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on the question of transmission of the human tapeworm additional communications

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Additional communications *

Today, February 2, 1888, I am able to report on a successful experiment of transmission of Ascaris lumbricoides to man. Although this is as yet a single experiment, it is altogether of such a nature that it ought to be regarded as proof of my supposition that transmission is caused by eggs containing embryos that still possess mulberry-like outer coats.

The 32-year-old subject of the experiment has been entirely free of ascarides for the past twenty years; he has not eliminated any eggs and lives in circumstances and surroundings where ascarides have never been observed. Although always very scrupulous in regard to drinking water and food, during the experiment he was even more careful to avoid everything that, so far as is known, might favor the importation of parasites. On each of these days – 4th, 5th, 6th, 7th, 19th, 23rd, 25th, and 27th of January – he voluntarily swallowed a small amount of Ascaris eggs, with their outer coats, derived from the culture mentioned earlier. The exact number of eggs was not recorded but amounted to approximately a dozen each time; only about one third to one half of these eggs could be proven to contain well-developed, mobile embryos and a large part were still at different stages of segmentation.

During the first days of the experiment, the person fell ill to dyspepsia, perhaps owing to outside influences. He vomited repeatedly and presented a slight remittent fever, and his condition soon became associated with an unusually severe case of bronchitis. While the latter improved on treatment with antipyrin, codeine, and morphium, the symptoms of enteritis became increasingly pronounced. The initial diarrhea disappeared after some days, but the man still experienced uncomfortable sensations, located in the epigastrium, which sometimes produced slight bouts of spasms. These symptoms seemed to increase soon after each new ingestion of eggs, while food was eliminated more quickly than expected and apparently very poorly digested.

Whereas the earlier manifestations were considered a result of chance, the persistent and unusual abdominal symptoms led to the supposition that the experiment had been wholly successful. In order to ascertain this and also to

eliminate the troublesome symptoms, anthelminthic treatment was initiated on the 1st of February. Half a gram of santonin and about 6 decigrams of calomel were divided into three doses. To reinforce their effect, 4 gelatinous 1-gram capsules [of thymol] were added as well. The first dose of santonin and calomel was taken at 10:30 p.m. and, shortly thereafter, two of the thymol capsules. A few hours later, the second dose was taken and, shortly thereafter, the 2 remaining capsules of thymol.

About 6:00 a.m., the subject awoke with a certain degree of xanthopsia, which soon passed, so at about 9:00 the third dose of santonin and calomel was taken. The first stool, eliminated at 6:00 a.m., was viscous and contained a thin, 12-mm-long worm that moved about vivaciously. Careful examination revealed 6 more, all of them with very distinct signs of life. Later stools were more viscous and smelled of thymol; a number of specimens were also found, although most were dead.

Thirty-five of these tiny little worms were isolated and found to vary between 5.5 and 13 mm in length. The shape of the head, with clearly visible lips, was enough to characterize them as ascarides. The relative proportions of the esophagus and the intestine as well as the shape of the tip of the tail agreed perfectly with the data and drawings of Heller and Leuckart. Comparisons with a tiny, 15-mm-long specimen, previously eliminated, also displayed complete similarity. The transversal striation of the cuticle was perfectly distinct all over; in larger specimens, the bladder-like muscle-appendages (between the skin and the intestinal tract) stood out very clearly. However, I abstain from further description, but am considering sending Counselor Leuckart a certain number of specimens1 to confirm the diagnosis. Unfortunately, preserving these delicate little creatures is quite difficult.

Since the last two specimens eliminated were still living, it seems possible that part of the worms may have been left in the intestine, something that will be verified later. A few isolated specimens may also have escaped notice. However, the number of specimens found was so great that it can be presupposed that the majority of the healthy eggs (if not all of them) must have reached full development. The differences in size evidently correspond to the different dates of ingestion and furnish further proof of my hypothesis.

Having shown earlier that living embryos can hatch in the human gut, from eggs with preserved mulberry-like outer coats, and having observed them develop into little worms from 5.5 to 13 mm in length within 1 to 3 weeks, in numbers corresponding roughly to those of the eggs capable of developing, I believe I can claim to have furnished proof that transmission occurs via eggs containing embryos and that this is tied to the good preservation of the outer shell.

Younger ascarides, found in the intestine by Heller, were smaller than my smallest specimens; more advanced stages of development have been observed by a number of authors, albeit with wide gaps. I therefore believe I can conclude that all post-

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1 The tiny worms reached me in fine condition. There is no doubt about their belonging to *Ascaris lumbricoides*. I shall examine them more painstakingly and offer a more detailed opinion on them in these pages. [Leuckart’s note]
embryonic development takes place in the intestine of the definitive host. I hope to corroborate this with further observations, although I will perform the experiments on animals since human beings are quite uncomfortable when these worms develop inside them. As to the symptoms, I would like to reiterate the point that the younger worms, unlike the adults, are incredibly mobile. Their movements persist for quite some time at room temperature and even after several hours can be induced by adding a little saliva at body temperature.