TRANSLATIONS.

On Gyrodactylus elegans, Nordmann.
By Dr. G. R. Wagener.

(From Reichert and DuBois Reymond's 'Archiv. f. Anat.,' 1860, p. 768.)

The curious phenomena connected with the reproductive process in Gyrodactylus render it a most interesting object of study to the physiologist. Till very lately, we are not aware that it was known to occur in this country; but Mr. C. L. Bradley having shown that one, if not two, species are very abundant on fish taken from the ponds on Hampstead Heath,* it will probably be found elsewhere. We have therefore thought it might be interesting to those of our readers who may meet with it, and be disposed to investigate the structure and development of this remarkable creature, to have before them the excellent account of Gyrodactylus given by Dr. Wagener, who has added so much to our knowledge of the subject in the present paper, which we have translated in all important particulars very nearly in its entirety.

Since the discovery, by Nordmann, of this remarkable parasite on the gills of the perch and other fish, it has been subjected to fresh examination by Creplin, Dujardin, and more recently by Von Siebold, the latter of whom more particularly has confirmed Nordmann's representations of the organization, and added observations of the most surprising nature as to the development of Gyrodactylus elegans.

He showed that a young Gyrodactylus arises in the interior of the parent animal from a self-dividing cell, that it becomes fully developed in the same situation, and whilst still itself in the embryo condition, produces a second offspring within itself. To these observations he added further statements respecting the organization of the animal, and especially pointed out the absence of any spermatic organs.

From the latter circumstance Von Siebold felt himself compelled to regard Gyrodactylus as a "nursing" animal; and in accordance with this view, he named the cell from

which the “daughter” individual is developed a “germ-cell,” and sought the terminal member of the series of generations among the Polystomata.

In the following observations the sexual reproduction of Gyrodactylus elegans will be proved, and, at the same time, some of the points in its organization, as described by Von Siebold, will be more fully elucidated.

Habitation.—Gyrodactylus elegans is found on the gills of all the Cyprinoid fishes brought to the Berlin market; it also occurs on the fins and abdominal surface of the fish, and may be obtained by scraping off the slime. Up to the present time, it has been found in the following species of fish:

- *Esox lucius* . . . . . The Pike.
  - “ *carassius* . . . . . “ Prussian Carp.
  - “ *erythrophthalmus* . . . . “ Rudd, or Red Eye.
  - “ *levi* . . . . . “

And from a drawing kindly furnished to me by Dr. Semper, a species very similar to, if not identical with, *G. elegans*, appears to occur on the gills of *Cyclopterus Lumpus* (Lump-Sucker).

Presuming that Nordmann’s figure is correct, specific distinctions would seem to exist between the hooks of the species noticed by him and that which has formed the subject of my observations; but I have reason to believe that these differences arise merely from trivial inaccuracies which it is very difficult to avoid making in the representation of the hooks.

Size.—The largest individual observed by me was about \( \frac{1}{4} \) mm. = \( \frac{1}{16} \) inch in length, and its greatest breadth might be about \( \frac{1}{3} \) mm. = \( \frac{1}{8} \) inch.

Form.—The form of the animal is flattened and tongue-shaped, with rounded borders. The cephalic extremity is divided into two short, slightly ventricose lobes, and is about \( \frac{1}{16} \) mm. = \( \frac{1}{8} \) inch in width. To the somewhat attenuated caudal extremity is attached, obliquely, a membranous, subtriangular suckorial disc, the concavity of which
is on the ventral aspect. The middle portion of the animal is usually enlarged, the enlarged portion corresponding to the situation of the uterus. Should this organ contain no ovum, nor any embryo, the vesicular elevation is produced by a clear fluid with which the uterine cavity is distended.

The cephalic lobes are separated from the root from which they spring by a shallow groove on the ventral aspect, which leads to and ends in the mouth. Frequently, also, a groove exists on the ventral surface, close above that border of the caudal disc which is unfurnished with hooks. The borders are continuous with each other, in the middle line of the body.

The external integument presents no definite structure. Occasionally, in certain states of contraction of the animal, very delicate transverse lines, formed of extremely minute points, might be seen crossing the surface at regular intervals, especially in the caudal portion. Around the mouth, when the eight pharyngeal papillae are protruded, fine longitudinal folds are often visible on the ventral aspect of the cephalic extremity. Below the mouth these folds become more and more distant from each other, and gradually disappear.

Muscular system.—Three parallel longitudinal lines may be seen at the border of the body of a Gyrodactylus. The external and middle of these lines belong to the integument. The space between the middle and inner lines is rather the narrower, but equally transparent with the other. The innermost line represents the outer border of the visceral mass, in which delicate longitudinal lines may often be remarked, which appear to radiate into the caudal disc; and may, probably, be regarded as representing muscular fibres. A radial striation is very obvious in the caudal disc itself.

Similar fine lines may be seen entering and terminating in the lateral process or appendage of each hook. In the same way the transparent substance inclosing the central pair of hooks of the caudal disc exhibits striae running parallel with its borders, and which are also, probably, to be referred to contractile elements.

The opening for the penis-like organ afterwards to be described, like the sexual aperture of Octobothrium lanceolatum, is surrounded with minute hooklets, from the base of each of which two striae proceed, which are, probably, muscular fibres.

A very remarkable phenomenon may be seen in Gyrodactylus, shortly after the birth of an embryo. Folds and club-shaped villi arise over the whole surface of the animal, into
the formation of which, besides the integument, the visceral fleshy substance of the body occasionally enters. Oil-drops of greater or less size are scattered through the entire body, and are very manifest in the perfectly fresh animal which, in that condition, may be said to be as clear as glass. The opacity, which very soon comes on under the microscope, is connected, for the most part, with endosomatic conditions of the external integument.

The caudal disc presents a central and a peripheral portion. It corresponds, in every particular, with the synonymous organ of some species of Dactylogyrus, with the one exception that in these cases, the points of the hooks are directed towards the dorsal whilst in Gyrodactylus they look towards the ventral aspect of the body.

The central part of the caudal disc is constituted by a fleshy bundle, very finely striated longitudinally, which completely surrounds the large hooks with their two lateral processes. The point of each hook corresponds to an opening in this sort of cushion, and on the edge of this opening, towards the body of the animal, a slender streak, curved into the form of a V, forms a partial border to the orifice.

The hook apparatus of the central part of the disc consists of two large flat hooks, each with its two transverse lateral appendages. They lie on the edge, and are curved upon it, the base being enlarged towards the edge in an irregular way difficult to describe. On the sides of the hooks, looking towards each other, are two projecting sub-parallel folds or elevations, corresponding to which are depressions on the external surface. These folds are short, of a circumflex form, and run from behind and above, forwards and downwards. That portion of the base of the hook which is not incumbent is somewhat thickened, and the terminal part of the free point is curved gently upwards.

The upper of the band-like appendages, which are placed transversely above the base of the hook, is the stronger and broader of the two, and it has an irregularly undulating border. The points of these appendages are bent downwards, rather over the hooks, and are truncated obliquely from without to within. The surface is slightly plicated. The upper and under borders of the appendages are also frequently thickened, and the latter border is continuous with a broad, apron-like fringe, which gradually becomes very thin, and has a narrow edging, or hem, on both its lateral margins, and corresponds in form to the space between the hooks into which it is inserted on either side. As the hooks are curved on their flat surfaces towards each other in the
form of an italic $S$, so as to inclose a heart-shaped space, the attached base of the apron-like expansion just described is necessarily wider than the free margin, which reaches almost to the point where the hooks begin to curve outwards.

The lower appendage is very narrow; its inferior border is produced into a very thin membranous fold, whose lower margin is slightly incised in a crescentic form. This appendage resembles a short curved thread or wire, resting on its free slightly ascending extremities on both hooks. The central disc presents a $V$-shaped transverse section, which towards the bases of the hooks expands in a single plane.

The peripheral portion of the caudal disc is very motile. At the periphery, except at the upper border, are placed sixteen minute hooklets, at equal distances apart; and according to the protrusion and retraction of these organs, the border of the disc varies much in appearance. When the hooklets, together with the fleshy substance in which they are imbedded, are protruded in a finger-like form, the intervals between them are often considerably retracted, each interval exhibiting two uniform incisions. On the other hand, when the hooklets are strongly retracted, the intervals appear to be slightly emarginate.

Each hooklet is individually motile. It may be retracted deeply into the finely striated fleshy envelope with which it is encompassed, so that even the very point is concealed; or it may be protruded to such an extent that the whole of the hooklet is exposed, resembling a finger armed with a claw.

In each of these little hooklets three portions may be distinguished—the hooklet itself, its stem, and an appendage, of which parts the latter two are subservient only to the motions of the organ.

The hooklet is flattened, strongly bent on the edge, and very sharp. The base is produced before and behind into two short wings, which are also placed upon the edge; the hook portion is seated upon the narrowest spot of this biscuit-shaped figure. One of the wings in question lies on the dorsal, and the other on the ventral aspect of the disc.

To the latter wing is attached, in a manner not yet ascertained, a very slender, elastic peduncle or stem, eight times as long as the hook, and slightly knobbed at the free extremity. Though often much bent by the contraction of the caudal disc, it quickly and readily straightens itself again on the cessation of the movement.

The wing corresponding to the under side of the disc serves as the point of attachment to a faintly defined elongated appendage, which is about half as long as the stem, and has
attached to it two strong, striated, fibrous bundles, which proceeding towards the centre of the disc are there lost. How this appendage is connected with the wing is not apparent. If we suppose the peduncle to be protruded, and the appendage drawn backwards, the point of the hook, which is somewhat moveable upon both, is elevated; whilst if the stem be retracted, the hook is withdrawn.

The transverse oral fissure, which is placed on the ventral side of the animal, close to the roots of the cephalic lobes, leads to the digestive apparatus.

The oral opening forms the lower termination of the shallow groove between the cephalic points, and leads into a short pyriform sac, with very thin walls, in which a longitudinal striation may sometimes be perceived.

Attached to the bottom of this sac, exactly as in Diplozoon or Diporpa, lies a protrusile pharyngeal organ, which, if the examination be awkwardly conducted, may even be forced altogether out of the oral orifice. This turban-shaped pharynx consists of two parts.

The upper, which projects free into the oral cavity, has eight points, which, as remarked by Von Siebold, can be moved against each other, like jaws. The conical summits of these eight divisions of the pharyngeal organ is finely striated longitudinally. The small jerking movements which take place in these parts give them the aspect of hard bodies. But when they are protruded beyond the mouth, they expand into an eight-rayed star; the fine longitudinal strie disappear, and they rather resemble a structureless, tough substance.

The lower portion of the pharynx, upon which the eight cones are seated, is of a flattened spheroidal form. It is composed of eight cell-like segments, separated from each other by as many meridional grooves. Upon each is placed a pointed process, which is also separated from it by a groove. These transverse grooves, forming a circle around the pharynx, divide it into a superior and an inferior portion. The eight celliform bodies have fine granular contents, in the centre of which may be perceived a very clear spherical cavity filled with fluid, and containing a globular opaque nucleolus.

The pharynx of many Distomata is formed in a similar manner, except as regards the conical processes. Within the longitudinal and transverse striæ, which are usually regarded as belonging to a muscular structure, may also be noticed transparent, nuclear, sharply defined spaces, inclosing each a nucleolar corpuscle.
The intestine of Gyrodactylus, which is bifurcate and cæcal, communicates with the pharynx by a short oesophagus, and is of uniform structure throughout. In individuals as yet uninjured by examination, the central space of the intestine and of the oesophagus is filled with a clear fluid, by which the walls are kept asunder. I have never seen this fluid resembling blood, as it does in Dactylogyrus monenteron. In the large, beautiful Gyrodactylus of the loach, the intestine was always charged with a clear, yellowish fluid, which served the purpose of an injection in the examination; in appearance this fluid resembled the yellow, homogeneous pigment by which the integument of the fish is coloured.

Two layers may be distinguished in the intestinal tube; the outer of which is, in appearance, structureless. The inner is much the thicker, and consists of a uniform layer of a fine granular substance, in which, here and there, transverse lines may be observed, which appear to indicate a cellular structure. In general this layer is soon broken up, and it then fills the intestinal canal. The course of the intestine is exactly the same as in many Distomata. It runs on the sides of the body immediately beneath the dorsal surface. The two cæcal sacculi meet in the middle line, making a short turn in order to effect the junction. The distance apart of the somewhat enlarged extremities of the intestinal canal depends upon the degree of distension of the uterus. In length it occupies about the two middle fourths of the animal. It embraces the ovum, the uterus, the testis, and rests upon the ovary; the upper enlargement of which, however, projects somewhat beyond it, on the outer side.

The vascular system is found not on the dorsal, but on the ventral side of the body. Its thin walls inclose a clear fluid, and the finer branches are furnished with distinct ciliary lobes. Four principal trunks may be seen lying in pairs on either side of the animal, close together, and corresponding with each other in their course.

In the caudal portion of the animal, near the upper border of the suckorial disc, and close below the ovary, the two pairs of vessels turn towards the mesial line. The two corresponding superficial vessels from each side join to form a short but not larger trunk, which bends so abruptly from the observer as to present a perfect transverse section. Whether it perforates the wall of the abdomen, or opens on the dorsal surface, as may well be supposed, could not be made out.

The other two corresponding vessels on each side, which on the whole, are less distinctly seen, are apparently lost in more slender branches, which, together with branches from
the loops, proceed towards the caudal disc. In the latter part, between the fourth and fifth hooklets on each side, and close to the border, are two very large, active, ciliary tags, whose free apices point directly inwards. It may also be noticed that an opening exists at this spot, on the somewhat swollen margin of the disc. Whether this opening communicates with a cecal cavity or a canal remains undetermined.

The two pairs of vessels in their course towards the head make two principal curves, by which the space circumscribed by the vessels is subdivided into three portions.

The lowermost of these divisions extends from the confluence of the vessels to the lower border of the testis. At this point the vessels bend suddenly outwards, but with a rapid curve again approach each other on a level with the lower border of the uterus, then again bend a little outwards, and with a gently undulating course run immediately on the pharynx, on whose sides they continue visible as far as the oral orifice, after which they gradually diminish in size until they are lost to sight.

On the spot where the vessels override the upper border of the intestine, a couple of minute rami muscles are given off on the inner side. Another far larger branch curves outwards, and pursues a winding course upwards and downwards through a mass of cells corresponding in form to unicellular glands.

These unicellular glands, as they may be termed, are situated in each side of the head, on either side, constituted of a superior and an inferior collection. The upper is the smaller, and consists of from six to twelve retort-shaped corpuscles, some of which always contain a transparent nucleus, together with a corresponding opaque nucleolus.

The inferior and larger glandular mass consists of from eight to twelve far larger cells. Each of these presents a clear nucleus and an opaque nucleolus, which, as in the superior glandular mass, lies in the midst of a more or less brownish, opaque, fine granular substance, with which the entire cell is filled.

From each of these bodies proceeds a finer or coarser filament, filled with a similar material; towards the cephalic lobe on the same side, at the border of which it terminates. These filaments are not of uniform diameter throughout, having here and there enlargements upon them. The glandular bodies themselves are placed on the dorsal side of the animal; but the filaments, united into a brownish sub-spiral bundle, run on the ventral aspect. In the cephalic lobe each filament becomes much dilated. Its course may
be traced through the structureless integument. At the apex of the cephalic lobe, a glutinous, viscous matter may often be seen escaping, which in appearance may be closely compared to the filaments by which the structureless integument is traversed. Immediately behind the inferior larger granular body, beneath the dorsal surface of the animal, are situated twelve to fifteen cells in close apposition, like those of tessellated epithelium, on both sides of the animal, and covering the outer side of the intestine. The uppermost of these cells are the largest, and they gradually become less and less downwards, so that it was impossible to determine the inferior boundary of the cellular layer. The nucleus and nucleolus of the cells resembled those of the glandular cells above described. The contents were quite colourless and finely granular, but very transparent.

Besides these unicellular glands, as they may be termed, three other similar, very minute aggregations of cells are placed on each side of the oral cavity, from which three brown, fine granular streaks proceed transversely to the mesial line of the animal, above or on the dorsal aspect of the oral cavity, terminating with a slight curve outwards.

On the back, rather higher than the mouth, I noticed four large, clear, fine, granular, cellæform bodies, close together, but whose nature remains quite obscure.

All these cellæform bodies, or unicellular glands, would seem to be comparable with those which are met with in the cephalic lobes of the species of Dactylogyrus. The four cellæform bodies last mentioned probably correspond with those lying above the mouth in Dactylogyrus, and which from their brown hue present a very peculiar aspect.

With them also may be associated the bodies existing in the integument of many Trematodes and Cestodes, first described by me under the name of "villi," or "villiform bodies." These also are furnished with a process filled with a brown granular material, arising from a sacculus in which a clear nucleus and opaque nucleolus may very frequently be seen, and terminating in the integument.

In the Cestodes it may be readily observed that an oil-drop is gradually formed at the spot corresponding to the termination of the cell-process in the integument, and that this drop of oil, gradually enlarging, is at last detached, a new drop appearing in the same place. The contents of the sac, in consequence of this, are rendered clearer, the number of fine granules is lessened, the nucleus appears to float loosely in the clear fluid, containing minute particles of the granular material; whilst a delicate, double contour line indicates the wall of the sac.
The sexual system consists of the single testis, and a horse-shoe shaped ovary.

The testis is a usually spherical or sometimes heart-shaped sac, the base of which is directed upwards. It is situated beneath the back of the animal, between the two branches of the ovary and of the intestine, its base reaching the horse-shoe shaped commissure of the former. Its upper wall slightly overlaps the oviduct, where the ovum is delayed before its entrance into the uterus. The wall of the testis exhibits a double contour line; the vas deferens is a short tube, which appears to penetrate the upper wall of the oviduct.

The common sexual orifice—that is to say, of the oviduct and testis—constitutes a papillaform elevation, projecting from the inferior wall of the uterus into its cavity.

The contents of the testis are sometimes composed entirely of cells; sometimes half of the sac is filled with a clear fluid containing either active spermatic filaments in tumultuous motion, or the well-known mulberry-shaded globules beset with spermatic filaments, associated also with immobile filamenteary bodies. Occasionally, also, an apparently virgin ovum may be seen in the oviduct surrounded with spermatic filaments, some of which may likewise be now and then perceived in the uterus itself, before its cavity is entirely occupied by the ovum.

The spermatozoa themselves are simple filaments, having no distinguishable cephalic extremity, except that one end seems to be a little thicker than the other.

The ovary is of large size, and occupies almost the entire lower half of the animal; it is very transparent, and usually of a horse-shoe form. Its upper extremities reach above the lower wall of the uterus, to an extent corresponding with the degree of distension of that organ.

The length and breadth of these glandular lobes depend upon the state of development of the ovary; and the uppermost of them, occasionally slightly hollowed, expands so as to embrace the intestine which rests upon it.

The gland is situated beneath the neutral surface. It is subdivided by shallow grooves into segments, which vary in different individuals, and are probably due to the formation of the ova. Each segment consists of a very clear matrix, in which transparent nuclei with nucleoli of pretty uniform size, though at irregular distances apart, may be noticed. Near the oviduct, a portion of the matrix appears separated from the surrounding substance by a circular line, encompassing and concentric with a nucleus. The oviduct appears to
arise from both lobes of the ovary. It constitutes a mem-
branous canal which runs in close apposition with the wall of
the uterus, transversely from one lobe of the ovary to the other
in a straight line. The vas deferens as before said, appears
to enter its upper wall.

The uterus consists of an oval cavity surrounded with a
strong membrane. It lies between the limbs of the intestine,
which are in contact with its walls on all sides, except the in-
ferior, which rests upon the oviduct.

The size of the uterus depends entirely upon its contents.
If it contain a fully developed embryo, it distends the entire
circumference of the animal on both the dorsal and ventral
aspect; and whilst pushing back the testis and ovary, it may
reach almost the whole length of the limbs of the intestine.
Immediately after the birth of an embryo it shrinks to \( \frac{2}{3} \) or
\( \frac{1}{3} \) its former size, and remains distended with a clear fluid,
which may be said to be poured out suddenly into its cavity.

This rapid emptying is accompanied with a simultaneous
shortening of the animal, in consequence of which also the
testes and ovary are made to occupy a rather higher position
than before.

During the gradual distension of the uterus when pregnant,
the papillaeform elevation through which the ovum and sper-
matozoa enter the uterine cavity, appears finally to be entirely
obliterated. After the birth this orifice is usually seen again to
project very prominently into the interior, though it some-
times happens that it remains invisible among the folds of the
uterus, so as to render its existence doubtful.

But, however uncertain the existence of a permanent orifice
of this kind may be, that of an opening for the escape of the
young is still more uncertain. The spot at which the birth
of the embryo takes place is perfectly definite, close beneath
the penis-like organ afterwards to be described, but I have not
yet succeeded in detecting any special indication of an open-
ing at this point.

Immediately after parturition, the integument is thrown
into folds, and a slight opacity of the organ ensues, which
renders it extremely difficult to detect the maternal orifice.*

The inner surface of the uterus is always covered with a
fine granular layer of irregular thickness, with which the
upper and lower points of the cavity are as it were, plugged.
In this layer may sometimes be seen minute cellæform bodies;

* Mr. Bradley (I. c., p. 210), states that “while observing these animals
with Dr. Bowerbank, they saw the young creature free itself by tearing
through the parental envelope, and containing within itself the progeny of a
third generation.”
and during the formation of the embryo it disappears altogether.

To the sexual system must also be referred a peculiar penis-like organ which has not been noticed by v. Siebold.

It is placed close behind the pharynx, beneath the integument on the upper boundary of the intestinal tube; and consists of a sacculus inclosing the proper penis, and having attached to it three peculiar sacciform organs.

The penis-sac is of a pyriform shape, or almost spherical; and it appears to be perforated at the obtuse point by which it is in contact with the integument, and this orifice is surrounded in a radial manner with from eight to sixteen hooks, the uppermost of which is distinguished by its size and figure. The points of all the hooks are directed towards the common centre, the apparent orifice of the sac; their bases are enlarged and spoon-shaped, the broad surface being applied upon the wall of the sac; and from either side of the base of each hook a streak proceeds in a meridional direction upon and immediately beneath the surface of the sacculus.

The large hook appears to have two lateral processes, by which it is affixed upon the obtuse angle of a triangular basal portion.

On the bottom of this armed sacculus lies a minute pyriform body, perforated in its longitudinal axis, and occupying about a quarter of the sacculus, with which the middle, sacciform organ, which is distinguished by a thick membrane and opaque granular contents, appears to be immediately connected. The sacculus is somewhat convoluted, and presents a constriction such as may usually be observed in the vesicula seminalis externa of the Distomatae.

I never noticed spermatozoa in it, nor could any channel be traced between it and the testis. On either side of this sacculus, which may be compared to a rudimentary vesicula seminalis, are placed two double follicles or sacs.

The two upper are elongated, and smaller than the two lower spherical ones. Their contents consist of a fine granular matter, and each division presents a clear nucleus, and opaque nucleolus. These organs cannot be compared to the vesicles connected with the penis of Dactylogyrus fallax, which are fitted with a viscous brown material, and situated on either side of the seminal vesicle.

The ovum of Gyrodactylus elegans, after its detachment (an act which it may be remarked has not yet been observed, owing, as it would seem, to the great slowness with which it takes place), is a transparent globule or cell with a nucleus, as clear as water, and sharply defined, though the nucleolus,
as well as the vitellus, is slightly opalescent. In the nucleolus may occasionally be seen a second globular body, as clear and well defined as the nucleus itself, the nature of which is unknown. In the oviduct may occasionally be perceived very minute ova (particularly in small Gyrodictylus), of hardly one third the usual size. It is possible that these may grow while still in the oviduct, which never contains more than one (full sized) ovum.

Whilst the ovum is lying in the oviduct changes go on in it, which have usually been referred to the influence of impregnation. The nucleolus, at first sharply defined, loses its definite outline, and the spot sometimes noticed in it is no longer visible. As the dissolution of the germinal spot proceeds, the nucleus becomes more and more transparent, the space which it occupies being increased in like proportion. At length the perfectly clear nucleus of the ovum is rendered turbid, from the remains of the germinal spot floating about within it.

I happened, on one occasion, to observe an ovum in this stage make its entrance into the uterus.

The appearances presented in this transit may best be compared with the passage of a viscous substance through a narrow orifice. The drops of vitellus gradually increasing in size, which was protruded from the papilla into the uterine cavity, appeared every moment as if it would be torn off. The nucleus or germinal vesicle was forced towards the entrance of the uterine papilla by the contractions of the animal, which are, apparently, the effective agents in the process. The lower part of its periphery during this, was still surrounded with a pretty thick layer of vitellus. The nucleus or germinal vesicle thus compressed assumed every possible shape, every inequality in the pressure causing a change of form. It appeared to oppose great difficulties to the passage of the ovum. Suddenly it burst, and the ovum rushed into the uterus.

When the entrance was thus effected there was seen, not as might have been supposed from the violence of the proceeding, several drops of matter, or an irregular amorphous mass, but the uterus was occupied by a large, dark, opalescent globular body, whose perfectly uniform aspect resembled very closely the rather lighter yolk of the uninjured ovum. In the case in which the above observation was made the animal perished before segmentation commenced.

Thus it appeared as if the altered contents of the germinal vesicle became intimately mingled with the vitellus, or that the same process takes place with the germinal vesicle and
vitellus, as previously occurs with the vesicular spot in the
germinal spot and itself; and somewhat later with the
germinal spot and germinal vesicle.

The following process also was directly observed. A
globular body, in every visible property precisely like that just
described, occupied the uterus, whilst almost in the middle of
the oviduct, which was otherwise empty, projected a small
ovum, still retaining its connection with the ovary. Suddenly
the first segment globule [ovum] lying in the uterus, threw
out an elevation on its upper side, whose base enlarging in
the direction of the greatest vertical diameter of the ovum
rapidly advanced, forming a progressive constriction, which
gradually increased in size and depth. When this groove
had reached the middle of the ovum it ceased to extend, and
visibly becoming deeper and deeper appeared at last to bisect
the ovum.

Further observation was prevented by the commencing
decomposition of the animal, at the end of four hours, during
which period the two coherent segment spheres remained
perfectly motionless.

The further process of segmentation, as already remarked
by Von Siebold, takes place with great irregularity.

Perfect cells do not appear to be formed until after this
first division of the ovum. Whilst in other cases a nucleus
and nucleolus are usually seen to be formed in the ovum or
first segment-sphere, and to precede the second division, in
the present instance the formation of a nucleus and nucleoli
does not commence until after the first constriction has taken
place.

The mode in which nuclei and nucleoli originate, is difficult
to follow. It appears as if in the interior of the ovum a
[ differentiation or] separation of the fluid from the solid
elements took place, since a sort of breaking up of the substance
may occasionally be remarked in the interior of the substance,
manifested by its coarsely granular aspect. Sometimes this
appearance might be attributed to the existence of very
minute, clear, closely contiguous nuclear vesicles with cor-
responding nucleoli, but sometimes this condition was not
obvious.

The nucleus and nucleoli, seen in the two segment-spheres,
are of very different sizes. The nucleus is always clear, sharply
defined, occasionally round, sometimes oval, or even more or
less regularly biscuit- or sausage-shaped. The nucleolus is
only more opaque; in other respects it resembles the nucleus
in form. When the nucleolus has attained a certain size it
may become elongated and irregularly bent, whilst shallow
constrictions on its surface plainly indicate an incipient multiplication by division.

When the number of cell nuclei which arise in every part of the segment-spheres, as well at the periphery as in the centre, has increased, they necessarily approach the surface, on which they cause visible protrusions. This appears to be the commencement of the exit of the cells from the segment-spheres. The nucleus must derive something from its nidus because bare nuclei with nucleoli are never seen attached in a very irregular manner to the segment-sphere [vitelline mass], but always cells. The opening through which these cells escape, owing to the viscous condition of the ovum above noticed, of course closes so as to be invisible.

The embryonal-cells adhere to the ovum only by a very small part of their periphery, although I have never seen them to become wholly detached, however active the movement of the animal might be.

The cells do not at first, any more than the segment-spheres, occupy the entire uterine cavity. Both float in a very clear fluid. At a later period the cells increase in number, whilst at the same time they diminish in size. The remains of the segment-spheres [of the vitelline masses] which are also reduced in size, retain the spherical form, until finally the cells cover them completely. The fluid at the same time disappears, and the uterus closely embraces its contents.

In this condition the embryo represents an egg-shaped mass of cells, which, within certain limits, are variable in dimensions, and have a very clear nucleus, an opaque, oval or rounded nucleolus, and equally opaque contents.

The remains of one or both of the segment-spheres, usually of both, rarely of one only, remain still visible for a considerable time. They are always found in the situation where the uterus of the embryo is afterwards formed. They are both still present, when, under a strong magnifying power, the commencement of the large hooks and of the sixteen small points around the caudal disc may be plainly seen at the lower end of the cellular and as yet perfectly oval embryo.

But this appears to be the limit to their future development. About this period one only of them is visible, surrounded with cells at its lower border, which may be distinguished from those constituting the parenchyma of the embryo by their being encompassed by a fine elliptical line. These cells are of very various sizes, representing in miniature the irregular process observed in the large segment-spheres.

At a later period the remains of the other segment-sphere
also disappear, when the hooklets and hooks of the caudal
disc may be viewed even with a low magnifying power, and
the egg-shaped mass, now composed of uniform large cells,
is seen of considerable size in the interior of the embryo.

In the further development of the embryo the cells con-
stituting the future cephalic portion are the first to be
reduced to the smallest size. A furrow which commences as
a shallow lateral groove, and gradually increases in depth
whilst advancing in an oblique direction from below to above,
marks off the cephalic portion.

A transverse furrow indicates the boundary of the caudal
disc; and fine lines mark the limits of the various organs,
amongst which the ovary and the so-termed unicellular
glands are distinguished by the size of the cells composing
them, whilst the cells which constitute the cephalic extremity
of the animal gradually lose their distinctness.

The mature embryo lies in a curved posture in the uter 
s, the head and tail being placed together, touching with their
neutral surfaces.

The uterus of the embryo, even at this time, contains a
second progeny in the shape of an embryo, whose hooklets are
already pedunculate, although it still manifestly consists only
of cells. The rudiments of the organs begin to be visible
here and there, and the situation of the ovary is indicated
by some cells remarkable for their size.

In the interior of this second embryo, in the situation where
the uterus is placed, even at this time may be seen an oval
aggregation of cells, which manifestly presents at its lower
end sixteen radiating hooklets; behind which are visible the
two points of the large hooks.

Within the second embryo also, with some attention will be
perceived an elliptical marking, which likewise corresponds to
the situation where the future uterus is to appear. At this
spot the cells are somewhat larger, but of very unequal size.

An embryo of this kind, at the period when an ovum is
perceptible in the oviduct, spermatozoa in the testes, and in
which all the organs are fully formed, is ripe for expulsion.
The uterus, whose much distended walls are no longer covered
with the granular layer, embraces it closely. The act of
parturition is very sudden; and the embryo escapes on the
ventral aspect of the body close to the penis, through an
orifice which, as before said, closes immediately.

The newly born perfectly mature Gyrodactylus resembles
its parent in every respect, except that it is a little smaller.
In its uterus may be distinctly seen two successive generations
lodged one within the other, and easily recognisable by the
hooks. In favorable cases indications of a third generation even may be perceived within the second.

From the foregoing observations it is obvious that *Gyrodactylus* produces at least one generation in the sexual way. How the second and third embryo arise has not yet been cleared up.

[To these observations succeed some remarks upon the question as to how the contained embryos of the second and third generations arise, which, however, we omit for want of space, merely stating the propositions, which appear to the author to require elucidation.

1. The second and third generations may arise like the first in which they are contained; that is to say, in a sexual manner.

2. Or it may be that portions of the original vitellus or uterine ovum from which the first generation was produced, remain over, which, even when contained in the embryo, repeat its formation.

3. Or the second and third generations are to be regarded as spores.

For further information respecting *Gyrodactylus*, refer to:

V. Nordmann.—‘Mikrographische Beiträge,’ i. p. 106; Tab. x, figs. 1, 2; ‘Ann. d. Sc. Nat,’ tom. xxx, pl. xix, fig. 7.

Creplin.—‘Ersch and Gruber’s Encyclopädie,’ xxxii, p. 301.

Froriep, ‘Neue Notizen,’ viii, p. 84; Wiegmann’s Archiv,’ (1839) p. 164. Bd. ii.

Dujardin.—‘Histoire naturelle des Helminthes,’ p. 480.


Wagener.—‘Natuurkund Verhandeling,’ Haarlem, xiii, p. 51, 54.
