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on a species of swine Rhabdonema and on the occurrence of Rhabdonema strongyloides (Anguillula intestinalis and stercoralis) in man in Brazil

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Several years ago, while studying the life cycle of *Ancylostoma duodenale* in Brazil, I tried – unsuccessfully, I might add – to infect pigs with larvae of the human species of *Ancylostoma* and *Rhabdonema*. I first examined the feces of the experimental animals so that the control would not be disturbed by the presence of similar eggs or larvae. In the first of these animals – a pig about two months old – I found a very plentiful number of tiny rounded eggs, with completely transparent thin shells through which a rhabditis-like embryo was visible. I was unable to take exact measurements of the eggs at the time, but I did notice that they were much smaller than the eggs of *Ancylostoma*. While keeping the dry, solid feces damp, I was able to watch the hatching of many eggs within a few hours; the first stages of the young larvae showed the greatest similarity to the *Anguillula*-larvae of man, with which I am quite familiar. The material was kept in a large porcelain container, which precluded contamination by other nematodes.

On the second day, when I resumed my analysis, after its brief interruption, I found a number of worms so small that they could hardly be recognized by the naked eye, and which could only have developed from the larvae mentioned above. Under microscopic examination, both sexes, which appeared to be present in approximately equal proportions, displayed a complete coincidence with the animals of the genus of the so-called *Anguillula stercoralis*, illustrated by Perroncito. These very transparent creatures allowed every detail to be easily observed. I also watched the birth of embryos, with and without eggshells, and saw eggs in different stages of segmentation. However, it was immediately evident that my worms were much larger – at least twice as big – of those described by Perroncito.

After I had preserved a number of specimens, I decided to sacrifice the pig so as to study the distribution of the mother-animals in the intestine. Influenced by papers published until then, I believed in a rather discretionary sort of parasitism. Consequently, I expected to find the same form and to be able to preserve it easily, by raising it and feeding it to other animals.

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* “Preliminary communication by Dr. Adolpho Lutz, physician in Limeira” [in Germ.], published under the title “Über eine Rhabdonemaart des Schweines, so wie über den Befund der *Rhabdonema strongyloides* (Anguillula intestinalis und stercoralis) beim Menschen in Brasilien” in *Centralblatt für Klinische Medicin*, 6 June 1885, v.6, n.23, p.385-90 (insert with its own page numbering: 1-5). Reviews of this article were published in *Gazette Hebdomadaire de Medecine et de Chirurgie* (Paris), v.22, n.4, p.633, 1885; *Recueil de Médecine vétérinaire* (Paris), v.64, n.7, p.47-8, 1887; and *Annales de Médecine Vétérinaire* (Brussels), v.35, n.6, p.343. [E.N.]
First of all, I confirmed that the eggs mentioned above were found throughout the digestive tract, from the stomach on down. I then examined the duodenum, which was practically empty and contained only a thick mucus. The contents were scraped from the walls and diluted in water and a thin layer was placed on a glass slide, which was examined under obliquely incident light, concentrated by a concave mirror. However, I failed to find the form I was looking for; rather, there were a great many specimens of a different nematode, over 1 centimeter long and as thin as a strand of hair. I isolated about 50 of these by my naked eye. They were almost completely enveloped in mucus and occurred principally in the duodenum, though some were found in the upper part of the jejunum, while absent from the stomach, the rest of the intestine, and the bile ducts.

Under the microscope only one form of the genus was found, containing countless eggs, wholly analogous with *Anguillula intestinalis*, except for the size difference. I immediately recalled the proportions of *Ascaris nigrovenosa*, with which I am familiar, and I concluded that this was another case of heterogeny. Of course, the two forms of *Anguillulas* in man would have to be in the same state, and I then understood why I had found only a larval form in fresh feces, whereas *Anguillula intestinalis* was always absent.

As these rather surprising findings might have been received with doubt unless fully substantiated, I refrained from publishing, in the hope that fresh material and more time would provide the opportunity for a more thorough investigation. However, I not only failed to find the parasites in any of the numerous pigs examined since, but soon convinced myself that preservation in alcohol and diluted glycerin made these delicate forms practically unfit for more precise examination.

I later learned that, in a publication to which I did not have access at that time, Leuckart had defended the heterogeny of human *Anguillula* and had also mentioned the occurrence of an *Anguillula* in pigs. If, on the one hand, this coincidence of opinion with that of a prominent authority in the field justified the conclusion drawn by me, on the other, it made publication seem belated and superfluous; consequently, I again refrained from a broader-reaching form of publication.

I conclude from Leuckart's paper that swine *Rhabdonema* is poorly known and not characterized as an independent species. This leads me to return to my own observations, which seem to support the opposite view. I do not wish to overemphasize the negative results of my experiments in feeding rations containing larvae of human *Rhabdonema* to pigs, although they probably contained many ripe larvae of the second generation. However, it is remarkable that in places where human *Rhabdonema* is so common (as I will show later), it should so seldom be found in pigs, which show marked infestations of *Ascaris* and *Trichocephalus*, the more so as conditions for infection are more favorable (due to the absence of latrines, pigs wandering about loose, etc.). It must also be pointed out that in swine *Rhabdonema*, eggs of intestinal generation hatch only outside the intestinal tract of the host animal. I never observed this in human beings during countless cases (not even in small children, with relatively short intestinal tracts). In fact, the differences in size between the mature forms of both generations are too great to be accepted as mere occasional oscillations due to changed conditions of life.
If these data and observations are confirmed, it might be better to change the name Rhabdonema strongyloides, proposed by Grassi and accepted by Leuckart, to R.hominis, and to give other species the names of their respective host animals. It seems likely that the Anguillula of the rabbit and the weasel discovered by Grassi are also independent species. Leuckart likewise adds Ascaris nigrovenosa to Rhabdonema, which may also include some free-living forms.

I would like to take this opportunity to communicate the hitherto unknown occurrence of human Rhabdonema in South America. I have observed it in over 50 individuals in Brazil, to wit, in widely separated places, in the Brazilian provinces of Rio de Janeiro and São Paulo. There can be no doubt as to the identity, since the larvae I found displayed total agreement with those of Anguillula stercoralis, from which a second generation of Rhabditis-like forms, of both sexes and with the same characters, can be raised.

Leuckart’s parasites probably came from Achin [Aceh, Sumatra]; in addition, we received the first communications from Cochinchina, in Asia; recently, the parasite has been repeatedly found in laborers from St. Gotthard,1 meaning that, according to my observations, it is already found in three continents. The fact that Rhabdonema has been overlooked in many places where it occurs is much less surprising than in the case of Ancylostoma, which is relatively large. However, it has often been found together with the latter, and seems to have the same requirements, so that we may expect to find it in all the countries where Ancylostoma is present.

The wide distribution of Rhabdonema speaks against any relationship between it and a very localized disease, such as Cochinchina diarrhea. An analogous disease has never been found in Brazil. Of course, I did note in a few cases that diarrhea coincides with the presence of Anguillula larvae, but it would appear likely that the diarrhea was due to the presence of another disease. In any case, even a very large number of Rhabdonema fail to produce special symptoms and a relationship could only be supposed in the case of a tremendous quantity of Rhabdonema, as I saw in one of my patients. I believe that cases of Cochinchina diarrhea have also been observed without any Anguillula larvae present; should this be confirmed, we would then have the crucial test of Cochinchina diarrhea without Anguillula and Anguillula without Cochinchina diarrhea, and we could definitively eliminate the hypotheses set out by Bavay and Norman.

In a sequential series of 100 examinations of stools carried out in Limeira, province of São Paulo [Brazil], these larvae were found 35 times, that is, in about one-third of the cases. (We must always presume the presence of a greater number of mother-animals, because, since the species is only moderately prolific, only a very thorough-going examination would allow one to preclude the presence of isolated specimens.) Seventy-two of these patients were suspected of having Ancylostomiasis and 70 of them were voiding Ancylostoma eggs; 29 out of the 70 (41.4%) were also voiding Anguillula larvae. In the other two, it is quite likely that

1 A 15-km.-long railroad tunnel through the Alps, linking Switzerland to Italy. Drilling began in 1878 and the tunnel was opened to traffic in 1882. [E.N.]
Ancylostoma had been present earlier but had been eliminated through the administration of an anthelminthic prior to examination of the stools; one of these also presented Anguillula larvae. If we add these to the others, we would have 30 out of 72, that is, a 41.7% coincidence between Rhabdonema and Ancylostoma.

In the other 28 cases, either the examinations were focused on Ascaris or were undertaken solely to complete the study. In this series, the larvae were found 5 times, i.e., in 17.9% of the cases; twice they were found alone (7.1%), twice with Ascaris (7.1%), and once with Trichocephalus (3.6%). Coincidence with both Ascaris and Ancylostoma was seen in 15 of the first 72 cases (20.8%). If the cases are put together, we find that in the 35 cases of Anguillula-larvae, Ascaris was present in only 17 (48.6%), whereas in 100 cases, Ascaris occurred 50 times – in other words, in patients with Rhabdonema, Ascaris was found in about the same proportions as with the other patients. In the fifty cases of Ascaris, Rhabdonema was found 18 times, which is again in the same proportion as with the other patients. On the other hand, in the 35 cases of Rhabdonema, Ancylostoma was present 30 times (85.7%), whereas Ancylostoma alone was found in a maximum of 72% of the total cases examined. However modest, these figures seem to speak in favor of more similar conditions of infection between Rhabdonema and Ancylostoma than those required for infestation with Ascaris, which is just what one would have expected a priori. As to the number of specimens present, Rhabdonema certainly surpasses Ascaris greatly.

The infected individuals were almost without exception rural workers or small children, which is also true of Ancylostoma in Brazil.

Although the presence of Rhabdonema alone may not be very important in itself, it is perhaps better to see that they are voided, if only for reasons of differential diagnosis. It is with this in mind that I report on my relevant experiences. However, I must point out that one should not count on recovering expelled specimens from the feces because they are too small and delicate. Healing or improvement can be deduced from the steady disappearance or decline of larvae. Rhabdonema can be expelled using the same resources as Ancylostoma. I have also achieved complete elimination of both parasites in a number of coincident infections. Rhabdonema is decidedly more difficult to get rid of, and often there will still be larvae present when the eggs of Ancylostoma are entirely gone. This I attribute less to their taking refuge in the bile ducts or in the “Ductus Wirsungianus,” which I consider to occur mostly after death or at least quite rarely (otherwise, retention of Anguillula would be the rule); rather, the causal factor is probably the same that holds true for unsuccessful cures of Ancylostoma. As I will explain more precisely in another part, this happens because both parasites are often completely enveloped in a thick mucus, which protects them from contact with the medicinal substances harmful to them. Ceteris paribus, the smaller the parasite, the greater this protection.

In treatment, I used thymol, applying a method to be described later; other authors have used either the same substance or Extractum aethereum filicis maris, with total success in isolated cases.

The case mentioned above, in which there was an extraordinary number of parasites, involved a 2-year-old black child whose greenish, mucus-bilious stools
contained a minimum of 200 embryos per centigram, all bunched together in veritable nests containing 30 to 40 a piece. They were found at a somewhat earlier stage than usual, which may be due to increased peristalsis. In this case, there was violent intestinal catarrh, which may easily be ascribed to the parasites, but the child suffered from a disease (not yet described), whose symptoms – which I carefully studied – are the same as those of gastro-enteritis.