A NEW AVIAN CESTODE—*METROLIASTHES LUCIDA*.

By B. H. RANSOM.

WITH PLATES XIII AND XIV.

The material worked up into the subject matter for this paper was obtained preserved in formol in two vials from a collection belonging to Dr. H. B. Ward. One vial contained what was apparently a single worm broken into three pieces, one of which included the head; the other vial contained pieces of two or more worms of the same kind as that of the first vial, but no head. The labels in the vials gave as the host, the domestic turkey; and the organ infested, the intestine. The specimens were collected in the vicinity of Lincoln, Nebraska.

The characteristics of the worm to be gathered from a superficial examination are as follows:

Length about 20 cm. Greatest width 1.5-1.8 mm. Width just behind the head 0.6 mm. The most anterior proglottides are five or six times wider than long; but in the older segments with the general increase in size, there is an added increase in length, so that the last proglottides are nearly twice as long as broad, being 2.5-3 mm. long by 1.5-1.8 mm. wide (Figs. 2, 7 and 8).

The head is somewhat spherical with its anterior surface exhibiting a slightly conical convexity (Fig. 1). In the compressed specimen the head is broader than long, measuring 0.58 mm. in length by 0.75 mm. in width. It has neither hooks nor rostellum. The four round suckers are prominent and well developed, and are situated somewhat anteriorly. They measure 0.2-0.25 mm. in diameter.

The strobilation of the worm becomes apparent immediately behind the head, and very distinct within a distance of two millimeters. In a contracted state of the worm the posterior portion of the proglottis forms a prominent projecting rim which overlaps more or less the anterior part of the succeeding proglottis. In some of the younger proglottides this overlapping covers the next segment for half its length. In all cases this border is a well developed part of the proglottis.

The worm is rather transparent throughout, in its posterior portion remarkably so. Some seven to ten centimeters from the anterior end of the worm one may notice a white spot in each proglottis, situated in the median line near the posterior border and occupying about one-third its width. This structure has the form of a double spherical sac, as becomes very evident with the increasing size and transparency of the proglottides. A little conical projection develops running forward from this sac in the median line of the segment (Fig. 2, FC). Later a bulb-like swelling appears at the anterior end of this projection. In the oldest proglottides only a trace of the double posterior sac (Fig. 7, U) remains, while the anterior bulb has become a well marked little spherical body (EC), situated in the posterior half of the proglottis with a diameter of from one-third to one-half the width of the latter.

The cirrus sac can be seen under slight magnification without difficulty. From the margin somewhat posterior to the middle of the proglottis it runs diagonally forward and inward, ending shortly after crossing the excretory canal. The angle it makes with a line drawn transversely across the proglottis increases with age. One cause at least of this change in the angle of the cirrus sac is the growth of organs behind it, the pressure of which shoves its inner end forward. It is found well preserved in the oldest proglottides. Its shape is that of a slender cylindrical flask, and its most usual adult size approximates 100μ by 400μ (Figs. 2, 5, 7 and 10).

Posterior to the cirrus sac the vagina (V) and seminal receptacle (RS) are often visible running towards the middle of the proglottis.

The genital pores are marginal and are located a little posterior to the middle of the segment. The margin around the opening is often bulged out into a papilla of more or less prominence and the pores alternate very irregularly.

INTERNAL ANATOMY.

Body Wall.—The cuticula varies in thickness from 3 to 6μ, and beneath are found the usual layers of circular and longitudinal muscles and of subcuticular cells.

Musculature.—The longitudinal muscle fibres are disposed in a layer of which two parts can be distinguished, an inner part consisting of about one hundred bundles of twelve to twenty fibers each, and an outer part consisting of fibers, arranged in bundles of three to five or isolated, scattered through the parenchyma and lying externally to the inner portion. The diameter of these fibers ranges from 1.5 to 4μ. The inner portion is continuous from segment to segment, while a great deal of the outer part is interrupted by the strobilation.

The transverse musculature lies in a thin band of fine fibers just within the ring of the longitudinal bundles. Except for portions of the cirrus sac and vagina all the organs of the proglottis lie within the transverse muscle bands. Laterally the fibers of this layer penetrate the longitudinal muscle layer, spreading out and attaching to the cuticula. The dorso-ventral muscle system is well developed.

Excretory System.—The ventral canals (Figs. 5, 8, 9 and 10, VC) vary in size from 40 to 180μ, and are very much larger than the dorsal. In the old segments where the ventral canal attains its maximum size the dorsal canal, has, on the other hand, become very insignificant, with an inner diameter of sometimes less than 1μ. The wall of the dorsal canal, however, is much thicker than that of the ventral canal, and commonly as thick as the lumen which it encloses. In the posterior part of each segment the two ventral vessels are connected by an anastomosis whose ramifications run behind and among the testes.

Sexual Organs.—Numerous testes are found in a mass in the posterior portion of the proglottis, occupying the middle field, and extending transversely from one ventral canal to the other (Figs. 5 and 8, T). They are arranged in two layers which contain two or three rows each in the lateral region, while at the middle they are only one or two deep, so that the mass is somewhat concave anteriorly. Medianly and ventrally in this concavity lies the yolk gland (Vit). Close to the yolk gland and in the direction towards the genital pore is the shell gland (SG). The ovary (Ov) lies anterior to the yolk and shell glands and dorsal to its posterior edge is the uterus (U). The cirrus sac (CP) lies with its proximal end near the anterior edge of the ovary and somewhat dorsal to it, and with the vagina running nearly parallel to it, passes between the excretory canals and dorsal to the nerve cord towards the margin of the proglottis.

Male.—The testes number about 35 or 40. They are approximately oval except where modified by pressure and range in size from 30 to 100μ. The number given is the maximum, found in youthful proglottides (Fig. 8), and with the growth of the various organs is reduced so that when the uterus begins active growth, only about twenty to thirty testes will be found, most of them approaching the maximum size.

In the median line of the proglottis two or three efferent ducts, in diameter 2 or 3μ, join to form the vas deferens. This structure (Fig. 5, VD), lies just beneath the dorsal transverse muscle layer. It runs forward near the median line in a straight or sinuous course, then bends toward the cirrus sac and twists and curves about the base of the latter in a mass of coils. The bulk of the mass lies anterior and median to the cirrus sac, several coils lie ventral, and there is a twist or two on the dorsal side, but practically none posterior. The vas deferens is surrounded throughout its course by a clear transparent sheath which finally merges into a similar sheath (CS) surrounding the cirrus sac and vagina.

The slender flask-shaped cirrus sac consists of a thick outer muscular layer, surrounding a tissue of a reticular nature in

whose midst is the cirrus (Fig. 5, C). The muscle layer has a thickness of 1 to 4μ, and consists of circular, diagonal, and a few longitudinal fibers. There is apparently also a system of fibers running radially from the cirrus to the muscular wall of the sac; but the base of the sac is free from such fibers. The sheath surrounding the sac (CS) is clear and transparent, of a fibrous or reticular nature, and towards its distal end merges imperceptibly into the general parenchymatous tissue of the proglottis.

The vas deferens penetrates the base of the sac and after one or two twists expands into the cirrus (C), which is spindle or cigar-shaped with a short curve at its inner end. Its wall is thin and is surrounded by a system of circular fibers. Within the wall of the cirrus reaching from one end to the other is a compact bundle of highly refractive, fine, smooth fibers. There seems to be no other conclusion as to the nature of these fibers than that they are enormously developed spines. Their size is truly extraordinary, some of them apparently reaching the whole length of the cirrus. The partial extension of the cirrus and its position in the vagina in one case observed among the numerous proglottides sectioned (Fig. 4), seems to indicate the occurrence of self impregnation, a phenomenon already noticed by various authors in many different species. In this connection I might say in passing that it is very common in sections I have of *Taenia cesticillus*, to find the cirrus well entered into the vagina of the same proglottis. In none of my preparations of the worm which forms the subject of this article does a cirrus protrude beyond the genital opening. The genital sinus is deep and narrow.

Running diagonally forward and inward across the ventral canal where the cirrus crosses it is a thin strip of tissue. This strip reaches across the canal and joins the wall both dorsally and ventrally, closing it except for a small opening at its outer edge (Fig. 10, x). Its function is problematical but it is evidently not a valve of the ordinary type at least.

Female Sexual Organs.—The vagina (Figs. 4 and 5, V) is a comparatively straight tube of 6 to 9μ in diameter. It opens

into the genital sinus just posterior to the cirrus opening and almost at right angles to it. Following the curve of the tip of the cirrus sac it runs toward the center of the proglottis keeping a position posterior to the sac and becoming also somewhat ventrally situated. The first bit of the vagina has a tolerably wide lumen and walls whose thickness varies in different specimens. The diameter of the passage soon narrows to about 2μ, the walls thicken, and are lined on their inside with bristle-like projections directed outward (Fig. 4, Cl). On the outside this thick walled region is surrounded by a heavy coat of glandular or myoblastic cells (Fig. 5, a) which deteriorate with the age of the proglottis. Before the excretory canal has been crossed the lumen widens again and the walls become thin. After copulation this thin walled region is seen to be filled with spermatozoa. It has swollen to several times its former size and functions as the seminal receptacle (Fig. 2, RS).

At its inner end the seminal receptacle branches into two tubes; one of these leads to the ovary, the other to the shell gland. The former I have designated as the ascending portion of the oviduct (Fig. 5, Ovd. a), the latter as the descending portion (Ovd. d). With age these tubes grow both in diameter and length, become more or less coiled or twisted and their walls become thinner. They are enveloped by the same transparent sheath (CS), as are also the remaining male and female canals. The ascending oviduct opens into the ovary ventrally on its posterior surface by a funnel-like opening of 30μ in diameter. No structure is present which could be regarded as an oocapt.

The ovary (Ov) is situated in the middle of the proglottis lying close against the ventral transverse muscle band and when well developed it reaches almost to the dorsal layer. It is a single sac-like organ divided into compartments. When filled with ova it has a plump rounded appearance, convex anteriorly and somewhat concave and sunken in behind where the oviduct opens into it. In cross sections through its posterior part the ovary often presents the appearance of being bilobed,

but sections through every other region show that it is clearly single and unpaired. The ova measure from 4 to 6μ in diameter. After the ova have left the ovary it flattens out, shrinks and dwindles away.

From its point of union with the seminal receptacle and ascending portion of the oviduct the descending portion (Ovd. d) pursues its course, slightly sinuous and twisted in the mature state, to the shell gland.

This structure (SG) is oval in section with its long axis directed dorso-ventrally. In the stage when the eggs have begun to fill the uterus, the shell gland has acquired a vacuolated or honey-combed appearance and after the filling of the uterus it degenerates rapidly and disappears.

As the oviduct enters the ventral side of the shell gland it is met by the vitelline duct (YD) which is about 15μ in diameter; it opens with a funnel-like enlargement of 30μ into the vitelline gland (Vit). The vitelline gland has a sacculated structure like that of the ovary but is smaller, being about half the size of the latter and more compact. When the uterus begins to take on its function as an egg receptacle the vitelline bodies break up into tiny eosinophilous granules, which are very persistent and in the oldest proglottides the remnants of the vitelline gland can be identified by their presence.

On entering the shell gland the oviduct becomes the ootype (Ot). This turns anteriad from the shell gland and after a short curved course empties into the uterus. The ootype has a diameter of 10μ and preserves its embryonic structure longer than any other of the female tubes. With progressing development of the uterus, the ootype grows longer and describes two or three loops in its course; its walls also become thin.

The uterus at an early stage (Fig. 5, U) is a transverse band of embryonic cells lying dorsal to the ovary and close behind its posterior edge. It extends somewhat beyond the limits of the ovary on each side and is joined near its middle by the ootype. The cavity of the uterus is formed by a hollowing out of the mass of cells and develops into a double spherical sac

which increases rapidly in size as it fills with eggs (Figs. 2 and 10, U). At the height of its development the uterus occupies almost the whole of the inner parenchyma back of the genital pore, and bulges out the proglottis wall dorsally and ventrally.

The eggs as they first appear in the uterus are in early stages of cleavage. They are surrounded with a very delicate envelope and measure about 20μ in diameter. During the sojourn of the egg in the uterus two more coverings become apparent, making the three enveloping membranes so common among cestode eggs (Fig. 3).

Shortly after the eggs have taken up their position in the uterus important modifications occur in the proglottis. Just anterior to the uterus within a cone-shaped space (Figs. 2 and 10, FC), the parenchyma becomes spongy with greatly thickened fibers. Many of these fibers are grouped into strands running transversely in zigzag wavy lines. Next to the uterus, instead of this appearance of striation, there is a more pronounced mesh-work or sponge-like network. The ovary does not enter in any way into the formation of this structure as its remains still persist ventral to the latter. With the progressing development the cone-shaped organ takes on a more definite structure. Some of the fibers group themselves to form a surrounding wall; their course in this wall is mainly in a circular direction. This wall, however, is not so compact that fibers do not exist which, arising in the external parenchyma, penetrate the wall and extend into the interior. The fibers enclosed within the wall become fine and form a hair-like mass. In the posterior part of the cone next the uterus, may be noticed running in a dorso-ventral direction amid these hair-like fibers, and apparently differentiated from them, some five or six bands of tissue which dorsally and ventrally unite with the fibrous enveloping wall of the cone (Figs. 2, 9 and 10, a). These bands unite also with the heavy fibers of a reticular or lace-like frame-work which covers the front of the uterus (Fig. 9, b). Certain modifications also take place in the structure of the latter. All traces of its epithelial cells disappear and it becomes enveloped

with a layer of fibrous network. Membranous partitions run inward from its wall branching and ramifying through its cavity among the developing embryos which now exhibit clearly the three-shelled condition.

At a later stage the embryos begin to pass out of the uterus. They leave it in groups carrying with them the intra-uterine partitions. Passages are kept open for the eggs by the dorso-ventral bands (Fig. 9, a). The cone-shaped structure contracts posteriorly so that it becomes cylindrical. Group by group the eggs are forced into the anterior part of the cone until it bulges out into an oval capsule (EC). This capsule increases in size as the eggs enter. During the passage of the egg masses through the fibrous tissue which fills the cavity of the cone-shaped structure, they gather heavy coatings of this tissue. It is this tissue which gives the wall of the capsule its thickness. The primary wall (Fig. 9, EC) is quite thin.

After the last groups of eggs have passed into it the egg capsule finally draws together posteriorly and the resulting spherical capsule is the final stage of development (Fig. 7).

At the tip of the cone-shaped structure or in front of the egg capsule will be found a triangular-shaped thickening or condensation of the parenchyma (Figs. 2, 7, 9 and 10, PC), whose function I do not know. From the appearance of fibers extending radially forward in the parenchyma from its tip, it seems to mark the attachment of supporting or contractile elements. The strain brought about by the development of the egg capsule and the migration of the eggs causes a retraction of the parenchyma from the anterior end of the proglottis leaving an open space bridged across by a number of taut straight fibers.

The adult uterine embryo, i. e., the embryo at that stage of development when it abandons the uterus, is surrounded by three envelopes, a very thin inner membrane closely enveloping the onchosphere, a thick middle envelope, and a thin outer shell of more or less irregular shape (Fig. 3). Between the middle and outer shells is a granular substance commonly in

two masses at opposite ends of the egg. The hooks of the onchosphere are of two kinds, one with a short double ventral spur, the other without any spur (Fig. 6). The length of the former is about 20μ, that of the latter some 4 or 5μ greater. The prong of each kind measured about 8μ. The dimension of the embryo (Fig. 3) are as follows: Onchosphere 30μ in diameter, middle shell 35x55μ, outer shell 50x75μ.

SYSTEMATIC POSITION.

In the last sheets of his work on Cestodes Braun (00) has given a revised system of classification. According to this classification the tape worm here in question comes under the order Cyclophyllidea. True, the ovary of our worm is not bilobed but single and unpaired, while Braun gives among the characteristics of the order Cyclophyllidea "Keimstock mehr oder weniger zweilappig." That this expression, however, is meant to be interpreted very freely is shown by the fact that numerous forms possessing only a single ovary, such as *Taenia dispar* Goeze, *Taenia dujardini* Kr., *Taenia planissima* S. and H., *Taenia bifaria* v. Sieb., are arrayed by Braun under this order without any restrictions. And the diagnosis of the genus *Panceria* reads plainly "Keimstocke nicht zweilappig."

Therefore, since the bilobed nature of the ovary cannot be looked upon as an especially distinctive characteristic of the order no discrepancy arises in placing this worm in it, and likewise in the family Taeniidae which has the characteristics of the order.

Among the subfamilies it is the Dipylidiinae, an extensive group of elastic capacity, with whose characteristics our worm corresponds. The genera cited under this subfamily show numerous rather wide differences in structure. For example some have doubled reproductive organs; in some the rostellum is well developed and bears hooks; in others hooks and rostellum are absent; the number of testes varies from three to thirty or forty; and the fate of the uterus and the final position of the eggs in the proglottides are also very varied. With respect to the last point, viz., the fate of the uterus, the

genera in this subfamily can be divided into several groups; one containing those forms in which the uterus is persistent; another, those in which the uterus breaks down into egg capsules; and a third those in which the uterus disappears altogether leaving the eggs imbedded singly in the parenchyma. In the first group would fall the genera *Hymenolepis*, *Dilepis*, *Choanotaenia*, *Amoebotaenia*; in the second *Dipylidium*, *Cotugnia*, *Nematotaenia*; and in the third *Oochoristica*, *Panceria*, and *Monopylidium*. A fourth group is represented by a new genus *Anonchotaenia* established by Cohn (00) upon the basis of a new species *A. clava* described by him. In this species the uterus unites with the shell gland to form a large cavity filled with eggs. Yet another condition is met with in our species. The uterus breaks down into a few large egg sacs or masses which are carried forward in the proglottis and become enclosed together in a specially formed capsule.

In certain respects our species resembles Cohn's new species but in others it is radically different. Like *A. clava* the head is unarmed, and the rostellum absent. The neck, however, is short or wanting, while in *A. clava* it is long. The relation in *A. clava* between the breadth and width of the proglottis in different portions of the chain, viz., several times broader than long anteriorly, and posteriorly nearly twice as long as broad, is very similar to the conditions obtaining in ours. The irregularly alternating pores are common to both species; but while those of Cohn's species are situated considerably towards the anterior end of the proglottis those of ours are more posterior. Both forms agree in possessing a non-lobed ovary. In regard to the arrangement of the sexual organs there is a wide disagreement. In *A. clava* beginning in the anterior part of the proglottis, the organs follow each other thus: Shell gland, uterus, ovary, and yolk gland. There is no definite ootype, the shell gland lying against the uterus and opening directly into it instead. All of these points differ widely from our species. While the two species resemble each other in possessing an egg capsule, they are very different, as already noticed, in regard to the origin of this capsule. The number of testes in

A. clava is rather small; in our species, on the other hand, considerable.

In Stiles (96) there are some figures (268-270) and a very incomplete description of a cestode, *Taenia nigropunctata* Crety, from the migratory quail, which indicate some resemblances with our form. There is an unarmed scolex without rostellum and a three-shelled egg as in ours while the structure outlined in the proglottis, if it were located more posteriorly, would be strikingly similar to the appearance of certain stages of the uterus with the developing egg capsule in front, of our form. Whether there is anything in this resemblance is a question which of course must remain until more careful investigation of *T. nigropunctata* has been made.

It is quite evident that our species belongs to no genus yet described. Accordingly it is necessary to establish a new genus for its reception. The diagnosis will read:

METROLIASTHES.*

Scolex in adult unarmed, without rostellum. Genital pores irregularly alternating. Uterus breaks up into egg-sacs or masses, which in turn leave this region, and become enclosed by a specially formed secondary capsule.

Type species: *Metroliasthes lucida.*†

Characteristics as given above. From the small intestine of the domestic turkey collected near Lincoln, Nebraska. Type specimens in the collection of the Zoological Department, The University of Nebraska, and in those of B. H. Ransom and H. B. Ward.

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The University of Nebraska.

* Referring to the disappearance of the uterus.

† By virtue of its unusual transparency.

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EXPLANATION OF PLATES.

ABBREVIATIONS.

C. Cirrus.
CP. Cirrus pouch.
CS. Sheath surrounding genital canals.
EC. Wall of egg-capsule.
FC. Fibrous mass in which is developed later the secondary egg-capsule.
N. Longitudinal nerve.
Ot. Ootype.
Ov. Ovary.
Ovd. a. Oviduct, ascending portion.
Ovd. d. Oviduct, descending portion.
PC. Terminal cone of condensed parenchyma.
PS. Sheath of cirrus pouch.
RS. Seminal receptacle.
SG. Shell gland.
T. Testis.
U. Uterus.
V. Vagina.
VC. Ventral canal.
VD. Vas deferens.
Vit. Vitelline gland.
YD. Vitelline duct.

PLATE XIII.

Fig. 1. Head and portion of strobila from a toto preparation. X 31.

Fig. 2. Proglottis from a region posterior to middle of worm. Toto preparation. X 29.

Fig. 3. Embryo from adult uterus. X 758.

Fig. 4. Longitudinal section through anterior portion of cirrus sac and vagina showing cirrus apparently in the act of entering vagina. X 495.

Fig. 5. Young female sexual organs. X 98.

Fig. 6. Embryonic hooks. X 1712.

PLATE XIV.

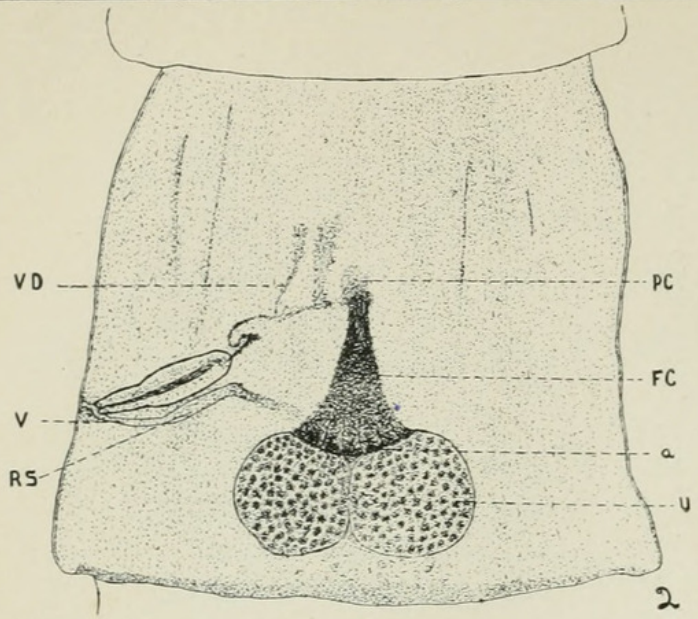
Fig. 7. A mature proglottis from end of chain. Toto preparation. X 32.

Fig. 8. Anterior proglottides from toto preparation. X 28.

Fig. 9. Longitudinal section of maturing proglottis older than Fig. 10. *a*. Dorso-ventral bands of tissue between which the eggs pass. X 48.

Fig. 10. Longitudinal section of maturing proglottis, eggs just beginning to pass out of uterus at *c*. *x*. Valve-like structure in canal. X 39.

PLATE XIII



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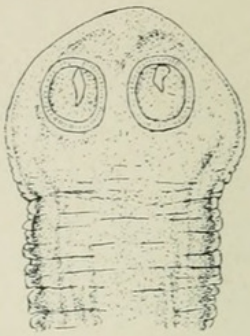

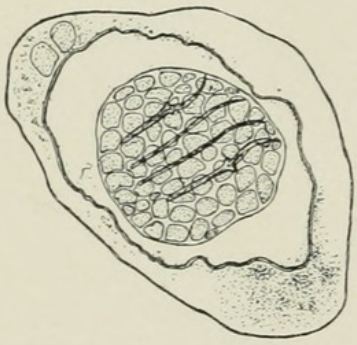

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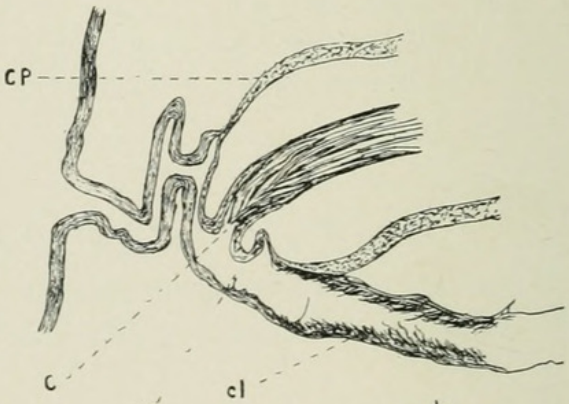

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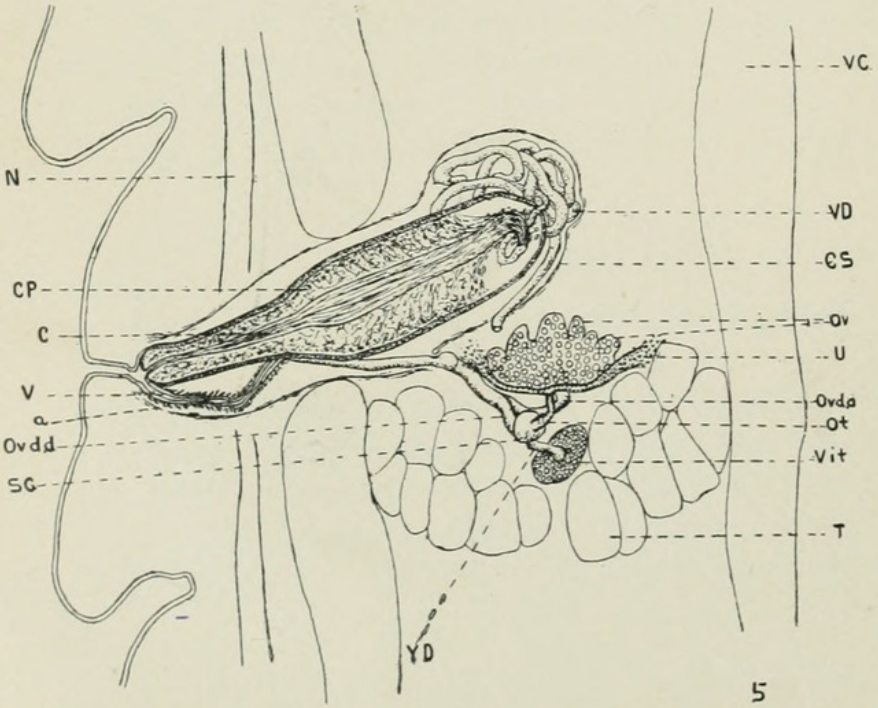

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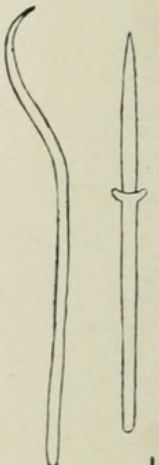

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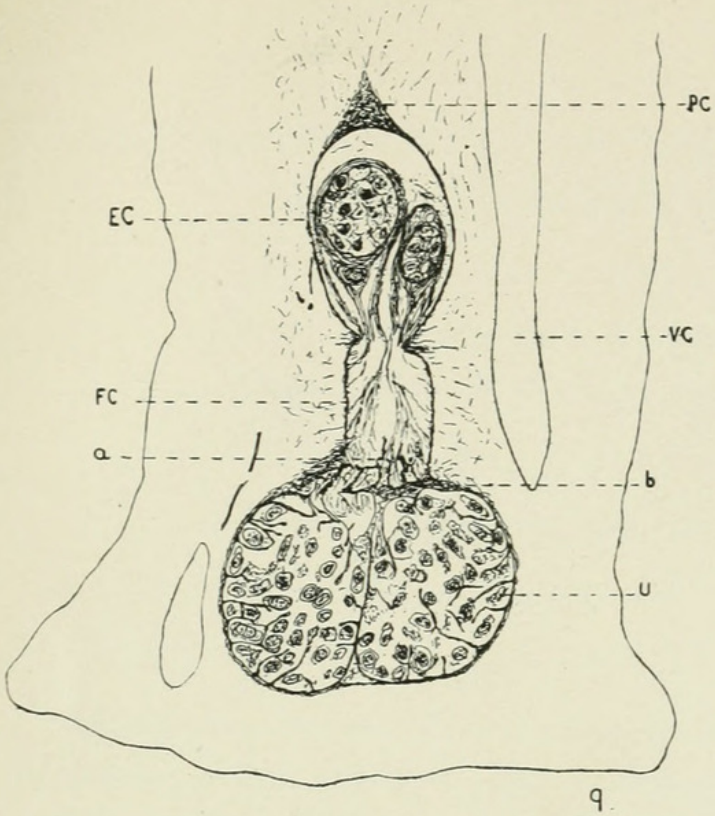
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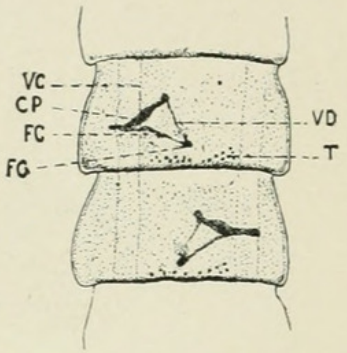
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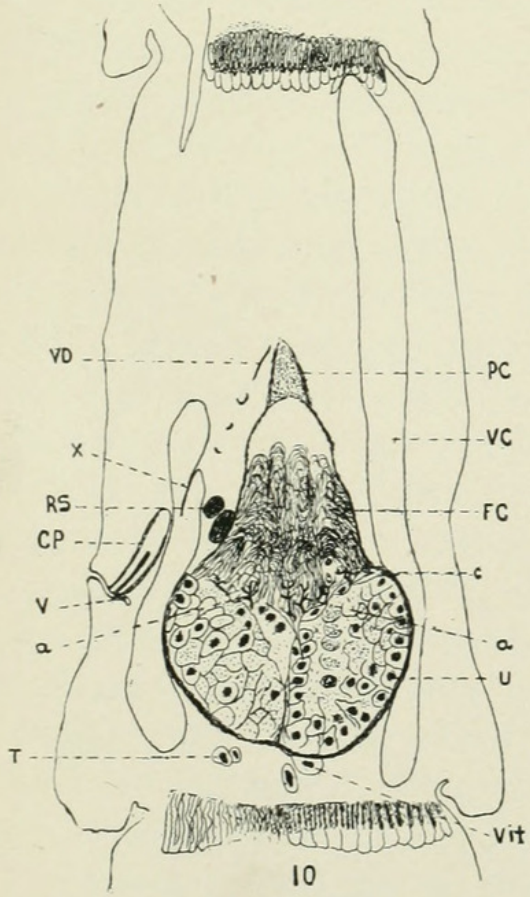
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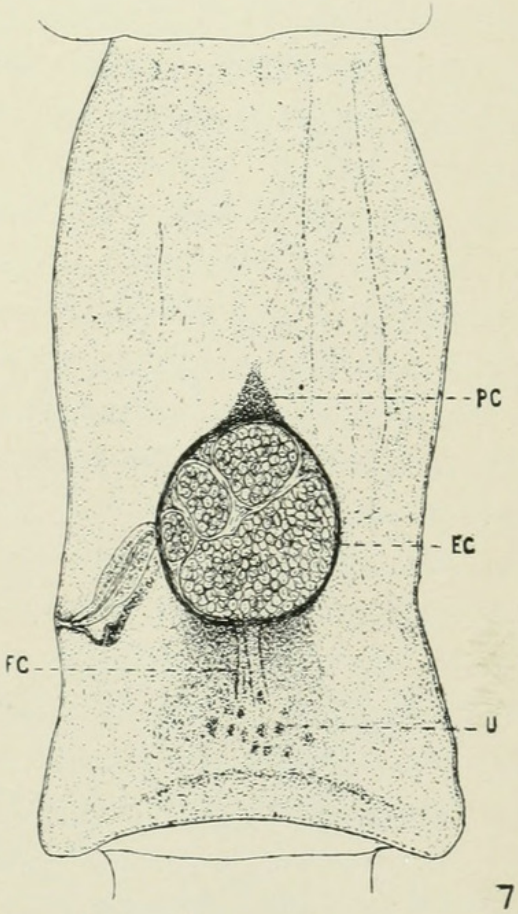
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