Development

of

Entozoa.

Vol. II

By

Henry: Nelson

Edinburgh 28 March 1850
On

The Development
of
Entozoa:
their
Metamorphoses and Migrations.

Also
Microscopic Researches
into
The Formation of the Ovum

By
Henry Nelson.

Illustrated
with
Two Hundred and Twenty Drawings.

Edinburgh 28 March 1850.
Introduction.

Three periods are said to have existed in the History of Science, through which it has passed from the earliest to the present Era. The First Period was characterized by the Confusion of Sciences, in which all knowledge lay confounded in one crude heterogeneous mass.

During this state of things the learned used Hypothesis as the instrument of investigation of the results they obtained in Systems.

The Second Epoch was that of the Division of Sciences, wherein the most strenuous efforts were made to disentangle, to unravel, to separate the elements of this incongruous mass; to purify it from the dross of ignorance,
supposition sufficiently, hoping by such means to arrive at a clearer understanding of its true constitution.

To effect this object, analysis was employed; & facts, inestimable in value, were obtained.

Another period now began to dawn. Men became aware that isolated facts could not constitute true science; that, although science could only be formed out of facts, yet something was needed to unite them, a generalization by which they could be combined in an orderly, connected, & intelligible manner. This third & present epoch in the march of human knowledge is characterized by the association of sciences. By synthesis we now combine facts, & truths from theories.

While theorizing, however, we must not forget the importance of facts; for as the ocean is joined of single drops, so a heap of sand of individual particles, so in science, built up of individual facts. Facts alone can swell the size of the heap, can raise the height of the edifice; although to prevent their dispersion & to retain each in its place, theory is essential.
Our first endeavour should be the discovery of new facts, which may augment in some measure however small the present amount of human knowledge, although the extent of their increase be hardly appreciable. Let each therefore add his grain of sand to the heap, trusting that some one else will add another, so that thus science will continue to expand, as it has done hitherto.

If however events preclude the addition of anything original each may remember that the character of the present era is Association, the mode of effecting it Synthesis, & its consummation Theory. Let each commencer to collect, to arrange, to theorise the innumerable facts that yet remain isolated, never yet amalgamated with the growing whole.

With this view the present Essay has been commenced. Though I may hope to add a grain of sand to the heap, it will be my chief aim to unite & arrange the very valuable contributions of others, so as to render the whole, if possible, a little clearer.

Fond of Natural History, a successor...
of events have led me to the present attempt.
A most interesting course of lectures delivered four winters ago in this University, by Professor
Goodsir, first awakened me to the beautiful
forms, wonderful adaptation, & surprising
changes which the Entozoa undergo. I obtained
then a general insight into the nature of this
remarkable class of beings, which I have ever
since found of the greatest use. More than once
has a reference to the notes of those lectures
solved all apparent difficulties.
Shortly after this I was in a manner
forced into the study by finding two cysts in the
livers of a mouse, each of which contained a
worm. Like all beginners I thought I had made
a discovery, & drew up an account of my
investigations. Great was my disappointment
on being shown the very animal in the work
of Jujéron, as the commonest & best known
of all the cysticerici. Notwithstanding this I
proceeded with my examinations obtaining
an important insight into the development of
these Entozoa, which was communicated to the
Royal Medical Society in the beginning of 1849.
It was however only at the
commencement of the present Session, that having
shown my observations on this Cysticercus to
Dr. Allan Thomson, he strongly advised me to
continue my investigations. Acting on this
recommendation, I devoted myself afresh to
the study, & now continue to present the results
of my labours.

I may be allowed to take this oppor-
tunity of stating the obligations I am under
to Dr. Thomson. When Professor of Physiology
in this University, he first taught me the principles
of those changes in the human embryo, which I
shall have to describe in the egg of the worm.
The worm has been & still is his principal
study; & greatly am I indebted to his skill,
caution, & experience in that part of my
research which relates to the changes incident
in fertilization. The confirmation of microscopic
observations on the worm by one who has given
so much time to its investigation must be
acknowledged by all, & to me is, invaluable.

The following is a list of the works I
have consulted, with the names of their Authors;
all of them, except two, are to be found in the
magnificent library of the Royal Medical Society.
Of the two exceptions I owe Leber'sheim's Physiology
Io the kindness of Professor Bennett; while the other,
Steenstrup, was obtained from the library of the
University.

In all my researches I have invariably
used a French microscope, made by Kachet; the
chamois leather definition of which I have very seldom
seen surpassed. While on the other hand accuracy
of delineation had been secured by the employment
of a Camera Lucida, adapted to one of Powell's
splendid microscopes, especially lent to me for
the purpose by my esteemed friend Mr. Nasmyth.

Although a large part of this Essay
is the result of the valuable investigations of
much able authors, I claim originality in
having first successfully traced the development
of the cisticercus into a Tania; the formation of
the phismatic particles in the Ascariis; as well
as the internal changes in the ovula incident
on sarcination. The propriety of this claim I
leave for the judgment of those far better acquainted
with the subject than myself.
List of Works consulted.


Decembre 1848.


J. Capelle.


Carlisle.

Trans. of the Liinean Society.


Suites à Buffon.

H. D. S. Goodf. On the Anatomy &
Development of the Cystic
Entozoa.

R. Owen. Lectures on the Comparative
Anatomy & Physiology of the
Invertebrate Animals.


Muller's Archiv. 1847.

C. A. Rudolphi. Entozoorum Historia
Naturalis.


J. F. S. Steenshage. On the Alternation
of Generations.


R. Wagner. Article, Semen.

Todd's Cyclopedia of Anatomy
& Physiology. Part 34.
On

The Development

of

Entozoa.

The Development of Entozoa was once a subject so little known that we find the best authorities of the period giving way to most extravagant conjecture and vain speculation. Two opinions have been held with regard to their origin. First, that all entozoa are generated from similar parents. Secondly, that they are the products of equivocal or spontaneous generation.

No one maintained the latter opinion more strongly than Bremner, nor carried his imagination to a greater length. “Knowing as we do,” says he, “that the world existed without form before the development of organized beings, it
"consequently, that these beings must have originated out of amorphous matter, are we to be astonished if the same thing occurs at the present time; if new individual lives are produced, if new organisations are developed?"

To prove that such organisms do owe their existence to spontaneous generation he gives the example of the non-fertilised egg becoming developed in the oviduct of the fowl. If it be objected that the production of the egg is the natural function of that organ, he replies, "to do the development of tenice & ascariides belong to the function of the intestinal canal, & the formation of flukes & hydatids to the function of the liver. On the other hand if it be argued that intestinal worms are not met with in every creature, he would reply, that neither are all animals capable of fertilisation, or of producing eyes.

He therefore considers every living organised body as an integral part of the vivified earth viewed as a whole; within which is reproduced in miniature what takes place without on the great scale. Within each organised being a continual fermentation
goes on, during which new substances are admitted, precipitated, assimilated, dissolved, decomposed, excreted. Its life in short consists of a continual decomposition & a perpetual recombinatation of matter.

What took place in the Macrocosm, takes place in the Microcosm. Not only do Entozoa originate, but different kinds appear at different periods. Thus the Oxyuris and Ascaris are as much the product of a fermentation occurring in Infancy, as the formation of the primitive Docks, which was precipitated after the first great fermentation of the then amorphous globe. The Cystica & Cestodes would, on the same hypothesis, be the result of a second precipitation, occurring at a later period during Adult Life.

It is surprising that, whilst so many have endeavored with the greatest success to refute the notion of equinoval generation, there should be found any who hold this opinion, however modified. Helminthologists have long given up the spontaneous evolution of several orders of Entozoa, in which cows have been discovered. None now maintain the
Nematocidae, Acanthotheida, Trematodes, Acanthocephala, & most of the Cestoidae, to be produced in any other manner than by sexual reproduction.

The Cysticerci and the Cysticerci have hitherto been the great arguments in favour of equinoctial generation. The Cysticercus I have attentively followed in its development; I hope to show in the course of this treatise that it does not originate spontaneously, but from an ovum. This will therefore no longer be a difficulty, especially as we can readily account for their presence in such inaccessible parts of the body as the brain & eye by the circulation of the blood, & embryos within the blood vessels; now that we know them to be only four times the size of a blood globule, I think ten thousand times, as stated by Rudolphi.

With regard to the Cysticerci, the development of the Echinococcus from an microscopic animalcule is well established, while the Acanthocephalyst is confidently affirmed by several modern authors to be identical with it.

Of this opinion is Sebaldl Mayor, &
Sicorius, the latter of whom states that he never failed to detect animalcula in the so-called Aecphaloceysts, when the microscope was employed. Although, following the division of Professor Owen, they have been separated into two distinct genera in the subsequent pages, I am yet strongly inclined to the opinion that they are the same.

The spontaneous formation of the "gigantic organic cell", as the Aecphaloceyst is graphically termed by that distinguished Naturalist, must therefore be laid aside.

Lastly, the Eecmenog Cerebralis is the only species whose origin is unknown; but that this should form a solitary exception to the product of equinoctial generation, while the other species, 1100 in number, are the offspring of similar parents, can hardly be maintained; and even if proved would not at all invalidate the truth of the general rule.

The arrangement I have followed is principally that of Owen; beginning with the lowest degree of organisation & passing on to the higher. But at the same time I have made some material changes in several of the genera; the reasons for which will be given when treating.
of them in detail. From the great extent of the subject, the want of the time at my disposal, many of the genera have been unavoidably left out. It has not been my intention to write a systematic work, but merely to give a general outline of the researches of others with some facts and generalisations of my own on the Development and Metamorphoses of Eutypaea.

I propose therefore to divide my Essay into the following Orders and Genera, treating of the development of each in its turn.
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Genus Ascaris
II  Order.  Cystica.

Although Rudolphi, who first established this order, rejected the Acetabulacra, confining it to those Hydatids only in which living beings were found, capable of locomotion. I now, on less armed with teeth & suckers, yet, following the example of Linnæus & of Owen, shall include under this head, the various Acetabulacra, Echino-
cerati & Echinoidea, leaving out the Cysticerae for reasons to be afterwards explained. Having no original observations to communicate regarding this order I am yet induced to enter more fully than I should otherwise have done into the nature & mode of development for these reasons.

1st. Many, adopting the views of Professor Owen, have denied the vitality of the cyst, believing it to be only a gigantic cell, similar at first to all the other cells composing the animal body, but which, instead of being metamorphosed into cartilage, muscle or bone, increases in size, becomes affixed to the denser, it assumes the form of a membranous
Having thus disposed of the cyst, it is not wonderful that they go a step further, I consider the organised microscopic beings sometimes contained within them as parasitical animals, whose presence is rather to be ascribed to accident, than to the reproductive agency of the encloping cyst.

2. Bremner, Blundell and others believe the Cystica to arise from an arrest in development of a totally distinct class of animals, the Tardia.

3. Because Rudolph and Bremner maintain the spontaneous origin of these as well as of all other Entozoa; although the latter has given perhaps the best account of their change and progressive development.

My object therefore is to give a sketch of the various notions held by different authors; to trace the development of the Entozoa contained in this order; I by disproving that which is erroneous to arrive at a right understanding as to their true nature and origin. To accomplish this it will be necessary to examine in detail the three genera comprising the Order Cystica.
Genus I. Accephaloceustis

Rudolphi divided Hydatids into two Classes, "Viventes," and "NonViventes," placing in the latter the Accephaloceustis, in the former the Echinococcus & Cestodes. From this it appears that he did not regard the cyst in which these little bodies are contained as a living being; since he denies the vitality of these cysts in which no Echinococcus are found.

Hence, however, proves most satisfactorily that such a cyst is never the less a distinct being; for although the simplest of all creatures the Accephaloceust is an animal, because it lives; because it does not decay; because it has no manner of attachment to the surrounding tissues; lastly, because, the fluid in which it lives not being endowed with life, it must be regarded as living alone and consequently an individual being.

Romé believed the Accephaloceust to be the simplest being known, composed solely of a stomach.

Bremner regards all Hydatids that are contained loosely within special capsules, without attachment either to them or to the organs in which they are found, as having a separate existence. But this definition it will be perceived excludes all those Accephaloceusts which in their young state are composed simply of
A spherical bladder embedded in the tissues of an infected animal, to which consequently have no second enveloping cyst. Thus, as I shall have occasion to show immediately, the first generation, or the parent cyst of all the Clam Cystics, must be excluded if this definition be adopted, I must be denied to possess vitality.

Croone divides the Acephalous into two varieties.

1. The Acephalous Endogenus of Kuhns; the A. Simplis or Proliferus of Cruveilhier; the Pia Boa Hydatides of Hunter; and the Astoma of Mr. F. Goddard. This is the kind most frequently developed in the human subject, in which the fifth parous process takes place from the internal surface of the parent cyst; the progeny being sometimes successively included.

2. In the second class he includes the Acephalous Endogenus of Kuhns; the A. Competus vel Sterile of Cruveilhier; and the Diskostoma of Mr. F. Goddard. These develop their progeny generally from the external surface.

The simplest form in which an Acephalous cyst is met with is that of a subglobular or oval vesicle filled with fluid, Plate I. Fig. 1. a., sometimes suspended freely in the fluid of a capsule formed by the condensation of the surrounding tissues; sometimes
attached to such a capsule. They vary from the size of a pea to that of a child’s head. They are of a pearly whiteness, without fibrous structure, elastic, speaking out their fluid when punctured. The tunic is studded with numerous minute globules of a clear substance. No contractile property was that of ordinary elasticity has been observed in the coats of the Accephalo cysts. No other organisation than that which has been just described. No internal cysts or young Hydatids seem to be seen. No other function apparent than that of assimilation of the surrounding fluid by the general surface, the development of new cells from the nucleus of hyaline. In fact, as Mr. Owen observes, it resembles a gigantie organic cell. This variety constitutes the A. Simplicia of authors.

The next variety is the A. Endogena of Huber; the Accephalo cyst Simplicia, Plate 1, Fig. 2. It consists of an Accephalo cyst Simplicia, such as has already been described, within which however other similar Accephalo cysts are developed. These young Hydatids originate in the substance of the parent cyst; that is, they are formed by the enlargement of the cells placed between the internal and external layers of the cyst.

A clear vesicle projecting from the inner surface...
of the internal membrane of the cyst is the first stage of the young hydatid. Plate 1, Fig. 2 a. At first it increases by the inner membrane, but by degrees as the young hydatid grows this membrane is ruptured, so that it floats in the cavity of the parent cyst. Plate 1, Fig. 2 b. Smaller cells are seen within the young hydatid soon after it is thus separated from the parent. These are the third generation. This process going on the parent hydatid becomes at length so full of young, Accephalo-cysts as to be distended by them. It ruptures then takes place, provided the surrounding capsule be not sufficiently strong to prevent such an occurrence. The young of all ages of stages are then immediately disseminated through the cavities of the infected animal; each of which in like manner repeats the same process, developing other Accephalo-cysts within itself.

The distinctive character of the A. Exogena of Kuhn, & Diskostoma of M. H. Goodwin, Pl. 1, Fig. 3, noticed am I am led to believe, from the fact of the external membrane being the weakest, the position of such hydatid on the surface of the peritoneum not affording a protecting capsule, the young ones, Pl. 1, Fig. 3 a, as they are developed force outward the external membrane, Fig. 3 b, in preference to the internals, which being supported by the fluid within it, retains its original form & size, Fig. 3 c.
These young hydatids, on attaining a certain volume, burst through the external membrane, it become free.

Hence it appears to me that the various names given to Aecophalocystis are altogether superficial, founded as they are on differences in development wholly due to the position in which they are placed.

Let us suppose an Aecophalocystis to be developed in the substance of the liver, a very common site. When it arrives at a certain size it will consist of nothing but a single cyst containing only fluid, surrounded by a dense capsule formed of the substance of the liver. This is then an A. Simplex. But in a short time the cells placed between the membranes, constituting the st. present simple cyst, begins to enlarge. It being prevented by the capsule from pressing outwards, develop themselves internally become free, I do disturb the mother as to render rupture inevitable. This then is what Ruben would call A. Endogene.

A growing hydatid follows the same law as an increasing abscess. It rises to the surface of the organ in which it is placed. Thus the A. Endogene, arrives at the surface of the liver, bursts into the peritoneum. The young at first float loose as they are sometimes found; but more commonly adhesion takes place between
them at the ascidian membrane. The development of cells still continuing, young hydatidæ are produced, which, however, meeting with no opposition to their eccentric progress force out the external membrane of the parent, constitute thus the Phleogena or Diskostoma.

If these terms be retained at all it would seem necessary to regard them as indicating merely varieties of the same species, not as they are now understood to mean, different species of the same genus.

Genus II. Echinococcus.

The name Echinococcus is given to a cyst resembling the Acetabulocyst, when in addition to the two-alveolarous fluid, it contains a number of microscopic organised beings, Pl. 1, Figs. 4-9, floating or freely swimming in it, or adhering by special prehensile organs to the internal surface of the cyst.

Boeck, following the example of Rudolfki, confines the term to these microscopic animalcules, believing as he does that the cyst in which they are found is nothing but a gigantic organic cell. It
not a distinct individual being.

Owen's however, with more propriety, gives this
name to all those hydratids in which such animalcules
are present, having traced the process by which the
minute animalcule is transformed into the
encapsulating cyst. Of this genus there are two
species; E. hominis; & E. veterinorum. The
characters by which these two species are distin-
guished are very uncertain. Pechlaner states
that the animalcules found in the human variety
are furnished with only a single circle of teeth, while
that of the lower animals has two rows; but I can
find no confirmation of this fact by other authors.

Dujardin indeed denies that there is any difference,
after having examined both varieties.

Hence the evidence, preferrable in favor of
these being only one species of the genus Echinococcus.

In Echinococcus there consists of a parent
cyst in every way resembling an Acetabularis,
likewise capable of being split up into an internal
& an external membrane. Within this parent
cyst a number of smaller cysts are frequently
found, but these are not necessarily present.

That, however which distinguishes the Echinococcus
from the preceding genus is the presence of animalcule,
Plate 1. Figs. 4, 5, 9, 12. These microscopic beings are oval
cordate or oblong in shape. One extremity is furnished
with a circle of spines, radiating from a center;
Figs. 4, 5, 9, 12, external to which, a little, more
posteriorly are four suckers, projecting slightly
from the surface of the body. Figs. 5, 6, 8, 9, 12. In
addition to these, Owen has discovered the presence
of cilia, by which these minute creatures are enabled
to change their position at will. On opening such a
cyst, these creatures are seen attached to its inner
surface, forming white patches in those places where
they are numerous.

A number of detached spines are, likewise,
met with floating in the fluid of the Echinococcus;
clearly indicating that after a time the animals lose
their spines. The oval nest disappears according
to Bremner; the little bodies at first of such a high
degree of organisation, after a time assume the
appearance of smooth globules about the size of
onion seeds. These gradually enlarge, till at lengths
they entirely fill the parent cyst, and become deformed
by the want of space and the consequent pressure. On
opening one of these little hydras, other still smaller
escape from within its cavity; and within these again are
perceived minute animals armed furnished with their
Spinous Tadpoles.

Hence it appears that the animalcula is the first, or primitive form, of the Echinococcus, which after losing its tail, its spines, its suckers, becomes a simple acelphalocyst, developing however from its interior other animalculae in every respect identical with its own former structure.

Genus III. Canurus.

The only known species is the Canurus Cerebralis, Plate 1. Fig. 10. It consists of a cyst about the size of a pigeon egg, situated in the brain of the Sheep, the Ox, Antelope, & Horse. Here it is scattered over its surface are a number of Semicircular heads, Plate 1. Fig. 10. a; a tenth of an inch in length; it, when protruded, projecting outwards into the substance of the brain. These heads are furnished with four suckers, Pl. 1. Fig. 11. a; a circle of teeth, Pl. 1. Fig. 11. b.c.; according to Rudolphi there is a double circle. A neck or body, Pl. 1. Fig. 11. d, rather narrower than the heads, composed of several joints, uniting it to the common cyst, Fig. 11. e. When disturbed the heads disappear by inversions, Fig. 11. f; if the bodies are then seen projecting into the cavity of the parent cyst.
Mr. H. Goodric has traced the development of the heads from cells contained between the layers of the parent cyst; but how this is formed, no one has yet shown, judging however from the analogies which this creature bears to the Echinococcus, it is probable that each head if detached would be capable of a separate existence, it would in time swell up, lose its spines, &c. &c. &c. in the end become a polyccephalous hydatid.

General remarks.

The Cystica, like all other beings, have their diseases, arising out of defective nutrition, pressure caused by the rapid increase of young, & some other unknown causes. After having traced the progress of development, I have now briefly to allude to the process of degeneration, by which this order of Entozoa lose their individual existence, decay, & disappear.

The first perceptible stage in this process is that the serous fluid loses its transparency, becomes thicker and thicker, it acquires a yellowish colour resembling soft cheese. The cyst from being much distended becomes flaccid & wrinkled; lastly that which was once liquid becomes entirely solidified. At first some parts of the wrinkled cyst may be distinguished, but these also disappear, till all that remains of the hydatid is a calcareous mass, covered however with a peculiar
epidermis: the whole separable with as much ease from the organ in which it is found as the hydatid itself.

The healthy hydatid, filled with limpid fluid, forms a convex, elastic protuberance on the surface of the organ in which it exists; but when degenerated into an osific mass it forms a depression encircled by wrinkles.

III. Order Cestoidea.

I. genus Tonia.

This genus contains the most remarkable of all the Entozoa, & at the same time those which are least understood. Hitherto the Cysticeria have been usually clasped with the Cystica, but, as I hope to show subsequently that they are only one of the degrees in development of the true Taeniid worms, I shall include them also under the generic term Tonia.

The distinctive characters of the Cysticeria, hitherto regarded as a genus, are given by Rudolphi in the following terms: "An external simple cyst, containing a solitary entozoon; whose body is round or flat, ending in a caudal seticle. The head is that of an armed Tonia, having four suckers, the proboscis
furnished with teeth." This definition however is scarcely suitable, for the Cysticeri of Dicynomos has no teeth; & the C. Salmoncum, according to Fröhlich, is not only unarmed, but three or four are often found inhabiting the same cyst.

Again Dujardin says that the Cysticeri are worms contained singly in cysts, of a Teariform body, with a double coronet of hooks, it terminated posteriorly by a ceride more or less coluscuminous. I shall have occasion to point out immediately that the C. Fasciolaris has no body at one period of its development, & no caudal ceride at another.

So fully was Blumenhard impressed with difficulties of this nature that he declines definition altogether. In truth individuals of this group, differ so much in conformation and shape, that the only character they can be said to have in common is a negative one, namely, the total absence of all reproductive organs.

Here we are met by a fresh difficulty. If there are no reproductive organs how are new cysticeri formed?

The celebrated French Helminthologist Dujardin believes the Cysticeri tend to be "a modified larva, springing originally from an egg;" but, from being imbedded in the substance of the tissues, incapable of attaining its normal development; it must
consequently at some time or other perish as a hyper trophyd embryo".

Blumberg, one of the most modern writers on the entozoa, gives it as his opinion that, "when single eggs of Tania, become introduced into the visceral cavities, they are developed into cystocercus. When however a mass of eggs, or an entire segment of a Tania is placed in the same circumstances an arrest of development takes place sooner, and Echinocoeus are the result."

That the caudal vesicles is not the result of the imbibition of fluids by the head, as was supposed by some, was first pointed out by Goetz, who states from repeated observation that the caudal vesicles are developed first, it attain a large size, while the worm is as yet imperfect. The fluid being first prepared by the vesicles the worm absorbs it, it is therefore in many cases found with the head invested that in projecting into the back. Thus, after all that has hitherto been written, we remain as ignorant as ever of the origin & final condition of the cystocercus.

By following another course, tracing carefully the progress of their development, comparing them with the allied genera, & drawing deductions from
analogy, I hope to remove some portion of the obscurity which has so long hung over this, one of the most difficult points in helminthology. Having been engaged for some time past in the examination of the Cysticercus Fasciolaris, a variety frequently met with in the livers of mice, I shall commence by describing its metamorphosed; after which the probable nature of this doubtful genus will I trust become more apparent.

Cysticercus Fasciolaris. Plate I. Fig. 12, 13.

The cysts containing this enterogrow are always apparent on the surface of the liver, Pl. II. Fig. 14; projecting somewhat, but embraced by its substance. So close is the attachment, to great the vasculosity of the livers at this part, that the cyst cannot be separated without tearing with it some of the gland. That portion however which projects beyond the surface is free from any covering of hepatic substance, it is enveloped only by the peritoneum. In one instance a small artery was seen, spreading itself over the free portion of the cyst.

When examined microscopically the cyst is found to be composed of two layers; which can be separated.
with ease after being heated with a solution of caustic potash, the innermost, Pl. II. Fig. 15, which is also the thinnest, consists entirely of cells placed side by side, it loaded with fatty granules in the normal state, not seen however after the addition of potash. The external layer on the contrary is fibrous, it is probably formed by the condensed circular fibers of the

tissues.

Containers within, but perfectly separate from the cyst, an entogon is seen, doubled up in an irregular manner. Withdrawn from its envelope, Pl. II. Fig. 16, the cysticercous presents the following characteristics. It is usually from one to two inches in length; elongated in form; Pl. II. Fig. 17, one extremity, dilated resembling a bladder. This is the cerebral vesicle; while the other terminates in a blunt point, the head, Pl. II. Fig. 17 a. The body, Fig. 17 c, & 23 b, when stretched is seen to be distinctly annulated; but so narrow are the segments, I so closely applied together that in the contracted state they are hardly perceptible to the naked eye; & near the head they disappear altogether.

On the head are five elevations. The terminal one, or proboscis, Pl. II. Fig. 18 a, projects in the form of a cone with a clear ring in the middle; round which on the outside curved teeth are arranged in a double circle.
These teeth are hard, somewhat resembling a cat's claw, Pl. II. Fig. 19. They are recurved, their concavity being towards the body; sharp at the points, it from 1⁄5 to 1⁄2 of an inch in length. The base of each tooth is rounded, Pl. II. Fig. 19. a, and articulated to the chela cartilaginous disc occupying the angle of the proboscis, which thus acts as a much efficient fulcrum.

About the middle of the lower sides of each tooth is a projection, Pl. II. Fig. 19 b, to which the muscular fibres are attached. These fibres form a circle round the base of the proboscis, Pl. II. Figs. 18. f, & 20. a. When these contract the cartilaginous disc is forced forward, the teeth turning on it as on a center, become first spread out, then drawn backwards.

When however the circular fibres relax, & the longitudinal muscles of the body come into action, the cartilaginous disc is drawn into the head, the points of the teeth become approximated & at the same time directed forwards, Pl. II. Fig. 20. c. If the longitudinal fibres continue to contract the proboscis is inverted, the teeth disappear entirely within the head. Those teeth which form the outer side of the circle are the smallest, Pl. II. Fig. 18. b, & alternate with these in the front rank, Fig. 18. c.

The four sucker, Figs. 18. d. & 20. b, are arranged at.
equal distances round the base of the proboscis outside the corona of teeth. In a side view the fourth, Fig. 18.e, is indistinctly seen, being obscured by the body. They are more transparent than the surrounding parts; they project from the surface, are covered externally by a well defined membrane. Each sucker presents a circular or oval opening, the margin of which is formed by a reflexion inwards of the external membrane. Figs. 18.d, 20.d

The body is covered with a thin cuticular layer beneath which a number of oval cells are seen scattered here and there, Fig. 25.a. This membrane at the hinder extremity becomes suddenly dilated, it constitutes the caudal vesicle. Figs. 17.b, 21.a. Pudolphus states that the longitudinal fibres pass from the hinder extremity of the body in two bundles, which expand themselves over the superior portion of the vesicle. This however is denied by Jordan; I certainly, none of the specimens that I have examined presented such an appearance. On the contrary all tissue of a fibrous nature ceased with the body, & the only structure that is continued to form the vesicle is the cuticular layer already described, Fig. 23.c. Within the caudal vesicle is a large quantity of fluid, for the most part perfectly transparent & clear, though a few minute granules are sometimes seen.
Such are the external appearances; we now proceed to the interior structure. In making a cross section, Fig 24, this appears to be entirely cellular, but differing in density or closeness, indicated by the light shade. There are five bands of close tissue on either side, Fig 24 a, d, an irregular mass in the same, Fig 24 b, in the middle, separated by clear bands. At either end of the central dark part is a clear round space, Fig 24 c, f, in the middle of each of these, an oval spot, Fig 24 e. The intestinal canal, better observed in the more magnified drawings, Fig 21, 22, where they are seen to present an annulated interior, corresponding to the segments of the body.

That the intestinal canals arise from the suckers was stated by Rudolphi; this has of late been confirmed by Bleekbärd, 4 may be seen by pressing the cystic duct between plates of glass. Plate III, Fig 25. Originally, they are four in number, Fig 25 b; one from each sucker, Fig 25 c; but as they proceed downwards the body becomes more flattened, they unite to form two lateral canals, III, Fig 24, d.

This then is an outline of the anatomical structure of the Lepticescus fasciolaris in the condition in which it is most commonly met with, as described by those who have written on Entozoa. We now proceed to
The examination of the steps by which this degree of development is attained, by George M. B. Goodier and his only observers, who, so far as I am aware, have said anything with regard to this development of the cysticerci. The former author is said by Rudolphi to have seen a round spot in the caudal vesse of the cysticercus, which he considered the primitive germ. Whether he traced its further progress I have no means of ascertaining, not having met with his work. After many attempts I have failed to discover any bodies presenting a spherical form, armed with teeth similar to those which Mr. T. M. Goodier has described as young cysticerci, existing between the cyst and caudal vesse.

On examining those cysts which had not yet reached the surface, but were covered by a thin stratum of hepatic lobules, it was necessary to extract them from the substance of the liver. I found the following appearances. Such a cyst, when separated, is of a very thin and tough outside from small portions of the glandular substance still adhering. When taken fresh from the mouse it is turgid, spherical, about \( \frac{1}{10} \) of an inch in diameter. Within is a filamentous testicle of nearly the same size as the cyst, but much more delicate in
appearance, more transparent; of which by a succession of changes, which I am about to describe is transformed into the Entogon.

The lowest degree of development in which I have observed the Cysticercus Fasciola, is that shown in Plate III, Fig. 27, where the vesicle, Fig. 27, a., is seen to present a cup-shaped depression, Fig. 27, b., the cavity of which is filled up with a mass of larger granules. These granules were neither covered by an investing membrane, nor were they arranged in any regular manner. No such granules however were to be seen in any other part of the vesicle.

In the next stage of development the vesicle, Fig. 26, a., presented a light spot, about $\frac{1}{8}$ of an inch in diameter, Fig. 26, b.; the vesicle itself being about $\frac{1}{10}$ of an inch when flattened between glassed but not compressed. On placing this vesicle under a power of 120 its general structure appeared cellular; but the cells so loaded with granules of fat or oil, as to render it nearly opaque, completely hiding the cell walls so as to give the whole a granular appearance. Fig. 28, a. The vesicle had burst in one or two places but no fluid had escaped being coagulated by the spirit in which it was placed for preservation.

As already stated this vesicle was opaque except
in one spot; Fig. 26. b; and when magnified presented a remarkable appearance. Fig. 28. b. It looked like a sphere imbedded in the vehicle, that is to say, the lower surface was distinctly seen to be covered by a layer of cells, not constituting the sphere. But I could not satisfy myself as to whether the same existed on the upper side, which is the one shown in Fig. 28. I am convinced of opinion that the external membrane of the vehicle passed over the sphere, I covered it with the exception of the central light spot, Fig. 28. c. This sphere was darker at the edges than towards the middle, Fig. 28. b. In the centre of all was a light spot, with a very definite margin, Fig. 28. c. This was not owing to a depression, because, when viewed as an opaque object, it was seen to be on a level with the surrounding parts. The only difference seemed to be that the substance composing the central light portion, Fig. 28. c, was not covered by the external membrane of the vehicle, it was more transparent from containing fewer granules, those of a very minute size, as compared with those of the surrounding tissues.

The substance of which this spherical body was formed appeared to be composed externally of very delicate cells, polygonal from compression against each other; beneath or within which fatty granules...
were accumulated to such an extent as to render the cellular structure very difficult to be perceived. But that such is the true nature of the external layer I feel every confidence in affirming; for by alteration of the focus so as to throw the granules out of sight, the polygonal cellular structure became visible.

I next isolated this spherical body, by tearing away the surrounding substance, and examination presented the appearance figured in PL III. Fig. 30, namely that of a second sphere, Fig. 30. a, within the first, of about one half its diameter; & within this again was a dark oval spot, Fig. 30. b.

By pressing the glasses this internal smaller body was forced out as seen in Fig. 31, in form spherical & cellular in structure. The cells were nucleated, & placed so as to present an even surface externally, but not limited by any visible membrane, Fig. 33. a. The granules filling these cells being smaller allowed their walls to be better seen.

On one side of this mass was the dark spot already mentioned, Figs. 31. a, 33. b; but now its structure became more apparent. The cells forming the general mass appeared to be arranged in a circle, Fig. 33. c, having a well-defined boundary within which I slightly deeper than the cells composing the circle, were the cells
which constituted the dark part, Fig. 33. b.

This dark spot was seen to consist of prismatic cells, Fig. 33. a, arranged side by side with the greatest order, and having the ends only presenting at the opening left by the cells of the surrounding substance. These inner cells were smaller, of a dark amber colour, and together formed the hemispherical mass, Fig. 33. b, which was embedded in a slightly overlapped by the surrounding cells. On heating the whole with Aqua Potassa, or then applying fire, the cells were forced out in a mass, which, further magnified, is represented by Fig. 29. Their walls were most distinct, it no granules were to be seen within; their cavities being filled with a clear amber coloured fluid, which made them the more remarkable, as in no other part was there the least appearance of colour.

An individual cell magnified, Fig. 32. a, presented the appearance of smaller cells, Fig. 32. b, being contained within it; a nucleus again within these, Fig. 32. c.

The spherical body just described, after a time passes inwards towards the centre of the vehicle; if the central clear spot, caused by the reflection of the external membrane, Fig. 28. c, of the vehicle, becomes converted into a funnel shaped depression Pl. IV. Fig. 34. a. On opening the vehicle, Fig. 34. b, we find that the external
description. Fig. 34. B. 35 a., corresponds with a club-shaped body that projects into its cavity, Fig. 35. c. This is smooth on the sides, but slightly irregular and dilated at the extremity, Fig. 35. c. This constitutes the Third Stage; it is, in all probability, the pedicle of the Sphaeriodon, described by W. H. Goodier.

Fourth Stage. We now for the first time are able to distinguish the characteristic form of a cysticercus, P. T., Fig. 38, consisting of a body, Fig. 38 d, and a caudal vesicle, Fig. 38 f. But the animal before us is very different from that which had been already described as most commonly met with.

The body consists of two segments only, Fig. 38 a. d., but these are most distinct, & globular. The first joint or head, Fig. 38 a., presents evidences of the four sectorial organs, Fig. 38 b.; it is fifth transparent, & slightly depressed. Spot in the centre indicates the cartilaginous disc, Fig. 38 c. When viewed from above, Fig. 39, three concentric circles, Fig. 39 d., are observed, surrounding the cartilaginous disc, Fig. 39 c., indicating folds of the future proboscis. Between the two outside rings, & at equal distances from each other are the four suckers, Fig. 39 b., but as yet without visible openings. The teeth likewise are absent. & a few dark marks round the edge of the disc alone point out their future site.
Between the first and second segments, Fig. 38. a. d., a deep, translucent vesicle. On the other side of the second, I separated by a similar, though not so deep a fissure is the caudal vesicle, Fig. 38. f.; flaccid, and irregular in shape, containing a granular fluid.

The next in order, or fifth stage of this cysticercous is that most commonly met with; it had been already fully described, Pl. III. Fig. 17. It is characterized by a body, Fig. 17. c., composed of numerous segments. The head, Fig. 17. a., is furnished with teeth; the sucker presents orifice, & there is the constant presence of a large caudal vesicle, Fig. 17. b.

In the sixth, condition the caudal vesicle very nearly, or entirely, disappears, Pl. IV. Figs. 40, 41. The animal is now wholly composed of segments, irregular towards the hinder extremity, terminating in a blunt point, more or less wrinkled. It is uncommon however to find the cysticercous Fascioloides in this state, having myself only met with it twice. It so happened that, in the first mouse which I had an opportunity of examining, I observed two animals in the stage just mentioned; my attention was thus directed to the subject under consideration. This condition of the cyst, in which it is entirely destitute of caudal vesicle, had been long known. It was however disbelieved.
by Rudolphii. Speaking of this identical Enteron, he says, "The caudal vesicle is sometimes abruptly cut off, and then it produces perfect worms without vesicles, but this is doubtful."

Having now witnessed the formation of the jointed body, and the total disappearance of the caudal vesicle, Fig. 110, the question naturally suggests itself, how are we to distinguish between the Cysticerus and a Tenia, now that the characteristic caudal vesicle has disappeared? Is it not, then, we justified in calling it a cysticerus any longer? Should we not rather term it an Encysted Tenia? But Tenias again commonly live in a free state in the intestinal canal, where their teeth or suckers come into play, what use are these appendages to an animal closely shut up within a cyst? If it could get out of its prison, they might be employed.

Let us follow out this idea by examining the opinions of former Authors. Joseph Capelle, in the Transactions of the Philadelphia College of Physicians, states that the larger was the worm the thinner was the cyst; which induced him to believe that in a future day it would have forced its way through, has fallen into the abdomen. Continuing his observations, with a view to this fact he mentions cases where the...
syst had become ruptured. In one of these instances the worm had as yet only partially escaped through the opening. Of other three cases where they had completely freed themselves, one lay on the liver, & the other two on the intestines.

This is one step in our investigation, & an important one; proving not only the occasional rupture of the cyst, but likewise that the cyst is not essential to the life of the animal, but that it can live in a state of freedom. But the cavity of the peritoneum is no more the habitat of a tapeworm than the liver is. Were it possible for the creatures to pierce the walls of the intestines it would be in a much more natural position.

Planchard endeavoured to compare a large number of cysticeri with the Teneias usually found in the same animal, but did not succeed in obtaining sufficient evidence of their identity to lead him to the belief, that they are two conditions of the same creature; with the exception however of the Cysticercus of the Rabbit. He compared the C. Fasciolaris with the Teneia Murina, found in the intestines of the Rabbit Mouse, but the single circle of teeth of the T. Murina, as well as the material difference in the form of the teeth...
proved that they were not the same. Hence he adopts Du Jardin's view; & says, "If the C. Fasciolaris is only an abnormal development of the Tania Marina, we can at least fully understand the presence of this species as its being enclosed in a cyst." It seems however a contradiction, in terms to say that the C. Fasciolaris is an abnormal Tania Marina, & then to account for the differences between the two as consequent on that abnormality.

The difference is still greater as regards the other Tanias found in the intestinal canals of the genus bidens. Hence it is to be presumed that this species does not find its way into the digestive system of the same animals in whose liver it has been formed.

It suggested itself to me whether we might not possibly find the object of our search in some of those animals which feed on mice & rats. Pursuing this idea I found that the Tania Erasticollis PI XIV Fig 42, found in every Cat, corresponded very closely with the C. Fasciolaris, & especially in the character which distinguishes it from all other Tanias, the breadth of its neck.

The following as given by Du Jardin are the characters of the two contrasted, so as to give a clearer
notion of their differences, as well as their points of agreement.

<table>
<thead>
<tr>
<th></th>
<th>Cysticercus Fasciolaris</th>
<th>Tania Graftiollis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length</strong></td>
<td>1.20 - 7.0 - 16.0</td>
<td>6.0 - 24.0</td>
</tr>
<tr>
<td><strong>Breadth of hinder segments</strong></td>
<td>0.08 - 0.18</td>
<td>0.16 - 0.24</td>
</tr>
<tr>
<td><strong>Breadth of head</strong></td>
<td>0.08 - 0.12</td>
<td>0.06</td>
</tr>
<tr>
<td><strong>Number of teeth</strong></td>
<td>36</td>
<td>48 - 52</td>
</tr>
<tr>
<td><strong>Length of longest tooth</strong></td>
<td>0.018</td>
<td>0.01 - 0.011</td>
</tr>
<tr>
<td><strong>Corona</strong></td>
<td>double</td>
<td>double</td>
</tr>
</tbody>
</table>

By this table it will be seen that the maximum length & breadth of the C. Fasc. is greater than the minimum length & breadth of the T. Crafts. The neck however of the Tania is about one half the breadth of that of the Cysticercus. This is only the case when the former is stretched out, Pl. V. Fig. 45, a; for when contracted, I have often seen it a fifth of an inch broad, Pl. V. Fig. 46, a. No dependence is to be placed on the number of the teeth. I have a preparation of the head of a small tania of this species, from the cat, in which there are only 36 teeth; and another I counted had 44. Pl. IV. Fig. 44. I have also seen C. Fasc. with 38 & 40 teeth. The length of the teeth is very nearly the same in both. Thus, according to my own measurements, they are from $\frac{1}{100}$ to $\frac{1}{60}$ in the C. Fasc. & from $\frac{1}{84}$ to $\frac{1}{55}$ in the T. Crafts.
Both have their teeth arranged in a double corona. Pl. IV
Fig. 44.c.

Capelle found the C. Fas. to measure 16 inches
in length; I have found the T. C. ras. of all lengths from
2 inches to two feet. Pl. V. Figs. 45, 46, 47, 48.

Lastly, I once met with a T. C. ras. which
presented a most distinct cyst, Pl. IV. Fig. 42 b, 43 c;
atrophied & wrinkled, but entire; offering a strong
contrast to the usual ragged extremity of this creature.
Pl. V. Fig. 45 c. Now as this individual, Fig. 42, was taken
out of the intestinal tube of a cat; & as from its size &
characters no doubt could possibly, be raised as to its
being a T. C. ras.; it as the only difference between it
& the C. Fas. nearly, the absence of the verticle, was in
this instance wanting, the verticle being there as Fig. 42 b, 43 c,
it is impossible to classify it with either exclusively,
corresponding as it does exactly with both.

Thus we have found their physical characters
to agree. We have also the negative proof that no other
tenia had a broad neck; that we have found the
transitive state of the passage of the Cysticercus Fasciolaris
of the Mauder into the Tenia Grassiullis of the Cat. They
are therefore identical.

As the Teniaform condition is a subsequent
stage to the vesicular form, the development of
reproductive organs is not to be regarded as an indication of their non-identity, but as a natural circumstance, one which an attentive observer would be led to expect.

The T. Crofts, as already stated is from two inches to two feet in length. Its head is identical with that of the C. Fae. The segments of its body become longer as we approach the tail, where they are sometimes three or four times as long as they are broad. Pl. IV, Fig. 45. a. b.

But on the slightest irritation, the creature contracts itself to such a degree that one, Fig. 45, twenty-four inches in length will contract into three inches, Fig. 46.

The whole body is covered with a fine cuticular layer, immediately under which lie a number of large nucleated cells, Fig. 49, very easily detached and perfectly transparent.

Beneath this cuticular envelope, are the circular layers of contractile fibres, encircling the body; below which again are the longitudinal muscles by which the body is shortened. Pl. II, Fig. 24 a. b. The walls of the interior become thicker, Pl. IV, Fig. 44 a. b. The four intestinal canals are seen distinctly to originate from them, Fig. 44. c. d. Then approaching each other they pass downwards for a short distance in two pairs, placed at opposite sides of the body, these
soon unite to form the characteristic single pairs of
canals seen in all tenuias V. Fig. 51. a.

These lateral canals communicate at the
junction of the segments by transverse tubes, Fig. 51. b;
rendering the whole system equally permeable to the
nutrient fluid.

The vascular system of the Tenuas, according
to Blanchard, consists of four delicate longitudinal
canals, of which two lie externally but close to the
digestive tube, while the other pairs are placed nearer
the centre of the body. An immense number of
branches break off transversely, to keep up a complete
as well as free communication between the different
objects.

The nervous systems of the Tenuias & that of
the Cysticeri are the same; consisting, according to
the author just quoted, of a nervous branch extending
between two very minute ganglia, placed at the base
of the proboscis. From these ganglia nervous fibres
towards other nervous centres, placed behind the four
suckers. There are also two very delicate filaments,
which pass down the whole length of the body, supplying
the various segments. These putorial ganglia supply
these organs with nervous filaments; influencing &
regulating their action.
The reproductive organs of the Tania Cusp. are unilateral; that is to say, each segment presents only one genital orifice, and that is on the margin, Fig. 51. c. These orifices are very minute, circular, situated nearly in the centre of the margin of each segment, and slightly depressed, Fig. 51. a. They do not alternate regularly, nor follow any rule; but are found sometimes on one margin sometimes on the other, Fig. 51. f.

From this orifice, 51. c, a straight tube passes inwards towards the centre of the segment, 51. d, dilated near the margin, becoming gradually narrower towards both extremities.

This tube is the oviduct, 51. f, passing into the ovary, which is dendritic, 51. f, occupying the whole segment, and containing an immense number of eggs. A little anterior to the oviduct is a much finer tube, 51. g, leading from the terminal vesicle, 51. h, and opening into the dilated portion of the oviduct, close to the external orifice.

In confirmation of the general belief that the different segments of the same Tania are capable of fertilizing each other, it may be as well to mention what I have several times noticed with regard to the Tania Cusp. In those cases where only one solitary worm exists it is generally so doubled up that
intestine that the head & tail occupy nearly the same spot; the rest of the body being affixed margin to margin. When however several are found together I have never seen any doubling, their bodies being extended side by side.

The ovum of this triaena though known to exist have not been examined by any author. The following are my own investigations upon the subject.

The ovum are minute & are seen to be adherent to the walls of the ovaries, as well as filling its cavities, Figs. 52 to 55. When magnified they are seen to be globular & to consist of three envelopes. The outer one is transparent; of an inch in diameter; membranous, & very easily ruptured. Figs. 52 to 55. a. The second is only 1/1000 of an inch in diameter; it is thick, brittle, granular, & opaque. 53 to 55. b; completely hiding the embryo within. Between this & the outer membrane are a number of loose globules, Fig. 53 to 55. c, resembling oil, b floating in a transparent fluid. When this second or middle envelope is ruptured by pressure, Fig. 54, 55, 57 b; the inner membrane is forced out entirely, Fig. 55, 57, 58 d; along with a very fine granular fluid.

This inner membrane is only 1/1000 of an inch in diameter. It is perfectly transparent, & very thin. Fig. 57, 60, d. Contained within it nearly filling this
membrane in the embryo, Fig. 55 to 60. fi; of a slightly oval form; granular in substance, furnished with six spines or teeth, radiating from the centre, Fig. 58 to 60. h. Sometimes these spines are placed side by side in the substance of the embryo. At other times, their points are seen projecting slightly into the cavity of the inner membrane.

All that I have been able to trace as to the formation of the ovum is that at first the outer membrane alone exists, Fig. 52. a; containing within it a granular fluid, 52. g, that in all probability this is the yolk membrane, it that the large globules it afterwards contains, 53 to 55. e, are portions of the yolk which have not been transformed into the embryo & its two proper coverings. The outer membrane is very easily destroyed, so that it is most common to see the ovum without it, Fig. 56.

The embryo when very young consists only of a membrane contained without entirely filling the inner envelope, 5 containing nothing but a granular fluid. As it progresses in development, six granules appear larger than the others, & these by degrees become elongated into the six spines or teeth. At this period the embryo is semi-transparent, & darker towards the centre, from the presence of a
few granules.

We have now traced the cysticercus Fasciola through a series of changes. We have seen it encysted in the liver of the mouse, III, Fig. 14; at first consisting only, of a cystic with a patch of granules at one point. III, Fig. 27. We have followed the successive formation of the head, III, Fig. 28; the segments, IV, Fig. 38; the suckers, IV, Fig. 39; the teeth, II, Fig. 18. We have witnessed the disappearance of the caudal vessel IV, Fig. 41; and the occasional rupture of the encysting cyst. Then follows the migration, the translation of the Cysticercus from the liver of the mouse into the intestinal canal of the cat, and its consequent transformation into the Fasciola crofticolmis, V, Fig. 45. We have proved the identity of the two. We have observed the gradual formation of reproductive organs V, 51; the development of the ovum, V, 53.

It only remains to investigate the way in which the embryo Fasciola, V, 59, 60, is cast off by its parent, assume the cystic form to complete the remaining portion of this wonderful and beautiful circle of development.

It is highly probable that the last segments of the larva become detached from the fact of the posterior extremity almost always presenting as
tangled and uneven appearance. Whether this takes place or not; whether the ova are thrown off singly or in mass, still contained within the ovary, that gives them birth, they get loose the system of the infective animal as ova, presenting externally the character of a granular membrane. [56.] In this state I have met with them, differentiated through the faces of the cat.

The eggs produced by a single segment are innumerable, how many, then, must be contained in each tenia? How great the number that falls off in the excretions of a single cat, containing as it often does from 5 to 12 of these tenia.

Let us take the cubic contents of one of the posterior segments to be 3/10 of an inch. The cubic contents of the ovary will form one third of this, or 1/10 of an inch; and assuming the mean diameter of the ovum at 1/50 of an inch linear, the number of eggs contained in a single segment will be 125,000. Now as it is impossible to estimate exactly the number of segments in each tenia from the fact that they become shorter the nearer they approach the head, we shall be greatly within the mark in estimating them at one hundred. This will give us the enormous number of 12,500,000 as the produce of each tenia croficultis. [57.]
estimated the ova contained in the Tinea Serrata of the Dog at 25,000,000.

This calculation, startling as it may seem, shows how wide & universal must be the spread of these ova. The whole neighbourhood round the dwelling of a cat must be swarming with them. Their number alone defies all the various destructive agencies put together; to say nothing of their minute size & the admirable manner in which they are encased & protected.

Are we then to wonder that they should again enter the body of the mouse; whose vicinity is courted by the cat; whose food is picked up from the ground; whose drink is the drainage of the neighbourhood; its sole method of cleansing itself consists in licking the dust from off their fur. This last is the method in which I suspect the ova enter the intestinal canal of the mouse. But it matters little, as to the means so long as entrance is effected. Many eggs doubtless are destroyed in the passage through the stomach; but from the nature & constancy of their envelopes many more must arrive safely in the small intestines.

Once there in the circumstances most favorable for incubation it is no great presumption
To suppose that the egg membranes ruptured that the embryo, furnished with its six teeth, becomes free. The softening of the membranes, consequent on the action of the intestinal juices, no doubt contributes much to the facility with which they may be torn; but I believe the rupture is effected by means of these teeth already mentioned.

Dujardin, in his investigations on the ova of the Texan Cucumbererica, notices that he has seen the teeth moving within the egg. He states that they appear to be placed in three pairs, but in all probability are really situated at equal distances. He observed their points to approach each other, the six teeth became parallel, caused by the contraction of the embryo; that these points began slowly to separate, and finished by occupying the transverse diameter of the ovum as at the first.

Although Dujardin does not indicate any result as likely to follow these motions of the teeth, it appears to me that this movement must be intended for the rupture of the egg membranes, since it is the precise motion that is calculated to effect this object. The contraction of the embryo collects the teeth together, directs their points against the enveloping membranes, into which they are forced.
by the consequent elongation of the body. The teeth are then separated, they tear the membrane acting against each other as fulcra, thereby effecting an opening large enough for the exit of the embryos. At the same time that the rupture is being effected, the embryos will by the same means be forced out of the sipuncul membrane.

That this does take place is proved by the fact that Du Jardin saw embryos of the species Serpentina which had, Pl. VI. Fig. 65, just escaped from the egg, Fig. 64, moving about in a state of freedom armed with their six large teeth, Fig. 65, a. At the hinder extremity was a uterine, 65, b; caused as he supposed by the action of the water in which they had been placed for examination, it not present in the normal condition.

Thus then the embryo of the Serpentina presses itself out of the tube, Fig. 65, a, floats freely in the cavity of the intestine; presenting an oval form; from one end of which project the six spines, it is composed internally of granules. Still there remains the difficulty of explaining how these little bodies are transported into the liver. Three ways present themselves, all of which are followed by different species of embryos.

1st. The embryo Serpentina may ascend the bile duct; 2nd. enter the liver, as is done by the
Distoma Hepaticum.

2°. It may pass directly through the coats of the intestine, & penetrate the adjoining portion of the biliary organ.

3°. It may bore its way into one of the mesenteric veins, be carried by the current of the blood, along the Vena Postica, nearly to the limits of the portal system; the minute size of the capillaries precluding its further progress.

With regard to the first of these methods it must be objected that the bile duct at first very difficult of entrance, must be still more difficult to ascend. The embryo tenea is also very minute. Its teeth are not adapted for locomotion along membranous surface. Seekers are at this period absent; for although Lejard has figured two granular shapes in the embryo of the T. Distilium, Pl. IV. Fig. 70. & 71., his observations have not hitherto been confirmed. None of the other families of teneas, while in the embryonic condition, are found to present a similar appearance.

By own observations also with regard to the embryos of the tenea craspi collis enable me to state positively that they have no seekers at the period now indicated. The difficulty of entrance, the distance to be traversed by the individual
exertions of the young tenia, it against the current of
the bile, render it improbable that this is the route
selected.

With regard to the 2nd method, the Echinorhynchi
are known to pass from one organ to another through
the tissues of the body. But, if the young tenia passed
directly into the livers through the walls of the adjoining
intestines, we should find the young cysts situated
at first on the surface of that organ, & not, as is
really the case, imbedded in it. The fact also of
the intestines being in constant motion, I of course
as continually changing their relative with the
adjoining viscera, is greatly against the possibility
of any such passage.

The 3rd route is that which appears to me
to be most easy of accomplishment, it best adapted
to the organs with which the embryo of the Tenia Corp.
is provided. The vessels of the intestinal canal are
close together, their ramifications so numerous,
that it would be hardly possible for the young tenia
to penetrate further than the submucous coat without
encountering a vein. Hidden amongst the villi,
or embedded in a follicle, the teeth can be used with
advantage. On all sides they have something to
lay hold of. The same process by which the enveloper
of the egg were pierced will enable the little creature to penetrate the wassermann coat, whose texture is most easily torn of all the organic membranes, it therefore best adapted for such penetration. Once in the veins no great difficulty is to be apprehended, as the embryo is only 3 or 4 times larger than a blood globule.

Sternheim states that antigons bore into the blood vessels by means of their hooks, without leaving any perceptible trace, it may be thus carried to any part of the body. Schonitz found worms in the capillaries of the yellow toad, and Valentin observed young individuals of the Anguillula intestinalis circulating with the blood corpuscles in the foot of a frog. Gudge also found one of these antigons, mentioned by Valentin, within the heart of a frog.

Grube & Delespouy found young antigons in the blood of a dog. Lastly Kleencher completed the investigation of this subject by the discovery of living infusorial antigons in his own blood, as well as in that of five of his friends. He describes them as elongated, varying in shape, & measuring in length three times the diameter of a blood corpuscle.

Dr. Allan Thomson informed me that he also had seen antigons in blood drawn from a frog. My own observations on this subject have not been
very satisfactory; but in the blood drawn from the jugular vein of a mouse, I found bodies that must be regarded as entozoa; 4 of the forms of which I have given a sketch in Pl. XVI Fig. 73.

These were from 4 to 8 times the size of a blood disc; round, Figs. 73 b. d. l.; oval, 73 a. c. g.; or flattened, 73 f. h. k. m.; with a dark spot or depression near one extremity. No motion was visible but this might have arisen from the presence of the super-imposed plate of glass, which from their relatively great size rested almost entirely on them. Some appeared to be formed of a double membrane Fig. 73 c. m.

I do not bring these minute bodies forward as embryonic tendons, but merely to prove the possibility of an embryo tendon circulating with the blood. On the other hand, it is just possible that they may be young tendons which have lost their hooks, i.e. thus carried along by the blood, ready to undergo further change should they find a fit locality.

From the observations of the various authors I have just enumerated the possibility of the passage of the embryo tendon into 1 of its circulation within the veins is fully established. That they do so...
enter it circulate is rendered probable from their being developed in the liver, through which the visceral blood passes. The cysts also are at first embedded in the liver, only, by degrees rise to the surface. In short, all the arguments urged against the likelihood of the two other ways in which the young tomas might arrive at the liver are so many negative proofs in favour of this route.

It only remains therefore to trace the transformation of the embryo into the primitive cyst of the Cysticercus Fasciolaris.

The first change is the loss of the teeth, which probably is effected while yet in the veins. It is now established that these six embryonic teeth are caduceus. Bruguière first pointed out the difference in actual size between the teeth of the embryo that of the adult; as well as the fact of the ova of the unarmed tomas containing the usual complement of six teeth. The number six seems to be universal with all the embryonic tomas, whatever the number with which they are furnished later on in their development.

Beyond this nothing is known positively; but judging from the change which the young Echinostoma Ph. I. Fig. 9, undergoes when it leaves its spined sucker,
It swells up into a cyst, we may I think with propriety conclude that the embystomia does in like manner swell up & constitute that vesicle with its patch of granules whose development I have investigated.

Setting out therefore with the egg, the metamorphoses of the Fascia Cruciferae are as follow.

1. The ovum with its three membranes, it includes an embryo, armed with six teeth, V. 53; leaving the digestive system of the tadpole, & entering still as an egg into the intestinal canal of the mouse.

2. The rupture of the egg membranes by the embryo & its consequent freedom. The embryo is now composed of a globular or obvoid body, armed with six large teeth. In this state it passes through the mucous membrane, enters a vein, & circulates with the blood.

3. When in the vein the embryo loses its teeth, swells up, it forms a vesicle with a granular spot. This becoming arrested in one of the hepatic capillaries, distends the surrounding tissues, which thus form the investing capsule or cyst.

4. The inversion of that portion of the vesicle, Pl. III. Fig. 57, with the granular patch. The narrowing of the mouth of the inverted portion. III. 28. The development of cells among the granules. III. 33; & the formation of the head. IV. 35. The eversion of
the head, IV. 38; the formation of segments, by
constructions of the vesicle, II. 23. The successive
development of the suckers; lateral canals; the
probes, IV. the teeth, III. 25; the gradual diminution
and total disappearance of the caudal vesicle, IV. 40.
5. The passage of the entozoa into the intestine
of the cat; the suckers of the cyst, to the second
free state of the animal; its rapid increase in
size; the appearance of reproductive organs,
V. 45; the dentritic ovary, 51 f.; dilated oviduct,
V. 51 d; the seminal vesicle, 54 d. deferent, 51 h. g.
The development of the ovum, V. 51. 52, within the
ovary; its expulsion or escape from the body of
the parent tenia.

The first stage of the Tenia Capricollis is
therefore an ovum, V. 53; within which an embryo
is contained. 59. 60 f.

The second stage is analogous to the
larval condition; it is in this state the young tenia
is armed with the teeth, adapted for boring into
the blood vessels.

We have now the pupa, or third stage;
when the embryo loses its spines, & locomotive
powers, it becomes a simple vesicle.

The fourth stage is still a portion of the
proper condition, but that in which the development of the tenea from body to head takes place. In which state it has hitherto been called Cysticerces Testicularis.

II. 14.

In the fifth stage we find the adult animal free, rapidly enlarging, making great use of its suckers & teeth. In above all perpetuating its species by shedding off mature ova. p. 45.

This then is the mode of development of a tenea, traced through all its changes; that is to say, one of the ways in which a tenea is produced.

Before entering however on the other modes of development I shall lay a few words on the remaining Cysticerces likewise found in the animal kingdom.

Cysticerces Testicularis, Rudolphi.

This cysticerces is found inhabiting cysts in the mesentery,omentum, & spleen of the horse. It is four or five inches long, & three or four lines thick behind. The head is small & quadrangular having four suckers only. The body itself is about half an inch in length, round, presenting the appearance of segments, increasing gradually, indigo, then passing by degrees into a long, cylindrical caudal vesicle, 3 to 4½ inches long. This vesicle becomes larger.
at its termination in a rounded extremity, \( \mathcal{E} \), although it appears smooth to the naked eye, when magnified it presents very fine transverse ruga throughout its whole length, differing in nothing from the body except in softness of texture and its hollow form.

This creature is contained, folded up, within a thick and strong cyst, it is evidently the young of some tenia corresponding to the fourth stage, or juvenil condition of the Tranio Braficollis. To what tenia it belongs will still remain obscure, but what I wish to be remarked is the continuity, or rather absolute identity, of the body to caudal vesicle, which is better seen in this than in any other cystic creature. The formation of the body by the doubling up of the caudal vesicle into segments is also very evident.

We are not to suppose, however, that this cystic worm must inevitably belong to an unarmed tenia because no teeth have as yet been discovered; for in my investigation with regard to the development of the Tranio Braficollis, I have shown that at one period of its cystic condition it has no teeth at all, although the suckers of body are present. Still I do not mean to say that the Cysticeres Fistularius may not be when fully developed a tenia of the unarmed.
variety; but merely to guard against laying too much stress on the presence or absence of teeth.

**Cysticercus Periformis (Flede).**

This creature is found in the peritoneal cavity of the hare or rabbit. It is commonly situated on the peritoneal surface of the intestines, in the omentum, or even in the cellular tissue around the intestines. It is thus described by Rudolfki:

Head globular, furnished with four suckers as proboscis armed with a double corona of 36 teeth.

The head & body are attenuated; the latter articulated, second, of nearly the same length as the globular cephalic nucleus. Blanchard however states that there is no proboscis, nor teeth; that on the contrary there is a slight central depression. But he has in all probability been misled by his desire to establish the identity of this *Cysticercus* with the *Tecania Destinata*, which is commonly found in the intestinal canal of the rabbit. The very fact of there being a central depression is sufficient to prove that there must be a proboscis which has been inverted, & this inversion would account for the supposed absence of teeth.

I should be much more inclined to believe it to be the cysticercal state of a *Tecania* found in
Some animal which commonly preys upon the rabbit. Thus the Tenuis tenuicola, infesting the different species of the Mustelidae, is characterized by a very short proboscis armed with a double row of caduceus teeth, 24 or very large and prominent suckers. The length of the body is from 5 to 85 tenths of an inch, 6 as its name signifies, is thin.

Now the body of the Cysticercus Percae is from 7 to 485 tenths of an inch in length. Its head and body are thin, 8 its suckers being much excavated and uniform. The head, according to Leder, Gohle, and Schubert, is furnished with a proboscis and a double circle of teeth. It is highly probable then that this is another example of the vesicular stage of a tenuis being passed in a different species of animal to that which it infests in the adult condition.

Cysticercus Percae.

This is found in the liver of the common Perch. Its body is indistinctly annulated. It is, according to Schubert, without a caudal vesicle. Schrank however says that a vesicle does sometimes exist, of an oval form. It is very frequently found associated with the Triopsidianus Nodulosa, the Tenuis Ocellatum, all these infesting the same animal; 6 as sometimes found, included in
cysts, in the livers of the perch.

The want of distinctive characters renders it impossible at present to hazard a conjecture as to which of the Tremes this cysticerous belongs; but an attentive comparison of these

creatures with the Tremes infesting the birds and fish which feed upon the perch will in all probability be successful. I mention this creature to show

that other observers have noticed that in some cases

the cysticerous present no caudal vesicle.

*Cysticerous Salmoenn.* Rudolphi.

This species is found in the livers of the

common Trout, varying in size from the head of a

penny to the size of a pea. When contracted it is 1/2 thence

in length; 1/5 inches when stretched. It is often found

two, three, or four together in the same cyst. According

to Fröhlich the head is furnished with four semilunar

sockets, it is unarmed. The body is roundish with

crenate margins, it transverse striae as if articulated,

but which disappears on stretching. The caudal

vesicle is of a middle size, round, it punked

at the margins. If really articulated, says Rudolphi,

it may perhaps be placed with the T. longicollis of

the Salmon.

The question naturally arises, how does
It happen that more than one embryo is found in the same cyst, if as embryos they have an individual existence, it work their way singly into the circulation.

If, however, we admit the notice to which I have already stated my adherence, that the enveloping cyst is formed by the distended tissues of the organ in which it is found, it is easy to see how, when one of these embryos therein becomes fixed in a portal vein, it will retain all the other embryos that may happen to pass, till the defect becoming thoroughly choked up, there is no more circulation through it, it consequently no more tissues can arrive. From this embryo being so closely packed together any cyst that may be formed from the surrounding tissues must of necessity include them all.

Cysticercus Cellulosae.

This variety is so named from it being commonly found in the cellular tissue; but it is also met with in the muscles, in the brain. It is very widely spread, it occurs most frequently in the pig, often in the Herbivora, in the monkey tribe, occasionally in man, and more rarely in the dog. It is identical with the Cysticercus Tenuicollis of Rudolph, as he himself suspected at the time.

The body is about half an inch long, with...
a caudal vesicle of about the same diameter, often very much larger. The head is small, furnished with four suckers, armed with a double corona of teeth. The neck is very thin, but the body attains the breadth of the tenth of an inch as it approaches the caudal vesicle.

Fischer found 23 cysticerci of this species in the choroid plexus of a young man. He states them to have been without any cysts; but Rudolph & Premner argue in thinking that external cysts were present, though from their transparency they escaped notice. Another observer, Steinbück, denies that the suckers are perforated. He evidently met with a young individual, in which the suckorial cirrhus had not yet appeared.

Fretheim also remarked 17 cysticerci in the choroid plexuses. He describes them as having only one sucker, of a single corona of six teeth. From an unwillingness to admit the presence of a second variety differing from the cysticercus cellulose, Rudolph inquired that those seen by Fretheim could not have been fully developed.

But from my own observations on the development of the Cysticercus Fascioloides we are enabled to decide at once as to the exact point.
in their growth to which they had arrived. The six teeth are those of the embryo; while in all probability the single sucker is the inclination of the ventricle immediately preceding the formation of the head. PL III. Fig. 28.

Thus the likeness which in the Cysticercus is almost reduced to a certainty, though not absolutely seen, appears to have been long ago observed by Trembley, though he, as well as all subsequent Helminthologists, failed to discover their actual state of development.

The head of the Cysticercus Cellulosae resembles in every respect that of the Taenia Solium of man. The two figures given by Breuer are identical if we allow for the stretching of the neck in the latter. Both have a double circle of teeth, y, although the taenia solium is sometimes found without any teeth, Breuer has fully proved that this is the result of age, and not the original condition. He also observed that as the worms increased in age, one row of the double coronas first fell off, it was after a time followed by the other leaving the worms thus unarmed. The size of the head is the same in both, as also the attenuated neck, y, the gradually increasing body.

The caudal sucker of the Cysticercus Cellulosae is the largest of any of the cysticerci; y
The body of the tenia solium is likewise the longest broadest tenia known. Are we not justified in admitting the probable identity of the two.

It may however be objected that as the cysticercous cellulosae occurs in man, judging from the analogy afforded by the cysticercus of the bovine, it cannot be a cystic condition of the tenia solium because that is likewise found infecting the human species. Man however is omnivorous; hence he is liable as the bovine to be infected with the cysticercus. But as he feeds also on animals, if on the pig, all of which are infected with this cysticercus, he renders himself also liable to be infected by their more advanced condition, in other words, by the tenia which are developed from them.

It is however a very rare occurrence for a man to be infected with a tenia solium though almost every European is in the constant habit of eating animal food. This arises in all probability from the fact that all races of mankind cook their food by submitting it to the influence of heat.

Entozoa however will sustain a very high temperature without being injured. Again how often is roast meat brought to table underdone?
where cut into, the central portion being hardly
warm.

Cellular leucine is the favorite haunt of the
Cysticercus Cellulosae, & "the Pope's Egg" is equally
esteemed among epidemics. The sheep & pig are the
animals most commonly infected with this cysticercus
I have precisely, those most universally consumed
among civilized nations.

Again, although man masticates his food
it will be found on examination that fat, from
its soft, yielding, slippery nature, is often swallowed
entire, if at most is very slightly masticated. I
see therefore no grounds for denying the possibility
of the entrance of the Cyst. Cell. into the digestive canal
of the human species, & its subsequent development
into the Ténia Solium.

It would be out of place here to indeed
perfectly useless for me to give a description of the
Ténia Solium, since it is treated of at length in
every work on intestinal worms. Still however I
cannot pass over one or two points in which I find
the most distinguished authors differing. Thus
Carriére, Bramier, & Professor Owen state that the
head is furnished with a small tubular process, placed
at the extremity of the proboscis, & in the
centre of a double corona of teeth. Rudolph, Injardin, and Blanchard on the other hand most distinctly deny the existence of any such central buccal orifice.

Carlisle's observations can hardly have much weight, as they were made at a time when the microscope was very imperfect. Spencer regards the /teeth as mere organs of precaution, though he mentions the existence of two white lines running longitudinally on either side of the segments, he regards them only as white lines, not as intestinal canals; for he says, "I propose a tannia which has only one intestinal canal, placed along the middle of the articulations."

Since he is under the necessity of establishing a mouth, it is he places in the centre of the circle of teeth. The very fact however of his having only one tannia with a single intestinal canal, admitting that such was the case, proves that all the others he met with had more than one.

Professor Owen again states that the two lateral intestinal canals unite near the head, to form one tube leading directly to the central buccal orifice. Rudolph denies this altogether; he maintains that instead of uniting to form one, the lateral canals
bifurcate to form four tubes, the white lines of Bremser, which pass directly to the four suckers. He further states, that "in the Senia, Solenium, a true mouth is wanting, but that in its place are four sectorial orifices". These opinions are borne out by all the more modern investigations on the Senia, which are now found to possess without exception four suckers. Four canals originating from these suckers, soon however uniting to form two lateral intestinal canals, situated one on either side of the ribbon-shaped body.

In my observations on the Senia, I have indicated the presence of a hard disc in the centre of the proboscis, to afford a firm point of attachment as well as of resistance to the teeth, which are in a measure articulated round its margin. It is also impossible that a central buccal orifice could exist, because we find, that, instead of the intestinal canals uniting to form a single tube, they subdivide into four canals, each terminating in a sucker.

Senia Pictilum

It would be unjust towards the eminent ichthyologist Dujardin to pass by his researches...
on the development of this teneia in the Shrew mouse. Pl. VII. Fig. 67. He found the eggs as well as the young imbedded in masses of tenacious mucous between the villae cities of the intestine; which prevented his observing those which had nearly left the egg.

The eggs, according to him, are 1/500 of an inch in diameter, Fig. 66, 68, 69, 70, containing an embryo of half that size, or 1/1000 of an inch, armed with six teeth(a). The egg is composed of three envelopes, Fig. 66. d. f. the inner one spherical. This membrane he observed in some instances to have been separated from the walls behind the embryo, Fig. 69, 70 f. He could not examine the intermediate stages on account of the rapid alterations they underwent, caused by the action of the water in which they were placed for examination; but states that he saw some not more than 1/10 of an inch long, which were however already furnished with a globular head, 6 or 7 narrow segments. Fig. 71, 72. The heads were provided with four suckers; a proboscis, Fig. 71, 72 a & b, & a circle of 16 to 20 teeth. Fig. 71, 72 c.

Dupuis and then gives it as his opinion that the embryo found in the egg forms only the head of the young teneia, & that segments are developed afterwards.
From the metamorphoses of the Tenia Graeca, I am led to believe that the change, which Dujardin imagined to arise from the action of water, was simply the vesicular stage of the Tenia Distilium.

This would account for his inability to discover anything like the adult form of this tenia, with the embryo condition of which he was acquainted.

If this inference be correct, we must admit that some of the Tenias undergo all their changes within the digestive system of the animal, in which they are found in the adult condition.

This is a most important point, one on which I am inclined to lay much stress, namely, that, while some of the Tenias pass their vesicular condition in the bodies of other animals, others do so within the digestive canal of the same animal. In this way we can explain the occurrence of adult Tenias in the herbivora, which could not have existed if all Tenias had to pass their vesicular condition in another animal to that which they infest when fully developed.

General Remarks.

These exist some differences of opinion as to the mode in which the segments are developed. Thus Ambly believed that new segments
were formed by the subdivision of the old segments; but this change, if it exists at all, must be progressive, and it has never been seen. The experiment he adduces in confirmation of his views has been contested by Rudolph and Breslau.

Breslau maintains that renewal takes place at the caudal extremity by the formation of a bud or germ on one of the margins at the point of union between two segments; that this bud increases, pushes aside the lateral by degrees the adjacent segment, and not only takes its place, but also its form and position. This opinion also is purely hypothetical, and contrary to observation.

Lastly, Rudolph and Breslau maintain that new segments are constantly produced by the head; that as the neck increases under the influence of the head, its posterior extremity subdivides to form new segments. In this way we can explain the gradually increasing development of the reproductive organ, the further the segments are removed from the head.

The analogy likewise which Professor Owen and others endeavour to draw between the Trematoda and the Trematoda, considering the former as a compound Diploema, falls to the ground: the facts upon which
Their conclusions were based having been proved erroneous. For the Distoma has a single intestine, originating in a central buccal orifice, and dividing afterwards into two lateral canals. The Teneria has four intestinal canals, originating in four peripheral mouths, tending to form two longitudinal tubes.

The four suckers, or oscula, as Rudolfi called them, are not, as usually supposed, mere organs of intension, but the true mouths of the tenia; these by which food is imbibed & nutrition effected. The following is their mode of acting, according to my own observations made on the Teneria Bovicidens.

Within each sucker, or osculum, is a cup-shaped cavity, opening externally, that is, on the exterior of the animal, by a round buccal orifice when expanded, PL IV. Fig 44 b; & presenting a mere slit when the sucker is contracted, 44 b. This contraction & dilatation may either be a property inherent in the transparent substance forming the osculum, or depend on the extent of their inclusion within, or protrusion from the head of the tenia. This last I think the more probable, that the mouth of each sucker will be...
closed when that sucker is drawn into the head by the action of the circular fibres, Fig. 44. b; and that this constitutes the narrower slit so often remarked. While it is protruded by the action of the longitudinal muscles or the retraction of the proboscis, the orifices of the orifices of the orifices will expand, it assume the circular form.

Internally, the cavity of each osculum is in direct communication with one of the tubes which are seen in the neck, Fig. 44. d, which are now or left contracted previously to opening into the tube. Fig. 44. f. I have already fully described how the tubes from the four oscula, Pl. III, Fig. 25. c, are continued along the neck of the tunic, at first in two pairs, 25. b, but by the union of the terminal tubes, the two lateral longitudinal canals are formed. V. 51. a. As long as the four tubes remain separate these are in transverse communication; but when the unites take place, 3 segments begin to appear, transverse tubes are also formed, along, the posterior margin of each joint V. 51. b.

Now when the creature is feeding, all the suckers except one appear to be closed, that is to say, are so contracted as to preclude the entrance of liquid; as in IV. 44; which was taken from a living
Specimen. That sucker which remains open is applied against the coats of the intestine, is retained in one spot by the teeth.

A peristaltic contraction then takes place, commencing at the head, and passing gradually along the body. V. 47. By this contraction the fluid contained in the four tubes, in the two longitudinal canals is forced towards the tail, Fig. 47. e; but the elastic cellular tissue which surrounds the canal, Pl. II. Fig. 21, 22, causes them to expand again immediately after the annular contraction of the body has passed.

The dilatation of the canal must naturally cause a vacuum, to fill which the fluid rushes in at the open osculum, that being the only available entrance; for the contraction of the body as it passes forces the fluid if it then prevents all regurgitation. Any fluid contained in the longitudinal canals, which is not taken up or assimilated by the segments in its passage, is probably forced out from the lower extremity, visible in all adult tearing.

I am led to believe that the Tenia Crocid was not imbibe the chyme existing in the intestine of the cat; but that one or more of the intestinal villi are drawn into the cavity of the dilated osculum,
I being surprised by the motion, a direct stain is
thus established on the cactals. The lania hereby
obtains a continuous supply of nutrient fluid, already elaborated by the digestive apparatus
of the animal which it infects.

The reasons for this supposition are
that we never find the vessel full of the thick a
dark coloured fluid, loaded with the debris of
animal tissues, which fill the small intestines
during digestion. Yet it is then that the tissues feed,
because it is then only that they are seen to be plump,
plumped, & active. When the animal has been fasting
they are on the contrary, flaccid, elongated, I contract
feebly on irritation.

The distribution of the nervous system
also is in favour of this view of the action of this
vessel; for, according to Blanchard's observations,
there is a separate ganglion situated immediately
behind each; communicating by filaments with
the central pair of ganglia; these again giving rise
to two long slender nerves which pass down the
whole length of the body, contiguous to & parallel with
the lateral canals.

Each osculum, having a separate
ganglion can act separately. Again, when one
Suckers is in position, by the influence of the central
pair of ganglia, the others are retracted or closed, by
the heavy contraction of the body, regularly enforced by
means of the long nervous filaments.

The fluid contained in the lateral
canals of the 
Tecnia, 
E. 
, is transparent and
slightly milky, but homogeneous, never containing
any undigested particles or biliary matters, such
as are always to be seen filling the intestinal
canal of the 
Ascarios, which infect the same animal.

With regard to the male organs of the
Tecnia, very little has been made out; consisting,
as seen it described by all authors, of a seminal
vesicle, 
K. V. Fig. 51, b, which however is seldom distinct;

It is the deferent, Fig. 51, e, opening into the dilated
portion of the occluder, near the margin of the
segment, Fig. 51, c. This is very well seen in the

Tecnia Elliptica, K. V. Figs. 74, 75, another variety
likewise found in the cat, but which have two
genital pores on the opposite margins of the same
segment, Fig. 74, a.

There is no distinct ovary. The ova
are formed in masses, several together, Fig. 77, e,
appearing at first entirely granular; K. VII. Fig. 78.
Then the external envelope becomes transparent
from the disappearances of the granules, Fig. 79. a, & the ova are distinctly seen, each composed of two membranes, Figs. 79. 80. a, b, within which is the embryo with its six teeth, Fig. 79. 80. c, e.

When these egg masses are visible, Fig. 79, the seminal tube is long and narrow, Fig. d, presenting a dilatation of its upper extremity, Fig. c, the exact confines of which can never be clearly determined.

On examining some of the segments, however in which the egg masses had not as yet appeared, Fig. 74. a, 76, I found a large, well-defined round body, of a yellowish hue, Fig. f, crenated on the margins, F communicating by a tube, Fig. c, with the oviduct, which even at this early period was fully developed; Fig. b. This body, apparently, the testicle, is formed before the ova are visible, it disappears entirely, except a small portion of its investing membrane, Fig. d, after fecundation has been effected, & the ova developed. The so-called seminal vesicle has often attracted attention; but I am not aware of any previous mention of a distinct testicle.

When a segment of a tunic becomes detached, it constitutes, according to Biard, 86.
a Proglottis; according to Professor Owen, as Trematoda: these maintaining the Tania to be an imperfect animal, from which other perfect beings are detached.

I have already shown the want of analogy between the Tania and the Trematoda; it remains for me to prove that the Proglottis is not an animal at all.

In the first place, it has no mouth; as is seen by reference to the drawing of an Proglottis of the Tania Elliptica, Pl. VII. 82. Both extremities of this oval body are exactly alike, each presenting two round depressions, Fig 82. a, with a groove between, 82. b; the whole surrounded by the puckered integument. The round depressions are the true lateral canals; 82 the groove is one half of the transverse tube, for that being the weakest part separation of the segments takes place there only.

They are never met with in the intestinal canal higher than the Tania from which they are derived; but on the other hand are commonly seen in the flees, being ejected through the deficiencies of organs by which to maintain their position.
The only motion these suppositories
Proglottis are capable of is caused by a wavy
contraction, which commences at one end, t
propels to the other. But this is not a voluntary
motion. It is merely a portion of that irritability
which remains in a member after separation
from the trunk. Yet it is on this contractility
and consequent motion that the chief argument
rests for the existence of the Proglottis.

Many of these detached segments,
especially those found in the colon, lower portion
of the small intestines, have not this power, but
have lost all contractility, which have therefore ended
their existence, yet the ova within them have
undergone no change, nor has the segment itself
become altered.

The segments therefore only become
detached when the ova are mature. Though still
possessing some measure of contractible irritability,
they do not possess an individual life; for they are
incapable of voluntary motion; incapable of
taking in food from the absence of a mouth; unable
to retain their position in the intestinal canal; if
they soon lose the small amount of contractility
they possess. They become inanimate masses,
although they have not undergone any change in form, organisation, or development; which would have been the case had each segment been a separate animal. Hence the Brugletti is not an animal: only a part of one.

With this I must conclude my remarks on this genus; trusting that my investigations have in some measure cleared up the gloom which has hitherto enveloped the closely allied forms of the Leptocerous & the Scutia.

The remaining Centoidea have been classed under two heads, or genera; The Bothriocephalus, & the Rheolobothriidae; on each of which I shall have to be very concise from the presence of more important subjects.

II Genus Bothriocephalus.

This genus, according to Bujardier, is characterized by an elongated body, composed of numerous segments; an oblong head, square or flattened on the sides, furnished with two narrow elongated bilateral, or four ear-like projections, or four suckers armed with teeth. The genital pores are situated in the middle of
each segment. These are the characteristics of
the adult forms of the Pothriocephali: let us endeavour
to trace the changes they undergo previous to the
perfect condition.

An Entogonon has been detached by
Brebikin & Guajard, from the present geneus, under the
name of Schistotrephalea Demorphiæ; so named
from the head being cleft at the extremity, it being
without the lateral bothria. But Rudolphi,
Abilgaard & others have called this entogonon a
Pothriocephalea; because it has the two characteristic
bothria, but from their being placed very much in
front, they appear to divide the head into two lobes.
This fully accounts for the cleft head, & the absence
of other defecation's lower down.

This creature, the Pothriocephalea Nodosus
of Abilgaard, is met with in the intestinal canals
of the Gasterosteus clupea of fishes. It is composed
of a head, as already described; of an elongated
body, divided into obscure segments, in the
centres of which is the solitary characteristic
generative pore. But while this Pothriocephalea
remains in the fish no development of ovar
takes place; & hence it is an imperfect animal.

The second locality in which the
B. Novotux has been met with in the intestines of the Aquatic rapacious Birds that feed on fish, such as the Divers, Guillemot, Heron, Grebe, Penguin, Tern. In these their entogon is found in a state of perfection, for the segments are now filled with ova.

Hilgard made a direct experiment by feeding two ducks for some time on the fish which most commonly contain this species; on dissection found in one 63 individuals arrived at their full development.

It is further easy to see how the ova of the Deltobranchiops, expelled with the feces of the aquatic birds, find their way into the bodies of other fish. But the B. Novotux, or Schistomphalus forms, according to Dujardin, the passage or connecting link between the Ligula and the Deltobranchiops; if, as we have found this to be a true Deltobranchiops, may not the Ligula be so also.

The Ligula are worms having the appearance of long white bands, without distinct articulations, with a very rudimentary head, without reproductive organs. Such is the condition in which we find them in fishes, Cyprinid, called by Rudolphi Ligula Simplicissima. They are not found in the intestinal canal, but external.
to it in the peritoneal cavity. Cephalo somers has
proved their identity with the tegulae found in the
intestinal canals of the fish-eating birds.
In the tegulae of birds the head becomes more
distinct. At first, according to Dujardin, it
presents a slit resembling the head of the
Ichistocenephalus; but as it becomes more developed
the cephalic extremity becomes pointed, the two
bottesia are distinctly seen. In this condition the
body presents a series of segments, containing a
single or double row of ovaries with central generative
pores; hence it is to all intents a Bathrocephalus.
In the liver of certain fish, Gadidae, cygns are found about the size of peas, each
containing a long flattened cutaneous, without
segments; having a head without visible organs;
in short, a tegula; but Daudelin calls it cysticercous
Gadicotea, because the posterior extremity terminates
in a caudal sucker.

Another kind, called Cysticercus
Salarici, is found encased in cysts in the liver of
the Salmo Salarici. The head is furnished with
two suckers, which Lebrun claims to be in reality
pits, or bottries, situated on the margins. The body is
flat and smooth; but found when magnified to be
composed of segments, terminating in a caudal vesicle.

In fact the first condition of a *Dicrocoelium* appears to be a *cysticerxon*, enclosed in a capsule; which, according to Rudolphi, is sometimes softened, and the creature then exists free within the peritoneal cavity, in the form of a *ligula*.

A transfer from one animal to another then takes place; if the *ligula* is next met with within the intestinal canal, in which it sometimes arrives at maturity, but in other cases remains dormant. Another transfer occurs if the *ligula* or *Schistosoma* finds itself in the position best adapted for its perfect development. The characteristic botria, the central generative pores now become distinct; segments appear if the eggs are mature; the whole constitutes a true *Dicrocoelium*.

This creature is peculiar to fish, and to those birds and animals which live on fish. Hence we must conclude that the species infesting man passes the first period of its development within the body of a fish embrowned in the ocean. In accordance with this supposition we find the *Dicrocoelium* later confined almost exclusively...
to Russia and some parts of Switzerland, these fish form a large proportion of the food of the inhabitants. In Russia fish are preserved by packing in ice. They are not salted; they are also said to be eaten raw in some parts of that empire. In this country the attention paid to the removal of the

III. Genus Rhynchobothrius.

These are Ecto-parasites whose heads are furnished with two or more generally four retractile trunks armed with hooks. This genus has been lately investigated, the whole development beautifully traced by an eminent Danish Helminthologist, Van Beneden. To a concise account of whose researches I am compelled to restrict myself.

The first state in which Van Beneden has observed the Rhynchobothrius is in the form hitherto called Scolex, inhabiting the pyloric caeca of fishes. It is a free enteron, at first more or less rectilinear, afterwards becoming filiform. The head is
furnished with four suckers at a trunk. The whole worm is extraordinarily contractile; it has two dark spots on the head, supposed by him to be eyes.

The Scolex, after a time, throws off from its surface a thick mucous, which, in concretizing, forms a tenacious envelop, composed of concentric layers. Within this envelop, the Scolex, now become contractile, has some resemblance to a Distoma, it contains within itself another entogon, a Tetrasygnum. The Scolex, therefore, according to van Beneden, is a scolex; within which a Tetrasygnum is produced by generation.

The genus Anthotyphus of Rudolphi of H. Du Jardin is in reality, only the condensation of the Scolex, or rather of the Rhynchobothrii; it is met with attached to the peritoneum of several varieties of fish.

The next, or third state, is that in which we find it free, inhabiting the intestinal canals, or embedded in the tissues, of the Shark, Raies, & Skates, & passing by the names of Tetrasygnum, Gymnoryynchus. It is an elongated worm, having a head furnished with four retractile suckers, armed with spines, & elliptical bothria. The body, however, is cylindrical, with scarcely
any trace of segments, no appearance of reproductive organs.

The transverse lines begin next to appear across the body of the Tetrahydroflexus, by which it is divided into segments; I think the tetraformed entozoan is produced, called a Rhynchosobothria. Reproductive organs are then developed, eggs for the first time produced; showing this to be the last or adult condition.

Van Beneden, however, is of opinion that the segments by separation constitute a species of Distoma, analogous to the Proglottert of Buyskard. But the Proglotteor has been already proved not to be an animal; hence we cannot admit that the analogous segments of the Rhynchosobothria are transformed into flukes to constitute the fourth condition of Van Beneden.

He states also that the eggs of the Rhynchosobothria pass out with the excreta, are swallowed by the smaller varieties of fish; in the intestinal canal of which they assume the form of Scolex. On arriving at perfection the Scolex pierces the walls of the intestines, it lodges itself beneath the peritoneum, where it secretes its thin wavy envelope, it becomes an
Anthocephalus; within which again a Tetrarhynchus is developed by gemmation.

The Order Cestoida may therefore be reduced to three genera; of which all the other genera are mere degrees in development.

Genus I. Tania. comprising

Cysticercoidea Rud.
Tania Rud.

Genus II. Dostrioccephalus.

Cysticercoidea Rud.
Ligula Block.
Schistocephalus Creplin.
Dostrioccephalus Rud.

Genus III. Rhynchobothriyes.

Scolex Müller
Antocephalus Rud.
Tetrarhynchus Rud.
Gymnomphyrhynchus Rud.
Rhynchobothriyes Dujardin.
III. Order Acanthocephala.

Genus Echinostyphus. Müller.

These are entozoa of flaccid, vesicular, or elongated bodies, with a retractile trunk, cylindrical, clavate, or globular in shape, armed with numerous minute spines. The sexes are separate, that is to say, in different individuals.

According to Steenstrup, the Echinostyphus appears to breed, or are incubated between the skin and the viscera of the animal they infect. It is uncertain, he says, whether they spend part of their life externally to the organism which as full grown entozoa they inhabit; but it is very probable that they do so, since the embryo attains no real development in the ova so long as these remain in the Echinostyphus. Though met with in the excrements by thousands as they are still in the same condition; so that the development of the young within the ova, if their escape from thence, must occur long after the eggs have reached the water. The found however in the regeneratory cellular tissue, surrounding the liver of...
intestines of the Sale, in the spring of the year, small bodies consisting of a thick membranous cyst, within which was enclosed a small much constricted Echinochyneis. When extended, by the decapitation of the enveloping cyst, they measured from ½ to ¾ of an inch in length. Their pharyngeal organs, with its book, was deeply retracted within the animal; which after some time was protruded in the form of the armed proboscis characteristic of this order.

Eschrichti's observations are also highly interesting. He found during the summer months in the flesh of the Copenhagen Haddock numerous Echinochyneis, which he could only regard as young ones, in the act of passing through the skin of flesh to the intestinal canal, in which situation alone they are met with in the adult state.

Siebold, probably examining only the intestinal canal, never met with individuals so young that the so-called "loose ovaries" were not developed within them; nor ever found any which he could call even small.

Putting these facts together Steenstrup came to the conclusion that the cystic state corresponds to the pupa condition. A proof of his favorable idea, concludes that the "loose ovaries" are perfect
individuals whose entire existence is passed within the parent Echinostylinnaeus, which he in consequence looks upon as a nurse.

The young Echinostylinnaeus seen by Eschricht traversing the flesh of the haddock may either be a previous state to the cystic, described by Steenstrup, or what I am inclined to think more likely, a later stage. For the observations of Steenstrup were made in the months of February, March, & April; whilst those of Eschricht were conducted through the summer. If, in all probability, had Steenstrup examined the muscular tissues he would have found similar cysts embedded in its substance.

The idea that the loose ovaries are adult individuals whose life is to be passed within the body of the nurse, is very problematical. I may say that it is at variance with fact: for admitting Steenstrup's theory to be the true one, we find the sexes developed only among the nurses; they are not even united in the same nurse, but exist in distinct separate individuals.

If, therefore, we regard any such nurse, it must be the ovaries. These however merely form off fleshy ova, under the influence of fecundation
in the parent. Duck viewed in this light all ovaries must be accounted nurser, whether loose or otherwise. The mere fact of their being loose not destroying the possibility of their being ovaries.

Hence all that we at present know with regard to the development of the Scanthocephala is that at first they occur as ova. Secondly, they are met with as young Echinocephalyse, either enclosed within cysts, or in a state of freedom, but without reproductive organs. Thirdly, the adult form, or that in which the Echinocephalus has reproductive organs of a high order. The young are expelled with the feces. They are situated either in folds of the peritoneum, or are embedded in the tissues. Lastly, the adult form is found within the intestinal canal of the infected being.

IV Order Trematoda.

The Trematoda, or Flukes, have been the subjects of much research. Many have investigated their nature; I well have their labors been rewarded. To Steintrup is due the merit of having first drawn the attention of naturalists to the metamorphoses through which the animals forming
This Order was before arriving at their full degree of development. These consist of the successive evolution of a series of "Nurdes" or "Germinates" from the last of which germs are thrown off to pass through the pupa state previous to their final attainment of the perfect form. I shall however confine myself to the changes he describes as occurring in the Monostomum Metabole, & the Cercaria Echinata.

The Monostomum Metabole infects the cranial cavities of certain water birds; and the embryo is frequently hatched just as the eggs are expelled. The newly hatched young are oval in form, furnished at the anterior extremity with short retractile lobes, while the rest of the body is covered with retractile cilia, by which it moves through the water. On the anterior part of the body are two eyes; while the posterior two thirds of it are slightly transparent.

The contained being after vigorous efforts captures the body of its parent, & presents itself as an animal of an entirely different appearance. The young of the Monostomum resemble very closely the embryos of another Distoma, the Cercaria Echinata, found in several
Species of fresh water snails; 4 which have been called by Steindruck "Parent Nurses", from their producing other nurses like themselves.

The "parent nurse" of the cercaria Echinota is formed of an elongated body, a head, furnished with a muscular oral cavity, central mouth, & a collar; at the root of the tail are two pointed projections. The bodies of these parent nurses are filled with a progeny, much resembling themselves in outward appearance, originating from spherical germ cells.

These germ cells elongate, by degrees assume nearly the form of the parent nurse, though not quite so long. They are the "Nurses" of Steindruck. They are found adhering to the walls of the cavity containing the viscera of the snail. The body of the Nurse is cylindrical, furnished with a spherical head containing a muscular oral cavity, & a small circular mouth. Below the head is a sort of collar, while at the posterior extremity are three projections, the central one being longer than the other two. At constituting the tail. The oesophagus opens into a small stomach situated below the collar, while the whole of the rest of the body is filled with cercariae in all stages.
of development.

These at first present the appearance of spherical germs. They then elongate at one end, the head remaining globular, while the other becomes attenuated to form the tail. The body assumes an oval form with its two suckers; last of all appears the collar. As the tail increases in development, the more lively are the motions of the embryo within; till at length they pass out of the body of the nurse by two apertures placed behind the collar.

The body of the Cercaria is more or less elongated, with an oral aperture at one end, surrounded by a sectorial disc; beyond which are two concentric circles of minute spines, separated from the trunk by a fleshy collar.

A little behind the middle of the body is the abdominal sucker, where is a tail of about the same length.

The Cercaria now swims about freely in the water, or attaches itself by means of its abdominal sucker to the surface of a freshwater snail. The little animal then by means of its spines perforates itself into the integument, and after strenuous efforts throws off the tail.

As soon as this has been effected
the Cercaria, by turning itself round on the same spot, forms for itself a circular cavity within the mucous, which by gradually hardening over it forms a tough but transparent case. Here the Cercaria undergoes its pupa state, in which it appears to remain till the following spring.

They then leave their cases, having the same form, provided still with the suckers, spines, & collar, by means of which they penetrate by degrees through the integument into the deeper organs of the snail. On entering the liver they lose their spines; the collar disappears, & the suckers diminish much in size. The cestojeous becomes sluggish in its movements, & constitutes a perfect Distoma or Fluke.

Thus admitting the analogy between the Monostoma Schistosum & the Cercaria Echinata to be correct, if commencing at the ovum, we have Eight different forms necessarily assumed by the Distoma.

First, The Ovum.

Second, The Ciliated Embryo.

Third, The Parent Nurse.

Fourth, The Nurse.

Fifth, The Cercaria.
Sixth, The Pepra.

Seventh, The Imperfect or Armed Fluke.

Eighth, The Perfect Distoma.

One fact in connection with these remarkable changes is the multiplication which takes place in the third and fourth stages. At a moderate computation each Parent Nurse produces ten Narces; 1 each Nurse again gives birth to ten Cercariae, each of which is transformed into a Fluke. Thus one hundred Distomata are developed from a single ovum.

V Order Acanthotheca.

Genus, Pentastoma, or Linguatula.

The genus which forms this Order is composed of round annulated worms; with a straight intestinal canal; a mouth nearly terminal, & placed on the ventral surface, accompanied by two pairs of single or double hooks, which are retractile each into a distinct cavity. When the hooks are retracted there appear to be five rounded orifices. Hence the name Pentastoma, which however ought to be rejected as based on an illusion. The nervous system approaches closely to
that of an insect. The sexes are separate; & the body is made up of rings.

They occur in the respiratory vessels & the lungs: they are also met with enclosed in cysts on the surface of the peritoneum, liver, pancreas, & abdominal viscera.

Van Beneden says the Linguatulae are not entozoa, but most allied to the Lernèidae. He describes the embryo as found within the egg before it is expelled from the ovicellus: When hatched it is oval, round in front, flat below, & terminating behind in two points. On the ventral flat surface is placed the mouth, likewise two pairs of feet, each composed of three articles. The first is basilar, it is articulated to the body; the second joint moves upon the first, supporting in its turn the third portion, which consists of a solid bifurcating hook.

This appears to be all that is known of the development of the Linguatulae; at first an ovum, then a four-footed embryo; thirdly, an encysted juvenal, & lastly, a free entozoon, armed with four retractile hooks.
VI Order Nematoidea

This order contains all the round worms which have a terminal mouth, a straight intestine, the body covered by a resisting cuticle, ending in a pointed tail with an almost terminal spicule, 9 the sexes in separate individuals.

Some idea of the extent of this order may be formed from the fact that Dujardin has divided it into 52 genera; of which 43 are well established, 9 doubtful. I must however confine myself to the description of a single species of the genus Ascaris; a genus of peculiar interest to the Physician, being one of the very few kinds of enterogæ commonly met with in man. It is also that with which the valuable researches of a number of distinguished authors have made us better acquainted than perhaps any other.

Genus 19 Ascaris  Dujardin
Species  Ascaris Mystax  Lecher.
The Ascaris Mystax is found in the intestinal canal of the domestic cat.
To common is it that out of about 25 examined for the purpose I have not failed to find them in more than 3 or 4 cases. The part preferred by them is apparently the duodenum, between the jejunum and the point where the bile-duct enters. When the cat has fasted for some hours the Ascoides passes the jejunum into the stomach, perhaps in search of food. But this is never the case during digestion. On the contrary they then appear to be swept farther down the intestine than usual.

The male Ascoides leptos is about an inch and a quarter in length, Pl. VII. Fig. 83, whilst the female is from 2 to 3 inches, occasionally even 4 inches long, Fig. 84. The males are easily distinguishable by their shorter, fatter bodies, the peculiar curve of their tails, 83. a, which are coiled round on the ventral surface. The tails of the females increase slightly in thickness to within a short distance from their termination, 83. a, and are perfectly straight, without any curvature of the point, 84. a.

This creature derives its specific name from two lateral projections on either side of the head, resembling mustaches, VII. 85. a. These projections are flat, transparent and striated.
being covered by the horny cuticle which envelopes the whole body. In front is the mouth with its three lobes, 85. b, opening directly into the intestinal canal, 85. c. The entire body is covered with cartilaginous rings, placed side by side, exactly of the same breadth; the whole forming one continuous cuticular envelope, appearing to be regularly fringed when viewed externally, 85. d.

The posterior extremity of the female becomes suddenly narrowed to a blunt point, 84. a. A short distance from this is the anus, a round aperture. The tail of the male, as we have said before, is abruptly curved on itself, so that its dorsum is convex, 86. a, & its ventral aspect concave, 86. b. Near the conical after part on the ventral surface in front of the anus, 86. 87. c, is the genital orifice, 86. 87. d. On either side of the concave surface in the male is a projecting ridge, 86. f, consisting of a number of conical tubercles placed in a row, supporting a horny membrane stretching between them. This membrane is finely serrated, the teeth looking towards the tail, & no doubt serve an important part in giving it a secure hold while clasping the body of the female.

The intestinal canal, 85. c, 87. i, is a
Straight tube, passing from the mouth to the anus, situate in the axes of the body, is surrounded by loose cellular tissue. It usually contains indigestible particles, & portions of intestinal villi.

I now proceed to the consideration of the reproductive organs, I commence with the generative apparatus of the male as being most simple. By squeezing the tail carefully between plates of glass, two Spiculae, PL. VII. 86, 87, g, are forced out of the genital orifice already mentioned. These Spiculae are slightly curved, the curvatures looking towards the body, & in the ordinary state of the parts are entirely retracted within the trunk. They are placed one before the other, & are about 3/4 of an inch in length, & 1/6 in breadth. Their confluence is horny & their structure tubular, 89, a, b. That part which always remains within the body, 89, f, 89, c, is furnished with tooth-like projections for the attachment of muscular fibers, 89, d.

Of the way in which copulation takes place, I can speak with certainty; having in my possession a Specimen in which the tail of the male, 88, a, is wound round so as to embrace that portion of the trunk of the female where the orifice of the vagina is situated, 88, b, by
which means the spiriculae are directed into its cavity.

The internal organs of generation in the male consist of a single tube, variously dilated and contracted, but without any branching, Pl. IX. 118. This tube is placed between the integuments of the intestinal canal; it originates in a very fine caecal extremity, 118. a. As it gradually enlarges it becomes much contorted, doubled backwards and forwards, surrounding the intestinal canal, b, occupying the lower half of the body, 118. b.

Commencing at the narrow extremity is a very long tubular portion, 118. b. c, answering to the testicle. Joining to this is the seminal vesicle, 118. d, which is dilated to several times the diameter of the testicular tube. Slightly, 118. f, it forms the mouth of the spiriculae, within which in the ordinary state they are contained, VII. 87. f. The membrane forming the caecal extremity, VIII. 90. a, is very thick, but it soon becomes thin, so that the upper portion of the testicle is perfectly transparent, t, at the same time homogeneous; 90. 91. b.

On examining the membranous wall of the generative tube lower down, Fig. 92, it is found to present longitudinal striæ, 91. finely granular.
structure. A little above the terminal vesicle, IX. 118. c, the tube becomes muscular, presenting transverse ripples, VIII. 93, intended no doubt to force forward the contents. The vesicle itself, IX. 118. d, is covered by reticulations of long muscular fibrilla, giving it the appearance of being enclosed in a net. The contraction of these fibres must be attended with considerable power of propulsion. The speculum are provided with special muscles for protrusion and retraction; but I pass to the more important investigation of the mode in which the terminal particles are developed.

I have already described the local extremity as composed of a very thick membrane, VIII. 90. a, but this membrane, although perfectly well defined on the exterior, is not so within. Externally homogeneous, it becomes more and more granular till the inner surface appears almost entirely composed of very minute granules. This is the true secreting organ, for the granules 90 c, 94 a, when thrown off, begin immediately to enlarge and form nucleated cells, 90 d, 94 b.

The homogeneous portion of the testicle is filled with little else than these cells of various sizes,
floating in a transparent fluid, 90 d; but as it gradually becomes striated, the cells are obscured by an immense number of minute opaque granules, 91 a. The nucleated cells of granules are at first intermixed without any order, 94 a b; but, after a time, the granules group themselves round the cells, forming envelopes for each, individually, 95 a b.

On rupturing the testicular tubule about the middle of its length, 92, these granular masses are protruded, 93, irregular in form. Within them the nucleated spermatic cell may be distinctly seen, 95 b. They are, however, so delicate that the slightest pressure destroys them altogether, 95 c.

Passing as far down as the muscular portion of the testicle, 93, we find the masses much smaller in size, as well as more regular in shape, 95 a. The granular envelope is globular with a well-defined margin, perfectly opaque, so as to render invisible the included cell, except on applying a gentle pressure, 96 b c.

This, 96 a, is the utmost development, the semen undergoes as long as it remains in the male organs. A spermatic cell may indeed sometimes be seen which has escaped from its
granular envelope, & increased to twice or three times its former diameter; but this is very rare, &c.d. The granular envelope appears to perform the important function of preventing the enlargement of the spermatic cells, &c., the occurrence of which would prevent their passage through the spicula, whose calibre is capable of admitting only a single granular mass at a time.

Although the further changes which the spermatic cells undergo take place within the female, & consequently are unconnected with the generative apparatus of the male, I shall, to avoid confusion, treat of them here.

On examining the uterine contents of a freshly impregnated Ascaris Mysitae, a granular fluid is observed in which a number of nucleated cells are floating, fig. 97, 98; but I have never observed the granular masses already described in the male. The disappearance then of the granular envelope is the first visible change in the constitution of the semen, & it can be accounted for in many ways.

The loose granules are the debris of the cell cases; while the nucleated cells, 97, 98, are simply the spermatic cells, &c., much enlarged.
By this enlargement a most beautifully transparent spherical cell, 97. 93. a, is produced, 1/200 of an inch in diameter; enclosing or rather having attached to its inner side, a round discoidal nucleus, 97. b; within this again there is a nucleolus, 97. c, 4 sometimes two.

Before I describe however the transformation of these nuclei into spermatic particles it will be useful to examine curiously the statements of others on the subject. Wagner & Leuckhardt in their article on Semen in Todt's Cyclopaedia, speaking of the Ascarus Ascarinata, say, "the nucleus has at first a roundish shape, PL IX. Fig. 119 a; but gradually stretches itself more & more, projects more or less outwards with its point, 120. 121. 122. a; thus metamorphosing itself into the peduncle-like appendage of the spermatogonia; the body of which is formed from the persisting membrane of the seminal cell. 119 b. 122 b."

Holliker states that these cells are formed, four at a time, 123 a, within other larger cells, 123 b; that the elongated nucleus, of Siebold & Wagner, are mere bundles of undeveloped spermatogonia, whose form he supposes, but has never seen, to be capillary.
Reichert, in his researches on the development of the spermatogenesis of the Ascaris Acuminata, indicates a spermatogenic cell containing a nucleus & nucleolus. The cell increases in size as does the nucleolus, but the nucleolus becomes less definite & retains its former size, 124. This, according to him, is the fully formed spermatogenesis consisting of a spherical cell, 124 a; a nucleolus, 124 c; 4 indistinct nucleoli, 124 b.

This is the substance of what has been done with regard to the investigation of the development of the spermatogenic particles in the Ascaris Acuminata. I now proceed to state my observations as to their formation in this Ascaris Skystaw; the phenomena of which will be found to differ materially from those just described.

I have previously said that in the more developed condition of the spermatogenic cells these bodies present the form of a transparent vesicle, Pl. VIII Fig. 97, 98 a, free from its granular envelope, & containing a nucleus & nucleolus, 97, 98 b & c. The nucleus appears discoidal when seen from above, 97 b; but lenticular when viewed in profile, 98 b; apparently enclosed
between two portions of the membranous cell wall, 98 a.d.

The internal margin of the nucleus, 98 a.d., soon loses its clear and defined outline, 99.

The granular mass constituting the nucleus undergoes a marked increase in volume, projecting more or less in a conical form towards the centre of the cell, 99 to 102. 105. A membrane is then produced over the whole of that part of the nucleus which is in contact with the wall of the spermatie cell, 99. 100. 102 f. This membrane is very distinctly seen to separate the granular matter of the nucleus from the external cell wall, with which it is in accurate contact. The margin is not in apposition with the cell wall, but has a tendency to surround and enclose the nucleus; giving the membrane the form of a watch glass whose concavity is in contact with the spermatie cell, while its convexity is filled with the granules of the nucleus from which it was formed.

The watch glass form however is soon lost. The membrane, acquiring a tendency to become more convex at its centre, assumes first the appearance of a cup filled to overflowing, 102, 103. 105; then that of a rounded cone, whose margin
is coveted to enclose the granular substance, 103, 104, 108, 109; but occasionally the nuclear matter surrounds & hides it from view, 110.

When this concavity takes place exactly in the middle the external cell wall is projected in the form of a papilla, 101 to 104; but this is probably only an accidental occurrence, I not the general rule. Although in variance with the statements of Wagner I speak with the more confidence as Dr. Allen Thornton, with whom I had an opportunity of examining these changes most fully coincides in the views I have here taken.

A slight projection of the external cell wall is common indeed at one period; but in no instance have I observed a greater amount of protrusion than that figured in 104. The elongation of the nucleus into a tail to the spermatic cell must be regarded as doubtful in *Ascaris lumbricoides* as it is certainly not the case in the *A. hystric.* How then are the spermatic particles formed?

I have described the tendency of the nuclear membrane to become more & more convoluted as this concavity increases the apex in the middle of the cell wall, 103, 108, 110, protruding it slightly, at the same time...
that it is itself diverted from the straight course to form a curve. 106. 107. By this time the granular portion of the nucleus has become much diminished in volume, still presenting however the nucleolus; while the nuclear membrane has passed from the conical to a cylindrical shape, 106. 107. During these changes in form the nuclear membrane also increases in thickness; it presents a double outline, 106 to 110.

The now cylindrical membrane being prevented from pushing directly outwards is curved along the concavity of the spheromice cell. By further contraction in its transverse diameter, & elongation in the other, it assumes the appearance of a bent tube, forming often the quarter of a circle. 111 to 114.

From the period at which a double outline is first visible the granules begin to disappear; till at last the nucleus becomes entirely transformed into an elongated coaxal tube with very thick sides; its interior occupied by a dark homogeneous substance. At its mouth is found the nucleolus & a few granules that have not yet disappeared. The whole is enclosed within a spherical cell. 113. 114. The blind
extremity next becomes enlarged, the enveloping cell is dissolved, and a flask shaped body, the two spermatic particles, is thus set free. 116. 117.

Although the disappearance of the spermatic cell occurs normally at this period, it often happens much sooner; then we find the spermatic particles set free in all their stages of development, from the primitive nucleus, 115. a, to the perfect condition, 116. 117. In many of these spermatic particles the nucleus but still remains 116. a; but it also in course of time disappears, leaving the mouths of these hollow bodies open, 116. b.

Originally, the nucleated cells in the caudal extremity of the testicle are not more than \( \frac{1}{10000} \) of an inch in diameter. Pl. VIII. 94. As they descend they become enucleated by granules; at first forming irregular masses about \( \frac{1000}{1} \) of an inch, 95; but these gradually contract to become round opaque bodies measuring \( \frac{17}{1000} \) of an inch, 96 a, each of which contains a single spermatic cell; now however increased to \( \frac{2500}{1} \) of an inch, 96 b. c.

After the spermatic cells are introduced into the female uterus they enlarge rapidly, 97 a.
but with measuring from \( \frac{1}{1000} \) to \( \frac{1}{1000} \). I have however represented them of the average size of \( \frac{1}{1000} \) of an inch. 97 to 114. The nucleus, 97, 98 b, is about one third the diameter of the cell of \( \frac{1}{1000} \); while the breadth of the spermatitic particles differs from \( \frac{1}{1000} \) to \( \frac{1}{5000} \), & their length from \( \frac{1}{1000} \) to \( \frac{1}{500} \). 115 to 117.

The spermatitic particles have long been known, but their nature has not hitherto been fully determined. Clossick in his elaborate works on the Ascaris Lumbricoides, mistook them for undeveloped ova. More lately Holliker imagined them to be bundles of capillary spermatitic filaments. Wagner believes them to form the tail only of the Spermatogon 122. a. Reichenb clearly did not recognize their function, for he makes a nucleated cell his "Eigel-

Körperchen." Lastly, Siebold conjectured these corpuscles to be Spermatogon, having seen them in contact with the ova; but he appears to have gone no further into the investigation.

That these black shaped bodies, VIII. 117, are mature spermatitic particles cannot now be doubted, since we meet with them the highest in the oviduct, while nearer the external orifice of the vagina.
none but nucleated cells or cup-shaped nuclei are seen.

As I have said before, I have never observed a spermatocyte particle forcing out the cell wall except at a very early period of its development, 101 to 105. But when perfectly formed it is set free by the total disappearance of the cell, nothing remaining except a few of the untransformed granules surrounding the nucleolus. I, although the cell wall is very frequently lost much earlier, 115,yet the development of the spermatocyte particles seems to go on as long as any of the nuclear granules remain, 116 a.

Wagner therefore is not correct in supposing these bodies to be mere tails, because they never project as such from the spermatocyte cells. Also when they become free it is by the total disappearance of the cell wall; and lastly, because they alone are found highest in this ovoidest. Again, speaking relatively what immense spermatocytes these cells, 97 to 114, would form, if the opinions of Wagner & Reichert were true, from 1/1000 to 1/700 of an inch in diameter, or one third that of the egg in the same animal, a circumstance altogether unparalleled.
Nevertheless I see any reason to believe Huxley's statement, that the spermatid cells are formed four at a time within a mother cell, PL IX. 123. b; never having observed such an occurrence.

The whole of the change I have described may easily be traced by examining the uterus of the larger individuals, as in their impregnation has in all probability not occurred till very recently; their size apparently depending on the non-evolution of fecundated ova. However from the delicacy I brandpoint nature of the spermatid cell when at its greatest development it is perfectly useless to employ any but the very best microscopes.

Having now fully traced the formation of the spermatid particles from the nucleated granule thrown off by the caecal extremity of the testicular tube in the male, VIII. 90, to the flask shaped body such with in the oviduct, 117, I now pass to the description of the female organism previous to entering on the development of the ovum.

The Female Ascaris Illustata, VII. 84, as I have already said is larger than the male, 83. Its tail also is straight, 84 a. I not curved as. The orifice
of the vagina, IX 126. a, is placed about one third the length of the animal from the head. It is a simple circular opening; so small that it enters with the greatest difficulty.

On squeezing gently between glass plates, I magnifying at the same time, the convolutions of the coagulum tubes, 125. b, are observed; filling the body from the tail to within a short distance of the head. This reproductive apparatus is not fixed firmly in one position, but moves backwards and forwards with considerable facility; the tubes, 125. b, being coiled round the intestinal canal, 125. c, lying between it and the integument, 125. d.

The following is the method I employ for the extraction of these generative tubes. Cut off the head a little above the convolutions, freeing the tail with forceps, by gradually increased pressure commencing at the tail passed along the body towards the cut extremity. Squeeze out the whole visceral contents, leaving nothing but skin behind. To prevent entanglement of the different parts it is best to effect this expression under water. When this has been accomplished, unravel with needles the convolutions, & remove the.
Intestinal canal; which is easily recognised by its straightness, its great relative diameter. If carefully performed we thus obtain two very long, almost capillary, tubes, 127. a. b. c. d., which after enlarging, 127. f., become united into one canal, 127. g.; whose termination has already been described as the generative orifice. 126. a.

On examining this apparatus we observe it to be composed of several portions, differing in appearance as well as structure. The tube commences near the tail in two equal extremities, 125, 127. a., gradually increase in size as well as in opacity, & after performing various convolutions backwards & forwards throughout the greater part of the body, 125, 127. b., they suddenly become constricted; 127. c. These are the ovaries, or more properly ovarium tubes, as the local extremities alone appear capable of throwing off germinal vesicles.

This ovaean portion, 127. a. c., is from four to six inches long; while the second part, 127. c. d., is only, about half an inch in length, nearly transparent, separated in like manner from the rest by another constriction. 127. d. Each tube now becomes greatly dilated so as to be several times
the diameter of the formed portion, & from what are termed the uteri. 127. g. The uteri are also about half an inch long; parallel to each other, & unite together to form the vagina, of about the same length, 127. g.

The capacity of the ovaries, uteri, and vagina, 127. b. j. g, is dependent on the eggs with which they are distended; the transparent part, 127. c. d. contains hardly any. This portion has not received any definite name, nor have its limits been pointed out; but, as it is here that the all-important proof of fecundation takes place, a name becomes indispensable. To this therefore I shall apply the term ovicidet.

The upper extremity of the ovary is formed of a membranous, & perfectly transparent tube, Pl. X. 131. The membrane however is much thicker at the very end, Pl. XI. 132. a, where it presents a finely granular structure. This is the only part from which germinal vesicles are thrown off, it consequently the true ovary.

A short distance from the extremity one or more apparent invaginations occur, 132. b; as if other follicular tubes were contained within the first. These appearances are caused
by granular casts of the internal surface of the upper end of the ovary, 132 a, which are probably thrown off at intervals.

On examining a portion of the ovarium tube where it begins to become opaque, 133, we observe it marked with very faint lines, minute granules, which gradually increase in distinctness, 133 a. The tubes also become thicker, so that about midway, the tube is formed of a homogeneous membrane outside, 134 a, and a number of longitudinal ridges or streis internally. Each of these streis contains a number of granules embedded in them, causing them to project into the interstices of the tube, giving it somewhat the appearance of a rifle barrel.

This is the structure presented by the ovarium tube for the greater part of its length, X, 130; commencing as soon as granules are seen to surround the germinal vesicles, XI, 133 b, it becoming gradually more distinct to within a short distance of the ovicist, where the streis disappear, if the external membrane alone remains, to form the lower portion of the ovary, 129 a; 135, 136 a.
The spot where the ovary terminates of the oviduct begins, 129 c, 136 b, is marked as already stated by a constriction, 129 b, 136 d, causing the tube to become so much narrower as only to admit the passage of one ovule at a time, 136 c.

The whole length of the oviduct, 129 c, is characterised by transverse markings evidently of a muscular or contractile nature, but most developed at the ends where the constrictions occur, 129 b, d. While the exterior of the oviduct is transversely ribbed, 136, 137, b, its inner surface is covered with large cells distended with a dark granular fluid having the appearance of secreting cells, projecting strongly into the cavity of the tube.

That these cells secrete some sort of fluid is proved by the fact of their becoming turgid when the Ascaris has been feeding, I on the contrary, so flaccid as to be almost invisible when fasting. Again, while the ovary, 129 a, is filled with an almost solid mass of ovules, the oviduct, 129 c, contains a transparent, finely granular fluid with only an ovule here and there. It is probable also that a peristaltic
action is set up by these fibres, by which means the closely packed ovaries are detached & forced forwards singly into the uterus.

As already stated, another constriction, 129d, 137, but not so well marked as the first, indicates the termination of the oviduct; immediately beyond which the tube becomes suddenly dilated into the uterus, 129 f; which is several times the diameter of the preceding portion.

The uterus commences by an rounded extremity, the fundus, 129 f, into which the oviduct, 129 c, opens; it becomes gradually narrower, 128 f, until it unites with its fellow to form one tapering vagina, 128 g. The uteri are formed of an external serous coat lined with broad, flat quadrangular cells, 138 a. Each of these presents an oval or round nucleus, 138 b, & central nucleolus, 138 c; the whole forming a very beautiful microscopic object.

Lastly, the vagina, 128 g, presents some transverse raphes externally, 139; & flattened cells internally; completing thus the views of the complex structure of the female reproductive apparatus.
The caecal extremity of the ovary, 132a, thrown off as I have said before, is divided into granule, 132c, which enlarge rapidly, and form the germinal vesicles, 132d. These granules are formed by the thickened apex giving its substance a semitransparent structure. A fluid likewise fills the upper part of the ovirary tube, by which it is secreted, appearing like that of an albuminous nature.

The germinal particles, then first thrown off by the internal membrane of the caecal apex, are only 1/10,000 of an inch in size, 132c; but begin almost immediately to increase to several times their original bulk, become vesicular, 132d, and present a nucleus within each cell 132f. These are the germinal vesicles caused by the swelling up of the primitive granules. Holliker mistakes the invaginated appearance of the upper end of the ovary, 132 a b, for large cells, whose nuclei are the germinal spots, set free by the successive opening up of the large cells. See Müller, Archives for 1843.

He further states, that the germinal spot is first formed, 132 a b; it surrounds the germinal vesicle, which is developed like a primitive cell round its nucleus. My own observations however lead me to believe
that a germinal particle is first formed 132e, 140e. This appears to be semi-opaque and solid. By the imbibition of the surrounding fluid, the external membrane of this germinal particle becomes distended, and thus forms the germinal vesicle. XI 132 d, XII 140 d; leaving the solid contents to form a central nucleus or germinal spot, 132 f, 140 f. The germinal vesicles are now \( \frac{1}{2,500} \) of an inch in size, 132 d. As they pass down the ovary, they disappear from view, becoming enveloped by opaque granules, 133 b.

At first, that is to say in the upper part of the ovarian tube, these granules are perfectly free, floating loosely in the fluid, lying in contact with though not adhering to the germinal vesicles, 132 g.

A little further down, we observe the whole contents of the tube to become almost solid, at least gelatinous, and to consist apparently of nothing but granules, 133 b. On impaling this portion of the tube, and applying gentle pressure, the granular contents are easily forced out, it may be seen to break up into a number of semitransparent masses, 141, 142. Each mass constitutes an ovule, small and imperfect, but...
containing all the parts essential to an ovule.
In the centre of each we find a germinial spot, 142 a, encased in its germinial vesicle, 142 b, c. This again surrounded by a few granules, 142 e, embedded in a transparent jelly, d, contained within a very delicate membrane, the vitelline membrane, 142 d. These granules are the first appearance of the yolk. They are opaque, separated from each other, d, surrounded by the gelatinous fluid.

The ovule in this stage of its existence is very irregular in form; sometimes cuneate, 141. 142; sometimes triangular, 143; 4 at others round, 144. They are all more or less flattened and transparent, so that the contained germinial vesicle and spot may be distinctly recognised. When of a triangular or cuneate form the vitelline membrane is often imperfect at the apex, 145 b, d, which seems to be the part last formed. It is invariably placed nearest the centre of the ovaean tube. Whence the vitelline granules are formed is problematical. They may be either thrown off by the coecal extremity along with the germinial particles, or separate spontaneously from the surrounding fluid, or lastly be formed
by the striated wall of the ovary.

I believe that the large granules, 142 c, first of all seem surrounding the germinal vesicle, 142 b, are thrown off by the blind extremity, it becomes attached to the vesicle previous to the formation of a vitelline membrane, 142 d. But when the ovule arrives at the striated portion, 134, the number of yolk granules is greatly increased, 143 to 145, leading to the supposition that the granules contained within the stric are thrown off it become embedded in the ovule.

The possibility of such an occurrence might be doubted from the existence of a vitelline membrane. But this membrane is only the external limit of the gelatinous mass, 142 c, consolidated a little, so delicate as to offer no resistance to the entrance of the oily particles which the globules obscuring the germinal vesicle at this period, 145.

The germinal vesicles maintain all along a very uniform size, but becoming gradually larger. They are globular in shape, it contain a highly refractive fluid, which makes them easily distinguishable, 1144. The ovula
appear to increase in size by the accumulation of granules from the walls of the ovary, 145. The reasons for this are, first, that the granules become more and more numerous as the ovule passes down the tube. Secondly, the granules exactly resemble in size, colour, and form those produced by the internal wall of the ovary. Thirdly, the fibre ceases just where the ovule ceases to become larger. Lastly, that these granules are not produced by the germinal vesicle, is evident from its remaining of the same size.

As the ovule descends we find it increasing in diameter from 1000 to 280 of an inch; becoming more and more opaque, as well as thicker.

The fact that the ovula are packed edge-wise in this part of the tube, 147, was first pointed out to me by Dr. Allen Thomson; also that three or four occupied the same plane, 146. This I have found to be perfectly correct; it at once explains the reason why the triangular form is the only one met with at this part, 143, 145.

The ovary is about 1/120 of an inch broad at its widest part; there it is that we find the ovula packed generally four on a plane, 146, with their edges presenting externally, 147, appearing
long it narrows when viewed in profile, but broad at triangular in front, 147 b; entirely filling the transverse section of the tube, XI. 135 a.

The belt of clear substance that separates the vitelline membrane from the granules surrounding the germinal vesicle, XII. 144, becomes left and left as these granules increase in number; so that at last the whole ovule appears to be entirely composed of yolk globules; immediately encircling which is the yolk membrane, 145, 146.

This is the state in which the ovula are next met with close to the entrance of the oviduct, XI. 136 c. They now become separated, detached singly from the mass, X. 129 a; lose their triangular form; 

After passing through the first constriction, 129 b, XI. 136 d, enter the glandular portion of the reproductive apparatus, 129 c, 136 b.

When the Ascocarion has been impregnated, the ovule first meets with the spermatatic particles in this part; but I think it may be best to trace the further changes it undergoes in the uninpregnated state of the female, as they enable us to explain, or what is of more importance to contrast the appearances presented by the fecundated ovum with those of
The non-cirrified egg.

As soon as the ovule enters the glandular portion, it floats free in a clear liquid secreted by the cells lining the oviduct. The ovule becomes thicker and more rounded, losing the flatter form it assumed that of an oblong sphere. It gradually constitutes an elastic shell.

While this external chorion is forming, the internal contents are undergoing change. The yellow granule becomes much smaller, and the germinal vesicle is no longer visible; but in its place we find a number of large transparent globules, having much more the appearance of oil than of being formed by cells.

These globules appear to be formed partly by the disappearance of the germinal vesicle, and partly by the separation of the oily matter from the granular vitellus.

After a time, these oily globules approach the periphery, while the mass much more minute as well as opaque particles pass towards the center.

By some process, perhaps of
The oily globules disappear; and at the same time a membrane, 154, 155 b, separates from the internal surface of the chorion, 154, 155 a; & contracts on the particles contained within it, forming one spherical, perfectly opaque, molecular mass, 155 f.

This false ovum, 155, if I may be allowed to call it so, is surrounded externally by a peculiar granulated chorion, or shell of an irregularly ovoid form, 155 a; within which but separated by a clear fluid is the opaque spherical mass already described, 155 f, with its delicate membrane, 155 b; probably the vitelline membrane of the ovule, 142 a.

No further change takes place, but that of decomposition. The false ovum is expelled in this state from the uninfigurated female, & finally decays & disappears. In some cases I have observed spermatic particles to exist in the lower part of the uterus, which had not yet ascended to the oviduct; yet all the eggs were imperfect, having the characters of the false ovum just described, & like them incapable of further change.

From this we may infer that...
The formation of the chorionic impragnation is impossible; and, since it is formed while the egg is yet within the oviduct, fertilization must take place there before the appearance of the external enveloping membrane. Let us return to the fertile condition of the female, and trace the development of the ovum as it threads its way along the oviduct.

The ova are here surrounded by the spermatic animal cells. Here, therefore, it is that fertilization takes place: that all important process as wonderful as it is unknown; but by which alone fertile ova can be produced. I shall endeavour to describe the conversion of the ova from into the fertile ovum, according to my own repeated observations.

Immediately, that the ova leave the ovary, it enters the oviduct, it comes in contact with the tenuin XI, 136. It has an irregularly oblong shape. XII, 148, 149. It is thickly studded with opaque granules, rather lighter towards the margin. The edge is uniform, that is to say, not ragged; being limited by the vitelline membrane. Sometimes a faint trace of the germinal vesicle, XIII, 156, 157 a, may be perceived; but the ovule is to opaque that...
on the other side can never be seen through it. 148, 149.

At first the margin of the ovule is entire, that is, in to-day, the vitelline membrane is imperforate; but a little further we perceive the spermatic particles to be closely applied against this membrane, depressing it slightly in some places, 158, 159, 161 b.

Another step I ate the ovule, present a rupture in some part of their periphery, 156, 157, 161, 164; generally at one point, but frequently in several places at the same time, 158, 169. At these places some of the yolk granules are seen protruding through the opening in the vitelline membrane, 156, 158, 159, 161 c. That these appearances do not arise from pressure applied during the examination I am now perfectly satisfied; having repeated my observations above a hundred times, I varied them so as to remove all possibility of such an occurrence.

The effect of pressure on the ovule is also very different from that just described; as I have repeatedly seen. If an entire ovule is squeezed between glass the vitelline granules coalesce; the yolk membrane dilates; at last, the whole disappear into a yellowish fluid.
From the immense number of ova, in which I have seen this partial impenetrability of the vitelline membrane, I was of opinion in my endeavours to cause a similar protrusion of the gold granules by compression, I am irresistibly led to the conclusion that it is a vital phenomenon, consequent upon some natural cause, and not the result of accidental violence.

Further, by Dr. Thomson's suggestion, I divided the ovule at both ends, washed away all loose ova by a gentle stream of water, then superimposed as carefully as possible a piece of the thinnest glass. No other force than the weight of the piece of glass was applied; yet every one of the ova, as they slowly found their way out of the ovule, presented in some part or other this want of continuity of the membrane.

The reason why all the granules do not escape is that they lie not in a fluid but in a sort of gelatinous substance, easily broken up if it is true, yet sufficiently coherent to retain the granules in their places. In what are these appearances owing, I have seen them produced by spermatic particles, as applied at first to the...
periphery of the ovula, 158, 159 b. Either by the contraction of the ovicyst, or, more probably by some property inherent in these particles, they are next seen to indent the vitelline membrane.

A little lower we find the spermatie particles not only in contact but partially embedded in the ovule, 164, 165 b, surrounded by loose granules yet free by the suspense of the vitelline membrane.

Sometimes only one is seen to be thus embedded, 164, 165 b, but more commonly several spermatie particles are applied at the same place, with their closed ends directed generally toward the center, 167, 170 b. Penetration next takes place; the particles passing into the substance of the ovule among the vitelline granules, 167, 169 to 173 d.

I have seen the spermatie particle in all stages of penetration; from mere contact, 167, 168 b, to perfect involvement within the ovule, 170 d. In their course they appear to effect very little displacement, passing readily in all directions among the granules. Their transparency and high refractive power renders them easily distinguishable when near the surface, 169 to 173 d.
I cannot here enter upon the consideration of the changes which occur in the mammiferous ovum, as I intended to have done, from the length my Essay has already attained as well as from want of time. I confine myself therefore to a few remarks.

Dr. Barry says, "On one occasion in an ovum of 5½ hours, I saw in the orifice of the membrane, (the external membrane of the ovum,) an object very much resembling a Spermatozoion which had increased in size. I am not prepared to say that this was certainly a Spermatozoion, but it seems proper to record the observation." Whether we believe Dr. Barry to have really seen the penetration of the Spermatozoion into the mammiferous ovum, or whether we, agreeing with Bischoff and other distinguished authors, deny the correctness of Dr. B's observation, as well as the possibility of any such occurrence, the present investigation appear to be the first by which the fact has clearly been made out; by which the entrance of the Spermatozoion particles into the ovule has been first established, in one of the most highly organised of all Entozoa, the Ascariis Mystax."
Of the possibility of penetration no one who has seen an ovule of this Aconis can have any doubt. 148, 149. The only protective envelope it possesses is the vitelline membrane, which is so delicate, 142 d, that, as I have already remarked, there is great reason to believe the very granules it encloses, 142 e, have passed through its walls.

Secondly, with regard to the probability of such an occurrence there is the breaking up of the vitelline membranes, 156, 158, 159, 164 e, in certain places, rendering it still easier for the entrance of the spermatic particles.

Thirdly, the application of the terminal spicules to the broken edge, 159, 161, 164, 167, 168, 170 b.

Lastly, I have repeatedly seen the spermatic particles within the ovule, embedded in its substance, 167, 169 to 173 d, surrounded on all sides by the vitelline granules & membrane.

Having shown the possibility & the probability, it remains for me to prove the accuracy of my observations. That the spermatic spicules seen by me might possibly have been
external to the ovule will naturally occur to every microscopic observer. Several considerations will establish that there is no room for such a doubt.

1. The particles could not have been lying upon the ovule, because vitelline granules were visible above them. By distancening the Object glass slightly, the spermatic particles became indistinct, and a layer of granules came into focus entirely covering the space they occupied.

2. They could not have been below, for the ovule was neither too opaque to admit of being seen through.

3. The terminal particles observed within the vitelline membrane were only in focus when the margin of the ovule was in focus, I must therefore have been on the same plane with it. As the ovule is a more or less spherical body, the focus of its margin corresponds with that of its center; hence, the particles already mentioned could only have existed in the substance of the ovule.

Another objection might be raised. Admitting the particles to have been situated in the substance of the ovule, might they not have been oil globules, like those seen in the non-seedated egg.
must have a cluster, for not only were the particles elongated, of cylindrical, XIII. 167, 172d, but the one extremity was closed, and the other open, 169 to 171, 173d. Hence, they could only have been the spermatic particles of the male XIII. 116, 117.

The accuracy of my observations being I must satisfactorily proved, we must admit that the flake-shaped spermatic particles do penetrate into the ovule.

The accompanying drawings present these appearances as exactly as possible, being taken from actual specimens by means of a camera lucida. In some we find the broken margin of small extent, 156 to 159, 164; in others it embraces nearly one half of the circumference, 168 to 171. Some give a faint indication of the contained germinal vesicle, 156, 157a; but in most the granules are too opaque to admit of its being seen at all, 158 to 164. Occasionally we meet with an ovule here and there that appears destroyed, nearly transparent, in which the yolk granules seem to have coalesced, the germinal vesicle having disappeared, 160.

Sometimes, when they have lately entered, the spermatic particles present their
ordinary flask-shaped appearance, 159 to 173 d., but in others they seem to have undergone a change, 
& to have swollen up into transparent, rounded masses, 156 to 159, 162 g. I infer that 
these are transformed terminal particles 
because they are met with in all stages of the 
change, both within & outside of the ovule, 
156 to 159, 162 h.

Let us pass now to the examination 
of the changes which take place in the ovule after 
the entrance of the spermatic particles.

Immediately after the passage 
inward of the flask-shaped bodies, the ovum 
begins to acquire a chorion, XIX 174 a. The 
formation of this does not appear to be at all 
dependant on the penetration, but to the ovum 
reaching that point of the ovidity by which the 
membrane is secreted: for we find it occurring 
even in the unfertilized egg. This chorion 
differs however from the granular shell of the 
fallop ovum, 152 to 155 a., in being perfectly 
smooth, membranous, & transparent, 175 to 181 a. 
It first shows itself on those portions of the 
vitelline membrane that remain entire, forming 
with it a single dark line, 174 a. This dark
line; sometimes only partially encircles the ovule, 174 a, being imperfect at these places where there is a protrusion of the granules, 174 b; at other times it surrounds the yolk entirely, 175 to 181 a.

The apparently single envelope thus formed consists really of two membranes, though from the great tenacity of the vitelline membrane within it cannot be seen. At first, the chorion is flaccid, 4 the ovum appears of an irregular shape, 174, 175, 178; but by the imbibition of fluid it swells up, becoming tense, spherical, 176, 177, 180, 181.

Very shortly after entering the ovule the spermatic particles disappear, probably by becoming dissolved, for occasionally transparent irregularly roundish bodies, 179 i, are perceived within the chorion, 179 a; which seem to be undergoing the process of solution.

The vitelline granules that previously to the insemination of the ovum formed one uniformly opaque mass, 148, 149, now become broken up, excavated in some places and dissolved in others, 174 to 181 b. This seems to be owing to some direct influence of the
terminal particles on the yolk; for many of the granules disappear entirely, 174 to 186 b; while others, 182 to 186 m, are changed both as regards colour & size: a transformation quite different to that which I have described as taking place in the false ovum. 176, 177, 180 a.

The ovum at this period presents a very peculiar mottled appearance: from the breaking up of the yolk into masses of opaque granules, 175 to 182 b; separated by interspaces of transparent fluid, 175 to 182 e. Sometimes the whole yolk is thus, 180 b, broken up; but more commonly it is only the surface that is thus first affected; the process of disintegration gradually passing towards the centre. This mottled, 180 a, appearance has been previously noticed in the egg of a Strangulus, I ascribed to the formation of cells within the yolk; which is certainly not the case in the egg of the Ascaris mystax.

When there is much disintegration the germinal residue may be seen, 177, 180, 181, 183 d, with its nucleus, 177, 180, 181, 183 f; & occasionally within this again one or two nucleoli, 177, 180 g. But in by far the greater number of cases the breaking down of the vitelline mass commences
on the surface; first eroding it, then passing gradually near the centre, from which cause the germinal vesicle, being covered by a layer of opake granules, cannot be seen.

As the solution of the yolk goes on the opake granular masses in the centre become less and less, leaving a clear margin of fluid surrounding it on all sides, 183 to 186 c. Some granules however escape, 1 are seen floating in the fluid; but they are larger and more transparent than the original yolk granules, 182, 186 m.

About this period the ovum acquires another envelope, consisting of two membranes, as is distinctly seen in those cases in which disintegration has occurred. 186 h. 1.

When the granular mass has become much reduced in size, 185, 186 b, it suddenly loses its opacity, and thus the whole vitellus is transformed into a few large, nearly transparent granules, 187, 188 m; among which we look in vain for a germinal vesicle, 188 m; if only now at these are we able to distinguish one granule to be larger than its fellows, 187 f; it to contain within it a dark spot, 187 g. In short the germinal vesicle, 177, 180, 181, 183 d, substances when disintegration has proceeded a certain
length. Its disappearance is followed immediately by the transformation of the remaining vitelline granules.

I propose to call these transformed or altered vitelline particles by the name of Embryonic granules, 187 to 189 my. Since they appear about the same time as the embryonic vesicle, I, in connection with it, help to form the embryo.

After the rupture of the germinal vesicle, the interior of the egg is filled with the embryonic granules; but however packed close like the vitelline, but scattered loosely. About the centre of these granules, one a little larger than the rest, 187 f, may sometimes be seen leaving in it an opaque spot 187 g. On comparing these with the nucleated nucleolus 177 f, g, of the germinal vesicle 177 d, before its rupture, I found them to resemble each other completely, having the same size, shape, and appearance, the same degree of refractive character.

The germinal vesicle immediately before its rupture is \( \frac{1}{1000} \) of an inch in diameter. Its nucleus, or, as it is commonly called, the germinal spot 177 f, is \( \frac{1}{4000} \); and the contained nucleolus \( \frac{1}{8000} \) of an inch. After rupture the
nucleus, the nucleolus are of exactly the same sizes respectively. But soon the nucleolus, which at first solid, begins to enlarge, swells up, and constitutes a transparent cell, 1894; while the nucleolus remains of the same size, 1894; forming in short, an embryonic vesicle of spot.

As soon as the embryonic vesicle begins to form a membrane, separates from the internal surface of the egg envelope, 1904; and gradually, 191, 197, contracts on the embryonic granules till a perfect sphere is formed, whose breadth is equal to the lesser internal diameter of the ovum, 193k.

This membrane is perhaps the vitelline membrane of the ovule, 142d; but on this point, I cannot speak with certainty; for it present therefore we must rest satisfied with the fact that the innermost layers of the shell separate and contracts on the granules contained within it; forming another, an embryonic gold, 193k, in contradistinction to the first or ovular, 148, vitellus.

When the membrane of the embryonic gold first separates from the inner surface of the egg, it encloses not only the
embryonic granules, vesicle, 193 e; but likewise the clear fluid in which they float. But as contraction goes on this fluid passes through the membrane, 193 c; it occupies the space between it and the external envelopes. The membrane therefore acts as a diaphragm, allowing the fluid to pass but retaining the granules, 193 m, 193 m, bringing them within the influence of the embryonic vesicle.

The embryonic yolk is at first large and irregular, 190 to 192 m; but it soon becomes perfectly spherical, 193 m; 500 of one inch in diameter, enclosing an embryonic vesicle with a spot, whose diameter are 2000 and 5000 of an inch respectively; 193 f, g.

At this period the egg, 193, is oval; its longer diameter being 3/10, its shorter 3/50 in. Its membranes are firm and resisting, and with this amount of organization it is expelled from the body of the mother. The perfect ovum therefore consists of two or three homogeneous membranes, united to form an oval shell, 193 k; some thick fluid, 193 c; a spherical embryonic yolk, 193 g; membrane, 193 k; embryonic granules, 193 m; an embryonic vesicle, 193 f; and its nucleus,
the embryonic spot, 1939.

Compare the Text XIV, 193, with the false ovum XII, 155. One is immediately struck with the immense difference that exists between them. In the false egg, there is no embryonic vesicle, no embryonic spot. The substance that does exist is apparently the colouring matter of the vitelline granules, collected into a small globule, and surrounded by a membrane. 155 b. The whole is enclosed in a granular chorion, 155 a; instead of a laminated shell XIV, 193 b.

The formation of the embryonic yolk membrane is not the effect of fertilisation, for we see one produced in the false ovum 155 b. But after the entrance of solution of the spermatie particles, certain other changes are effected which in the ovule which do not otherwise occur. The spermatie particles by penetrating each over the ovule an influence of three distinct kinds of effects.

First, A preservative effect; preventing the decay, disappearance, & blending together of the vitelline granules, the germinal vesicle, & spot.
Secondly, A destructive, or solvent influence; by which the vitelline granules, & germinal vesicles are, after a time, gradually dissolved.

Thirdly, A power of transformation by which the vitelline are changed into embryonic granules.

The Generative, Destructive, & Transformative Influences commence, as we have seen, with the union of the spermatic particle & ovule. They are inferred by the spermatic particles on the ovule; which continues to exist, while the sperm is destroyed by the act. And, lastly, they appear all three to be of a purely chemical nature.

These properties once acquired continue not only throughout the whole life of the creature, but remain even after the death of the individual. In one or other of these influences may be ascribed all the changes that take place in the living body, with the exception of those that are referrible to vitality alone.

But before entering on the consideration where life commences, it is in what part it resides, it is essentially necessary that we.
make ourselves fully acquainted with the
changes it occasions in the ovum, by which the egg
is transformed into an embryo in all respects like
the parent, like it capable of voluntary motion,
aspiration, &c the power to produce other eggs.

These are most beautifully seen
in the egg of the Ascaris Muytia. As they have
been already described by as able authors I
shall confine myself to a very brief outline of
the changes as they occurred under my own
observation.

The first alteration that the ovum
undergoes is the division of the embryonic spot,
XX 195 a, & elongation of the embryonic vesicle,
195 b. This division is sometimes seen even before
the germinal vesicle has disappeared XIV 1819;
but it usually does not take place till after the
formation of the true or embryonic yolk, 195 c.

The division of the nucleus is
immediately followed by that of its cell, the
embryonic vesicle, 195 b; the two embryonic
vesicles are formed, 196 b, each containing
a nucleus or sper, 196 a.

As soon as this has occurred,
the two cells are seen to separate, & approach the
of opposite sides of the yolk, 196 d. A portion of the yolk membrane, 196 d, is protruded outwards by the application of one of the embryonic cells against it. At first this protrusion is very slight, 196 d; but, by the continued movements of the vesicle, it becomes more and more increased, till at length the yolk assumes an oblong shape, with a constriction about the middle, 198 e. This constriction gradually deepens, 199 e, and finally two yolks are formed, 200 e, by the division of the investing membrane, 200 d.

I have repeatedly watched this process as it occurred under the microscope. The division of an embryonic vesicle, 196 b, takes from 5 to 10 hours; but as soon as this is effected the division of the yolk does not take more than half an hour. The separation of the yolk into two parts is, I think, entirely mechanical; I see produced by a vitality inherent either in the yolk granules or membrane.

I have observed during the progress of division that, beside the rapidity of its accomplishment, the embryonic vesicles continue to revolve round and round in circles; the one moulding the newly projected portion.
of the yolk membrane into a spherical form; while the other prevents the original part from collapsing. Sometimes, when the formation of a yolk has been prevented by immersion in preservative fluids, the division of the embryonic vesicle still takes place, 194 b; if they are seen occupying opposite sides of the egg, but without any membranous or granular investment.

As soon as the yolk has divided into two a change occurs. The two embryonic vesicles, 200 b, remain stationary; their nuclei, 200 a, subdivide. They themselves elongate, 201 a, alternately separate into two each, 201 b. Thus four embryonic vesicles are formed; two within each yolk mass, 201 c, which by the repetition of the same process is subdivided into four, 203 c.

Occasionally, when one embryonic vesicle divides more rapidly than its fellow, three yolk masses are produced, 202 c; but this is rare, and not normally the case.

By a third series of divisions, commencing like the former with the nuclei of an embryonic vesicle, the yolk is parted into eight, more or less globular masses, 204. As this proceeds in repeated from time to time, the numbers of yolk
maes increases from eight to sixteen, 212f. to one to 32; 64; 128; 256 x, till they become so minute as to appear like granules. Yet each such granule is composed of a nucleus, an embryonic cell, yolk substance, yolk membrane. From the minute subdivision of the number of interfacial particles arising from the spherical form of the globules, the whole of the egg is filled with them, giving it a dark, opaque appearance. 209.

A membrane, 210f., appears to form on the external surface of this mass, 210g, the production of which is attended with the loss of some of the more superficial granules.

Next a depression, 211f., of the membrane occurs, corresponding usually with one of the sides. This depression is at first slight, 211f.; but it gradually increases, 212f., forcing some of the granules before it, while others disappear into a limpid fluid, which passing through the membrane, occupies the space between it and the shell.

A hemispherical mass is thus, 212g., produced; but the central partition continues to advance till it touches I unite with the membrane covering the opposite or inner.
surface, 213. By this means a thick circular ring is formed, 213 g.; which soon presents a constriction at one part, 214 g. This constriction is deepening divides the ring, which is then transformed into a cylindrical body, bent round so that the two ends are in opposition, 215 g.; covered internally with the membrane, now become thick, while internally we still see nothing but granules.

As the body elongates the two ends overlap, & are seen to be painted, 216. At first this overlapping is slight, but it gradually increases, 217, 218; till at length the little worm forms nearly two turns of a spiral, 219, 220 g.; surrounded on all sides by a fluid, & the shell or egg envelope.

By rupturing the egg, the embryo worm is set free, 221; & is seen to possess the three lobed mouth, 221 h, peculiar to this genus; & a very thick cuticle, 221 g.; enclosing a number of untransformed granules, 221 g.

The development of the embryo is best observed by placing the female entire in Spirits of Turpentine, for a fortnight or three weeks; at the end of which I have found the
oraries distended with ova, all of which contained young worms. There were not only fully developed but alive, doing their utmost to rupture their shells; by rolling themselves up into a tight spiral, 220 g, and then suddenly reversing the coil.

Let us now consider shortly which of these changes are vital and which physical. The most remarkable as well as most apparent alteration that takes place in the ova, and in the division of the yolk, which, though singular, seems to be entirely mechanical. For the yolk membrane when at rest as seen before the division, assumes the spherical form by its own molecular attraction; but, when drawn out by the embryonic vesicles, acquires first a cylindrical shape, then that of an hour glass, because that part of the membrane occupying the centre of the cylinder having nothing to distend it collapses; the two ends being prevented from doing the same by the continued movements of the embryonic vesicles. When the hour glass form has been attained, the molecular attraction of the membrane tends no longer to draw it into a single sphere, but into two globules, until the division of the yolk is completed.
This view is further confirmed by the fact that, while the first steps of the process take comparatively a long time, as soon as the hourglass form has been once acquired, complete division is effected with the greatest rapidity.

But, on the contrary, the division movements of the embryonic vesicle can only be ascribed to vitality. That they are not produced by the action of the spermatic particles is evident from the fact that, the division does not take place from without inwards, but from within outwards. The embryonic spot divides first. If this is seen to take place even before the germinal vesicle has been ruptured, while it is still entire, it consequent long before the terminal fluid could possibly exert any influence over its nuclei, embedded as they are, in the substance of the yet solid nucleus, surrounded by fluid the product of the ovule, it protected by the germinal vesicle.

The superficial growth of the embryonic spot proves beyond a doubt that its division is caused by its inherent vitality. The embryonic vesicle, though it owes its division to the nuclei it encloses, is likewise alive; because
it grows in size; it moves when divided, not by
direct attraction alone, as some suppose, for I
have most distinctly seen it continue to revolve
in different directions, & in circles of various
diameters.

But the embryonic vehicle itself
are nothing else than the nucleus & nucleules of
the germinal particle. Is this then alive? Yes!
because when first thrown off by the ovum, as a
germinial particle it is solid. The external layers
of it by growth forms a vesicle, while the interior
remains solid some time longer & constitutes its
nucleus.

This nucleus has already been
shown to possess vitality, & as it exists in the
germinial particle it must also be alive. The
growth of the germinal vesicle therefore from the
germinial particle is as vital as the growth of
the embryonic vesicle from its nucleus, the
erminial spot.

We have seen that life does not
originate at fertilization. We have traced the
vitality possessed by the ovum as far back as
the very commencement of the ovule. We must
therefore admit that it is derived from the mother.
For as the germinal particle is living when thrown off by the ovary; and as the ovary being part of the female shares its life; the vitality possessed by the germinal particle can only be derived from that of the mother.

From this it appears that the embryo or young Ascaris obtains its vitality from the mother; but that certain conditions are necessary for the continuance and development of that life.

That these conditions are furnished by the changes effected by the product of the male on the substance immediately surrounding the living cell.

When the male secretion is not present, when the above conditions are not fulfilled, life ceases; the vital point dies; if, although the surrounding substance does not immediately perish, it no longer encloses a germinal vesicle, nor even a germinal spot.

Finally, I would desire to draw attention to the beautiful analogy that exists between the products of the ovarian and testicular tubes. The caecal extremities of both the male & female reproductive systems throw off solid particles of the same size, shape, & appearance. Both kinds seem present spots in their centres.
of both swell up into nucleated cells, yet the one is a terminal, the other a germinal vesicle.

granules are now accumulated round both. Both might with equal propriety be called ovaules. So analogous are they in structure, that size alone distinguishes them, but the one is an ovule, the other a granular terminal mass.

The granular matter of the ovule dissolves, the germinal vesicle enlarges, it disappears, setting free its nucleus. The terminal mass likewise loses its granular covering, the terminal vesicle enlarges, and disappearing, its nucleus also is set free.

Thus far the analogy is complete, but here it ceases. The transformed nucleus of the male cell enters the granular vitelline substance of the female ovule, purishing by solution. On the other hand the nucleus of the germinal vesicle enlarges, divides, subdivides, redivides, till a mass of granules are formed, each professed of an individual existence; it together capable of producing a living whole: a worm, in every respect like its parent; endowed like it with the powers of assimilation, locomotion,
and reproduction.

A new life therefore is not generated during the development of a new being by the happy combination of physical forces: but the same life, bestowed by God at the Creation, continues without intermission, it is transmitted from mother to offspring; pervading & redeveloping itself in each individual member.
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