the more highly developed structures, the nerve-corpuscles, are those which regulate and primarily carry on the action.

It may further be allowable to suggest that, although in the nervous actions connected with sensibility and movement throughout the body, the travelling of impressions plays a most important part, yet it seems more probable that in the cerebral hemispheres such travelling has only the subsidiary end to serve of bringing all the corpuscles into communication, and that it is a condition of these, in some degree comparable with the contracted condition of a muscle, which is the physical element necessary for mental action; that the total amount of mental action at one time is thus dependent on the total amount of the physical action; and that it is very questionable if there be any closer connection between the special qualities of the mind and the structure of the brain.

On the Embryonic Form *of* Nematobothrium filarina, Van Ben. By Dr. Edouard Van Beneden. Plate VIII.

In his memoir on the Intestinal Worms, M. P. J. Van Beneden made known an extremely remarkable animal which he described under the name of *Nematobothrium filarina*.[1] It lives parasitically in *Sciæna aquila*, a fish which is found sometimes on our coasts and which is met with from time to time in the Channel and on the coasts of the Atlantic. But as it is always a relatively rare fish, one has not at all times the opportunity of studying the singular parasites which this animal harbours.

Nematobothrium differs considerably from all known worms. It has the external form of a Nematod, attains an enormous length, often more than a metre, and is always rolled up on itself, forming a regular ball, the volume of which varies between that of a large nut and an ordinary orange. This ball is lodged beneath the skin, which covers the region of the shoulder-girdle of the fish, in a regular closed cyst, which presents exteriorly the aspect of a voluminous tumour.

The Nematobothrium is not free in its cyst; it is lodged in a membranous tube rolled up like the worm which it lodges, which acquires adhesions on all sides, and from this

[1] P. J. Van Beneden, 'Memoir sur les Vers Intestinaux,' Paris, 1858, p. 107, pl. xiii.

arises the extreme difficulty which there is in disentangling the animal and isolating it throughout its length. It requires the exercise of unusual patience to succeed in isolating even a small portion of the body. In such conditions, it is easy to understand how difficult it is to study the organisation of an animal, so difficult that one cannot even distinguish with certainty its anterior from its posterior extremity. What place should be assigned to this animal in helminthological classification? It is not without doubt that M. Van Beneden has placed it among the Trematods. In assigning to it this place, he depended chiefly on, 1st, the extreme mobility of the extremity considered as cephalic, which extends and contracts, shrinks and enlarges successively as is observed in certain Trematods and some Cestoids, such as Caryophyllæus; 2nd, on the presence in the axis of the body of a contractile vessel, opening very probably on the exterior, and which must be a part of the excretory apparatus; 3rd, the analogy which this animal presents with certain Trematods, such as *Distoma filicolle* (Rud.), *Distoma Okenii* (Köll.), which lives in the *Brama Raii* in cysts similar to those in which *Nematobothrium* is found.

Nematobothrium appears then to be an exceptional Trematod, of at least a metre in length, having the external characters of certain Nematods, such as Filaria and Gordius, which, like it at the period of sexual maturity, become reduced, in a great measure, to a mere bag of eggs.

The knowledge of the embryonic form is an element which ought to be of great weight in the solution of the problem relating to the affinities of this singular animal. V. Carus, whilst placing Nematobothrium provisionally among Trematods declares that the position of this strange form cannot be determined certainly until the time when the embryonic form is known.[1]

It is this embryonic form which I propose to make known by this notice.

I will say a word to begin with concerning the egg. The egg is of extraordinary minuteness, of oval form; its long axis measures barely ·027 millimetres, its small axis reaches about ·020 millimeters. The principle that the number of eggs which an animal produces is indirectly proportional to their dimensions is, completely verified here; it is neither by hundreds nor by thousands, but by millions of eggs that our animal reproduces. The calculation is easy to make; knowing the number of eggs contained in a given length of the

[1] 'Handbuch der Zoologie,' von J. V. Carus und Ad. Gerstaecker, ii Bd., p. 480.

ovigerous tube and the diameter of the tube, we can calculate the number of eggs contained in any portion of the tube. This organ is folded up in every direction in the interior of the body, so that in the breadth of the body it crosses and re-crosses six or eight times. With these data I have been able to estimate approximately the number of the eggs contained in a piece of the worm of a decimetre in length at six or seven millions. One can judge in this way of the total number of eggs which the animal can contain at one time in the interior of its body.

The egg presents a very thick shell of a chitinous character, the colour of which varies from yellow to dark brown. The dehiscence of the egg takes place by the formation, near one of its poles, of a circular crack always very regular, which divides the shell into two very unequal portions (Pl. VIII, figs. 2 and 6). It is the manner in which the eggs burst in the majority of Trematods.

The length of the body of the embryo measures nearly double the long axis of the egg in which it is folded up, bent at its middle in such a way that the posterior half of its body is found to be applied against the anterior half. Its average breadth is about equal to half the breadth of the small axis of the egg. Its body is of an elongated form, and draws itself slowly along from before backwards. In front it is furnished with a distended part, probably of a muscular nature, on which a crown of bristles or hooklets is implanted, the form and disposition of which are very remarkable.

The anterior enlargement of the body, which we will call the muscular disc, is naturally divided by two diameters, cutting each other at right angles, at the centre of the disc, into four sectors, which are nearly equal. *The form and disposition of the hooklets is the same in two opposite sectors, different in two adjacent sectors.* If we were dealing with a crystal, we should say that it presented a bilateral symmetry.

In each of the sectors A and B (figs. 4 and 8), we counted seven hooklets, of which four larger are separated from one another by three others, which are smaller. All are arranged in a radiating manner on the disc, and diverge from the centre to the periphery. All these hooklets are nearly straight. The large ones present, nevertheless, in one point a slight enlargement, which gives them a certain resemblance to the bristles characteristic of the six-hooked embryo of Cestoids. I was not able to recognise the presence of this median swelling in all the individuals which I have observed, but that may depend on the position of the hook-

lets. The little prickles, which alternate with those which I have just described, are placed in the peripheral part of the disc. They are straight, very slender, and do not present, I believe, any median enlargement. In the sectors M and N (figs. 4 and 8), very minute hooklets are implanted of great delicacy, which are all disposed in a radiate fashion on the disc, and are situated at equal distance from one another, without our being able to discover any regular order in their disposition.

All these hooklets, those of the sectors A and B, as well as those of the sectors M and N, are implanted in the substance of the disc for the greater part of their length; their points alone are free, and project a little from the edge of the disc when seen in projection.

If the surface of the disc is examined with care, concentric transverse striations can be observed, which speak to the existence of muscular fibres (?), the presence of which appears to be indispensable, in order that the embryo may avail itself of the crown of hooklets.

At the centre of the disc is seen a small circular space, much darker, appearing like a black spot. It is exceedingly difficult to determine the nature of this organ, on account of the extreme minuteness of the embryo. It, however, appears to me scarcely doubtful that the central spot of the disc of Nematobothrium has the same signification as the organ which G. Wagener has considered as a true orifice in the embryos of several Trematoids and of various Echinorhynchi.[1] Is it a sucker? is it really an orifice? This point I have not been able to settle in the animal which now occupies our attention.

The disc is the part of the body of the embryo which presents the greatest consistence. The body possesses great mobility, and its length augments and diminishes in inverse proportion to its breadth, during the movements which the embryo executes.

Structure.—The body of the young Nematobothrium is covered by a cuticular membrane of some thickness. Under this cuticle a cellular mass is found, composed of clear and transparent cells of extreme delicacy, and of very small dimensions. There are also distinguishable small refrangent globules, of which some are fatty in nature, others mineral, probably calcareous.

G. Wagener[2] and other helminthologists have recognised

[1] G. Wagener, "Helminthologis che Bemerkungen aus einem Sendschreiben an C. Th. v. Siebold," 'Zeitschrift für Wiss. Zool.,' Bd. ix, pl. v and vi.

[2] G. Wagener, loc. cit.

in the ciliated embryo of many Trematods the existence of vessels representing the urinary apparatus of the Trematoda and Cestoida. I could find no trace of these vessels in the embryo of the Nematobothrium; and I have not been able in consequence to verify the relation which Claparede[1] has pointed out between the calcareous corpuscles and the origin of the urinary apparatus of Trematods.

Affinities.—As we have said, M. P. J. Van Beneden, relying on certain anatomical characters, has assimilated Nematobothrium to the Trematods, remarking, however, that certain facts would tend to make one consider it as forming a veritable transition between Nematods and Cestoids.

The embryonic form of Nematobothrium has nothing in common with that of the Nematods; and the knowledge of the embryo enables us to affirm that Nematobothrium does not belong to this group of Worms.

The embryo of all the Cestoids is characterized by a common form; at the moment of exit from the egg it is provided with six hooklets: of which two are directed anteriorly, two to the right, and two to the left. There are only some Cestoids peculiar to marine fishes, which, in place of three pairs of hooks, present but two. The embryonic form of the animal which occupies us diverges considerably from that of the Cestoids; and in spite of a certain resemblance in the form of some hooklets, we do not hesitate to declare that Nematobothrium is not a Cestoid.

According to the manner of their development the Trematods are divided into two great groups: 1st, that of the *Trematoda monogenetica*, comprising all the ectoparasitic Trematods and some endoparasitic Trematods, such as the *Polystomum integerrimum* of the frog; 2nd, that of the *Trematoda digenetica*, which presents all the phenomena of 'alternations of generations.' The first have, when born, the form of the adult, the second come into the world in a form which gives no indication of that of the sexual animal. The embryo of the Digenetic Trematods is generally ciliated at the moment of birth. However, Von Siebold observed that the embryo of *Distoma tereticolle* is deprived of vibratile cilia; and some time after G. Wagener observed the same fact in the embryo of *Monostoma filum*.[2] The learned helminthologist pointed out at the same time the existence, around the cephalic extremity of the embryo, of a crown of

[1] Claparède, 'Ueber die Kalkkorperschen der Trematoden: Zeitschr. für wiss. Zoologie,' Bd, ix.

[2] 'Muller's Archiv,' 1854, page 16, pl. ii. Note of Wagner in a communication by Lieberkühn, "On the Psorospermia."

hooklets, which he compared to the crown of hooklets of the Cestoid worms.

In his memoir on the development of the Entozoa, G. Wagener figures the embryo of *Distoma tereticolle* carrying in front a complete crown, composed of two score of striæ, which are, he says, like hooklets.[1]

I have myself studied the embryo of this Trematod which had been incompletely studied by G. Wagener, and which he has figured without bringing out clearly the distinctive characters which it presents.

The embryo carries round the anterior enlargement of the body four little plates, of a triangular form, similar one to another, and disposed symmetrically. Each of them formed by a thickening of the cuticle carries a system of hooklets. These hooklets are very small, and present, at a short distance from their point, a little swelling, which gives them a peculiar aspect.

These plates are supported by the anterior extremity of the body, which is greatly enlarged; where they are disposed at the extremity of two diameters, cutting each other at right angles. There is here, then, a *quadrilateral* symmetry.

Near the posterior extremity of the body exists a circular zone of little ray-like fine bristles, which completely surround the body of the embryo.

I could not distinguish in the cellular mass of the body any trace of digestive tube nor any appearance of excretory canals.

It is impossible to overlook the analogy which the embryo of Nematobothrium presents to those of *Distoma tereticolle* and *D. variegatum* and of *Monostoma filum*; and it seems to me evident that the animal which forms the subject of this note ought to be ranged by the side of those Trematods in the group of *Trematoda digenetica*, with non-ciliated embryos. Their embryonic form is characterised—1st, by the absence of vibratile cilia; 2nd, by the swelling of the anterior part of the body, separated from the posterior part by a circular furrow; 3rd, by the presence around the cephalic extremity of a series of hooklets or prickles, the form and disposition of which varies slightly in the three genera.

The embryonic characters come then to the support of the conclusion which M. P. J. Van Beneden had drawn from the study of the organisation of Nematobothrium, and

[1] G. Wagener "Beitrage zur Entwickelungsgeschichte der Eingeweidewürmer," page 25, pl. xx, in 'Natuurkundige Verhandelingen van de Holl. maatsch. der Wetenschappen te Haarlem,' 2nd Verz., 13th sect.

render it necessary to consider this animal as a true Trematod; but it is a Trematod presenting the external form of a Nematod, which attains more than a metre of length, and which lives in quite exceptional conditions.

These digenetic Trematods whose embryo is deprived of cilia cannot be considered as forming the transition to the Cestoids; and we must not suppose that in these embryos with prickles we have the homologue of the six-hooked embryo of the Band-worms. From the beautiful observations of Schubart and of Knoch[1] we know that in the Bothriocephalids the six-hooked embryo is not the first embryonic form, but that this embryo succeeds a ciliated form, from which it arises by metagenesis.

I have pointed out in my memoir "On the Composition and the Significance of the Egg" that in the Tæniadæ (*Tænia bacillaris*) a membrane is formed corresponding to this ciliated investment of the Bothriocephali; but it is constantly free from vibratile cilia. The hexacanth embryo is then both in the one and the other a *secondary* embryonic form, born by metagenesis from an embryo, sometimes ciliated, sometimes free from vibratile cilia. The ciliated embryo of the digenetic Trematods corresponds to the ciliated form of the Bothriocephali; and it is the sporocyst which corresponds to the hexacanth embryo of the Cestoids.

The embryo of *Distoma tereticolle*, of *Monostoma filum*, of *Nematobothrium*, is evidently the homologue of the ciliated embryo of the other Distomata, and consequently, in spite of their crown of hooklets, they represent in no respect whatever the hexacanth embryo of the Cestoids.

The following table sets forth the remarkable parallelism which one can establish between Trematods and Cestoids as regards their development:

Cestoids	Monogenesis	= *Caryophyllæus*.	
	Digenesis.—The first embryonic form is	Ciliate = *Bothriocephalus*.	
		Non-ciliate = *Tæniadæ*.	
Trematods	Monogenesis	= Ectoparasites.	
	Digenesis.—The first embryonic form is	Ciliate = *Distoma, Monostoma, Gasterostoma*, &c.	
		Non-ciliate = *Distoma tereticolle, Monostoma filum, Nematobothrium*.	

[1] Knoch, 'Naturgeschichte des breiten Bandwurms.' St. Petersbur 1862, 4to.

It is observable, however, that the presence of vibratile cilia in the first embryonic form is a character of little importance, and cannot serve as the basis of a natural classification.

Remarks *on* Opalina *and its* Contractile Vesicles, *on* Pachydermon *and* Annelidan Spermatophors. By E. Ray Lankester, B.A. Oxon. Plate IX.

In examining the anatomy of oligochætous Annelids, I have necessarily met with certain species of Opalina, that curious mouthless genus of Infusoria the life history of which, like that of so many of the class, is as yet quite unknown. Some notes on the *Opalina Naidos* of Dujardin, which abundantly infests the *Nais serpentina*, may not be uninteresting; at the same time, I offer some evidence as to the nature of the bodies which Professor Claparède considered to be Opalinoid parasites, and termed *Pachydermon*, figuring them from two species of the oligochæt *Clitellio;* but which I think, from the characters of some observed by me in another worm (namely, *Limnodrilus*) must be considered as packets of spermatozoa or spermatophors.

Opalinæ.—The genus Opalina has sometimes been made to include those pyriform ciliated animalcules which swarm in the rectum of the common tadpole and in similar situations, called *Bursaria Ranæ* by Ehrenberg; but these forms should rightly be separated from those so frequently found in both marine and freshwater Annelids, from which they differ materially, as pointed out by Claparède in his work with Lachmann on the Infusoria.

The simple structureless body of these first-named parasites has really very little in common with Opalina, properly so called—an abundance of highly refrangent granules being the only differentiated portions of its substance (Pl. IX, fig. 9), no trace of the nucleus and contracted vesicles, nor of the furrowed cuticle of true Opalina being observable. It is not improbable that these swarming ciliated flakes of sarcode—for they are nothing more—may undergo subsequent metamorphosis of the most extreme character; but what is true of them does not apply to veritable *Opalina*.

Opalinæ of the type I am about to describe have been observed by Dujardin, Schultze, Schmidt, Stein, and Claparède in various worms. Thus we have *Opalina Naidos*,