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LIVERPOOL:

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A NEW SPECIES OF CESTODE *(ANOPLOCEPHALA VULGARIS)* FROM AN AFRICAN RHINOCEROS

BY

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(*Received for publication* 8 *December*, 1920)

Twelve specimens, a large number of fragments, and several single segments, were obtained by Professor Yorke on 23rd August, 1912, from a rhinoceros (*Rhinoceros bicornis*), at Ngoa, N.E. Rhodesia.

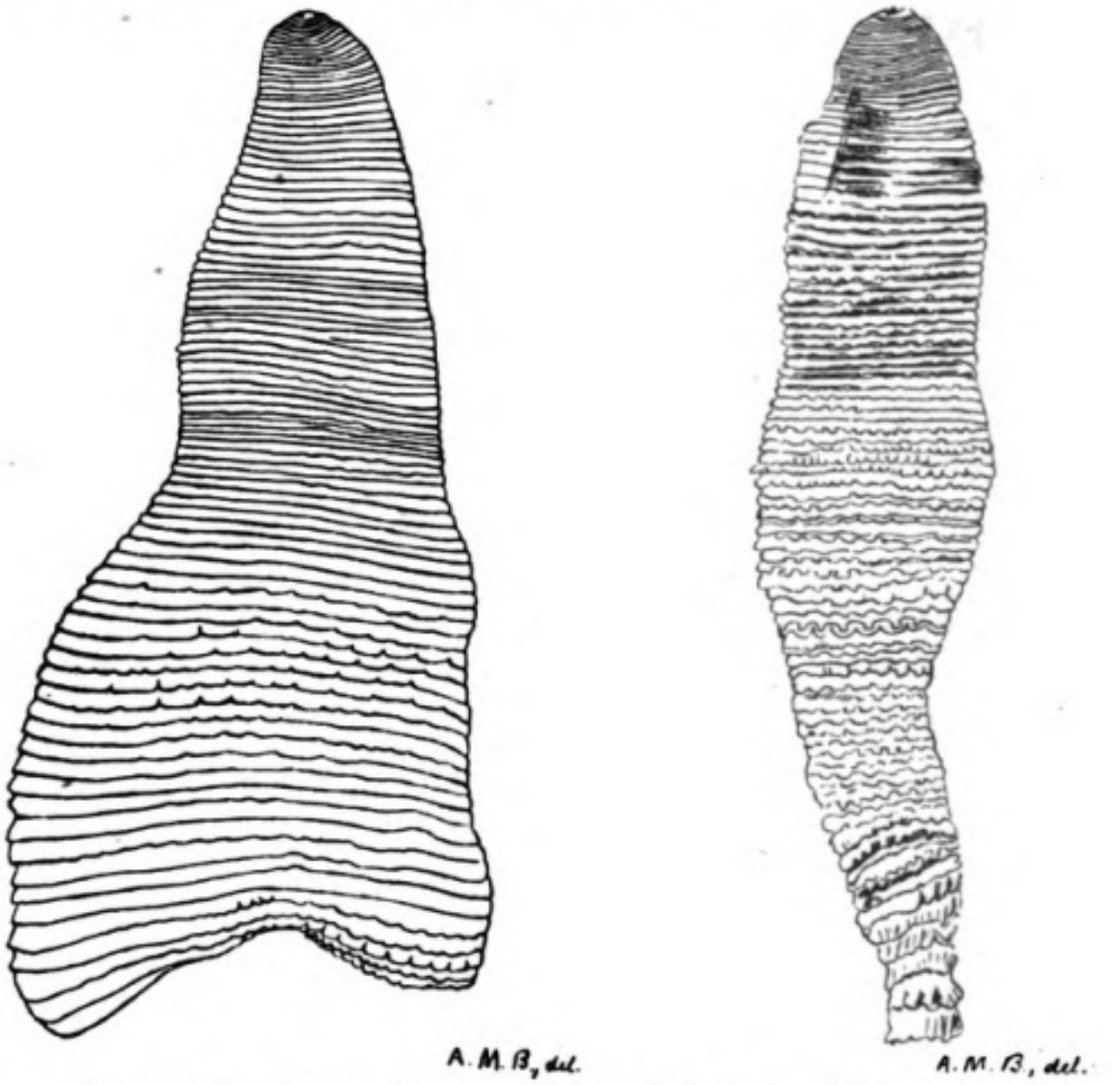
EXTERNAL CHARACTERS. Probably this worm does not exceed a length of about 12 cm. The measurement of six of the largest specimens were as follows:—

Length	Greatest breadth	Greatest thickness	Head length	Head breadth	No. of Segments
75 mm.	27 mm.	1·0 mm.	0·75 mm.	1·0 mm.	150
67 mm.	16 mm.	1·25 mm.	0·5 mm.	1·0 mm.	143
60 mm.	15 mm.	0·75 mm.	1·1 mm.	1·25 mm.	117
48 mm.	11 mm.	1·5 mm.	0·5 mm.	1·1 mm.	114
47 mm.	16 mm.	0·75 mm.	no	head	125
44 mm.	17 mm.	0·75 mm.	0·5 mm.	1·0 mm.	121

The worms vary in shape, as will be seen from figs. 1 and 2. In some, the posterior segments are very broad (27 mm.), and short (1 mm.), whilst in others they are narrow (4 mm.) and long (1·25 mm). The segments overlap each other, and the free edges are frilled, the frilling becoming much more pronounced posteriorly. The genital pores are all dextral.

HEAD. The head is very small (figs. 1, 2 and 3). The four suckers are directed forward and slightly outward. Their diameter is about 390μ, and the muscular rim has a thickness of about 80μ. There are no lappets, and there is no neck. The lateral margins of

the anterior segments curve forward so that the head rests in a deep depression between two shoulders, and can be seen only with difficulty with the naked eye (figs. 1 and 2).



FIGS. 1 and 2. Two specimens shewing variation in shape. (× 2.)

MUSCULAR SYSTEM. The muscular system is poorly developed; the longitudinal bundles have a thickness of about 50μ, and the annular bundles of 15μ; a single bundle of muscle fibres connects the

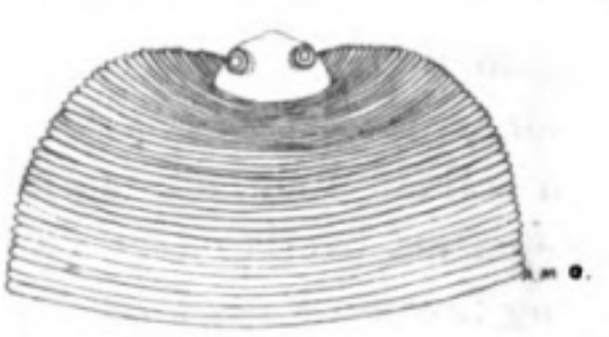


FIG. 3. Head and anterior segments. (× 10.)

internal extremity of the cirrus bulb to the ventral wall. The dorso-ventral muscle fibres are strongly developed, and extend, at irregular intervals, from the dorsal to the ventral surface (figs. 5 and 8).

NERVOUS SYSTEM. There are three longitudinal nerves on each side, the main nerve being median. The other two are small and are situated lateral to the main nerve, one dorsal and one ventral (figs. 4 and 5).

WATER VASCULAR SYSTEM. Only a single vessel could be made out with certainty on each side. It was well developed, and had a diameter of about 45μ. Numerous branches were to be seen, especially laterally (figs. 4 and 5).

MALE GENITALIA. *Testes* (figs. 4, 5 and 6). These first appear in segment 15, and they have disappeared in segment 62. At first they are small, each testis having a diameter of about 20μ only.

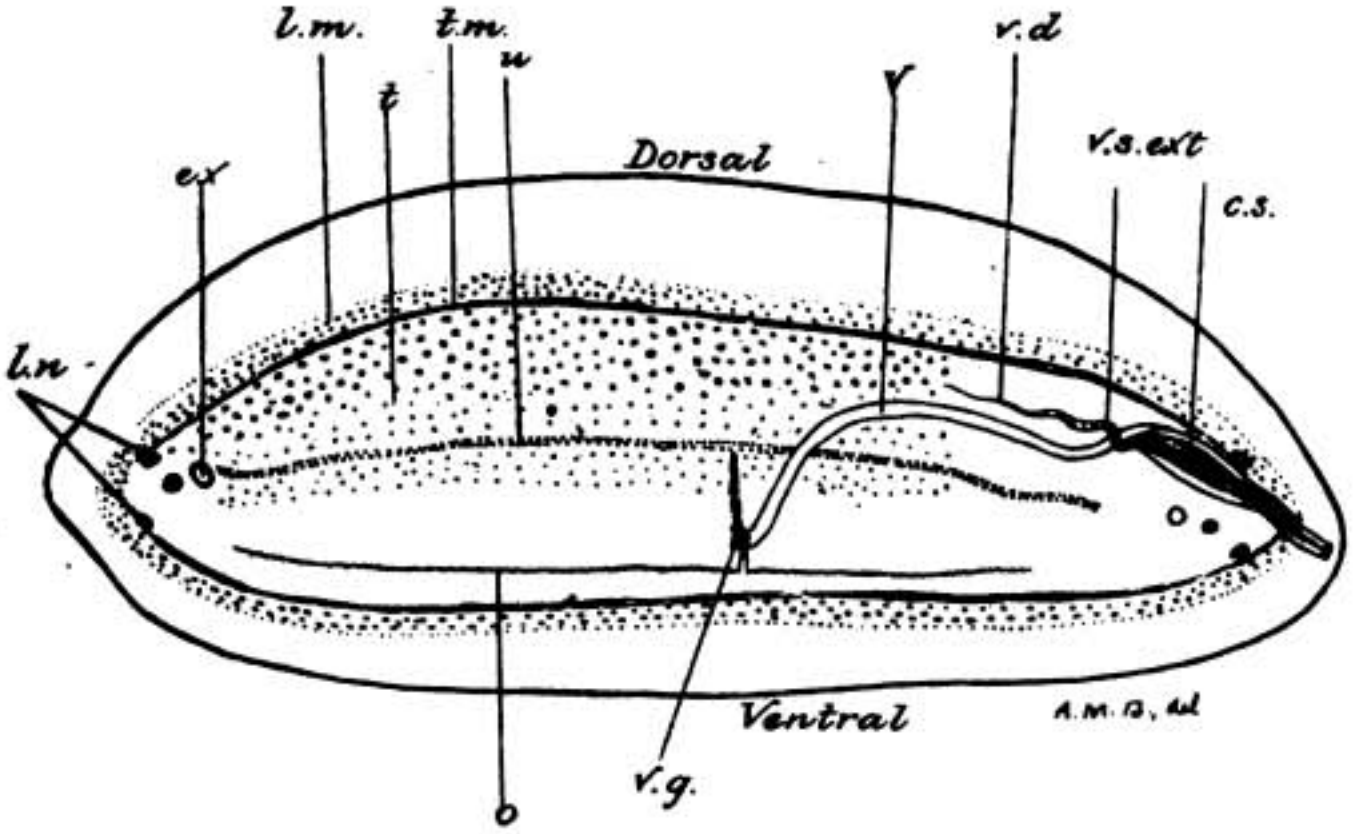


FIG. 4. Immature segment shewing developing of genitalia. *c.s.*—cirrus sac; *ex.*—ventral excretory vessel; *l.m.*—longitudinal muscles; *l.n.*—lateral nerves; *o.*—ovary; *t.*—testes; *t.m.*—transverse muscles; *u.*—uterus; *v.*—vagina; *v.d.*—vas deferens; *v.g.*—vitelline glands; *v.s. ext.*—external vesicula seminalis. (× 28.)

They attain their maximum development between segments 18 and 24, where each testis measures about 62μ by 30μ. When fully developed, they extend the whole distance between the aporal water vessel and the inner extremity of the cirrus bulb. While the bulk of the testes lies dorsally, a number of acini extend quite ventrally and reach the rudiment of the ovaries.

Vas deferens. The cirrus bulb is first evident in segment 10, where it measures about 250μ by 150μ. The rudiment of the outer seminal vesicle is also to be seen in this segment, lying immediately

internal to the cirrus bulb (fig. 4). In segment 23, the cirrus bulb has enlarged to 900μ, and its breadth is 275μ; it lies dorsal to the water vessel and nerve and gradually curves ventrally, until its internal extremity lies almost on the ventral surface. The outer seminal vesicle lies internal and dorsal to the cirrus bulb; it is a U-shaped tube having a diameter of about 40μ, the limbs of which lie close together. The inner limb gradually merges into the vas deferens, which narrows and pursues a wavy course along the dorsal surface. The inner seminal vesicle is first visible in segment 26, as a small club-shaped cavity near the internal extremity of the cirrus bulb; it enlarges rapidly, like the cirrus bulb itself, and

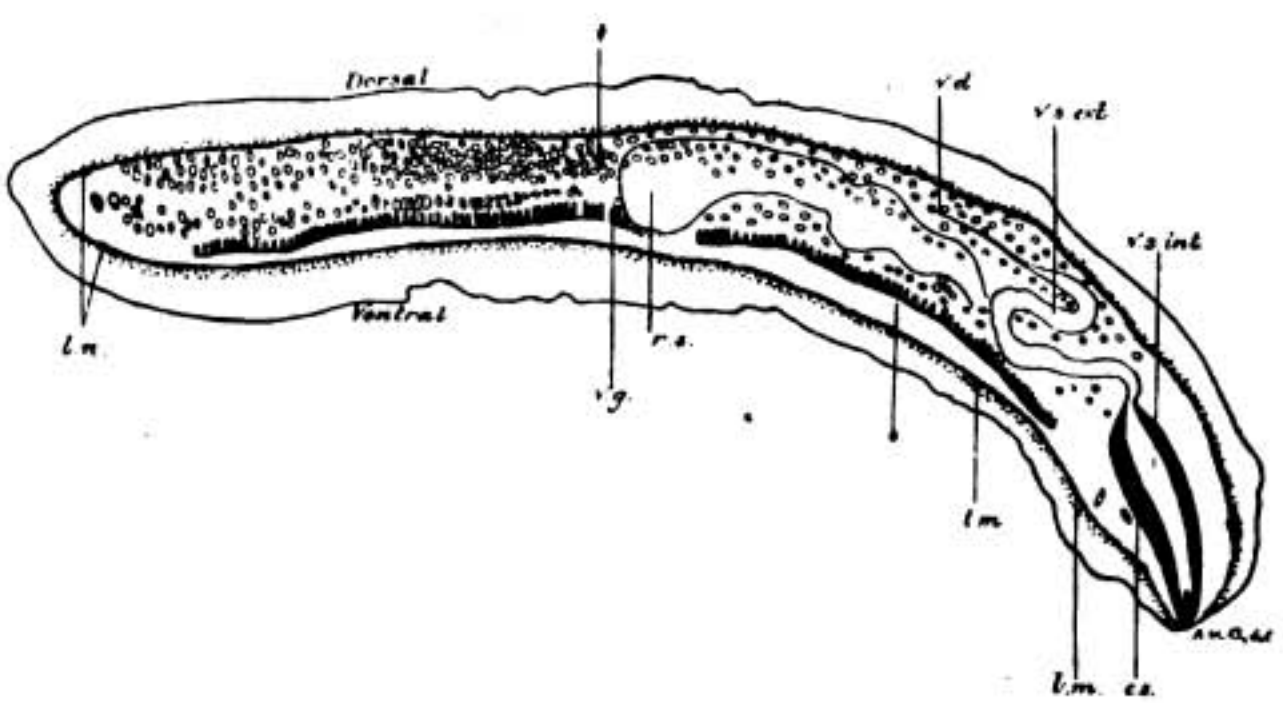


FIG. 5. Mature segment shewing genitalia. *c.s.*—cirrus sac; *l.m.*—longitudinal muscles; *l.n.*—lateral nerves; *o.*—ovary; *r.s.*—receptaculum seminis; *t.*—testes; *t.m.*—transverse muscles; *v.d.*—vas deferens; *v.g.*—vitelline glands; *v.s. ext.*—external vesicula seminalis; *v.s. int.*—internal vesicula seminalis. (× 14.)

in segment 37 practically fills the entire cirrus bulb. The cirrus shortens as the inner seminal vesicle enlarges, and eventually disappears altogether. No spines were seen on the cirrus.

In segment 50 the cirrus bulb is about 2 mm. long and has a diameter of 0·45 mm. It continues of this size up to about segment 80, when it gradually becomes straighter and narrower; it persists to the last segment. The outer seminal vesicle also enlarges enormously and alters its position accordingly up to segment 46, after which it gradually shrinks.

FEMALE GENITALIA. *Ovary* (figs. 4, 5 and 6). This first appears in segment 19; it is situated ventrally and measures 45μ

in the dorso-ventral diameter. It attains its highest development between segments 37 and 50, and disappears in segment 64. When fully developed, it extends laterally to within 650μ of the aporal water vessel, and to within 700μ of the poral water vessel. The ovary is divided into two wings by the vitelline glands; the poral wing has a lateral diameter of about 2·2 mm., and the aporal wing of 3·5 mm. (figs. 5 and 6). The median axis of the ovary is very slightly on the pore side of the segment.

The ovary consists of a series of club-shaped acini arising from a ventral horizontal base (fig. 6); the larger acini measure about

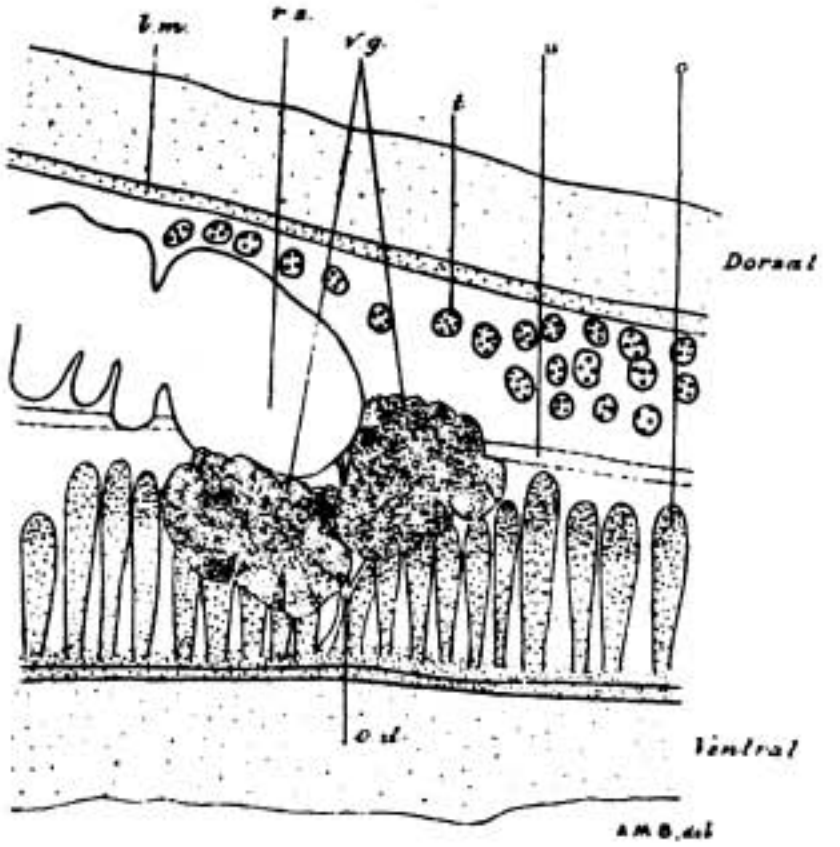


Fig. 6. Centre of a mature segment. *l.m.*—longitudinal muscles; *o.*—ovary; *o.d.*—oviduct; *r.s.*—receptaculum seminis; *t.*—testes; *u.*—uterus; *v.g.*—vitelline glands. (× 35.)

470μ dorso-ventrally, and 60μ laterally. They decrease in size towards the periphery of the ovary to a slight extent only.

Receptaculum and Vagina. In segment 12 the vagina is well defined as a clear irregular tube having a diameter of about 70μ, and in segment 14 the receptaculum is seen as a slight dilatation of the median extremity of the vagina. Both the vagina and the receptaculum increase in size rapidly, and become enormously distended; in segment 29 the vagina has a diameter of about 450μ, and the receptaculum fills the whole dorso-ventral area (fig. 5). After segment 51, both these structures atrophy quickly. The

vagina has the following relationship to the cirrus bulb; from the genital pore it runs inwards, ventral to the bulb, but dorsal to the excretory vessel and nerve: it then crosses posterior to the cirrus bulb and runs dorsal to it.

In the median direction the receptaculum is continued as a narrow tube, which is joined by the oviduct and continues in a dorsal direction as a long fertilisation canal to the uterus. After the vitelline glands and receptaculum seminis are well developed, they hide the other structures in the vicinity, but it was noted that the vitelline duct opens near the junction of the oviduct and fertilisation canal, posterior and ventral to the receptaculum seminis. The relative position of these ducts is shewn diagrammatically in fig. 7.

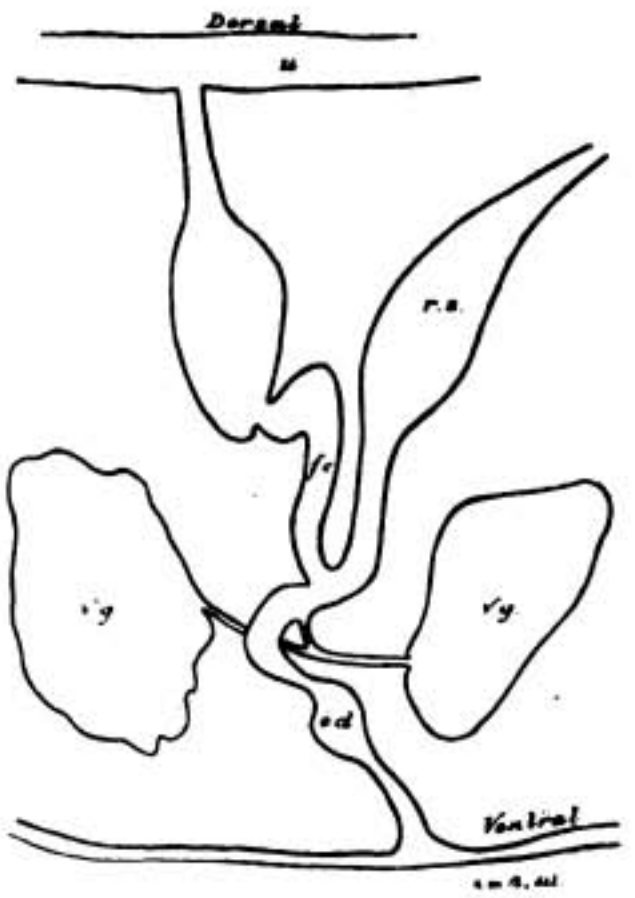


FIG. 7. Diagrammatic representation of the connections of the receptaculum seminis, ovary, oviduct, vitelline glands and uterus. *f.c.*—fertilisation canal; *o.d.*—oviduct; *r.s.*—receptaculum seminis; *u.*—uterus; *v.g.*—vitelline glands.

Vitelline glands. The rudiment of the vitelline glands appears with that of the receptaculum in segment 8, and in segment 14 a few small vitelline acini are present. The vitelline glands practically disappear in segment 94, but traces of them persist up to segment 99. They reach their maximum development between segments 44 and 50, and consist of two definite wings, separated from each other and presenting a V-shaped appearance. The poral wing is smaller than the aporal wing, the former measuring about 370μ by 200μ,

and the latter 390μ by 390μ; each is lobulated. Both wings lie on, but not touching, the ventral surface (figs. 6 and 7).

Shell glands. The shell gland consists in segments 24 to 27 of a thickening on the wall of the fertilisation canal, which measures about 75μ by 55μ. In posterior segments it could not be found.

Uterus. The rudiment of the uterus is to be seen in segment 7 or 8. In segment 17, it consists of a very faint cell-string running midway between the dorsal and ventral surfaces (fig. 4). Its future development was followed with some difficulty, owing to the fact that the testes, ovaries and receptaculum masked its presence. In segment 28, it runs between the ovaries and the testes as a straight tube from one water vessel to the other. In segment 48, it has enlarged a little and its course has become undulating. In succeeding segments, the undulations become more pronounced, and in about segment 70 it presents the appearance of a number of vertical tubes, not always clearly separated from each other ventrally and dorsally, and containing immature eggs (fig. 8). Laterally, the extremities

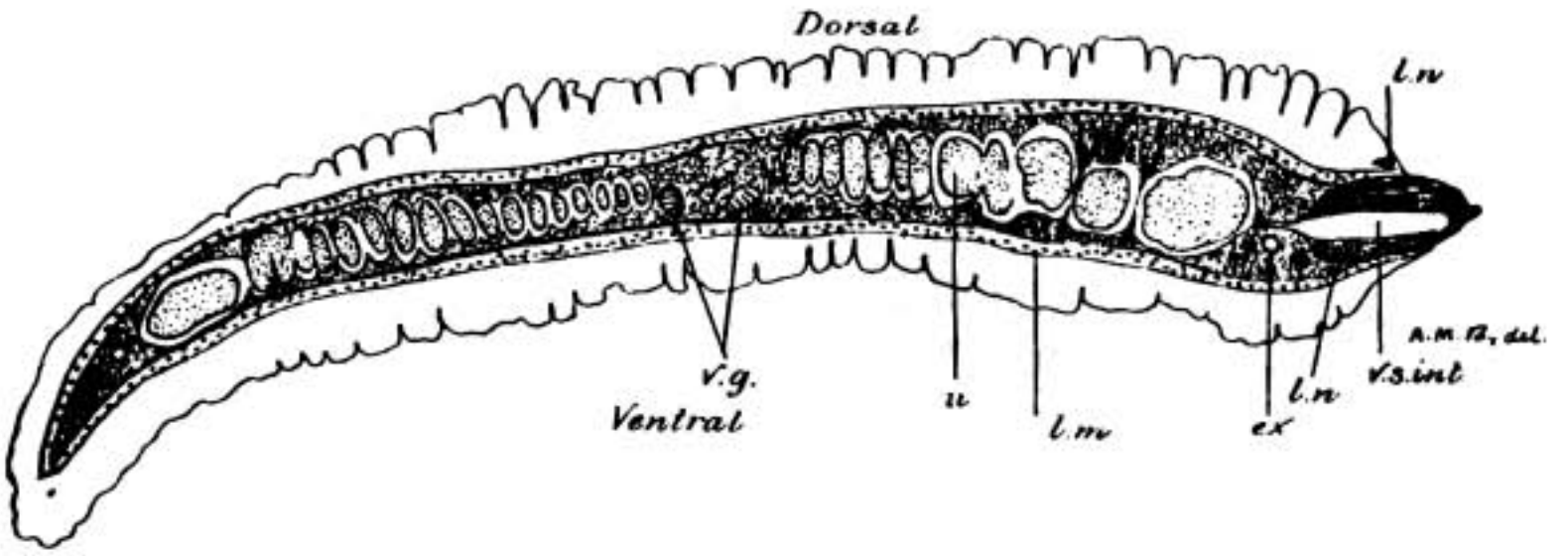


FIG. 8. Gravid uterus, posterior view, shewing isolated compartments into which the uterus is divided. *ex.*—ventral excretory vessel; *l.m.*—longitudinal muscles; *l.n.*—lateral nerves; *u.*—uterus; *v.g.*—vitelline glands; *v.s. int.*—internal vesicula seminalis. (× 14.)

of the uterus remain straight and dilated. In the posterior segments the uterus fills the proglottid entirely, and dorso-ventral and antero-posterior muscular partitions can be seen with great clearness in whole segments or in sections viewed either anteriorly, posteriorly, dorsally or ventrally. No sterile segments were observed.

Eggs. The eggs enlarge and mature gradually in the posterior segments, the pyriform apparatus appearing last. The mature eggs

in preserved specimens are of different shapes and sizes, a condition which appears to be dependent on reciprocal pressure in the uterus. Extreme types are either ovoid or cuboid, the latter predominating (fig. 9), but intermediate types occur in abundance. In preserved specimens the egg has the following dimensions:—Size of egg, 77μ to 95μ. Thickness of outer envelope, 16μ to 18μ. Diameter of embryo, 18μ to 19μ. Length of horns of pyriform apparatus, 18μ. The free egg in the fresh condition is undoubtedly spherical.

In immature eggs the middle envelope lies close to the outer envelope. As the egg matures the middle envelope gradually shrinks until it becomes a small mass, about 1μ to 2μ in diameter, attached to the filaments of the pyriform apparatus. Its size,

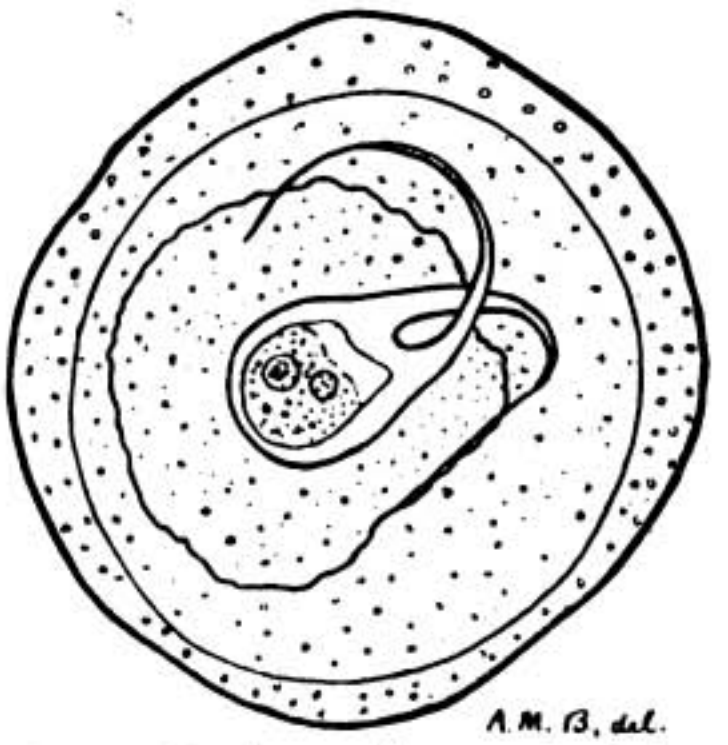


FIG. 9. Eggs from gravid uterus. (× 600.)

therefore, cannot be given. The eggs contain numerous yolk particles and granular material. The horns cross each other in very mature eggs, and each horn grows out into a long filament which becomes applied to the outer face of the vitelline envelope. The segments drop off either singly or in clusters of two, three, or four. When single they assume peculiar shapes.

DIAGNOSIS. Peters, in 1856, published a description of the external characters of a tapeworm from an African rhinoceros from Mozambique, to which he gave the name *T. gigantea*. The length of the worm was stated to be 12 cms. and the maximum breadth

as 27 to 29 mm. Some years later, Murie (1870) wrote 'A couple of years ago some dozen joints of what I may safely term an enormous tapeworm were placed in my hands by Mr. Bartlett, they having been passed by the young male *Rhinoceros indicus* in the Gardens.' He gives a brief description of the external characters of the segments, and named the worm *T. magna* (?). The following year (1871) Peters stated that Murie's *T. magna* was the same as his *T. gigantea*. The worm was transferred to genus *Anoplocephala* by Blanchard in 1891.

The next paper dealing with Cestodes from a Rhinoceros is that of the MacCallums (1912); they give a detailed account of the external and internal anatomy of the segments of an enormous worm at least 20 feet long passed by a Javanese rhinoceros (*R. sondiacus*). The MacCallums assume that their worm is the same as that described by Peters and Murie.

Douthitt, in his monograph of the *Anoplocephalidae* (1915) refers to the MacCallums' paper, and states that he considers the worm should be transferred to genus *Schizotaenia*.

Whether the MacCallums were correct in their inference that the worm found by them in *Rhinoceros sondiacus* is identical with those found by Peters and Murie in the African rhinoceros and Indian rhinoceros, respectively, seems to be a matter of some doubt, having consideration to the enormous difference in size, but, as neither Peters nor Murie give any detailed account of the internal anatomy of these worms, it is impossible to form any definite judgment.

It should be noted that the worm with which we are dealing conforms, as regards size, much more closely to Peters' worm than to the MacCallums'.

To avoid confusion, it appears to be best to associate the name *A. gigantea* with the worms described in detail by the MacCallums.

There is, however, no doubt that the worm with which we are dealing is different from that described by the MacCallums. The chief points of difference are shewn in the following table:—

	A. gigantea	*A. vulgaris*, n. sp.
(1) Size	More than 20 feet	Probably not more than 12 cms.
(2) Gravid uterus	A large sacculated cavity which extends laterally almost from one margin of the segment to the other	Consists of a series of apparently more or less isolated compartments which originate from ingrowths of dorso-ventral and antero-posterior muscle fibres between the limbs of a convoluted tubular uterus.
(3) Cirrus	Armed	Unarmed

I propose for this worm, which was obtained from *Rhinoceros bicornis*, the name *Anoplocephala vulgaris*, n.sp.

It should be noted that the MacCallums, both in their written description of their worm and in the illustration, have apparently confused the ovary and the vitelline glands and *vice versâ*.

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