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the problem of invasion by *Taenia elliptica* and by *Ascaris lumbricoides*

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The problem of invasion by *Taenia elliptica* and by *Ascaris lumbricoides*

In connection with the interesting investigations of Grassi on the development of certain *Taenias*,¹ I would like to present the following observation, which never seemed satisfactorily explained by the current views on the matter, but appears to support the data furnished by Grassi.

A dog, which was given to me rather young, began to defecate such an enormous amount of proglottides of *Taenia elliptica*, that one had to conclude that an enormous number of tapeworms must be present. To my great surprise, and in spite of repeated and careful searching, not one specimen of *Trichodectes*² could be found on the dog. Since it is quite unlikely that he could have repeatedly swallowed alien *Trichodectes* (N.B., containing cysticercoids) without also catching these parasites, or that one single dog-louse could have been the source of so many tapeworms, I decided to look for another intermediate host. The only likely one seemed to be the flea, of which the dog harbored many specimens; however, a number of examinations to that affect yielded wholly negative results. Although I might not have dared to try to shake prevalent views on the mode of infection on the base of this solitary observation, I did become personally convinced that our present knowledge on the subject is incomplete. Consequently, I was pleased to find confirmation of my doubts and an explanation of the facts in the indications furnished by Grassi.

I also cannot miss this opportunity to discuss another, correlated subject, i.e., the mode of invasion of the human *Ascaris*. For a number of years, I have submitted every single case of multiple ascarides to careful investigation, being firmly convinced that it must be possible to come very near to the solution of this problem using a purely clinical approach. I in fact succeeded in collecting some observations

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² *Trichodectes canis* – a species of lice that can serve as an intermediary host for the tapeworm *Dipylidium caninum*, of dogs, cats, and other animals. [T.N.]
that are almost equivalent to experiments. They all point towards infection by the embryos developing outside (either inside or outside the egg membrane) and to infection at the site of development. I am perfectly aware of the weight of the many negative results (especially those of Leuckart) but can only conclude that an unknown source of error occurred in the cultures and in feeding the parasites to animals. Moreover, some of Leuckart’s observations (on *Ascaris mystax* in kittens) seem to point in the same direction.

The results of my observations can be summarized as follows:

It is impossible to think of an intermediate host, which eaten, either whole or in part, could satisfactorily account for all the human cases of *Ascaris*. It is even less likely that these are due to the relatively rare accidental swallowing of small insects, crustaceans, mollusks, worms, etc., the probability of which does not coincide with the distribution of ascarides. The only somewhat plausible possibility is the simple passage through an intermediate host living at the site of development of the eggs, whereby the embryo, perhaps after loss of the eggshells in an early larval stage, would, like the parasites, be introduced into the body with prior stages freely developed. Although this opinion was held for some time, I believe it is wholly improbable. The disease caused by *Ascaris* is primarily associated with certain local conditions and habits: it is only brought about by handling earth, mud, sand and so forth, or by drinking dirty water, whereas food is of secondary importance. Small children who never leave the house are the most suitable subjects for investigating the conditions of invasion; they only begin to be infected when they start to crawl and the infection is most common when they are still walking unsteadily. Ascarides are never found in children who live in urban conditions, who are kept at home and do not have the opportunity to play with earth (provided that the drinking water is not suspect), and even so, the search for isolated tapeworms is usually useless. In adults, the disease sometimes is common enough to preclude widespread immunity, but its occurrence is more or less tied to certain occupations and conditions of hygiene. Correct disposal of the excrements of all *Ascaris* hosts (not only human ones) and preservation of a pure drinking-water supply prevent the appearance of endemic foci. The breach of one or another of these requirements (usually both) can always be found when multiple infections occur in the same place. Such conditions also favor invasion by other helminthes with partial development in the open air – hence, the common association of *Ascaris* with these other worms.

Isolated ascarides may of course occur accidentally, under all sorts of circumstances; but they are rare in whole classes of the population (which is shown by the secondary role played by fruits, salads, etc. as sources of infection). *Trichocephalus* is much more ubiquitous, as I have concluded from numerous stool exams; it seldom occurs in large numbers but is often found, more or less isolated, in persons who do not harbor other worms and in whom, a priori, nothing leads one to expect them (probably due to greater resistance and consequent easier delay of all the early stages – the fact that *Ascaris* eggs are easily destroyed has been well demonstrated in cultures). By taking the patient’s anamnesis of hygienic conditions and habits, it is possible to exclude the presence of *Ascaris*, with a high degree of probability; I have seldom found myself mistaken in this respect. The converse is
less certain, for even under poor hygienic conditions, there may be no infection for lack of *Ascaris* hosts. Stool examination is evidently of paramount importance when it comes to eggs, allowing us to easily ascertain whether even one single adult female is present, as I have often learned.

I now present two observations that illustrate the advantages of local inspection and surveys:

1) In a German family with very many children, the youngest offspring regularly develop a large number of *Ascaris*, often before their first birthday; these always recur in their first years of life, despite the successful administration of very effective medicine. The older children and adults have few or no worms, though the food is the same for everyone. The youngest children never leave the house and therefore must become infected there. Prolonged and careful observation revealed the following:

The drinking water is not suspect (being drawn from a well-closed well). Human excrements go into a latrine, from which they do not spread. The house has been lived in by the family since it was built, i.e., for a number of years. The premises are composed of a country store, the family’s residence, a shed, and corrals, enclosed by a small yard and garden (all together, about 150 square meters). The kitchen, which opens into the yard, has an earthen floor; the other rooms, all of them at ground level, have wood floors. The porch, used mostly by the children, opens into the yard by a door that is only shut when it rains. The children are constantly in the yard and keep bringing earth into the house on their shoes, etc. For some years now, once a week on average, pigs have been slaughtered in this yard; their intestines are filled with ascarides, as I have verified on many occasions. Large quantities of bowels and their contents are often thrown on the flat, even ground and left lying there for a long time, being gradually spread by heavy rains.

Microscopic examination of samples of earth taken from the gutter that carries rainwater away from the yard showed numerous *Ascaris* eggs – recognizable by their well-preserved albuminous shell, stained brown by bile – at the beginning of segmentation; others, at a more advanced stage and without shells, were also similar to those seen in artificial cultures. (In addition, countless unidentifiable larvae and some sexually mature, rhabditis-like forms were found, as they are also probably found in damp earth). It is evident that the children had ample opportunity to become infected, with *Ascaris* eggs present in part on the very floor of the house and more especially in the yard, and with the children crawling around and constantly touching the ground. A superficial examination would have failed to show why the children of this family, considered clean by ordinary standards, should be more prone to worms than those of some of the poorer and less cleanly neighbors.

2) A mason’s wife was presenting all sorts of digestive disorders and nervous symptoms. Microscopic examination of her stool revealed an enormous amount of *Ascaris* eggs, along with lesser numbers of *Ancylostoma* and *Trichocephalus* eggs, as well as *Rhabdonema* (*Anguillula*) larvae. Santonin is not well tolerated; it

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3 Santonin – an anthelminthic extracted from the absinth *Artemisia absinthium* or derived from naphthalene. [T.N.]
produces slight symptoms of intoxication, and not all the ascarides are defecated, so the treatment must be finished using thymol.4 Before the eggs had disappeared from the stools, the patient had expelled about one hundred *Ascaris*, some of them not sexually mature (one about 15 mm long and another, 50 mm long), as well as some *Trichocephalus* and several *Ancylostoma*. A few months later, this woman, who shares regional superstitions as to the origin of worms and consequently cannot be taught hygiene, was again found to harbor a good number of *Ascaris* (about 30). The husband, who generally eats at home but is away at work most of the day, in different places, has remained quite free from infection. (In accordance with Brazilian customs, the wife seldom leaves the house.)

Anamnesis and inspection showed that the premises consist of a plot of ground located on a dead-end street in a small country town and of a small house and a garden about 200 square meters, well tended, mostly by the wife. The drinking water is not suspect (a well-closed well). The latrine has a seat, under which straw is pushed through a side-opening. When the straw is covered with excrement, it is removed and spread in the garden to serve as manure. In this way, all the defecated eggs – which are not even caused any suffering by this method of disposal, contrary to what would happen in a sunken pit – reach a very limited area; by the end of a year, there must be quite a number of eggs per square meter. There are ample opportunities for infection during planting, picking, weeding, washing of vegetables, etc.

In other cases, opportunities for infection are still greater, since latrines are completely unheard of outside of towns – in other words, all the areas around the house (preferably the closest ones) are used for defecation; nor is the drinking water generally covered. Instead of presenting further details, I refer the reader to my paper on *Ancylostomiasis* (*Volkmann’s Sammlung Klinischer Vortraege*,5 nos. 255, 256, 265). Except for the differences due to the protracted development and lack of mobility in early stages of ascarides, my experience shows that the same conditions apply to the invasion of these worms. My observations have led me to the following conclusions:

The greater frequency of *Ascaris* in the tropics, which is often mentioned and which I can confirm to a certain degree, cannot be explained by climatic factors alone. No doubt, a higher temperature is conducive to more rapid development of the embryos, a factor which is favorable in several ways, but many eggs will also perish because they dry out. However, the main factor in warm countries is neglect of the elementary rules of hygiene (drinking water and sewage), for which the poorer classes (for instance, slaves and immigrants) suffer most. Where the same conditions hold true in more moderate temperatures and cooler countries, similar frequencies are observed. If the cited requirements are met, even in the tropics, one would certainly see a rapid decrease in helminthes with free early stages, until their near disappearance.

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4 Thymol, a thyme acid (isopropyl-meta-cresol – C10H14O), obtained from thyme oil (genus *Thymus*). [E.N.]

5 A collection of Volkmann’s clinical conferences. [T.N.]