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On the structure of *Taenia gigantea* (Peters).

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With 4 figures in the text.

Through the courtesy of Dr. W. R. BLAIR of the Bronx Zoological Park, we have been enabled to study several segments of an enormous taenia derived from a Javanese rhinoceros (*Rhinoceros sondaicus*). These segments were part of the mass of the body of the worm discharged in 1906. At that time about twenty feet of the worm was found and some of it preserved. Since then the caretakers of the animal, which is still alive and apparently well, have observed no trace of any further segments. The head was not found. It may, of course, have been discharged and lost in the straw with which the animal's stall was littered. The rhinoceros was said to have been rendered quite ill by the presence of this worm and lost weight.

The portions of the worm which were preserved apparently in alcohol seem to have been derived from quite widely separated parts, for some fragments are very much larger than others and far more mature. These larger fragments measure about 6,5 cm to 7,5 cm in transverse diameter while the smaller measure about

2.8 cm. They are as is shown in the drawings, composed of extremely short proglottides which measure not more than 2 to 4 mm in length and in the smaller fragments are still shorter. In thickness these proglottides vary from 4 to 6 or 7 mm. The worm is not particularly well preserved and appears to be a good deal shrunken so that undoubtedly when it was fresh the proglottides were still larger. The proglottides are so arranged that the lower free margin of each hangs like the eaves of a cottage over the next one behind it and partially covers it, leaving exposed in reality practically only its free margin which in a similar way covers a large part of the next one. At one lateral border these free margins come together smoothly, but on the other they are spread apart like a gable and there projects from between them a round prominent genital cloaca. The free margins are thrown into slight folds as is shown in the sketch. The whole has a yellowish brown color.

The literature which can be thought to deal with this enormous parasite is practically limited, as far as we can discover, to the papers of PETERS and MURIE. PETERS who described the form in: Monatsber. Akad. Wiss. Berlin. 1856, p. 469 as *Taenia gigantea* wrote as follows:

Note on a New *Taenia* Remarkable for its Immense Size — *Taenia gigantea* n. sp. Caput magnum latum, globosum quadrilobum rostello breve rotundato conico, bothridiis crassis, margine postico libero, collum subnullum; corpus crassum lanceolatum; articuli brevissimi et latissimi, marginibus postice excisis, angulis obtusis; aperturæ genitales marginales secundæ; penes filiformes limbo globoso cincti. Long. tota 0,120 m, artic. max. 0,003, latit. max. 0,027—0,029, lat. capit. 0,006, colli. 0,005. Habitat: *Rhinoceros Africanus* — CAMPER; in intestino tenui (Mossambique).

The next observation was that of MURIE (in: Proc. zool. Soc. London, 1870, p. 608, who described the segments, without having seen the head, of an enormous worm from the Indian rhinoceros which he received from the Zoological Gardens in London. He gives suggestive pictures of fragments of the worm which show particularly well the margin with the genital pores; but he apparently mistakes these fragments which were one or two inches long for the proglottides and describes them as such. He is consequently very doubtful of the nature and position of the genital pores. His description with which he terminates his brief note is as follows:

Taenia magna n. sp. — Segments of body pale colored, unequal in size and large, flat, relatively thick, broader than long and transversely ribbed or banded. The larger segments measure fully $1\frac{1}{2}$ inches broad and 1 inch in length. The smaller segments have a diameter of an inch lengthwise and across. The latter with lateral convex margins and concave attached surfaces. Other pieces are cubical in outline some parallelepiped but the larger chiefly subquadrate. The free borders of the bands are wavy, at some points verging toward suberenation. Here and there a band presents a partial fold upon itself; the outer recurved margins of the one band partially overlap that behind giving a somewhat lateral serrate character to each segment. Genital outlet apparently on each band and opening at the lateral border (?). Head and neck not known.

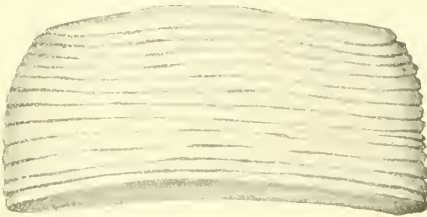


Fig. A.

Fig. B. *Taenia gigantea*. A part of the more anterior portion of the specimen. The margins of the segments are smooth. The genital pores are seen to the right.

Body supposed to increase from before backward to the middle or beyond and thence to diminish. Habitat: Intestine, *Rhinoceros indicus*.

PETERS comments upon this note of MURIE in the next volume of this same journal (in: Proc. zool. Soc. London, 1871). He repeats his diagnosis as quoted above and adds that to distinguish this form from *Taenia lata* he would propose the name *Plagiotaenia gigantea*. He gives a sketch of the head of the worm as he had seen it and this we have copied and reproduce herewith (Fig. A). He comments upon the obvious error of MURIE in saying that the segments are 1 inch long, for as he says, the greatest length of each segment is $\frac{1}{8}$ inch.

It seems that we are dealing with the same worm which PETERS and MURIE studied and which they, too, agreed to be one

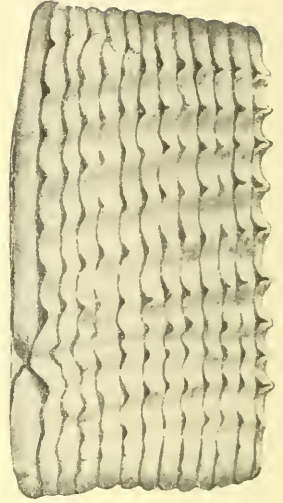


Fig. C.

Fig. C. *Taenia gigantea*. A part of the more mature portion of the worm. The margins of the segments are crenated.

Fig. D. *Taenia gigantea*. Semi-diagrammatic representation of the genitalia. *a* obliterated extremity of the vagina. *c* ovary. *d* vitellarium. *e* sphincter of oviduct. *f* shell gland. *g* orifice of the combined canal at its entrance into the uterus. *h* immature ova in *i* uterus. *j* lobule of testis. *k* cirrus sac. *l* cirrus with protracting pens. *m* marginal remains of vagina.

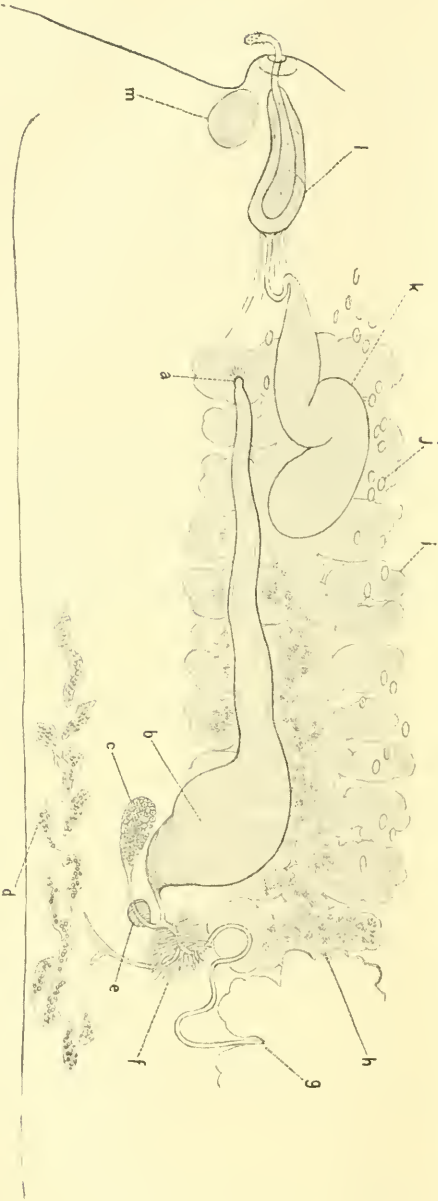


Fig. D.

species although in one instance the host was the Indian rhinoceros and the other the African. In this case we have apparently the same species from the Java rhinoceros, although since the descriptions of PETERS and MURIE are so meagre that no details of the anatomy can be derived from them, it is impossible to feel sure that there are not actually three distinct species which resemble one another in their general form.

The body of the worm is so thick that it is impossible to make out anything of the internal structure except by means of serial sections. These were made transversely, horizontally and sagittally through both the mature and the younger segments. It was found, however, that in the mature segments, the structure of the internal organs had been practically obliterated by the size of the uterus which was full of eggs. Merely remnants of the genital apparatus could be seen at one margin, and although the nervous system and excretory system were indicated, such segments on the whole scarcely lend themselves to the general determination of the arrangement of the organs. On the other hand, sections through segments of about 2,5 cm in width show as yet no accumulation of completely formed eggs and the organs are all intact.

The Skin and Musculature. In sagittal sections, the overhanging margins of the proglottides appear as projecting triangles which are covered with a smooth cuticle. In the furrows between them this cuticle becomes somewhat thicker. Underneath it there lies everywhere a layer of thin muscle fibers running transversely to the long axis of the worm. There are a few other fibers which run obliquely and longitudinally and which lie among the outgoing canaliculi of the cutaneous gland cells which form a thick layer beneath. The general body musculature is quite strongly developed especially in the form of longitudinal bands which run through from segment to segment. Cross bundles traverse each segment from dorsal to ventral surface and radiate out in arching fashion to the anterior or upper convex surface of the free, overhanging margins. The longitudinal bundles also give off fibers which radiate into these margins from below to fix themselves also in the convex or upper surface. Transverse bundles of muscle run from margin to margin of the proglottides just inside the longitudinal bundles. These, like the sagittal fibers, seem to accumulate in greater abundance in the lines between the proglottides.

The Parenchyma. The general parenchyma of the worm is

very lax and made up of cells which are widely branched, giving off sheets of protoplasm which form a loose, wide meshed network. The body of each cell is inconspicuous and contains a small nucleus. It is fairly uniform throughout, although it shows condensations about the various organs.

The Excretory System. The water vascular system forms conspicuous large marginal trunks which run through from segment to segment and are connected transversely in each proglottis by at least one large cross channel. Innumerable smaller branching channels are given off in every direction. The larger channels are lined by a structureless membrane which closely resembles the cuticle. They are well supplied with a musculature and numerous cells resembling those of the skin. The smaller branches, apparently devoid of musculature, still have a radiating halo of the glandular cells.

The Nervous System. No very minute study of the nervous system could be made in the worm preserved in this way. But along the margin occupied by the genital pores, there could be made out three rather stout nerve trunks. Of these one runs dorsally and one ventrally at the level of the cirrus, while the third lies in the middle line just internally to the cirrus. These three trunks are apparently connected more or less abundantly about the cirrus in each proglottis. In the opposite margin only one nerve trunk can be indistinctly made out.

The Male Genitalia. The testis exists in each proglottis in the form of numerous small oval or rounded lobules which are collected in the anterior portion of the segment, principally toward the margin which bears the genital pores. They do not extend far toward the opposite margin nor posteriorly and are in reality extraordinarily few in number when the enormous bulk of the worm is considered. The process of spermatogenesis can be observed within them fairly well, inasmuch as they are seen to be made up of small compartments lined with syncytium-like areas and with deeply staining cells from which there spring up sheaves of spermatozoa. These are collected into the branching vasa efferentia which finally reach, as the vas deferens, a large cirrus sac which lies medially in the anterior part of the proglottis occupying a large portion of the third of the segment near the genital margin. This sac is elongated and somewhat folded upon itself as shown in the sketch. Its walls are quite thin and lined by a low, flattened epithelium, and one

can make out practically no musculature except at its extremities. The distal extremity, passes, after folding upon itself, into a muscular walled tubule which runs to the marginal cirrus through a mass of hyaline fibrillated tissue which surrounds it closely. This tubule opens through a sphincter into the elongated muscular cirrus which is a somewhat club-shaped sac giving rise, at the margin of the proglottis, to an eversible barbed tube which projects into the circular genital pouch. The cirrus itself is quite muscular being provided with longitudinal and circular muscles and is lined by a thick cuticle. It is supplied externally with numerous radiating muscular strands, thick bundles of which extend back into the body of the proglottis. It is loosely embedded in the surrounding tissue, and in some portions of this very loose tissue one can make out large, clear cells with very large nuclei whose function is not very obvious. The tapering walls of the cirrus appear to pass into those of the filiform penis which is almost chitinous in its character. It is covered by numerous rows of minute hooklets and is apparently capable of turning upon itself. In a number of sections no other opening could be found in the genital pouch, but in one or two the penis seems to enter, by being recurved toward the proglottis, an indefinite canal in the margin of this sac, so that its extremity comes to lie in a rounded sac which is embedded in the substance of the parenchyma side by side with the cirrus. This sac has in no instance any other outlet. It is smoothly rounded off, not surrounded by any particular musculature and is filled with spermatozoa. These, like the spermatozoa which distend the cirrus sac, are apparently fresh and show no admixture of any anomalous cells or crystals. The significance of this thin-walled sac is not very clear. No other female genital outlet can be found on examination of a number of segments, so that it seems possible that it should be regarded as the termination of an otherwise obliterated vagina. Its inconstancy, since it is found only in a few of the segments, seems to support this view.

The female genitalia. The ovary lies toward the posterior margin of the proglottis, distant from the genital margin by one-third of the transverse diameter and toward the ventral surface. It is small and rather pear-shaped, somewhat indistinctly outlined and contains large ova with deeply staining protoplasm and distinct nucleus. It gives off an oviduct which is at first thin-walled but soon becomes surrounded by a thick, almost spherical sphincter-like structure comparable to that described by MONIEZ, PINTNER and others as the "sphincter

ovaricus" or "Schluckapparat". It resembles very closely that described in *Taenia coryphicephala* and is composed of a muscular radiating wall. After leaving this sphincter the oviduct is joined by a short wide tube which comes from a large club-shaped sac which extends far toward the genital margin. This sac is thin-walled, without musculature, and is completely filled with spermatozoa among which there are numerous, red staining, crystalline bodies. It has a peculiar shape, being at its distal extremity rather narrow and tubular; but as it approaches the ovary, becoming somewhat pear-shaped and turning ventrally upon itself to end in a point from which runs the duct just described to join the oviduct. Its blind distal extremity shows a thickening of the wall and a radial arrangement of parenchyma fibers from its end. It lies in a line with the spermatozoon-filled sac just described on the margin, but it terminates uniformly in every segment at a point at about the middle of the cirrus sac to which it runs parallel. The idea imposes itself at once, in spite of the dilatation of the proximal portion or perhaps on account of this dilatation which corresponds so exactly with the receptaculum seminis of many forms, that this must be the vagina which in this instance has become obliterated toward the distal portion throughout a short part of its course. In other words, it seems possible that in the still younger segments it was continuous with the marginal sac and in that way formed a typical vagina; but that after fertilization atresia took place throughout the distal portion, occasionally leaving the extreme distal portion open to the outside while the more central part becomes shut off into a receptaculum seminis proper.

The duct formed by the combination of the oviduct and the channel from the receptaculum passes dorsalward and becomes surrounded by a compact mass of elongated cells, radially arranged, which constitute the shell gland. In its passage through this mass it receives the duct from the vitellarium or yolk gland which is itself formed by the union of two common ducts which come from the lobulated gland. The vitellarium forms a lobulated mass which lies at the extreme posterior margin of the proglottis and spreads out laterally on each side of the shell gland. Its lobules are extremely delicate and thin-walled and are composed of a mass of cell-like, spherical globules which are highly refractive and pinkstaining, on the outer margin of each of which a nuclear-staining mass is

flattened into crescentic form. Such globules are seen passing along the duct.

After receiving the duct from the vitellarium, the combination duct leaves the shell gland and becomes surrounded by a pale-staining fine network of fibrils in which it courses dorsalward for a short distance. Then, after some convolutions, it finally enters the uterus through a sort of papilla which opens into one of the saccules on its posterior surface.

The uterus, at this stage, forms a large sacculated cavity which extends laterally in the more dorsal and anterior portions of the segment almost from one margin to the other, the most laterally placed saccules extending nearly up to the level of the cirrus. Its walls are thin, lined by a most inconspicuous flattened epithelium but not supplied with any intrinsic muscles except in the infoldings of the parenchyma between the saccules where there are some muscle fibers attached to the wall and embedded in a hyaline, red-staining material. In some places, and especially in the neighborhood of the papilla, the epithelium of the uterus becomes conspicuous and almost syncytium-like, with large nuclei and hyaline refractive globules. At this stage of the development the saccules contained clumps of cells with numerous nuclei and some refractive globules. These are arranged in small round masses but there are no definitely formed eggs. In the mature segments the eggs are provided with shells but are so shrunken by the action of the preserving fluid that it is hard to determine their precise form. In some which are better preserved, however, one can make out an oval form and the following measurements: length $100\ \mu$; breadth $50\text{--}70\ \mu$.

No external opening for the uterus has been found.

Summary.

In view of the general resemblance to the worms described by PETERS and MURIE, we assign this enormous parasite to the species *Taenia gigantea*. Its head, not seen by us but described by PETERS, is unarmed except by four suckers. The structure of the worm resembles closely that of other members of the genus *Taenia*, the only striking difference being the curious atresia of the vagina after fertilization. This explanation is given tentatively, although the careful examination in serial sections of a considerable number of segments reveals the condition constantly.

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