" of beef, but the result, Cobbold states, applies

equally to the "measles" of pork.

Pellizzari of Florence found that *cysticerceri* in the flesh of oxen die at a temperature of 60°C.

Contemporaneously with his investigations Dr Lewis, in India, concluded from experiments made, that after an exposure of five minutes to a temperature of 140°F life in the *cysticerci* may be considered absolutely extinct. In addition, investigations made by Cobbold on a young cow, shew that beef measles may be cured by a natural process through calcareous degeneration. Ten months is a sufficient period to ensure their destruction by this means. These results shew that a humane & more economic preventative is at our disposal than the destruction of infected animals. The flesh may be subjected to a certain temperature or in the case of oxen, the infected animals need only be removed for 9 or 10 months to a place where it can run no risk of renewed infection. At the end of that time the *cysticerci* will have perished. The flesh could then be eaten with impunity well-cooked, under-cooked, or raw. Smoked or pickled meat is generally prepared too quickly to kill the *cysticerci*. Cold means to them certain death. Frozen meat is therefore safer in this respect than home-killed meat.

Curative Treatment. Many remedies have been suggested for the expulsion of the tapeworm, but these are now generally reduced to half a dozen. Grainger Stewart

recommends principally the ethereal extract of *felix mas*, but says also turpentine seems to act in some cases even better than the commoner remedy. I consider the following treatment good and have found it effectual.

For a day or two before the administration of the anthelmintic, keep the patient on a light diet, <sup>and</sup> ~~or~~ give a few doses of sulphate of soda or any other saline to clear away any mucus that may be covering the parasite. Follow this by a 1 to 2 drachm dose of the *ferm* <sup>salt</sup> (in milk, syrup of lemon, or any excipient suitable as an emulsifying agent), <sup>at night or as Manson suggests in the morning</sup> on an empty stomach. He also recommends the anthelmintic to be given in half drachm doses for four successive half hours. Either method is successful, provided the taeniafuge is followed by a strong purgative in a few hours. Unless this point is attended to, there is a strong danger of the parasite, which has not been killed only paralysed by the male *ferm*, recovering itself, & renewing its hold on the mucous membrane. The patient ought to lie down for an hour or two after taking the anthelmintic, as he may probably feel the toxic effects which many of these drugs produce. After the complete treatment, unless the head is found, all efforts have been in vain. The treatment must then be repeated at the end of three months or so - thirteen weeks exactly in many cases - in which time the tapeworm has redeveloped from the scolex. An interesting point in this connection is, th //

this connection is that if, in the part of the tapeworm expelled, the narrow neck is seen and if before three months have elapsed, the patient begins again to pass proglottides *per anum* it may be inferred that more than one tapeworm is present.

Other important taeniafuges are pome granate root especially the active principal<sup>le</sup> of the root - pelletierine in doses of 5 to 7 grains with tannin in sweetened water. This drug ought not to be given to young children. Though supposed to be very effective, it is not, in my opinion, to be recommended. In toxic doses its action resembles curare, and even if the dose much exceeds <sup>5</sup> grains it may give rise to vertigo, nausea, vomiting, diplo<sup>o</sup>bia & other visual troubles.

Koussowich consists of the dried flowers of the <sup>Hagenia</sup> ~~Brayera~~ Anthelmintica of Abyssinia is a useful drug,  $\frac{1}{4}$  to  $\frac{1}{2}$  oz infused in boiling water & swallowed, powder & all, is an effective dose.

Kamla (2 to 3 drachms) acts both as a purgative and & expels the parasite lifeless.

The more recently used taeniafuges are thymol & benzol - the latter in capsules 20 to 30 mimms. Thymol I have proved to be an efficient, all round<sup>anthelmintic</sup> ~~anthelminter~~. It is very insoluble in water, but soluble in alcohol, ether, turpentine, chloroform & glycerine and certain alkaline solutions. These solvents must therefore be withheld while the drug is in the alimentary canal.

If the worm is expelled over a warm sitz bath there is less fear of the expelled portion contracting and breaking before the expulsion of the head. The worm, it is obvious, should not be pulled for the same reason.

Taenia Mediocanellata was long confounded with the Taenia Solium. The difference was first noticed by G<sup>o</sup>oze who named this parasite taenia saginata, but to *Kichenmeister* is due the placing of it as a species distinct from the Taenia Solium. He it was who gave it the specific name "Mediocanellata", believing it had a median water vessel beside the two lateral ones.

This is not so however. What he noticed must have been an accidental peculiarity of a mal-formed specimen.

Bland Sutton in *Quain's Dict: of Med: p.580*, *et* therefore in giving a "Median canal" as a differential feature. This taenia possesses no hooks, nor proboscis, but has four suckers. Its popular name is the beef tapeworm.

The T. Saginata is longer, broader, firmer & flatter than the T. Solium. Its average length is about 18 feet. Bland Sutton (*Ibid.*) sets a very small limit when he says they may attain 4 feet. This tapeworm is darker towards the distal end, than T. Solium. The place of the proboscis is taken by a small rudimentary disk which protudes on pressure and which may serve, to a

slight extent as a supernumerary holdfast. The ova closely resemble those of *T. Solinm* in the size and thickness of the capsule, but are somewhat oval in shape.

The segments number from 1200 to 1300. The *T. Saginta* is liable to mal-formations. Sometimes there are two or three genital pores in a single proglottis,, sometimes the segmentation is incomplete. The most remarkable mal-formation is the existance<sup>e</sup> of two distinct chains of segments united the whole length by one edge.

Experiments performed by *Leuckart* in 1861 on a young calf confirmed the suspicions that Medical men then had that *T. Saginata* corresponded with bladder-worms in cattle. Cobbold confirmed his results. These measles are scattered throughout the muscles, occasionally in the liver and other viscera. They lie lengthwise between the fibres - small. oblong watery cysts lighter in colour than pork-cysts. Each contains the invaginated head of an immature cestode. By placing the cyst in warm water the head extrudes itself & reveals itself as resembling in every respect the head of a *tacnia saginata*. It has been proved that from the time the cys<sup>t</sup> *ticereus* has been swallowed to the appearance of the segments in the stools, about 60 days must elapse. At the end of that time, 8 or 12 or more proglottides are thrown off daily by the now mature worm during an indefinite number of years. In

the manner of throwing off its proglottides, the beef tapeworm differs from the pork tapeworm in two respects. The joints rarely appear in the stools in strings. They are usually given off singly. Moreover they may pass out of the bowel <sup>by their own locomotion they may wander</sup> independently of defaecation, <sup>n</sup> about the patient's body, clothes or bed, expelling eggs en route, which may again reach an intermediate host.

With respect to the calcareous degeneration of these cyst<sup>ic</sup>erci. Manson (Allbutts System p. 1010) says "it is not known how long the cysticerci retain their vitality, several years probably, before undergoing calcareous changes". Cobbold, on the other hand, definitely states (as I have already noted) from his own experiments that ten months is sufficient to ensure their destruction in this way. My own experience leads me to favour Cobbold's view.

The prophylactic treatment of T. Saginata is on the same lines as ~~for~~ T. Solinm. Where much or imperfectly cooked beef is eaten, ~~there~~ it appears, where the cattle are badly fed & cared for, and kept under filthy conditions then every opportunity is given for infection. Perhaps the most striking instance of infection in this way is quoted by Fagge (in his Medecine 4th Edit: p. 456.) of the Buräter of the Baikal. This people live almost exclusively on flesh, neither well cleaned nor thoroughly cooked. They eat from unwashed tables on which the meat

has been cut up. It was found in many of this race who had been absent from the country for years that they were infected by beef tapeworms to such an extent that in 130 autopsies only two bodies were found free from the parasite. In many cases many were present - in one case as many as 15. Children fed on raw grated beef may be found suffering from this form of worm. Hence, unless precautions are taken to procure beef beyond suspicion for the purpose, the injury done may far out balance the good.

I have prematurely mentioned, under T. Solinm, that the removal of the suspected oxen to conditions under which they can run no further risks for the greater part of a year, ensures the destruction of the beef bladder worms. This indicates a line of *prophylaxis* with respect to beef tapeworms.

The symptoms and curative treatment are as for the former. I may here cite a case of my own. The patient is a butcher. He gave a history of small pieces of tapeworm, emerging spontaneously from his anus. He was advised to live sparingly for a day or two and go to bed fasting and in the morning to take a drachm of ethereal extract of felix mas in milk and three hours afterwards castor oil. He voided a large tapeworm in the afternoon and has had no further trouble. He confessed to be in the frequent habit of picking up pieces of beef off the chop block. This beef tapeworm was the result. He had suffered no inconvenience. In examining the throat of this patient recently - a year or so ago 16.

day before so after his cure - on the left tonsil in front of the posterior pillar of the fauces, embedded in a hollow, I noticed what I took to be a typical ~~cyst~~ *cysticercus*. I gave him an antiseptic spray for an irritable throat and on his returning to my surgery, four days after I was surprised to see no trace of the cyst. In one sense I was much disappointed as I had hoped to excise and examine it. Provided it had been a bladder worm the question occurred to me was it possible for an ovum to be stranded in a follicle of the tonsil and then be developed by juices & warmth in the throat into a cysticercus, or did it come via the stomach by the blood-current. Moreover, as the patient in question had not had much to do with pork, but dealt almost entirely with beef, and taking into consideration the fact that he had already suffered from beef tapeworms, I was the more anxious to test the nature of the cyst in view of the following statement by Manson (Allbutt's System p. 1011) "*Cysticercus T. medicanellata* unlike *cysticercus T. Solim* is not known to occur in man."

The third and last species of tapeworm I shall discuss belongs to the *Bothriocephalidae* family & is named *Bothriocephalus Latius* or fish tapeworm. It is the largest known parasite. Its average length is at least 30 feet. - Bland Sutton (in *Quain's Med*: as before referred) in-

correctly stating it as 5 to 8 feet. Its breadth sometimes measures an inch - hence the name "latus". It has from 3000 to 4000 joints closely packed. The segments do not individually separate so as to become independent organisms. The sexual openings are *ventral* unlike the openings of the two first named species, which ~~was~~ <sup>are</sup> lateral. There's a mesial ridge traversing the whole length of the strobila. The head is club shaped, has no hooks or prominences, but merely two longitudinal slits, one on each side, whence it takes its generic name "pit-headed". The eggs are larger than <sup>those of</sup> the former species, measuring .07 m.m. in length. They are oval, brown with an *operculum* at one end which allows of the escape of the embryo. Owing to the dark colour of the egg shells, the *uterine rosette* is readily seen by the naked eye. The embryo is not developed in utero as in the case of *T. Solinm* & *T. Saginata*. To secure maturation of the ovum, it has to lie in water for a longer or shorter time according to temperature and other circumstances. A ciliated six-hooked embryo <sup>is</sup> then formed, which when sufficiently mature forces back the operculum and makes its escape from the egg. It then becomes a free-swimming animalcule, and in the ciliated form it gains access directly or indirectly to certain fishes - pike - salmon trout and other fresh water species. When found in the intermediate host it generally lies

free or only feebly encysted in the viscera<sup>and</sup> muscles. The head and tail are usually *invaginated*. In this condition it is transferred in raw, smoked, imperfectly cooked or cured fish to the final host. This parasite occurs principally in immigrants from countries *where* it abounds, but in these days of international intercourse & travel the chances of meeting it in general practice in this country increase yearly. It is very common in Switzerland, Germany, parts of Russia, Sweden & Poland. It is indigenous in Ireland and, though not common there, has been named the Irish tapeworm.

The symptoms induced by it are more marked than in cases of *T. Solinm* and *saginata*. They may be divided into two classes - gastric & nervous disorders. Tumid condition of the abdomen, sickness, giddiness, and various hysterical phenomena occurring<sup>^</sup> specially at night are often noticeable. Pain in the region of the heart, palpitation and faintness frequently accompanying its presence. Perhaps the most *characteristic* ~~charestic~~ symptom is the profound anaemia it causes - produced possibly either by toxins given off by the worm or by its absorption of a large amount of alimentary juices.

An interesting case was reported in Pathological Transactions for 1890 by Dr Montague Murray, in which an Englishman who had been resident in Sweded died of tubercular men<sup>n</sup>ingitis without abdominal symptoms. In the caecum were found seven tapeworms of, this species,

unattached but in an entangled mass.

There is no danger of auto-infection, as the larval stage lives only in fishes, not in warm blooded animals.

The prophylaxis is the avoidance of undercooked salmon, trout or pike - or of raw fish, the practice of eating which prevails abroad & amongst many foreigners in this country.

The curative treatment already given in the other species applies equally well to this.

The second group of Intestinal Parasites is the Nematoda. This group is composed of several families the commonest in this country, being the Ascarida.

Three species of the family are parasite in man, two of which are of great clinical importance (1) *Ascaris lumbricoides*. (2) *Oxyuris vermicularis*. The distinctive features of Ascaridae are the mouth with three papillae,<sup>ℓ</sup><sub>^</sub>

one dorsal & two *ventral*, the oesophagus with bulb, one or two spicules, ovary double.

The Ascaris Lumbricoides as the name implies is like the common earth worm. It differs from it however in several respects. Out patients at hospitals have been known to bring earthworms which they say, have been passed from the bowel. The earthworm tapers less at its extremities It has rows of small bristles to aid it in locomotion.

Its mouth is a short fissure on the under surface of its rounded head, whereas the mouth of the ascaris is a triangular opening at the more pointed end, surrounded by three tubercles and lined with numerous teeth. The female is 9 to 12 inches long, the male 5 to 8 inches. Both are cylindrical. They are grey or pinkish in colour and firm to the touch. The surface is glistening & marked by fine closely-set transverse ridges. When the presence of the parasite is suspected certainty is easily acquired from a microscopical examination of the faeces, which, if the worm be there, will be full of eggs.

*ova of the*  
The <sup>ova of the</sup> ascaris are elliptical & measure .075 m.m. by .058 m.m. They have a rough mammillated surface, a multiple outline and granular contents. They are of a brownish colour from bile - staining. In unfertilised instances, the ova are smooth, the rough outer layer being almost or altogether absent. A point of practical importance to be attended to lies in the circumstance that the rough outer layer on the shell is very easily detached. The shell then presents a smooth outline, mistakable for the ova of other species. There is no sign of an embryo in the ovum at birth. It develops in water & moist earth after a long period of incubation. Freezing & dessication do not injure the powers of development. They suspend them, but kill neither ovum nor embryo. At a medium temperature it takes from 30 to 40 days for the embryo to become

formed. In the heat of summer 14 days have been proved sufficient. When fully developed the embryo - spirally rolled up with its so-called tooth formed by three papillae-remains in the egg and does not seek to leave spontaneously. Davaine is said to have kept an embryo-containing ovum alive for 5 years.

With regard to the question as to the necessity of an intermediate host in the life-history of the ascaris, opinions have varied. Leuckart maintained after an unsuccessful attempt to infect himself by swallowing embryos that there must be <sup>an</sup> intermediate host & surmised that it was the <sup>l</sup>ava of an insect. Cobbold was of opinion that water plays the necessary part of intermediary. Davaine proved by an experiment on rats that the <sup>l</sup>avae hatch out in the intestines & settle there. *Giam* after swallowing 100 embryo-containing eggs, found, five weeks after, that the worms had attained maturity & ova appeared in the <sup>f</sup>eces. Other experimenters were equally successful. Von Linstow however still suggested that a certain myriapod plays the part of intermediate host but Manson looks on this suggestion as superfluous. The weight of evidence therefore seems to be on the side of direct development.

When swallowed by the permanent host the embryo speedily breaks through the shell & develops so rapidly that at the end of a month, it is a sexually mature animal,

sending forth countless ova.

The ascaris is practically universal in its geographical distribution. Manson may not strictly be correct when he says in Allbutts Med: that A.L. is cosmopolitan, being found in all countries from the Arctic circles to the Tropics. Finsen testifies to the fact that Iceland is exempt, but the reason for this immunity does not seem apparent. It infests persons of all ages - though it is rare in infants under a year. It is perhaps most common among children between 3 & 10 years. In the case of children, the worm may be found in numbers, frequently in large numbers. They have been known to be present in hundreds. In the case of an adult, it is found more often alone than in numbers. A case of a pregnant woman came under my observation, whose continued nausea was so disturbing as to be abnormal.

Nature came to her assistance by an act of vomiting, so ridding her of one large ascaris, after which all distressing symptoms abated.

The parasite is more frequent in rural districts than in towns - particularly so in low-lying damp localities.

It was in a low-lying damp country district that I first saw an expelled specimen, in general practice. It had been vomited by a child shortly before I arrived at the house.

Insanitary habits of the people & the filthy conditions

under which many poor live tend to foster the increase of this worm. A case is on record in a village where sewage from pigs was allowed to pollute the water in a stream, used for all domestic purposes. *Endemic Helminthiasis* was the result.

The prophylaxis consists in cleanliness of habits, a pure water supply, a good sewage system, especially in a crowded lower class neighbourhood.

To the free use of the filter in Paris is due the fact that the presence of the ascaris there is infrequent. In China, on the other hand, where the population is excessive and sanitary precautions absent, expulsion of enormous numbers of parasites forms part of the daily routine of practice. If the fertilisers used by market gardeners are not above reproach, all vegetables should be cooked, or well washed in boiled water. Calcining manure is a preventative against the spread of dessicated ova, and their entrance on fruit or vegetables into the human stomach.

The symptoms caused by these worms vary according to their number and the irritability of their host. It has been my experience that, especially in children, grave symptoms either reflex or *direct*, may follow the presence of these round worms. The small intestine is their normal habitat and when confined to it, the common symptoms produced are pain of a colicky nature, diarrhoea, nausea, irregularity of appetite, vomiting. A large quantity of mucus is generally caused by the irritation of their presence

and the stools often present a mucoid & bloody appearance.

Itching at the anus, and picking of the nose are local symptoms. Reflex symptoms include vertigo, obstinate cough, squinting, convulsions & dreams. Braun (in his Animal Parasites p. 10) views with favour the opinion of many authors that ascarides (in common with other species) produce materials that are toxic to their host.

From this fact he deduces the cause of pathological symptoms rather than from the theory of reflex action.

He quotes cases in which these toxic materials have been isolated and their effects on *living* organisms demonstrated by actual experiments. Further, the products formed by the decomposition of dead worms may cause toxaemia.

Either of these two theories may account for the foetor of breath which accompanies their presence. It is moreover a common experience in experiments on lumbricoides for the investigator to be attacked by suffusion of the eyes and other *catarrhal* effects, clearly shewing a

*miasma* must be emanating. This toxaemia may account for the meningeal symptoms often seen in *ascaris* cases.

If the *ascaris* confined itself to the small intestine and was guilty <sup>only</sup> of these effects already enumerated - serious though many of them are, parents & practitioners might be pardoned for treating worms so lightly as many of them do. We hear of cases in which round worms have passed up the *oesophagus* & entered the larynx and caused asphyxia. They may enter a bronchus

and cause gangrene of the lung. They have been known to cause obstruction of the bowel by coiling themselves together in knots. They have been responsible for cases of peritonitis. They have been found blocking the bile-duct and so causing jaundice, also blocking the *pancreatic* duct. They have caused abscesses of the abdominal wall. Cobbold relates a case in which a single ascaris caused <sup>its</sup> ~~his~~ host to be a lunatic for 8 years. Cataleptic fits were the most pronounced symptoms in his case. This wandering habit of the ascaris may lead to its own destruction. Round worms have been evacuated intertwined with foreign bodies swallowed by the patient - such as metal buttons, hooks & eyes etc., Such an example may be seen in the Museum of the Royal College of Surgeons, Edinburgh. A fevered condition of the body tends to expel the Ascaris and in post-mortems specimens have been found wandering in the air passages, this demonstrating that in acute diseases and as death approaches the round worm shews a tendency to quit the patients body.

Curative treatment Manson tells us that so common is this worm in China that he was in the habit there of giving young patients, a few doses of santonin twice a year, which action was invariably justified by results. He therefore advocates  $\frac{1}{2}$  to 1 grain santonin for a child, 3 to 5 grains for an adult - three doses on successive nights, the first & last followed by castor

oil or calomel next morning. In my own practice I have found santonin & calomel an efficient combination. Patients & Mothers should be warned as to the effect santonin may have on the vision & urine. Also, if the drug is too often repeated or the medical dose exceeded, *tenesmus* or *hemorrhage* from the bowels may result. Turpentine and Castor oil, 2 drachms to half an oz of each, constitute an excellent *vermifuge*, but the combination is nauseous. Quain enumerates as useful remedies - aloes, scammony, jalap, calomel, ~~kamala~~, sulphur & turpentine. Both aloes & ~~k~~alama, I find, both kill & expel the worms. Since round worms develop rapidly in an unhealthy condition of the enteric mucous membrane and as this leads to the formation of much viscid mucus, a course of bitters - gentian preferably - is recommended to clear this away, thus allowing of freer access for the *anthelmintic*. The second class of *nematodes* most commonly met with in general practice is the *Oxyuris vermicularis*. This species is much smaller than the former. As its common designation "threadworm", <sup>*imphic*</sup> this worm resembles a small piece of white thread. It is very small & delicate, *fusiform*, whitish and semi-transparent. The female is 9 to 12 mm. long and it is ~~she~~ which generally appears in the feces. The male is from 3 to 5 mm, and is hard to find without the aid of a lens. According to Manson the ova of the thread worm are seldom found in the stools

as this parasite does not as a rule part with its ova until it has entirely left the alimentary canal. The eggs are oval. <sup>Leuckart</sup> ~~Tenchant~~ has shewn that the eggs need only to be exposed to the action of the sun's rays in a moistened envelope when, at the end of 5 or 6 hours the tadpole-shaped embryos will have already become slender elongated worms. Unlike the ova of the round worms, the eggs of the *oxyuris* already contain embryos when deposited. It might be deduced from this fact that the *oxyuris* could multiply into the human intestine indefinitely, but although the embryo develops to a certain point & attains that point rapidly, yet its escape from the egg ordinarily does not take place till it has gained access to the human stomach and is there acted upon by the gastric juice. Although free *vermiform* embryos are occasionally to be met with in the intestine, yet hatching within the lower bowel is exceptional. The usual mode of procedure is the following. In the *duodenum* & other divisions of the small intestine the embryos undergo transformation. There, after casting their skins, they grow with great rapidity. Heller obtained mature worms from an infant only 4 weeks old. It may be conjectured that a period of from 3 to 4 weeks is sufficient to complete their growth. In the small intestine, impregnation takes place, after which the male dies off and passes out in the <sup>e</sup>feces. The females then transfer themselves to the caecum, where they take up their head-

quarters until the ova are matured. They then descend to the rectum and thence spontaneously, or with the faeces, into the open. They may spread over the neighbouring integument or wander into the vagina, urethra or prepuce. A case has been recorded where a specimen was removed from the cervical canal of the uterus. These migrations occur generally at night, the warmth of the bed seeming to incite the worms to action. From these nocturnal wanderings springs the greatest danger of re-infection. Their movements cause intolerable itching and by <sup>the</sup> scratching which ensues the worms are broken up. The ova let loose, with fragments even of worms, are carried by the finger nails to the mouth. Thus a new succession is started. An intermediate host is unnecessary in the life history - of this parasite.

Prophylaxis Cleanliness of person is of the utmost importance in guarding against infection by *oxyurides*. The ova perish quickly in water, so that eating with unwashed hands, meals in bed or bedroom may be a source of infection. The worms & ova after expulsion dry up & ultimately break into dust containing enormous numbers of ova still capable of springing into life under favourable conditions. These ova may enter the human stomach on fruit, raw vegetables etc., Great care therefore should be taken to well-wash or well-cook all fruit & vegetables. Flies may also carry ova about as in the

case of other parasites.

When a child is already infected precautionary measures ought to be taken to prevent auto-infection by covering the buttocks with short drawers or tying the night-dress round the feet. An affected child should also sleep by itself. Gloves might be worn and nail biting strongly prohibited.

Symptoms. The local symptoms caused by the *oxyuris* are due to the irritation produced by their creeping about the anus. This pruritus generally occurs in the evening and in the majority of cases at the same hour. Eczema about the anus is the natural result.

Mucoid and sanious stools, <sup>undue</sup> ~~undae~~ sexual excitement, and enuresis are concomitants. Irritability of the bladder and pain resembling stone in the bladder may be due to these worms. Occasionally there is tenesmus. In an extreme case of my own the little patient exhibited meningeal symptoms, had continuous & severe vomiting and shewed a tendency to peritonitis. The proximity of this worm to the *veriform* appendix might lead one to look to it as one of the causes in cases of appendicitis in children. A feature in the case of a child of 9 whom I treated for threadworms was dysphagia. Other reflex symptoms are convulsions, chorea, hysteria, *anaemia*, <sup>reversal</sup> ~~preven~~ of appetite & similar symptoms of prolonged intestinal irritation. In one family of my patients

the children all show marked anaemic symptoms, resulting in my opinion from the presence of oxyuris. Not long ago I was called to a case of convulsions. The patient was a fine healthy boy of two years. I prescribed  $\frac{1}{2}$  grain each of santonm & calomel on <sup>three</sup> ~~the~~ alternate mornings & swarms of thread worms in the faeces have been expelled. Further treatment is now being carried on. Apart from the special symptoms, the presence of thread worms must tend to undermine the general health especially in the case of young children. They must drain the system, thereby rendering the host more liable to the attack of other maladies. An instance of this came under my notice recently. I was attending a woman of the artisan class, who, with her family lived in an overcrowded insanitary house. She had symptoms of enteric (but was not confined to bed), I noticed particularly then a fine high-spirited child of 4 years. A few days later, on visiting the mother in whom the feverish symptoms had abated, I was asked to examine the child and found her in a highly feverish state, with vomiting, distended & painful abdomen, bordering on convulsions & with eczema round the anus & vulva. I gave an injection of salt solution. The result was liquid stool, literally swarming with wrig-

gling oxyurides, exceptionally large. Round worms were also present. Cerebral & peritoneal symptoms persisted & the cerebral symptoms increased to such an extent that she died in 5 days.

Curative Treatment. I have found that in treating a case of threadworms it is not only advisable but necessary to bear in mind the result of Grassi's experiment. After infecting himself with several female oxyurides, he found that fifteen days after, ova appeared in the stools & continued to appear at intervals during the succeeding four weeks. The treatment therefore must in my opinion extend over at least six weeks.

Oster in suggesting a ten days' treatment at least, might have extended his limit. Various enemata are recommended - salt & water, infusion of quassia, tincture of perchloride of iron, vinegar or alcohol & water. I find nothing superior to salt & water - one in twenty solution - warm water, though Oster recommends cold. In giving the injection it is important that the hips should be well elevated so that, by retaining the fluid as long as possible, it may come in contact with the lining membrane of the bowel. As an adult can only retain 1 pint of a fluid at a time & a child 5 ozs, it is obvious that if the

worms are fixed at the caecum, an enema will not reach them. Suppositories of quassia are said to be an efficient and convenient substitute for enemata, but in my opinion they are not so. If enemata fail to reach high enough, certainly suppositories will not reach. For this reason I approve of active saline cathartics repeated for several days in succession before the enemata are given. Large draughts of infusion of gentian are to be recommended. Aloes, rhubarb, jalap, asafoetida, calomel, santonin are all excellent in driving down the worms and in clearing away the mucus. An interesting popular remedy is a breakfast of red-herringe. The large quantity of chloride of sodium contained in them is the active ingredient producing the desired result.

For outward application many remedies are suggested. To prevent the worms from creeping out of the rectum at night mercurial ointment smeared on the verge of the anus will prove effective. The plan, however, requires caution in case salivation may follow. The itching may be relieved by ointment of carbolic acid. An excellent prescription is recommended by *Saundby* in Hutchison & Collier's Index of Treatment (1907) p. 436. composed of sulphate of iron & magnesium, with dilute sulphuric acid.

Though symptoms are less pronounced in adults than in children yet in many adult cases all medication has been in vain.

Application of the foregoing to the work of a Medical Inspector of Schoolchildren.

In looking through various books on the Medical Inspection of Schoolchildren, I have been struck by the small amount, and in some cases, want of consideration given to this branch of children's diseases. It seems to me of the utmost importance that the presence of parasitic worms should be a sufficient reason for keeping children from school. Perhaps many share the opinion of the Abyssinians that, by promoting a movement of the bowels, these worms play the part of good angels to their small hosts. A modern writer compares them to weeds in a garden, indigenous as it were, to the human soil. Apart from the question of physical effects, the moral effect cannot be otherwise than bad. Hygienic surroundings, a clean condition of the body, externally, are believed to increase our self-respect. Internal cleanliness should do so to a still greater degree. In two recent books on School Hygiene - Duke's Health at School (1907) & Hackworth Stuart's "Doctor in the Schools" (1908) - I was surprised to find no definite mention of worms in children. The first deals with schools on a level with *Rugby*, the second with State-aided Schools. Dr Stuart says (p. 6) "that the sanitary condition of schools and infectious diseases of children in relation to the public health might well remain under the supervision of the Medical Officer of Health, allowing the School doctor

to concentrate his attention on the more personal objects of inspection." Dealing with the presence of worms is a personal object of inspection. To be inflicted by parasites is not is not yet a notifiable disease, but the peculiar loathsomeness of the disorder is sufficient reason for preventing its spread amongst a body of school children. The term communicable is more applicable to parasites than the word infection and here the question of seating the pupils enters.

Even in these days of hygienic improvements and, in the majority of cases, excellent sanitary conditions of State aided Schools, it is generally agreed that the overcrowding or rather aggregation of the children is still an unremedied hygienic defect. Single or dual desks are fairly generally adopted in the Senior Schools, but in the case of young children, between 5 and 10 years, the long desks are still used in which the children are in constant contact. Especially in the case of thread worms, the danger of infection from this aggregation is great.

The prophylactic treatment of keeping the infected children from school, thus preventing the spread of ova amongst others, should be strictly enforced. Not only may the ova be spread by contact, but by the drinking vessels, towels, privies etc, which are in common use.

On page 18 Dr Stuart says "Cases certified at School as unfit to attend are often thereby consigned to continuous neglect unless frequently inquired after by Attendance

~~to concentrate his attention on the more personal objects  
of inspection".~~

Officers. Where possible, better results are secured by keeping them at school, under observation, in the plan of *Separation*." In my opinion good results are secured neither to the infected child nor to others from this plan of *Separation*. The opposite view of this question of regularity of attendance was presented to me a short time ago. I read that certain Educational Authorities had resolved to discontinue the practice of giving medals & prizes for regularity of attendance, on the ground that children physically unfit persisted in attending school in the eager pursuit not, we presume, after knowledge, but after a prize. Indeed these children, if suffering from the presence of worms, can have no gain in knowledge, if symptoms, as nervous irritation, headache, restlessness resulting in inattention are present. Moreover the ova from infected children, even when separated from the others, are strewn about and become dessicated. Then, although the routine cleaning and disinfecting of the school may be thorough, yet the openings between the boards of the floor are frequently only half cleansed. These openings gather dust, the dried ova, indeed all forms of vegetable and animal refuse and may become ~~ventable~~ <sup>veritable</sup> hot-beds of potential disease.

In the 'Lancet' for February 22nd, 1908. p.585. there appears the copy of a circular on the Medical Inspection of Schoolchildren, containing a Schedule of Guidance issued by the Board of Education.

if, as I presume, the Medical Inspector's duties include the tracing of disorders to their primal cause, and the suggesting of necessary treatment, then the question of intestinal worms bears on practically two-thirds of this Schedule. The numbers refer to the nos: in Schedule.

7. Nutrition. If in the case of a child examined, a state of mal-nutrition is observed, it is to be noted that this state may not be due to underfeeding but to the presence of *helminthes*.

8. Cleanliness & Condition of Skin. Body. Marks of scratching on the buttocks, eczema round the ~~arms~~<sup>anus</sup>, signs of enuresis suggest *nematodes*. Cases might occur, though the probability is small in the cases of young children, of proglottides being found on the body - indicating the presence of a tape worm.

9. Teeth. In the case of young patients affected by worms, transverse ridges on the front surface of the teeth are frequently noticed.

10. Throat. Dysphagia & salivation would come under this heading, effects to be met with in such cases.

11. External eye disease. Amongst the reflex phenomena frequently encountered in worm cases are squinting, dilated pupils, oedema of the eyelids, specks before the eyes and in the case of the *ascaris* particularly a watering suffusion of the eyes. It is obvious that the

usual remedy of spectacles would not be ~~too~~<sup>so</sup> useful in many eye cases as expulsion of worms.

14. Hearing. Perverted hearing is a reflex system. Cases have been known to occur, though rarely, of round worms creeping up the *Eustachian* tubes through the tympanum to the external ear, thereby affecting the hearing.
15. Speech. The habit of stammering has been known to occur in children affected by worms. There is no reason why neurotic aphonia should not also occur.
16. Mental Condition. It can readily be conceived that a normally attentive child might easily deteriorate into an inattentive one, while afflicted by worms. A bright child might be dull and persist in being so, until the cause is removed.
17. Heart and Circulation. Palpitation from anaemia caused by worms. *byapnoea.*
18. Lungs. Reflex cough simulating bronchial trouble, as in the case cited by *Craves* and above quoted.
19. Nervous System. Under this head, perhaps more than any other must the presence of intestinal worms affect the Medical Inspector's work.

Chorea associated with the presence of tapeworm, as in an interesting case reported by Dr Ronald Hodge in the *Lancet*, October 31st, 1903. There he deduced tapeworm as a partial aetiological factor in chorea. I have had many cases of

epileptic seizures, dysphagia and allied nervous disorders all traceable to worms.

22. Deformities. In a case of worms under my observation recently the tumidity of abdomen in a child amounted to an actual deformity.
23. Infectious or Contagious Diseases. I trust I have sufficiently shown that oxyurides and lumbricoides are as contagious, as harmful, in some cases as dangerous as the *Exanthematā* and ought to be as strictly guarded against.