

PARASITIC NEMATODES OBTAINED FROM ANIMALS DYING IN THE CALCUTTA ZOOLOGICAL GARDENS.

PARTS 4—8.

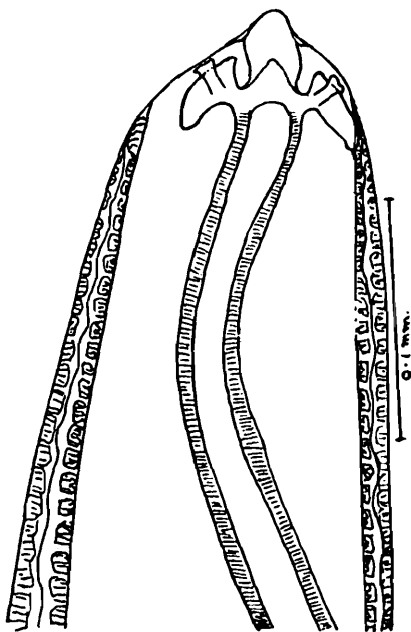
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Calcutta.)

PART 4.—ACUARIINAE.

Acuaria anthuris (Rudolphi, 1819).

Worms, which I have referred to this species, were found in the gizzard of a Red-billed Chough (*Graculus eremita*). One female worm of this species has been previously recorded by Baylis and Daubney (1922) from an Indian host, viz., the Red-billed Blue Magpie (*Urocissa occipitalis*). According to Cram (1927) the only hosts from which this worm has been recorded are several species of the genus *Corvus*, but my worms agree so closely with the description given by this author that there seems to be no doubt that they are the same species. This is an important species as it is the type of the genus *Acuaria*, and as such it represents a large group of worms. Cram, in her discussion of the genus, draws attention to the confusion that exists, owing to incomplete and discordant descriptions of this worm by early workers, and as no full description has yet been given by any one writer, it has been considered worth while giving a detailed account of the worm, using modern methods of examination and nomenclature.

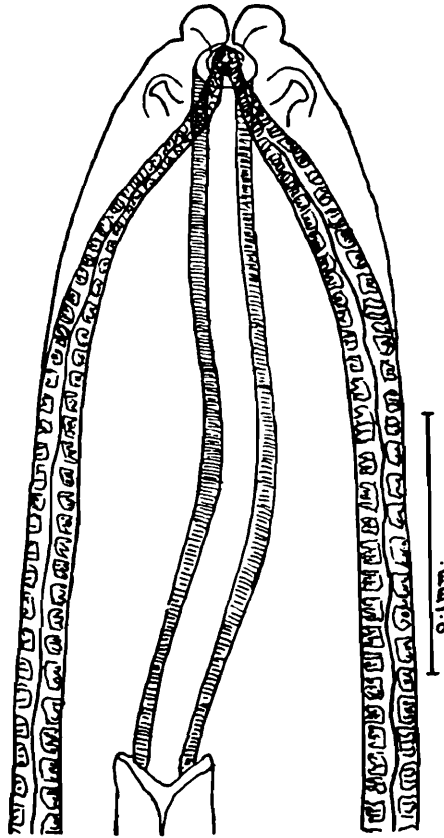


TEXT-FIG. 1.—*Acuaria anthuris*. Anterior end, lateral view.

There are two conical lateral lips each of which bears a pair of large papillae (fig. 1). Viewed dorso-ventrally the lips are thick and rounded

NOTE.—In the numerous tables given in this paper all the measurements are in millimetres.

(fig. 2). The cordons are double and they are four in number ; they arise in pairs on the dorsal and ventral aspects of the head near its anterior end, and they curve outwards and backwards to pursue a straight course in the sub-median fields for about one-third the length of the worm (figs. 1 & 2). In a lateral view of the head a complicated chitinous structure is seen, which is apparently an anterior expansion of the pharynx, dorso-ventrally this structure appears to be somewhat globular



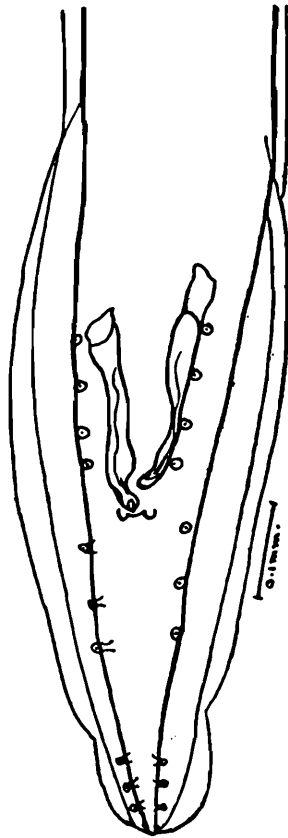
TEXT-FIG. 2.—*Acuaris anthuris*. Anterior end, dorso-ventral view.

(figs. 1 and 2). The pharynx is long with thick finely striated walls. The oesophagus is divided into an anterior short muscular portion, and a much longer thick glandular portion.

Male.—The male is 9.2 mm. in length and 0.28 mm. in maximum diameter. The pharynx is 0.22 mm. in length, and the total length of the oesophagus is 2.7 mm. The cordons extend posteriorly for a distance of 2.3 mm. from the anterior end, and they come to an end abruptly. There are relatively broad caudal alae which are 0.3 mm. in maximum breadth, and 0.75 mm. in length. There are eleven pairs of caudal papillae, four pairs of which are pre-cloacal. Immediately behind the cloaca is a linear group of three pairs of papillae, and another group of three pairs towards the tip of the tail, and finally there is a pair of minute papillae on each side of the tip of the tail. The distance from the tip of the tail to the cloaca is 0.34 mm. The spicules are thick and curved, they are subequal, being 0.254 and 0.224 mm. in length respectively, and they do not appear to have membranous alae (fig. 3).

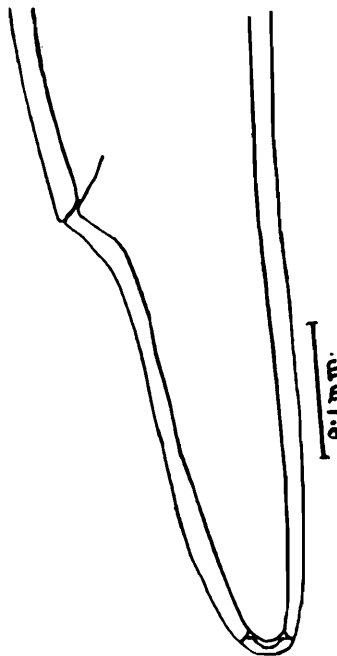
Female.—The females are about 21.3 mm. in length, and 0.32 mm. in maximum diameter. The cordons end about 7.5 mm. from the anterior end. The pharynx is 0.3 mm. in length, and the total length of the oesophagus is 4.95 mm. The vulva opens about 10 mm. from the anterior end, and the vagina and ovejector pursue a posterior course, but

their actual extent could not be determined as all the specimens available were too fully crowded with eggs. The anus is about 0.34 mm. from



TEXT-FIG. 3.—*Acuaria anthuris*. Posterior end, male, ventral view.

the tip of the tail, which is straight and rounded with the caudal papillae very near its tip (fig. 4). The eggs are 0.040×0.026 mm. with thick shells, and they contain an embryo in the uterus.



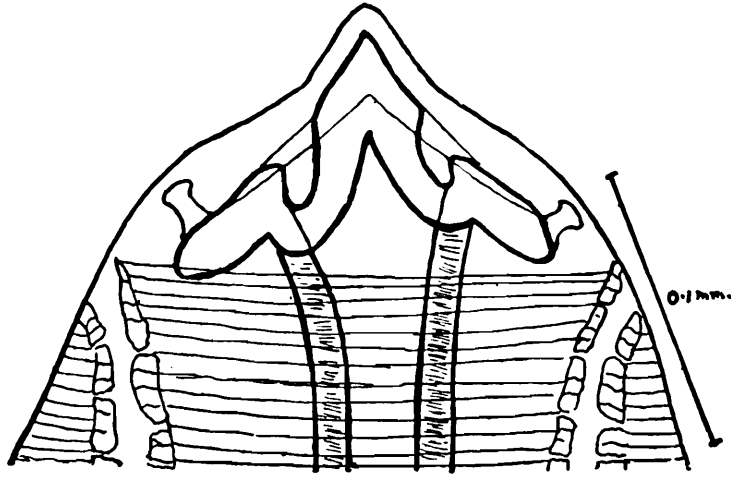
TEXT-FIG. 4.—*Acuaria anthuris*. Posterior end, female, lateral view.

Specimens of this worm have been placed in the Indian Museum, Calcutta.

***Acuaria scutata*, n. sp.**

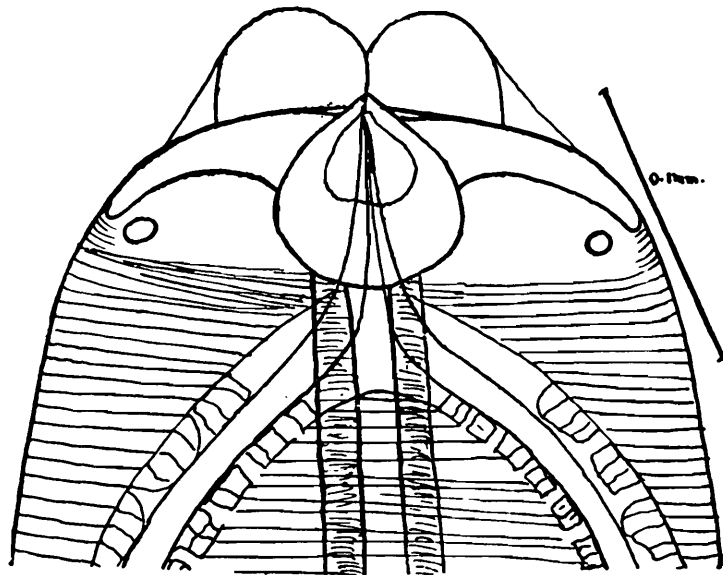
One male and one female of this species were found in the gizzard of an Indian Tree Pie (*Dendrocitta rufa*).

The worm has two large conical lateral lips, each of which bears two large papillae (fig. 5). The lips are thick and rounded in the dorso-ventral view (fig. 6). There are four cordons each consisting of a double



TEXT-FIG. 5.—*Acuaria scutata*, n. sp. Anterior end, lateral view.

row of cuticular prominences of varying shape. They arise in pairs on the dorsal and ventral sides of the head, and curving outwards pursue a posterior course along the sub-dorsal and sub-ventral areas. The coarse transverse striations of the cuticle are interrupted by the cordons. The four cordons gradually become less pronounced and finally disappear a little behind the middle of the worm. A little distance anterior to the termination of these cordons two other similar structures appear, one on the mid-dorsal and the other on the mid-ventral line, they are visible for about one-fourth the total length of the worm. The vestibule is surrounded by a complicated shield-like armature from the posterior

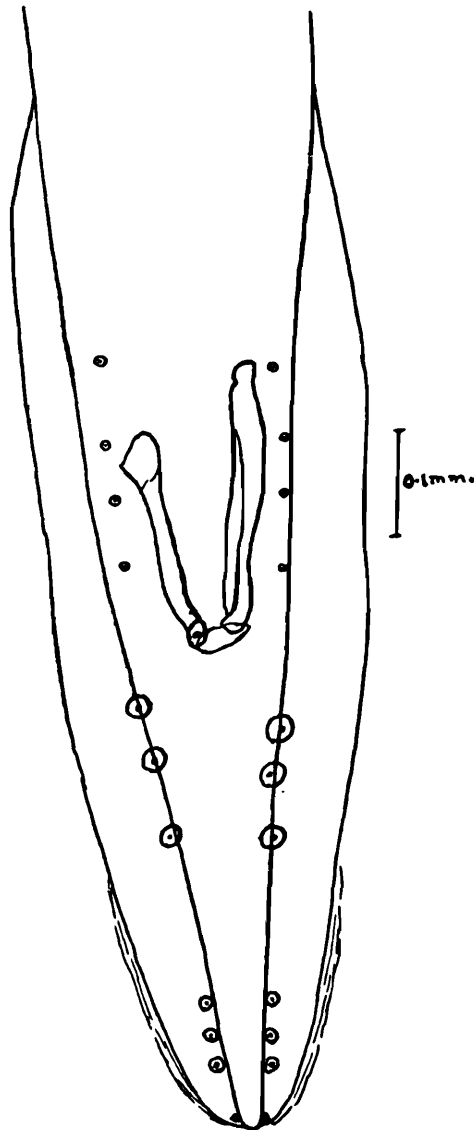


TEXT-FIG. 6.—*Acuaria scutata*, n. sp. Anterior end, dorso-ventral view.

end of which the pharynx arises (figs. 5 and 6). This structure is similar to that seen in *A. anthuris*. The oesophagus is divided into two

portions the anterior part being approximately half the length of the posterior part.

Male.—The male is 9.5 mm. in length and 0.23 mm. in maximum diameter. The length of the pharynx is 0.233 mm., and the total length of the oesophagus is 2.6 mm. The tail is straight and it ends in a rounded point. There is a pair of caudal alae supported by eleven pairs of pedunculate papillae. Four pairs are precloacal, and the remainder are postcloacal, and very similar in their arrangement to those of *A. anthuris*

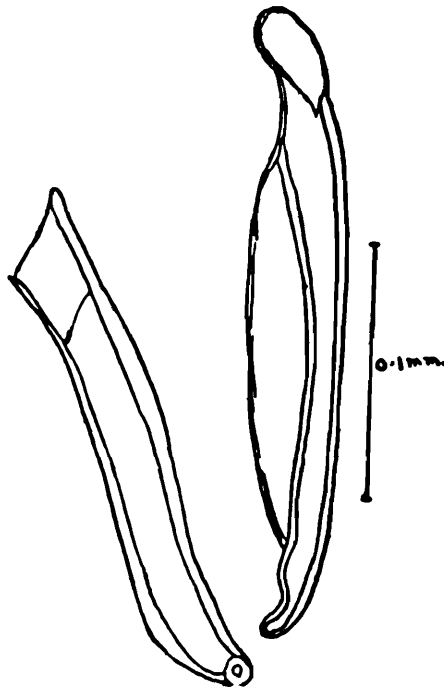


TEXT-FIG. 7.—*Acuaria scutata*, n. sp. Posterior end, male, ventral view.

(fig. 7). The cloaca is 0.44 mm. from the tip of the tail. The spicules are subequal and slightly dissimilar. The left spicule is 0.25 mm. in length and it has an alate expansion along its inner concave border, and the right spicule is 0.21 mm. in length, it is not quite so stout as the left spicule, and it has no alate expansion (fig. 8).

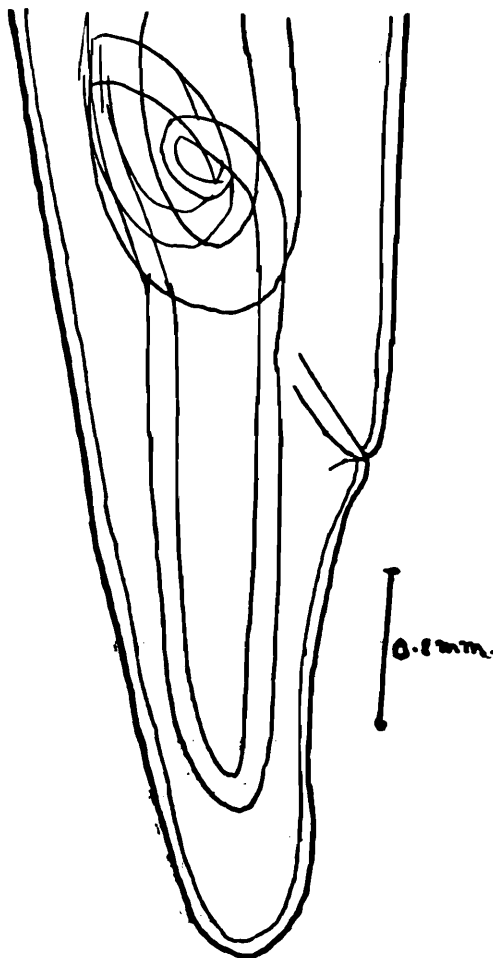
Female.—The female is 23.4 mm. in length and 0.4 mm. in maximum diameter. The length of the pharynx is 0.3 mm., the anterior part of the oesophagus 1.03 mm., and the posterior part 2.77 mm. in length. The vulva opens 11.5 mm. from the anterior end of the body, and the

vagina runs posteriorly from it. The anterior ovary ends about 3 mm. from the head, and the posterior ovary sends a single coil posterior to the



TEXT-FIG. 8.—*Acuaria scutata*, n. sp. Spioules.

anus, which almost reaches the tip of the tail (fig. 9). The anus is 0.35 mm. from the tip of the tail, which is straight and rounded with the



TEXT-FIG. 9.—*Acuaria scutata*, n. sp. Posterior end, female, lateral view.

caudal papillae near its extremity. The eggs are 0.034—0.035 $\times$ 0.026—0.027 mm.

This worm appears to be almost identical with *A. anthuris* except in one particular, *viz.*, the extent and number of the cordons. The posterior pair on the dorsal and ventral surfaces were not visible in *A. anthuris*, and the four anterior cordons reached for half the length of the worms in the present species. How far these characters may be liable to variation is not known, but both the male and female of this worm had cordons of the same type, and all the specimens of *A. anthuris* had short cordons and no accessory ones on the dorsal and ventral surfaces, so that it seems a distinctive character. *A. ornata*, of which the male only has been described, also has cordons like the present species, but it appears to differ in other particulars; it is accordingly proposed to name this worm *Acuaria scutata*, n. sp.

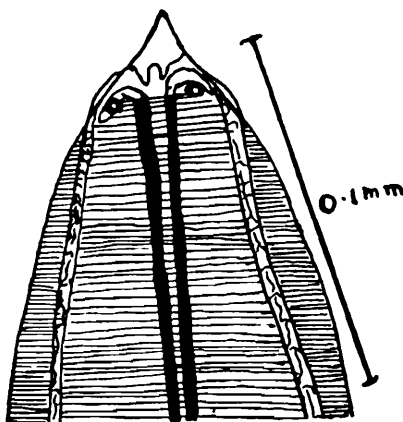
Host.—*Dendrocitta rufa*.

Type-specimens are in the Indian Museum, Calcutta.

Acuaria conica n. sp.

This worm was obtained from the gizzard of a Magpie-robin (*Copsychus saularis*).

There are two conical lateral lips, which are relatively long and pointed. There are two papillae on each lip with a triangular body

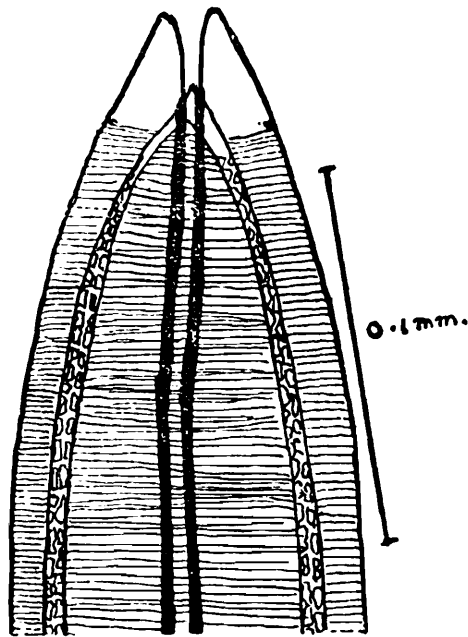


TEXT-FIG. 10.—*Acuaria conica*, n. sp. Anterior end, lateral view.

between them (figs. 10 and 11). The four cordons arise in pairs on the dorsal and ventral surfaces of the head, and curving outwards, they follow a posterior course in the submedian fields. They extend 0.28–0.3 mm. from the anterior end in the male, and 0.425–0.49 mm. in the female. The anterior opening of the pharynx is apparently a narrow oval with the long axis dorso-ventral, for the anterior end of the pharynx curves towards the dorsal and ventral surfaces, almost at a right angle to its long axis (fig. 10).

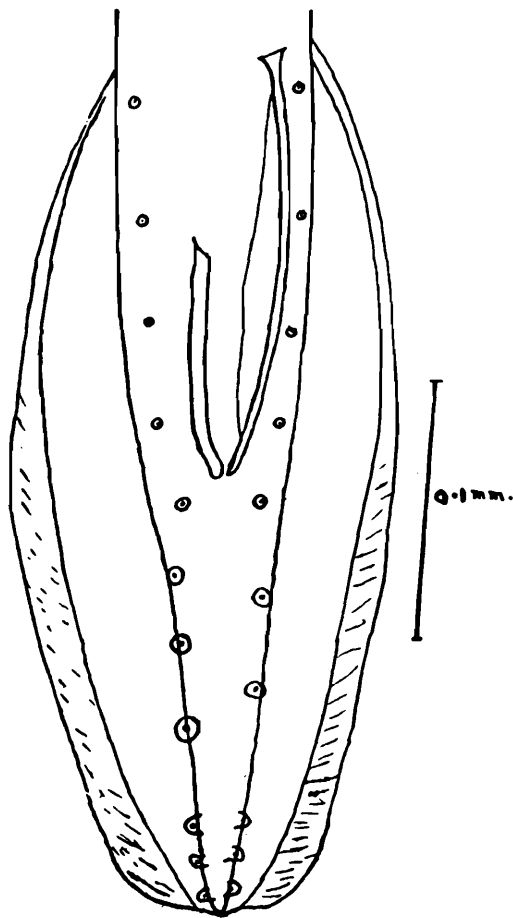
Male.—The male is 6–6.7 mm. in length, and 0.092–0.1 mm. in maximum diameter. There is a thick-walled pharynx with fine transverse striations, and it is 0.18 mm. in length. The oesophagus consists of two parts, the anterior part being 0.3 mm. and the posterior part 0.69 mm. in length. The caudal alae are broad and do not become much narrower towards the tip of the tail, so that the posterior extremity has a truncate appearance. There are four pairs of precloacal papillae and six or seven pairs of postcloacal papillae. The group of papillae immediately behind the cloaca are slightly asymmetrical, and in the specimen from which

fig. 12 has been drawn there are four papillae on one side and three on the other, this is an obvious abnormality, but whether the larger or smaller number of papillae is the normal, it is not possible to say without more



TEXT-FIG. 11.—*Acuaria conica*, n. sp. Anterior end, dorso-ventral view.

material. The spicules are unequal and dissimilar. The left spicule is 0.112 mm. in length and it is slightly stouter than the right spicule which



TEXT-FIG. 12.—*Acuaria conica*, n. sp. Posterior end, male, ventral view.

is 0.168 mm. in length, the former also has an alate membrane along the concave border (fig. 12).

Female.—The females are 12.6—16.2 mm. in length, and 0.136—0.156 mm. in maximum diameter. The tail is straight and the anus is 0.23 mm. from its tip. The vulva is $10/21$ to $10/25$ of the total length from the posterior end. The eggs are oval and contain an embryo, they are $0.030-0.032 \times 0.016-0.018$ mm.

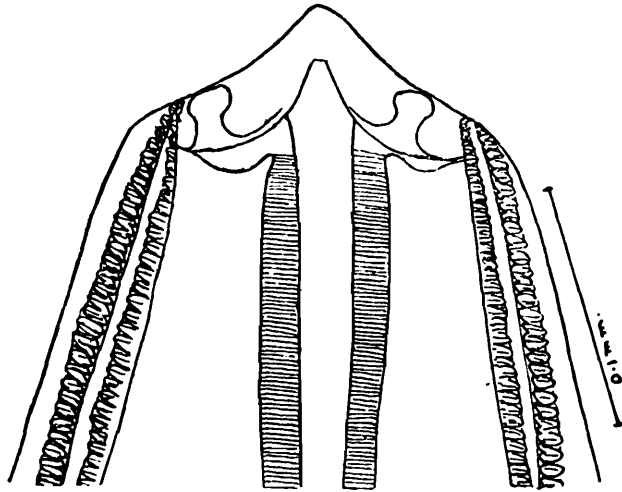
This worm appears to be close to *A. gracilis*, but it differs from it in most of its dimensions and the lips appear to be longer and more pointed, therefore it is proposed to name it *Acuaria conica*, n. sp.

Host.—*Copsychus saularis*.

Type-specimens are in the Indian Museum, Calcutta.

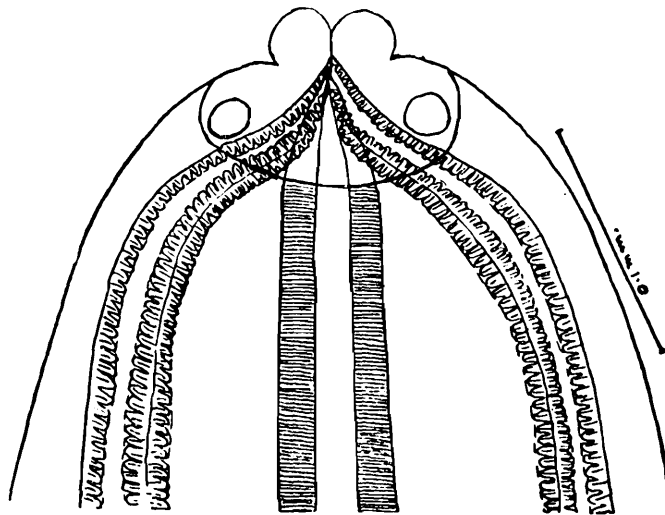
Acuaria lata, n. sp.

Two females of this species were found in the gizzard of a Red-crested Wood-quail (*Rollulus roulroul*).



TEXT-FIG. 13.—*Acuaria lata*, n. sp. Anterior end, lateral view.

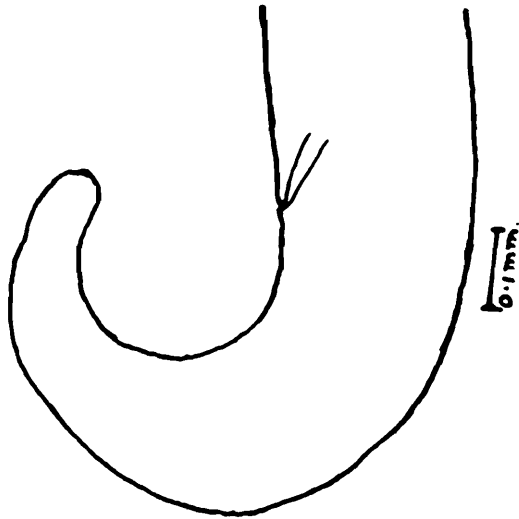
The worms are 28.5—29 mm. in length and 0.65—0.7 mm. in maximum diameter. The mouth is bordered by a pair of lateral triangular lips,



TEXT-FIG. 14.—*Acuaria lata*, n. sp. Anterior end, dorso-ventral view.

each of which has a pair of large submedian papillae, with a triangular area between them (fig. 13). There are four coarse double cordons, which

arise in pairs at the bases of the lips dorsally and ventrally (fig. 14). The cordons curve outwardly immediately, and they run posteriorly in the submedian fields for a distance of 20—21 mm. The thick-walled pharynx is about 0.26 mm. in length. The oesophagus is composed of two parts, the anterior part being about 1.4 mm. and the posterior part about 4.4 mm. in length. The vulva is an inconspicuous circular opening a little behind the middle of the body, being 15—16 mm. from the anterior end. The uteri are divergent and the eggs are $0.038\text{--}0.040 \times 0.024\text{--}0.026$



TEXT-FIG. 15.—*Acuaría lata*, n. sp. Posterior end, female, lateral view.

mm., and they contain embryos. The tail is curved ventrally and it ends in a rounded point 0.6 mm. from the anus (fig. 15).

Male.—Unknown.

This worm differs from all other species of *Acuaría* in its relatively great thickness and the long distance which the cordons run towards the posterior. It is therefore proposed to name it *Acuaría lata*, n. sp.

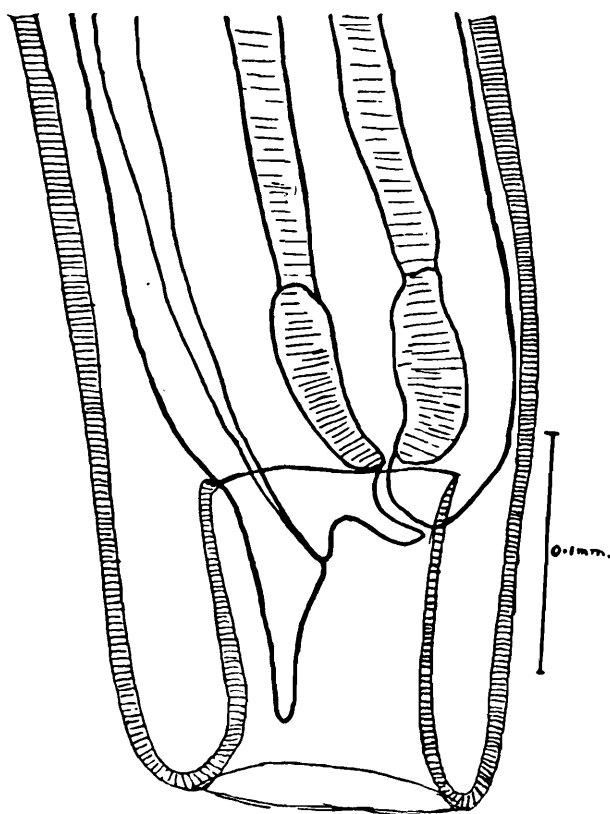
Host.—*Rollulus roulroul*.

The type-specimen is in the Indian Museum, Calcutta.

***Acuaría (Synhimantus) invaginata* (v. Linstow, 1901).**

According to Cram (1927) this worm has been found in Europe in the following hosts. *Bubulcus lucidus*, *Ardeola ibis*, the Purple Heron, and an unknown host. It is very common in the Cattle Egret (*Bubulcus coromandus*) in Bengal, as it has been found in nearly all the specimens of this bird that have been examined. Cram says the vulva is immediately anterior to the anus on a central prominence which is the real extremity of the body, as the small conical tail projects dorsally from it. Her figure, copied from Gendre, agrees with this description. Examinations of my ample material shows that the above is not the normal appearance, and it is probably only brought about by contraction of the tail. The usual appearance is that shown in fig. 16, where the tail

is seen to run posteriorly, and to end a considerable distance behind the vulva.



TEXT-FIG. 16.—*Acuaria (Synhimantus) invaginata*. Posterior end, female, lateral view.

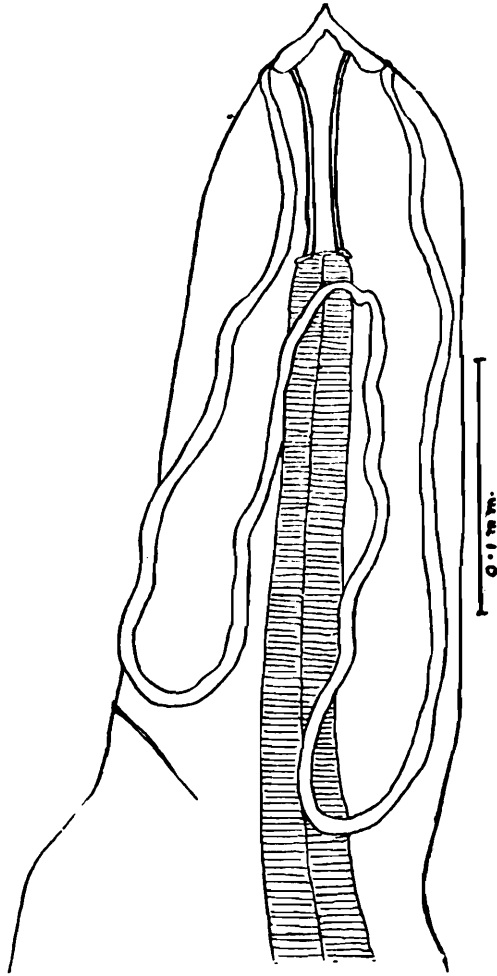
Acuaria (Synhimantus) nana, n. sp.

A single specimen of a female of this species was found in the gizzard of a Golden-backed Wood-pecker (*Brachypterus aurantius*).

The worm is only 3.3 mm. in length and 0.2 mm. in maximum diameter. It is curved almost in a full circle so that only a lateral view of the head was obtainable. It has two conical lateral lips surmounted by a chitinous cap in the form of an inverted V (fig. 17). The anterior part of the worm, which is occupied by the cordons, is only 0.12 mm. in diameter, and immediately behind this point it becomes suddenly thicker. There are two cordons on each side, the sub-ventral pair curve forwards along the lateral fields at a distance of 0.26 mm. from the anterior end, and the sub-dorsal pair run a little further back, as they curve forwards about 0.3 mm. from the anterior end. The excretory pore opens about 0.28 mm. from the anterior end (fig. 17). The chitinous pharynx is 0.08 mm. in length, and the oesophagus is divided into two parts, the anterior part being 0.44 mm. and the posterior part 1.3 mm. in length. The vulva opens about 1 mm. from the tip of the tail, and the vagina curves posteriorly. The uteri are divergent. The anus opens 0.1 mm. from the tip of the tail (fig. 18). The eggs are thick-shelled and contain embryos, they are 0.018×0.009 — 0.010 mm.

This species is much smaller than any known member of the *Synhimantus* group of the *Acuaria* and an especially characteristic point is the

relatively great length of the oesophagus. It is proposed to name it *Acuaria* (*Synhimantus*) *nana*, n. sp.

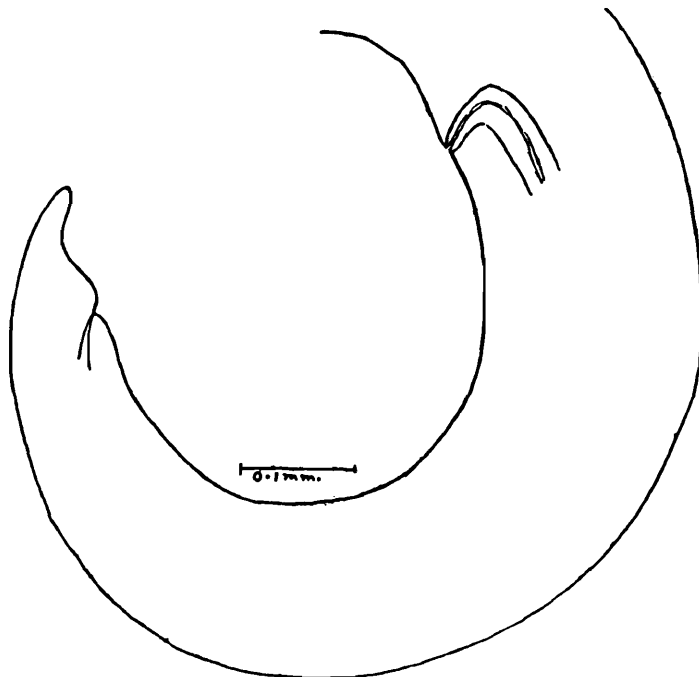


TEXT-FIG. 17.—*Acuaria* (*Synhimantus*) *nana*, n. sp. Anterior end, lateral view.

Male.—Unknown.

Host.—*Brachypterus aurantius*.

The type-specimen is in the Indian Museum, Calcutta.

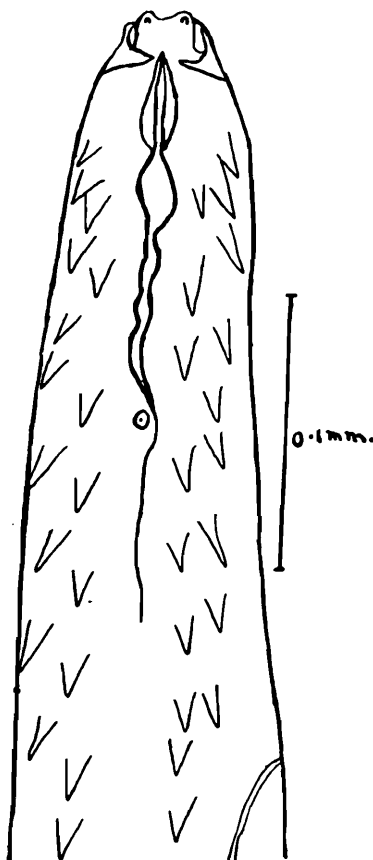


TEXT-FIG. 18.—*Acuaria* (*Synhimantus*) *nana*, n. sp. Posterior end, female, lateral view

***Echinuria spinosa*, n. sp.**

The males only of this species have been found on two occasions. Once in the gizzard of a Dun bird (*Aythya ferina*) and once in an unidentified duck.

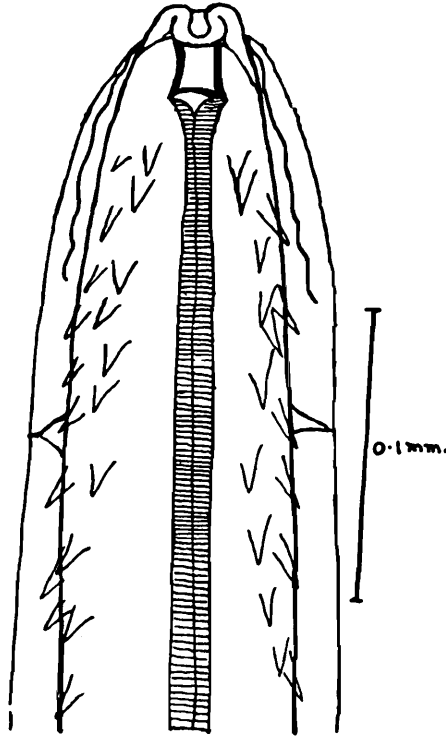
There are two thick bi-lobed lateral lips each of which have two papillae (fig. 19). Immediately behind the lips there are two triangular



TEXT-FIG. 19.—*Echinuria spinosa*, n. sp. Anterior end, lateral view.

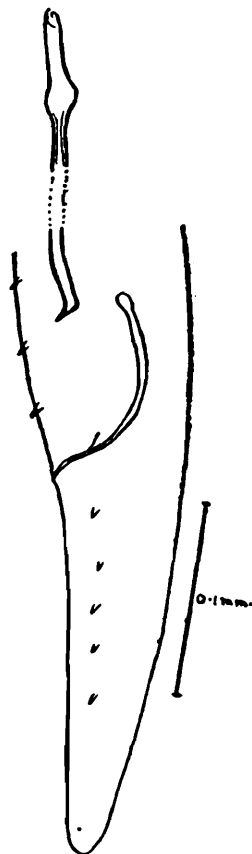
chitinous plates on each side of the head. The apices of these structures appear to fuse with the anterior end of the vestibule, and their bases coincide with the dorsal and ventral borders of the head (fig. 19). The cordons arise from elongate oval prominences on each side of the head from which they pursue a wavy posterior course, being roughly parallel. They fuse just anterior to the cervical papillae, and curving ventrally to these structures they gradually become less well-defined and finally disappear in the lateral flanges (fig. 19). The lateral flanges arise opposite the bases of the lips, and are visible for almost the whole length of the worm, they become narrower and finally disappear a little behind the cloaca (fig. 20). The cervical papillae are large and prominent (fig. 20). The cuticle is closely set with large posteriorly-directed spines, which are irregularly distributed anteriorly, but they soon become arranged in four longitudinal rows on each side. The four rows continue to the level of the excretory pore, where two of the rows disappear on each side (fig. 19), leaving two rows, one dorsal and one ventral to the lateral flanges. The spines gradually become smaller and more widely separated, but they can be made out almost to the level of the cloaca.

Male.—The males are 4.7 mm. in length and 0.12–0.4 mm. in diameter. The cervical papillae are 0.14 mm. from the anterior end, and the excretory pore is 0.28 mm. from the same point. The vestibule is thick and circular; it is about 0.032 mm. in length and 0.020 mm. in diameter (fig. 20). The oesophagus is divided into two parts, the anterior part



TEXT-FIG. 20.—*Echinuria spinosa*, n. sp. Anterior end, dorso-ventral view.

being 0.32 mm. in length, and the posterior part about 1 mm. in length. The tail is straight and its extremity is round. There are no caudal alae



TEXT-FIG. 21.—*Echinuria spinosa*, n. sp. Posterior end, male, lateral view.

or papillae, but subventrally on each side there is a row of five spines posterior to the cloaca, and immediately in front of this opening there is a single row of spines on the mid-ventral line (fig. 21). The spicules are unequal and dissimilar. The short spicule is 0.044 mm. in length, it is thin and curved and ends in a sharp point, and the proximal end is rounded and knob-like. The long spicule is 0.4 mm. in length, and is much stouter, the point is shaped like a foot, and the proximal end is rounded with a bulbar swelling posterior to it (fig. 21).

Female.—Unknown.

Apart from the cordons, this worm closely resembles certain males of the genus *Tetrameres*, especially with regard to the short stout vestibule. The absence of females also suggests that it may possibly belong to this genus, but no species of *Tetrameres* have cordons, therefore in absence of the characteristic females it is considered advisable to place it in the genus *Echinuria*. The possibility of this worm really being a *Tetrameres* emphasises the point that Baylis and Daubney (1926) are probably correct in considering this genus as belonging to the Acuariinae, and not placing it in a separate family on account of the marked sexual dimorphism, as was done by Travassos (1914).

It is proposed to name this species *Echinuria spinosa*, n. sp.

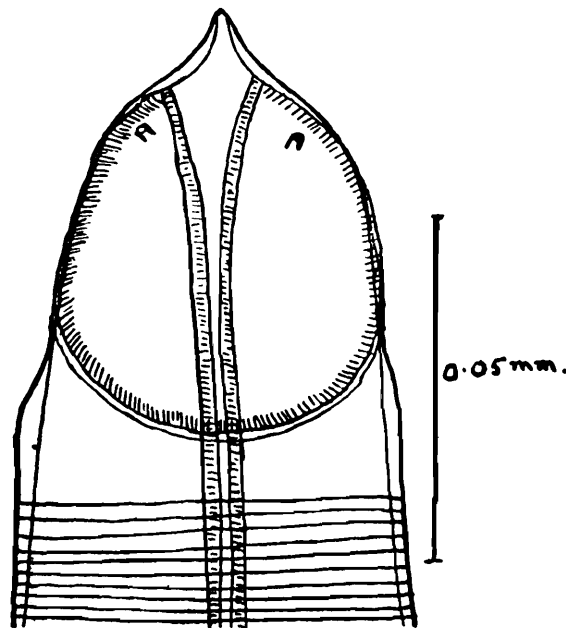
Host.—*Aythya ferina*.

The type-specimen is in the Indian Museum, Calcutta.

***Rusguniella brevis*, n. sp.**

One male and one female of this species were found in the gizzard of a Kingfisher (*Ceryle alcyon*).

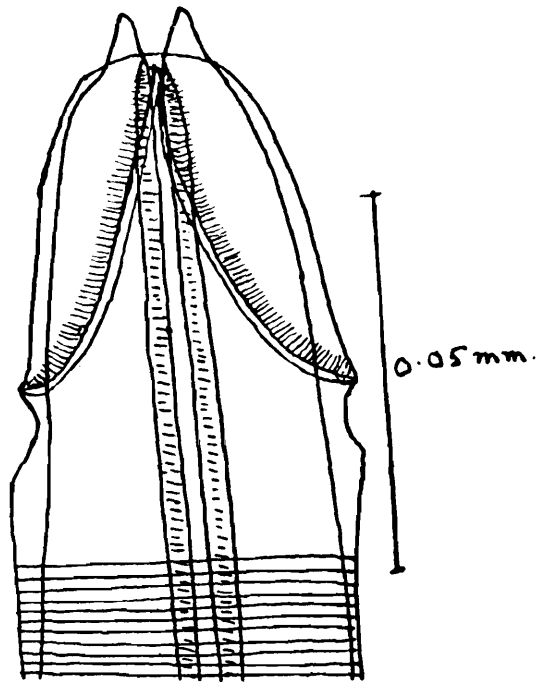
The body is attenuate anteriorly, and the cuticle is transversely striated. The mouth has two prominent lateral lips ending in conical points, and there are two papillae on each lip (fig. 22). The cordons arise



TEXT-FIG. 22.—*Rusguniella brevis*, n. sp. Anterior end, lateral view.

at the base of the lips dorsally and ventrally, and curving outwardly they unite on the lateral surfaces of the head in broad semi-circular

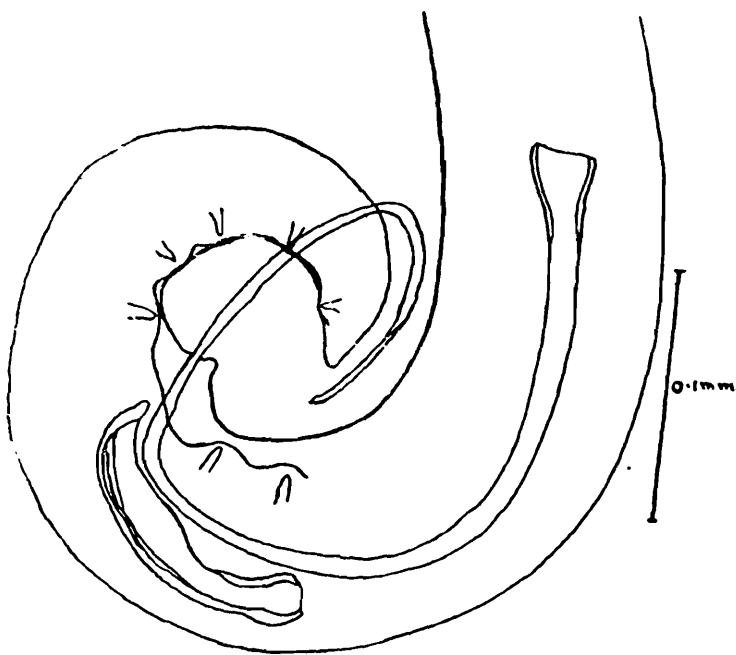
curves. They have concentric striations. Immediately behind the cordons there is a transverse groove in the cuticle which is most marked laterally on account of the narrow lateral flanges (figs. 22 and 23). Cervi-



TEXT-FIG. 23.—*Rusguniella brevis*, n. sp. Anterior end, dorso-ventral view.

cal papillae were not observed. There is a relatively long chitinous pharynx with finely striated walls. The pharynx curves dorsally and ventrally to a slight extent, so that when viewed laterally its anterior end is somewhat funnel-shaped (fig. 22).

Male.—The male is 4.75 mm. in length and 0.116 mm. in maximum diameter. The cordons extend 0.44 mm. from the anterior end. The pharynx is 0.196 mm. in length, and the nerve ring is 0.23 mm. from the anterior end. The oesophagus is divided into two parts and is

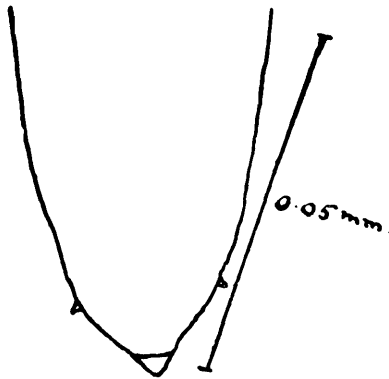


TEXT-FIG. 24.—*Rusguniella brevis*, n. sp. Posterior end, male, lateral view.

1.4 mm. in total length. The tail is curved ventrally and there are two pairs of precloacal and five pairs of postcloacal pedunculate papillae.

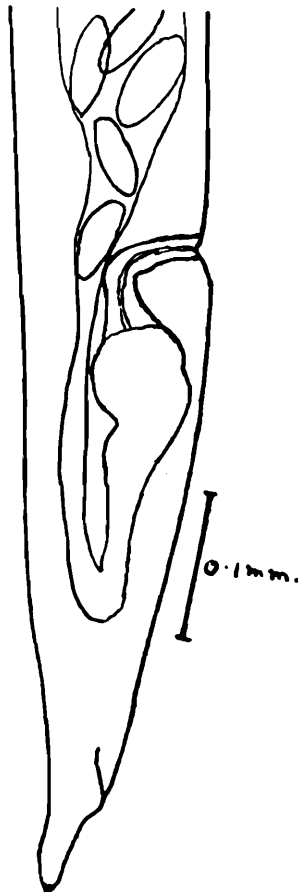
The papillae support caudal alae, but the shape of these structures could not be determined as the worm could not be rolled to obtain a ventral view of the tail, on account of its curve. The spicules are very unequal and dissimilar. The short spicule is stout and curved and it is 0.14 mm. in length. The long spicule is thin with a pointed tip and expanded base, it is 0.5 mm. in length. There is no gubernaculum (fig. 24).

Female.—The female is 7.3 mm. in length and 0.14 mm. in maximum diameter. The cordons extend 0.15 mm. from the anterior end, and the pharynx is 0.196 mm. in length. The nerve ring is 0.31 mm. from the anterior end, and the excretory pore lies 0.05 mm. behind it. The tail is straight and it ends in a blunt point surmounted by a cuticular cap. The caudal papillae are prominent and are situated about halfway



TEXT-FIG. 25.—*Rusguniella brevis*, n. sp. Posterior end, female, ventral view.

between the anus and tip of the tail (fig. 25). The anus opens about 0.112 mm. in front of the tip of the tail, and the vulva is about 0.04 mm.



TEXT-FIG. 26.—*Rusguniella brevis*, n. sp. Posterior end, female, lateral view.

anterior to the anus. A stout vagina curves posteriorly from the vulva for a short distance, where it joins the broad ovejector. The ovejector runs posteriorly for more than halfway between the vulva and anus, it then becomes narrower and turning forwards it divides into the two uteri just anterior to the vulva (fig. 26). The eggs measure 0.06×0.036 mm.

Williams (1929) in a revision of the genus *Rusguniella* defines it on broader lines than earlier workers, because the existing definition, applying as it did to a single species, included characters which are only of specific value. Williams definition is as follows:—"Cuticular cordons in the form of smooth, non-striated crescents extending from one angle of the lips to the other, limited to the head region. Lateral alae present or absent." In the present worm the cordons are of the shape and extent indicated in the above definition, but they are marked by very fine concentric striations and accordingly do not agree with it. This would mean creating a new genus for my worm on a single small point of difference, and it seems preferable to still further emend the generic definition by merely describing the cordons as crescents running from one angle of the lips to the other and to omit finer details of their structure. A point of interest in my species is that it is the only one in which a male has been described, and its coiled tail, marked dissimilarity of the spicules, and different arrangement of the caudal papillae indicate that it is more correct to regard *Rusguniella* as a distinct genus than as a sub-genus of *Acuaria*. The name *Rusguniella brevis*, n. sp. is proposed for this worm.

Host.—*Ceryle alcyon*.

Type-specimens are in the Indian Museum, Calcutta.

Microtetrameres Travassos, 1915.

Cram (1927) has raised this sub-genus of Travassos to generic rank. She follows Travassos in placing *Tetrameres* in a special family Tetrameridae, but the objection to separating *Tetrameres* from the Acuariinae has already been pointed out in the discussion on *Echinuria spinosa*, so *Microtetrameres* is considered here under Acuariinae.

Microtetrameres spiralis (Seurat, 1915).

According to Cram this species has only been recorded from *Bubulcus lucidus* in Algeria. Male worms, which I have referred to this species, have been found on three occasions in the Cattle Egret (*Bubulcus coromandus*). These birds are wild but frequent the Calcutta Zoological Gardens in large numbers, where they were found dead.

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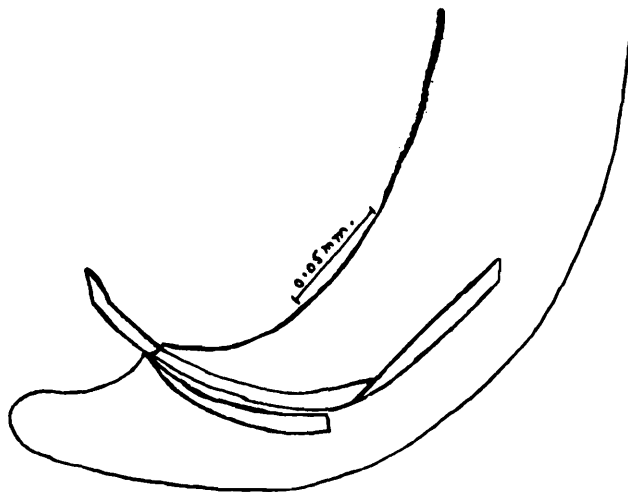
PART 5. FILARIIDAE.

Paraprocta, n. gen.

Chandler (1924) described "*Filaria brevicauda* n. sp." from a Hunting Cissa which died in the Calcutta Zoological Gardens. I have found worms which appear to be the same as Chandler's species in the following birds, also from the Calcutta Zoo. Six *Oriolus indicus*, two *Coracias indica*, and one each of *Arboricola atragularis*, *Dendrocitta rufa*, *Copsychus saularis*, and *Polyplectrum bicalcaratum*. The finding of the same worm in such a variety of hosts suggests that the infection is acquired in the Zoo, where the numerous species of birds, confined in close proximity to one another, would be easily attacked by an insect vector, and an infection of this nature thus readily propagated.

Chandler described the species from two males, and one female from the same bird. The latter he doubtfully named as the female of *Filaria brevicauda* as there were two species of microfilaria in the host's blood, but from the examination of my ample material it appears that Chandler was correct.

Male.—All of my male specimens agree with Chandler's description regarding dimensions, except in the case of the spicules, which I found to be normally 0.2 and 0.070 mm. in length, whereas Chandler gives their length as 0.106 and 0.065 mm. It will be noted in fig. 27 that the long

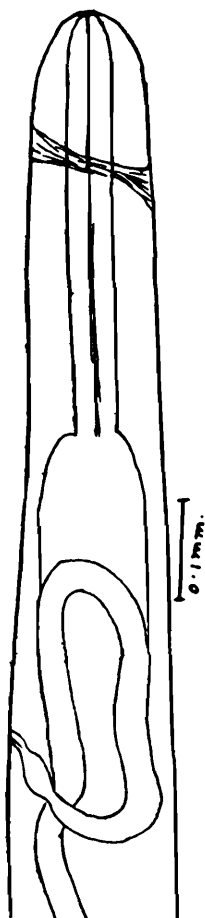


TEXT-FIG. 27.—*Paraprocta brevicauda*, n. gen. Posterior end, male, lateral view.

spicule is partially extruded, but in Chandler's figure both spicules appear to be wholly within the body of the worm. In one or two specimens, otherwise identical, I found spicules about the same length and appearance as those described and figured by Chandler, but most of the males

had the long spicule partially extruded as shown in fig. 27, it therefore seems probable that the long spicule is habitually partly extruded in this species, and when in this position the free portion may be broken off, thus giving the spicules an appearance similar to those of Chandler's material. Chandler also says there are two pairs of inconspicuous papillae, one pre-anal and the other post-anal. These were not observed in any of my specimens, but an appearance simulating papillae in these positions is caused by an optical section of the body pulp, which bulges round the cloacal aperture.

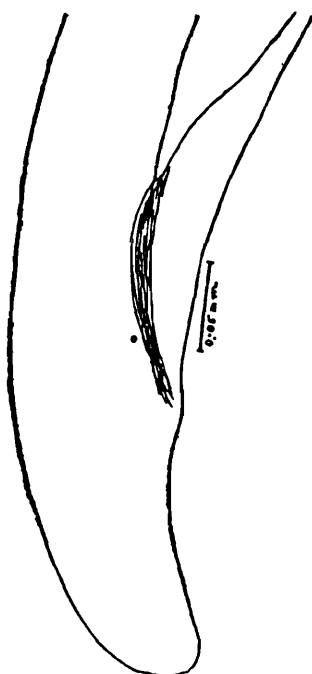
Female.—My female specimens also agree with Chandler's description. He describes, from his single specimen, a rapid widening of the intestine in the form of a cone just after its junction with the oesophagus. The shape of the oesophago-intestinal junction varies considerably in my specimens, and the most usual appearance is a sudden widening of the intestine at its junction with the oesophagus (fig. 28). Chandler



TEXT-FIG. 28.—*Paraprocta brevicauda*, n. gen. Anterior end, female, lateral view.

says the opening of the vulva is 0.38 mm. from the anterior end, and in all of my specimens this distance is about 1 mm. My fig. 28, which shows the curve taken by the terminal portion of the uterus, was drawn from a damaged specimen with the uterus nearly empty of larvae, but in intact specimens with the uterus crowded with larvae the course of this curve cannot be followed, and the vulva is also very inconspicuous and hard to see, so it is probable that Chandler took the vulva to be opposite the most anterior part of the uterus, which in my specimens varied from 0.25 mm. to 0.99 mm. from the anterior end. In any case a slight difference in the position of the opening of the vulva is not of specific value. The uteri are parallel and the ovaries both terminate in the posterior

end of the worm, but it was noted that the farthest posterior point reached by these organs varied from some little distance anterior to the imperforate anus, to the extreme posterior end of the body cavity, well behind the anus. The anus is completely covered by cuticle and a fibrous cord is seen leading anteriorly from it in young specimens, from one of which fig. 29 has been drawn; but in older worms even this



TEXT-FIG. 29.—*Paraprocta brevicauda*, n. gen. Posterior end, female, lateral view.

vestigial cord seems to have disappeared, and with the ovaries fully developed and occupying most of the hinder part of the body cavity the actual termination of the gut is difficult to find.

Although from the above discussion there may seem to be several important differences in these two worms the table below shows how similar they really are.

	CHANDLER'S MATERIAL.		MY MATERIAL.	
	Male.	Female.	Male.	Female.
Length	7.5—10.5	18	8—9.5	16.—17.5
Diameter	0.16—0.18	0.45	0.16—0.2	0.35—0.38
Oesophagus	0.4—0.48	0.6	0.45—0.5	0.4—0.5
Tail	0.06—0.065	0.16	0.064	0.16
Spicules	0.106 & 0.065	..	0.18—0.2 & 0.06—0.07	..
Vulva from ant. end	..	0.38	..	1—1.2

By the absence of head papillae and papillae on the tail of the male and by the presence of a short undivided oesophagus this worm agrees

with the genus *Aprocta*, but one spicule is over twice the length of the other. On the classification of Yorke and Maplestone (1926), which has been partly followed by Baylis and Daubney (1926), this character would exclude it even from the sub-family Aproctinae.

Chandler (1929) objects to the separation of Filariinae and Aproctinae on the length of the spicules alone. Although in some genera and even sub-families of Nematodes spicule characters are remarkably constant, Chandler's objection seems well-founded in the present instance, especially as the worm under discussion is a typical *Aprocta* in all but the difference in length of its spicules. Although one is reluctant to do so, there seems to be no alternative but to create a new genus to accommodate this worm, otherwise it would be necessary to alter the definition of *Aprocta* and in the present state of classification of the sub-families Filariinae and Aproctinae it seems to me better to create new genera if worms do not agree with existing definitions, rather than to alter the definitions. At present it is impossible to divide the genera of these sub-families satisfactorily, for in whatever way one tries to make groups, using one or two well-defined characters, exceptions and forms intermediate between what at first appear to be well-defined divisions occur. It is possible that when more is known of the worms in these sub-families distinct lines of cleavage may emerge, which will permit of a better system of classification. On account of these difficulties it is proposed to create the new genus *Paraprocta* to accommodate *Filaria brevicauda* Chandler, 1924.

Definition :—

Paraprocta, gen. nov. Filariform worms, lips and head papillae absent. Oesophagus short and undivided. Caudal alae and papillae absent in the male. Spicules unequal. Vulva opens near the junction of the oesophagus and intestine, uteri parallel, viviparous. Posterior portion of gut atrophied. Parasite of the body cavity of birds.

Type-species. *Paraprocta brevicauda* (Chandler, 1924).

Synonym. *Filaria brevicauda* Chandler, 1924.

Type-host. *Cissa chinensis*.

Specimens are in the Indian Museum.

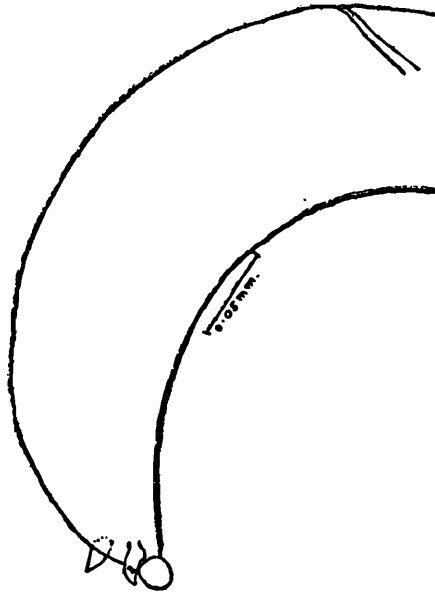
***Setaria cervi*, n. sp.**

Two female specimens of this worm were obtained from the abdominal cavity of a Hog deer (*Cervus axis*).

The worms are similar to *Setaria digitata*, according to the description of this species by Boulenger (1920), in all their dimensions but they are a little smaller. In the following description the measurements of my species are given first and in each case they are followed by the corresponding measurement for *S. digitata* taken from Boulenger, the latter being in brackets.

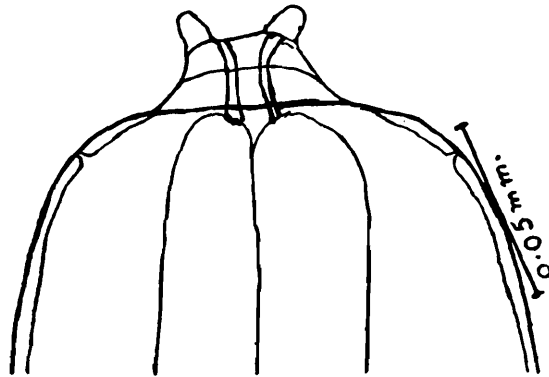
The worms are 60 mm. (62—78 mm.) in length and 0.5 mm. (0.5—0.68 mm.) in diameter. The anterior portion of the oesophagus is 0.44 mm. (0.53—0.8 mm.), and the posterior portion 4.1 mm. (6.5—8 mm.) in length. The tail is loosely coiled in one or two spiral turns and there

are a pair of large fleshy papillae about 0.5 mm. (0.1 mm.) from the rounded tip (fig. 30). The anus is 0.376 mm. (0.4—0.48 mm.) from the



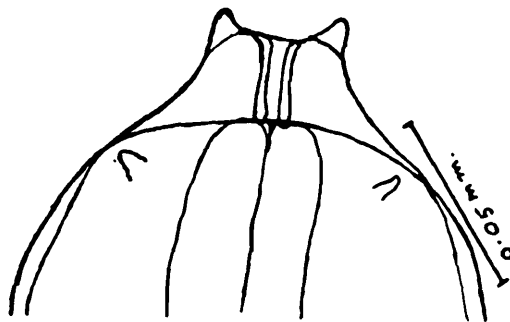
TEXT-FIG. 30.—*Setaria cervi*, n. sp. Posterior end, female, lateral view.

tip of the tail, and the vulva is 0.396 mm. (0.5—0.65 mm.) from the anterior end. Comparison of these measurements does not reveal any sufficiently marked difference whereon to erect a new species, but the



TEXT-FIG. 31.—*Setaria cervi*, n. sp. Anterior end, dorso-ventral view.

chitinous mouth collar is much more prominent in my material as it projects about 0.22 mm. beyond the anterior end of the worm, and within



TEXT-FIG. 32.—*Setaria cervi*, n. sp. Anterior end, lateral view.

it there is a definite cuticle-lined mouth of a corresponding depth (figs. 31 and 32), whereas the mouth collar of *S. digitata* appears to be only about

0.009 mm. in length, from Boulenger's figure. Another difference is that there is an anterior projection from the centre of the lateral surface of the mouth collar in *S. digitata*, and this is absent in my worms (fig. 32). Another slight difference is that the tip of the tail is more obtuse and the large lateral papillae are much nearer to it in my material than in *S. digitata*.

It is accordingly proposed to name this worm *Setaria cervi*, n. sp.
Male.—Unknown.

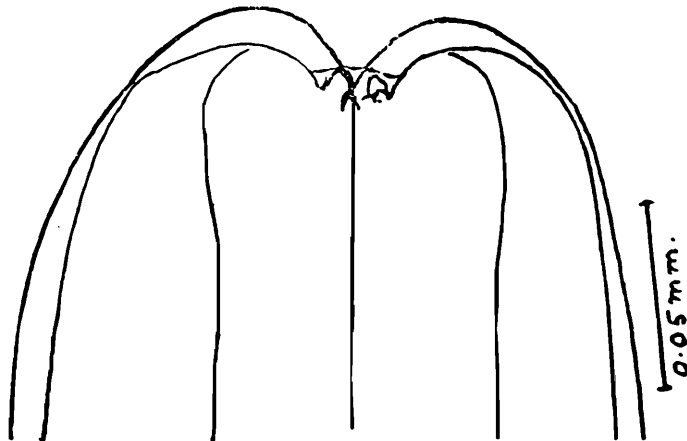
Host.—*Cervus axis*.

The type of the female is in the Indian Museum, Calcutta.

***Papillosetaria veversi*, n. sp.**

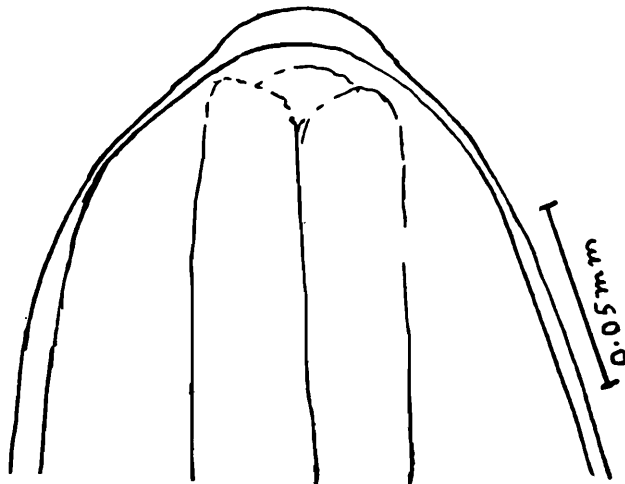
One male and one female of this species were found on the extra-peritoneal surface of the abdominal wall of a Java Mouse-deer (*Tragulus javanicus*).

They are long thin worms with irregularly placed papilliform structures on the cuticle. These papillae first appear opposite about the middle of the oesophagus, and in the female they are present as far back as the anus, but in the male they could not be seen further back than about 3 mm. from the posterior end. The mouth is bounded by two thick, simple lateral lips, which are surmounted by a thickening of the cuticle, which may be of a chitinous nature. No head papillae could be



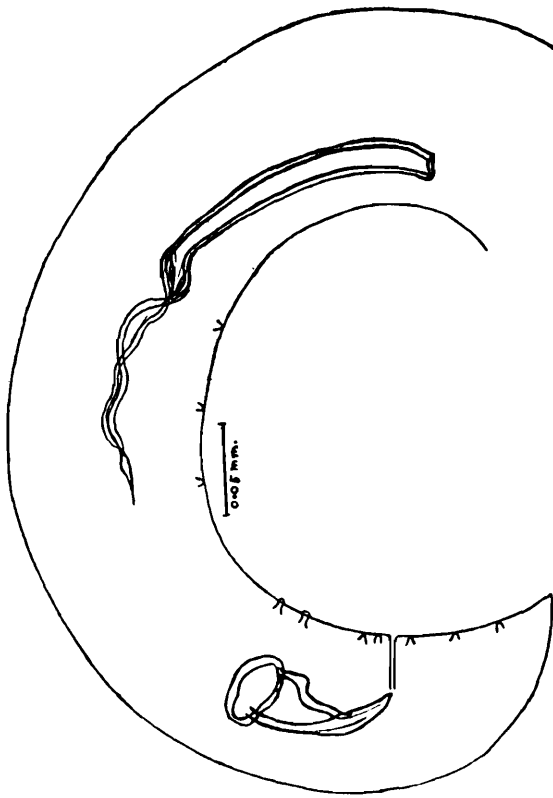
TEXT-FIG. 33.—*Papillosetaria veversi*, n. sp. Anterior end, dorso-ventral view.

made out (figs. 33 and 34). The oesophagus is long and is divided into two parts.



TEXT-FIG. 34.—*Papillosetaria veversi*, n. sp. Anterior end, lateral view.

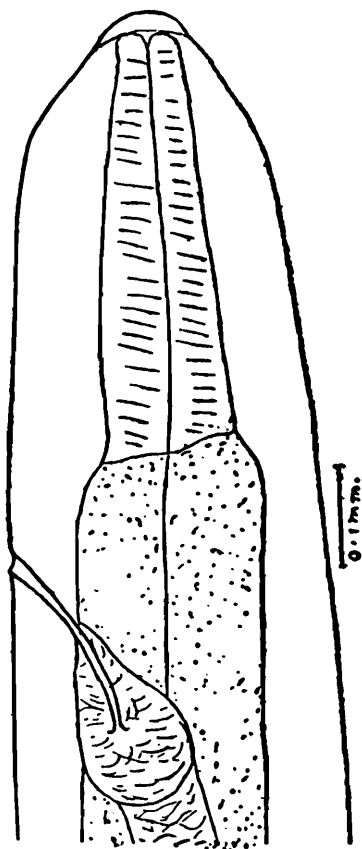
Male.—The male is about 70 mm. (57) in length, and 0.24 mm. (0.28) in maximum diameter. The anterior part of the oesophagus is 0.58 mm. (0.5), and the posterior part is about 11 mm. (9.1) in length. The nerve ring is situated 0.297 mm. (0.2) from the anterior end. The tail is wound in one or two open spiral turns and it ends in a point 0.09 mm. (0.12) behind the cloaca. There are seven pairs of precloacal and three pairs of postcloacal papillae (fig. 35). From the nature of the papillae it appears possible there may be narrow caudal alae, but this could not be determined as it was not possible to obtain a ventral view of the tail. The spicules are unequal and dissimilar. The long spicule is 0.275 mm. (0.37) in length, and its proximal part consists of a stout curved tube, and the distal half appears to consist of two or more lash-like portions coiled round one another. The short spicule is 0.09 mm. (0.085) in length, it is very stout and of a peculiar shape (fig. 35).



TEXT-FIG. 35.—*Papillosetaria weversi*, n. sp. Posterior end, male, lateral view.

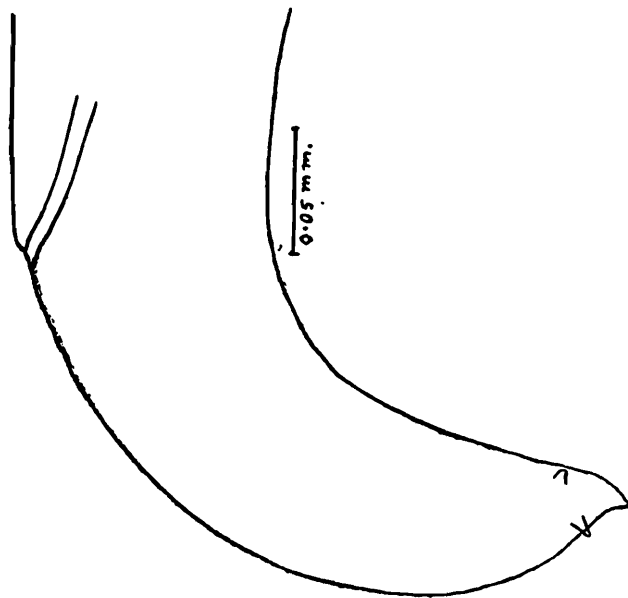
Female.—The female is about 142 mm. (145) in length, and 0.46 mm. (0.46) in maximum diameter. The two parts of the oesophagus are 0.44 mm. (0.4) and 8.8 mm. (9.6) in length respectively, as this is less than in the male it is probable that the length of the oesophagus is subject to considerable variation. The vulva opens 0.535 mm. (0.65) from the anterior end, and a cuticle-lined vagina leads inwards and backwards to end in a pyriform muscular ejaculatory organ (fig. 36). An unpaired trunk runs posteriorly from the ejector for a distance of about 17 mm. It then divides into two uteri, which run posteriorly and the ovaries terminate a little distance in front of the anus. The terminal two or three millimetres of the worm is much thinner than the rest of the body. The tail is curved with the anus on its convexity 0.26 mm. (0.5) from its tip. The tail ends in a simple point with a pair of

large prominent papillae on each side of it a short distance anterior to the tip (fig. 37). The uterus contains embryos.



TEXT-FIG. 36.—*Papillosetaria veversi*, n. sp. Anterior end, female, lateral view.

This worm is remarkably close to *P. traguli* Vevers in all its dimensions, which for convenient comparison have been placed in brackets



TEXT-FIG. 37.—*Papillosetaria veversi*, n. sp. Posterior end, female, lateral view.

after the corresponding measurements of my worms. The points in which these two worms differ is that in the male the tail ends in a simple point in my species, whereas it ends in a rounded knob in *P. traguli*, and in my worm there are seven pairs of precloacal papillae, whereas *P. traguli* has only four pairs. In the female of my species the tail ends in a simple point with two pairs of pointed papillae on each side of it,

whereas in *P. traguli* the tail is bifid with two lateral appendages; the anus is about twice as far from the tip of the tail in *P. traguli* as it is in my species. Vevers (1922) makes no mention of the peculiar ejaculatory organ in the female, but as the worms are so similar in all points described, it is probable that this organ is also present in *P. traguli*, but was not noted by him, therefore its omission in the description of this species is not of any importance unless specially looked for and found to be absent. The differences in the tail of these two species are so distinct in both sexes it is considered my worm is new, so it has been decided to name it *Papillosetaria veversi*, n. sp. The hosts from which these two worms come are closely allied, as Vevers obtained his material from *Tragulus stanleyanus*, and mine was found in *T. javanicus*.

Type-specimens are in the Indian Museum, Calcutta.

***Hastospiculum spinigerum* Chandler, 1929.**

Chandler (1929) described this species from *Varanus flavescens* which died in the Calcutta Zoological Gardens. I have recently obtained many female specimens but no males of this worm from the same host and locality.

Baylis and Daubney (1922) obtained several fragments and a single complete female from several *Varanus* species, which also came from the Calcutta Zoo. These they have referred to *Filaria macrophallos* Parona, 1889. My material agrees with their description and also with Chandler's, the only difference being in some of the measurements, which are found to be covered by normal variation when several specimens are examined. Two very striking characters, viz., the peculiar cuticular ornamentation, and the collar-like thickening at both ends of the eggs are present in all my specimens, and they appear to be identical with the drawings and descriptions of both Baylis and Daubney and Chandler. Therefore there seems to be no doubt even in the absence of males, that *Filaria macrophallos* Parona, 1889, of Baylis and Daubney, 1922 is identical with *Hastospiculum spinigerum* Chandler, 1929. Although Baylis and Daubney do not seem to have fully recognised the chitinous structure on the anterior end, there seems to be no doubt that the worms are the same for they describe two small prominent chitinous teeth projecting forward. From examination of my material I am in agreement with Chandler that this chitinous structure is similar to that in *Hastospiculum varani*. Therefore the correct name of this species is as follows.

Hastospiculum macrophallos (Parona, 1889).

Synonyms. *Filaria macrophallos* Parona, 1889.

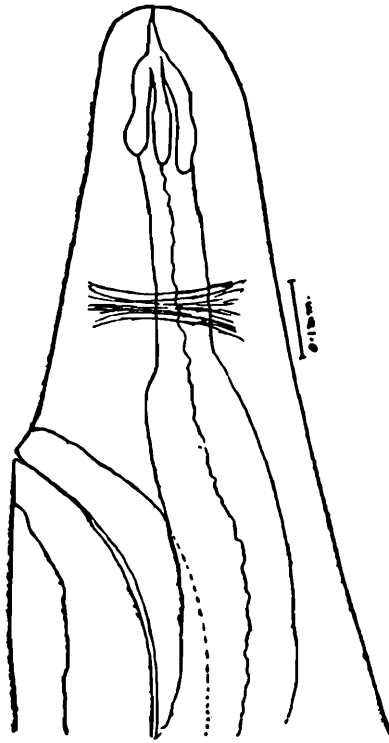
Hastospiculum spinigerum Chandler, 1929.

***Diplotrienia graculi*, n. sp.**

Seven females and three males of this species were found in the sub-peritoneal tissue of the body cavity of two Red-billed Choughs (*Graculus eremita*).

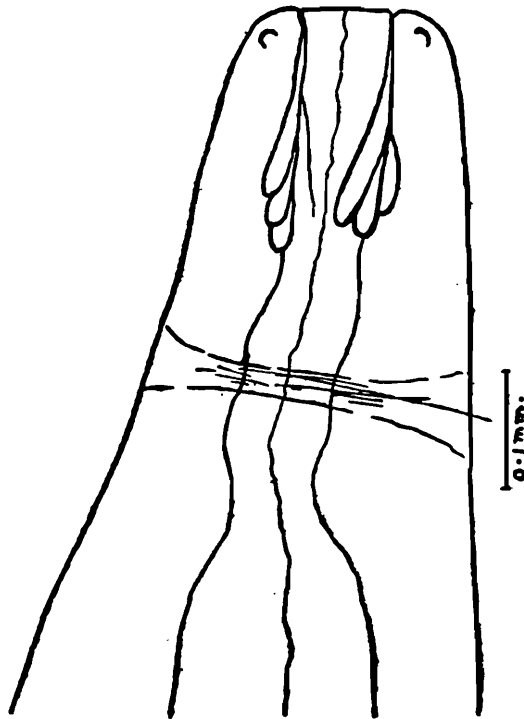
The worms are long and thin and the cuticle appears to be without striations. In lateral view the anterior extremity is rounded, and when

seen from the dorso-ventral aspect is flat (figs. 38 and 39). The chitinous tridents are somewhat irregular in shape and their branches



TEXT-FIG. 38.—*Diplotriaenia graculi*, n. sp. Anterior end, female, lateral view.

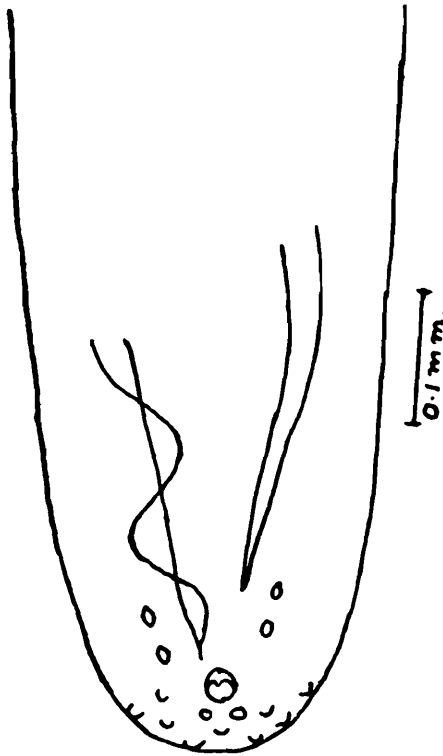
show considerable variation in length, even in a single specimen. The total length of the tridents from the tip of the root to the end of the branches varies between 0.180 mm. and 0.208 mm. The roots are finely pointed and they lie in the bottom of small pits on the anterior end of the worm (fig. 39). There are four large submedian papillae. The



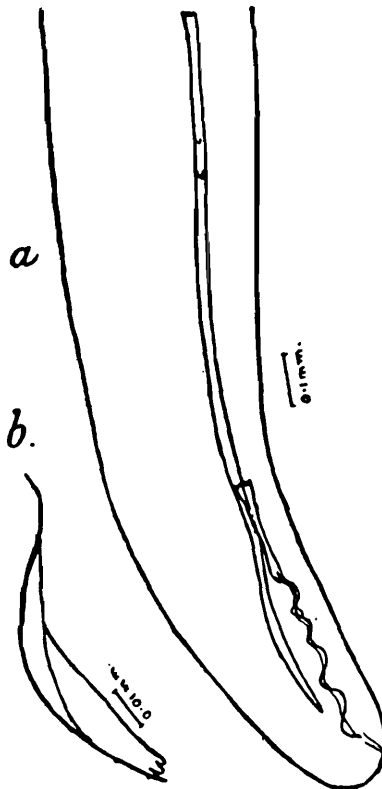
TEXT-FIG. 39.—*Diplotriaenia graculi*, n. sp. Anterior end, dorso-ventral view.

oesophagus is divided into a short anterior portion and a much longer posterior portion. The nerve ring encircles the anterior part of the oesophagus a short distance in front of its junction with the posterior part.

Male.—The males are from 27.5 to 32 mm. in length and 0.594 mm. in diameter opposite the posterior end of the oesophagus, and the head is 0.16 mm. in lateral diameter. The oesophagus is about 1.2 mm. in total length, of which the anterior portion composes 0.45 mm. The posterior end is bluntly rounded, both in dorso-ventral and lateral views (figs. 40 and 41a). The cuticle behind the cloaca on the ventral surface is closely set with small round bosses, and there appear to be a pair of



TEXT-FIG. 40.—*Diplotriaenia graculi*, n. sp. Posterior end, male, ventral view.



TEXT-FIG. 41.—*Diplotriaenia graculi*, n. sp. (a) Posterior end, male, lateral view. (b) Tip of short spicule.

papillae immediately behind this opening and two papillae on each side, in front of it. The right spicule is 1.565 mm. in length, and it is long and straight. The left spicule is 0.634 mm. in length, and its proximal third is straight and tubular, but the distal third is spirally twisted in five or six turns, and its broad membranous ala gives it an appearance similar to an auger (fig. 41).

Female.—The females vary from 70–108 mm. in length, and from 0.326–0.455 mm. in diameter opposite the vulva. The vulva is slightly prominent, and it is situated 0.49–0.59 mm. from the anterior end (fig. 38). There is an unpaired trunk or vagina running posteriorly from the vulva for a distance of 0.89–1.3 mm. The uteri are parallel and contain embryos, and the ovaries are in the posterior end of the body.

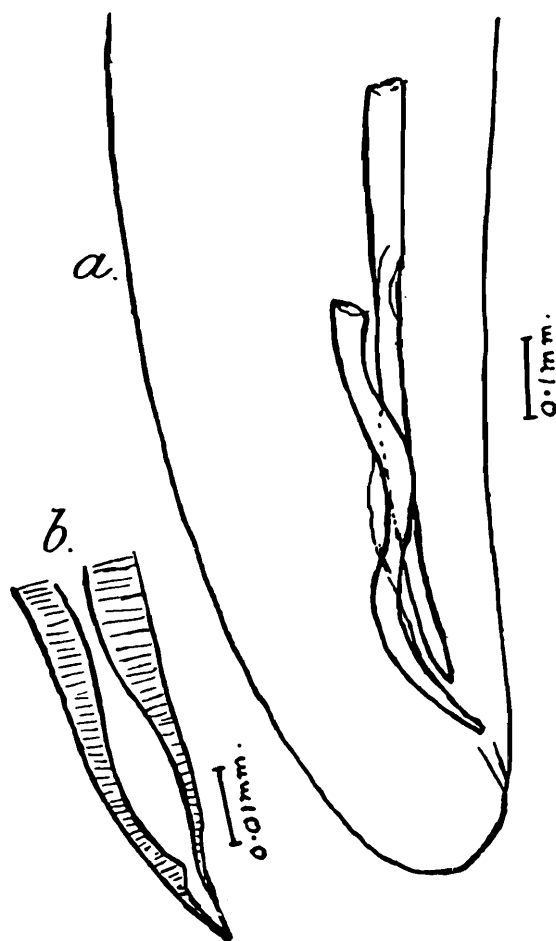
The members of the genus *Diplotriaenia* are for the most part closely allied, but the present species is characterised by the flat anterior end in dorso-ventral view, and in the male the posterior end is rounded, from whichever angle it is examined. In most species the anterior end is rounded from any aspect, and the posterior end of the male is rounded in lateral view, but truncate in ventral view. It is accordingly proposed to name this species *Diplotriaenia graculi*, n. sp.

Host.—*Graculus eremita*.

The type-specimens are in the Indian Museum, Calcutta.

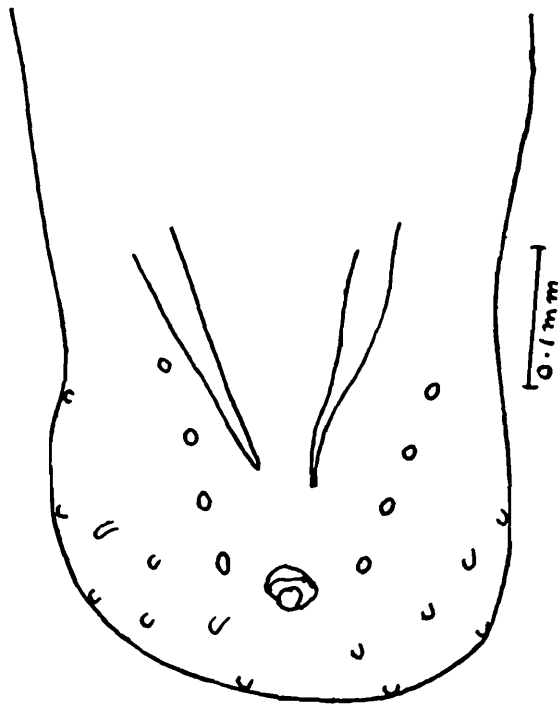
Diplotriaenia dubia, n. sp.

In one of the birds from which the above species (*D. graculi*) was obtained, a single male specimen of apparently a different species was found.



TEXT-FIG. 42.—*Diplotriaenia dubia*, n. sp. (a) Posterior end, male, lateral view. (b) Tip of short spicule.

The anterior end of the worm is indistinguishable from that of *D. graculi*, as it was the same size and shape and the tridents appeared to be the same. The length of this worm is 8.55 mm. and the diameter at the posterior end of the oesophagus is 0.693 mm. The total length of the oesophagus is 1.5 mm. The posterior end is rounded in lateral view (fig. 42), but when rolled to obtain a ventral view it is seen to be truncate, and slightly expanded laterally (fig. 43). The postcloacal portion of the ventral surface is covered with rather pointed papilla-like prominences, and there are four precloacal papillae on each side (fig. 43). The right



TEXT-FIG. 43.—*Diplotriaenia dubia*, n. sp. Posterior end, male, ventral view.

spicule is 0.812 mm. in length, and it is straight. The left spicule is 0.594 mm. in length and shows a broad double curve (fig. 42).

Although the anterior ends of this worm and of *D. graculi* are apparently identical, the posterior end and the spicules are clearly different from those of the latter, and in addition it is about twice the length of the male of *D. graculi*. It is therefore proposed to name this species *Diplotriaenia dubia*, n. sp.

Female.—Unknown.

Host.—*Graculus eremita*.

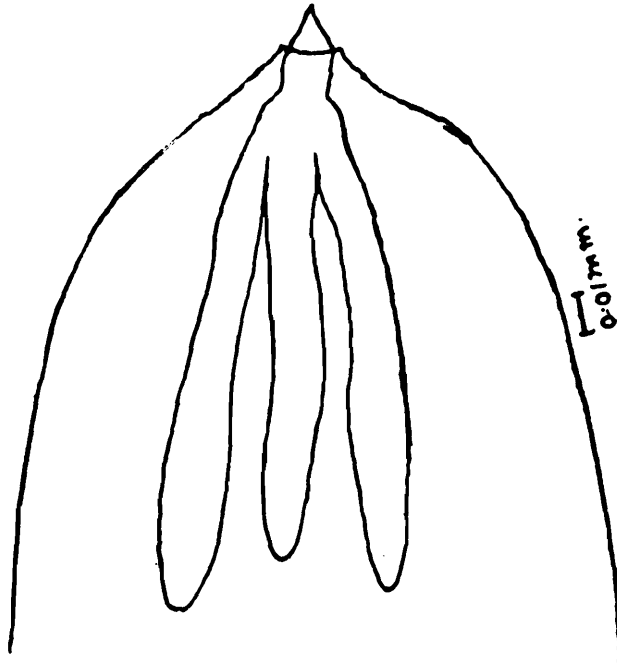
The type-specimen is in the Indian Museum, Calcutta.

As there are no differences apart from those of the males, whereby to distinguish this species from *D. graculi*, and as one of these characters is that of size it might be thought that the largest females of the collection belong to *D. dubia*. But the two largest females were found in bird 1 along with a single male of *D. graculi* and the remaining worms all came from bird 2, these consisted of five females and two males of *D. graculi*, and the single male of *D. dubia*. It seems probable that the females of *D. dubia* will be very much larger than those of *D. graculi*, as the male of the former is twice the length of the male of the latter species.

***Diplotriaenia urocissae*, n. sp.**

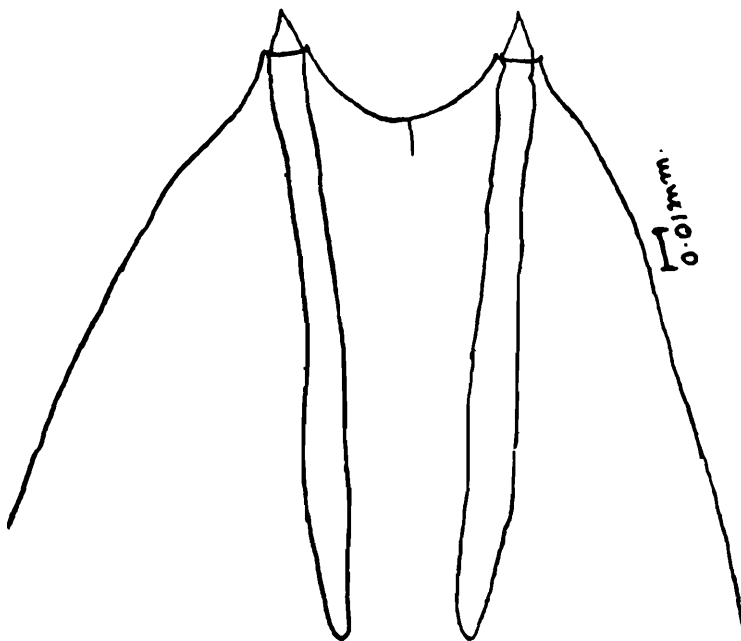
A single male specimen of this worm was found in the sub-peritoneal tissue of the body cavity of a Yellow-billed Blue Magpie (*Urocissa flavirostris*).

The worm is 18.2 mm. in length and 0.515 mm. in maximum diameter. The tridents are 0.148 mm. in length from base to tip. The anterior end of the tridents projects beyond the cuticle in a sharp point. Laterally the head appears rounded with the sharp root of the trident projecting from its anterior border (fig. 44). Dorso-ventrally the anterior ex-



TEXT-FIG. 44.—*Diplotriaenia urocissae*, n. sp. Anterior end, lateral view.

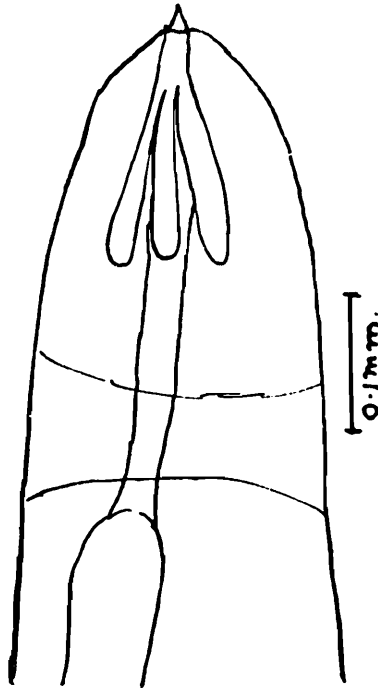
tremity is in the form of a broad curve concave anteriorly, with the tridents projecting anteriorly on each side of it (fig. 45). The oesophagus



TEXT-FIG. 45.—*Diplotriaenia urocissae*, n. sp. Anterior end, dorso-ventral view.

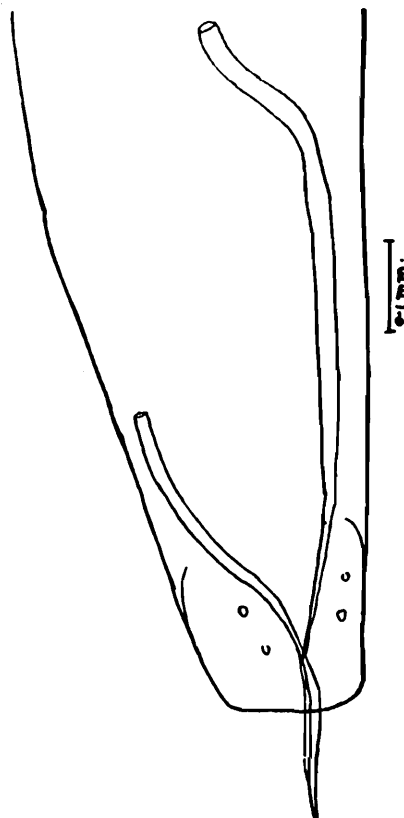
is divided into two parts (fig. 46), the anterior part being 0.257 mm. and the posterior part 2.2 mm. in length. The tail is truncate in the

ventral aspect, and there are two papillae on each side just anterior to the cloaca. The right spicule is 0.713 mm. in length, it is curved near



TEXT-FIG. 46.—*Diplotriaenia urocissae*, n. sp. Anterior end, lateral view.

its base, the remainder being straight. The left spicule is 0.495 mm. in length, and shows a broad S-shaped curve involving its whole length (fig. 47).



TEXT-FIG. 47.—*Diplotriaenia urocissae*, n. sp. Posterior end, male, ventral view.

The anterior extremity of this worm is similar to that of *D. pungens* (Schneider, 1866) according to the description of this species by

Boulenger (1928), but the anterior projection of the tridents are blunt and not so prominent in this species as they are in my specimen. The dimensions of the worms are very different as practically all the measurements of *D. pungens*, except those of the spicules, are about twice that of my worm. The spicules in the two species are different, as in *D. pungens*, the short spicule is spirally twisted, whereas it is only curved in my specimen. It is accordingly proposed to name this worm *Diplotriaenia urocissae*, n. sp.

Female.—Unknown.

Host.—*Urocissa flavirostris*.

The type-specimen is in the Indian Museum, Calcutta.

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- Chandler, A. C. (1924). New Filariae from Indian Birds. *Parasitol.* Vol. XVI, p. 398.
- Chandler, A. C. (1929). Some new genera and species of Nematode worms, Filarioidea, from Animals dying in the Calcutta Zoological Gardens. *Proc. U. S. Nat. Mus.* Vol. 76, Art. 6.
- Vevers, G. M. (1922). On the Parasitic Nematoda collected from Mammalian Hosts which died in the Gardens of the Zoological Society of London during the years 1919-21 ; with a description of Three New Genera and Three New Species. *Proc. Zool. Soc. London*, 1922, p. 405.

PART 6. THE GENUS *KALICEPHALUS* IN INDIAN REPTILES.

***Kalicephalus indicus* Ortlepp, 1923.**

Kalicephalus bengalensis Maplestone, 1929 was described by me as a new species because, from the limited material then available, it appeared to have definite differences from *K. indicus* Ortlepp, 1923. Since that time I have obtained large numbers of these worms, and study of this material has shown that the worm is subject to a certain amount of variation, which indicates that the differences noted are not constant characters. For instance the sharp points in which the bursa ends ventrally and the apparent prebursal papillae in *K. bengalensis* are only artefacts due to pressure of the cover-glass. In the female the degree of prominence of the vulva and the size of the post-vulval swelling vary considerably. The posterior ovejector in a very few instances runs directly dorsally as figured by Ortlepp, it nearly always forms a loop posterior to the vulva which extends from 0.2 to 0.5 mm. before curving forwards. The size of the eggs measured in utero is also of no diagnostic value, and the dimensions given by Ortlepp really represent the minimum size of apparently mature eggs.

It is therefore considered that *K. bengalensis* is a synonym of *K. indicus*.

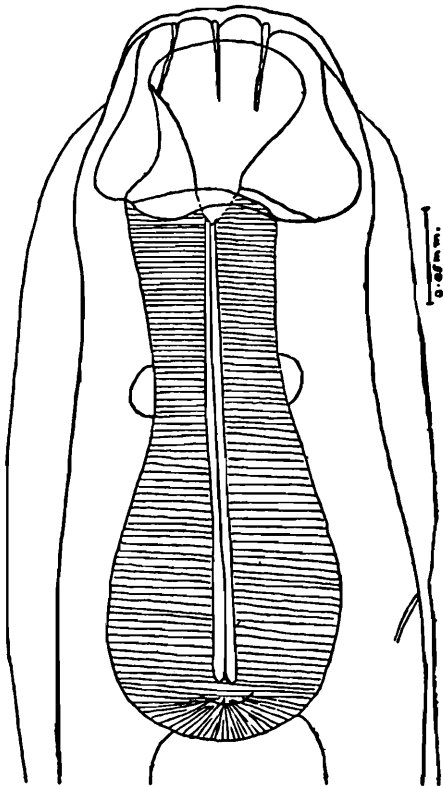
This species has been found by me in the Rat-snake (*Zamenis mucosus*) fifteen times, in the Green snake (*Dryophis mycterizans*) eight times, and single females have been found on one occasion each in the Cobra (*Naia tripudians*), the Snake-eating cobra (*Naia bungarus*), and the Bengal monitor (*Varanus bengalensis*). One female was also recovered from the intestine of a wild cat, but it is probable that this animal is not a true host, and that the worm reached this animal's intestine in a snake devoured by the cat, and it managed to remain alive in this abnormal host.

In the table at the end of the paper (p. 124) the full range of size noted in this species is given. The gubernaculum, of which the length is given, is represented in all the members of the genus in which it has been seen by me, by a chitinous lining of the posterior end of the dorsal wall of the spicule canal.

***Kalicephalus elongatus*, n. sp.**

Specimens of this worm have been found five times in the intestine of the Rat-snake (*Zamenis mucosus*), and once in the Cobra (*Naia tripudians*).

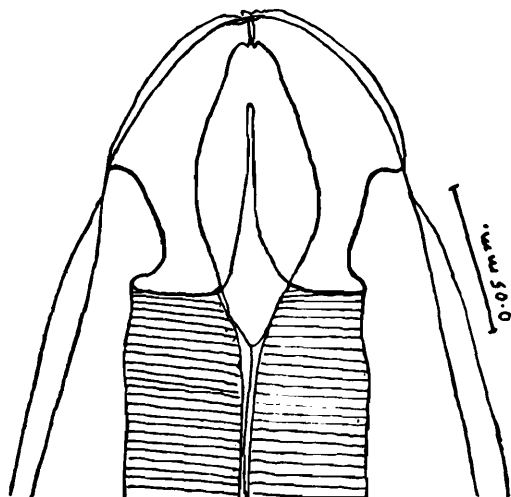
Apart from being considerably larger, these worms are easily recognised from *K. indicus* by the presence of a distinct cuticular swelling, which extends from the middle of the buccal capsule to about opposite the posterior end of the oesophagus, it is more marked dorsally and



TEXT-FIG. 48.—*Kalicephalus elongatus*, n. sp. Anterior end, lateral view.

ventrally than laterally (figs. 48 and 49). Other characteristic points are the presence of a long genital cone in the male, and small rounded prominences at the junction of the externo-dorsal and dorsal bursal rays

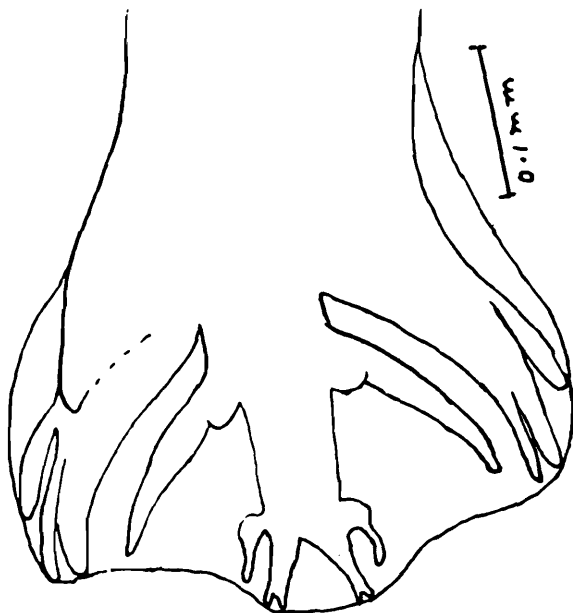
(figs. 50 and 51). The vulva is very prominent in the female; the



TEXT-FIG. 49.—*Kalicephalus elongatus*, n. sp. Anterior end, dorso-ventral view.

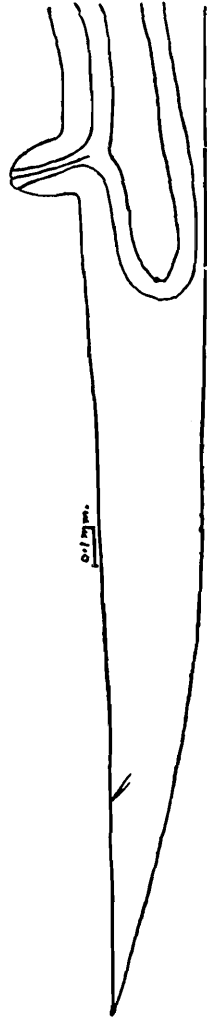


TEXT-FIG. 50.—*Kalicephalus elongatus*, n. sp. Posterior end, male, lateral view.



TEXT-FIG. 51;—*Kalicephalus elongatus*, n. sp. Male bursa, dorsal ray.

arrangement of the ovejectors is similar to that of *K. indicus* and they are subject to about the same degree of variation (fig. 52). It is con-



TEXT-FIG. 52.—*Kalicephalus elongatus*, n. sp. Posterior end, female, lateral view.

sidered that the other characters are adequately demonstrated in the figures, and in the table of dimensions, therefore a detailed written description is omitted.

This worm differs from all other species of the genus *Kalicephalus* so the name *Kalicephalus elongatus*, n. sp. is proposed for it.

Type-host. *Zamenis mucosus*.

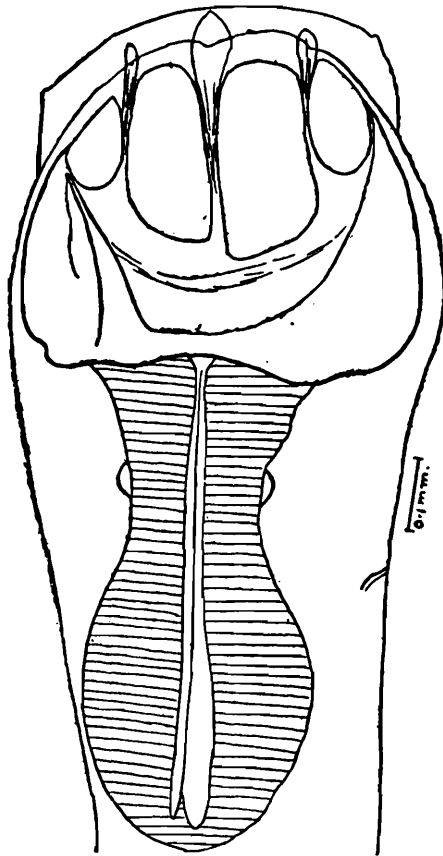
Type-specimens are in the Indian Museum, Calcutta.

***Kalicephalus brachycephalus*, n. sp.**

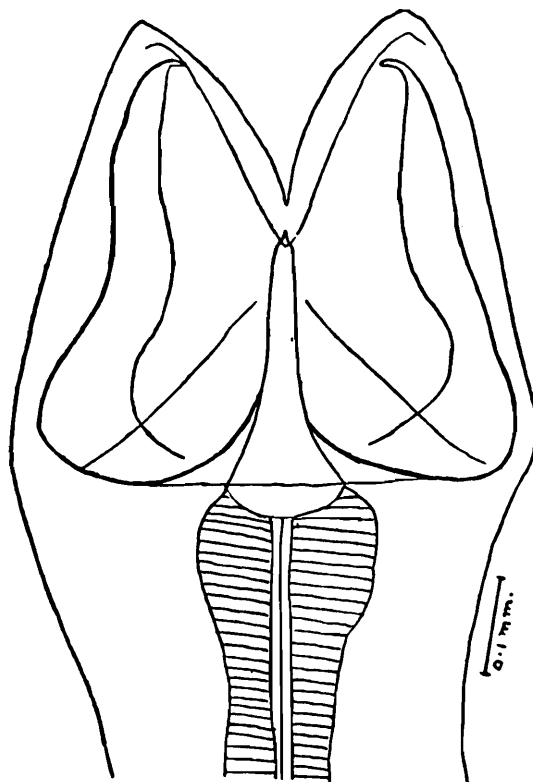
Two female worms of this species were found in collections of *K. indicus* from Rat-snakes. The relatively great size of the buccal capsule made them readily recognized as a different species.

The dorso-ventral diameter of the head is considerably greater than that of the body, so that the anterior extremity has a distinctly swollen appearance even to the naked eye (fig. 53). When viewed from the dorsal aspect the lips were found to be widely separated in both specimens (fig. 54). This is a very unusual condition for the lips in *Kalicephalus*, as they are practically always in close apposition in all species.

The vulva is slightly prominent and the vagina is short, dividing into divergent ovejectors furnished with ovoid muscular organs a short



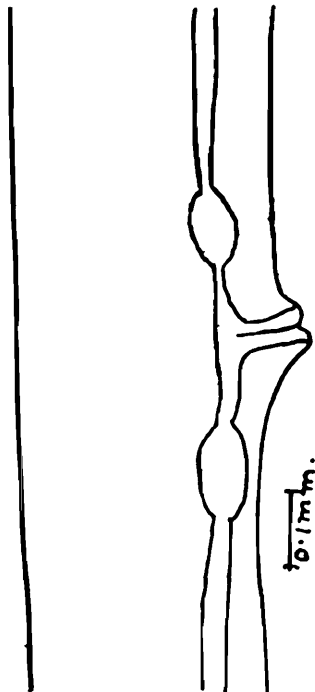
TEXT-FIG. 53.—*Kalicephalus brachycephalus*, n. sp. Anterior end, lateral view.



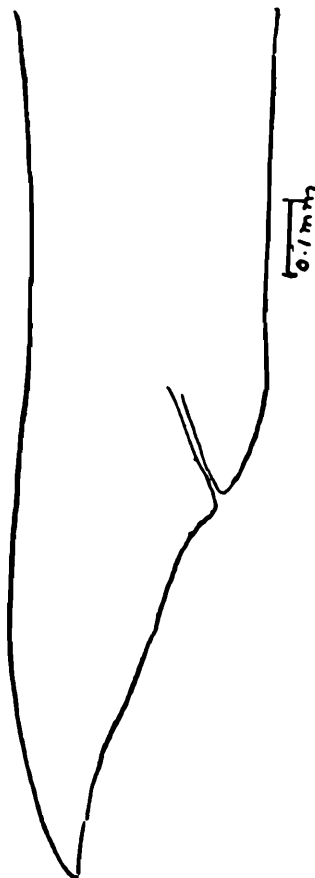
TEXT-FIG. 54.—*Kalicephalus brachycephalus*, n. sp. Anterior end, dorso-ventral view.

distance from the vagina (fig. 55). The uteri are directly continuous with the ovejectors, and they in turn pass into the ovaries which lie towards opposite ends of the worm. The lips of the anus are slightly

prominent and the tail is conical (fig. 56). The relatively great size of the buccal capsule of this worm differentiates it from all other species



TEXT-FIG. 55.—*Kalicephalus brachycephalus*, n. sp. Vulval region.



TEXT-FIG. 56.—*Kalicephalus brachycephalus*, n. sp. Posterior end, female, lateral view. of *Kalicephalus* so the name *Kalicephalus brachycephalus*, n. sp. is proposed for it.

Male unknown.

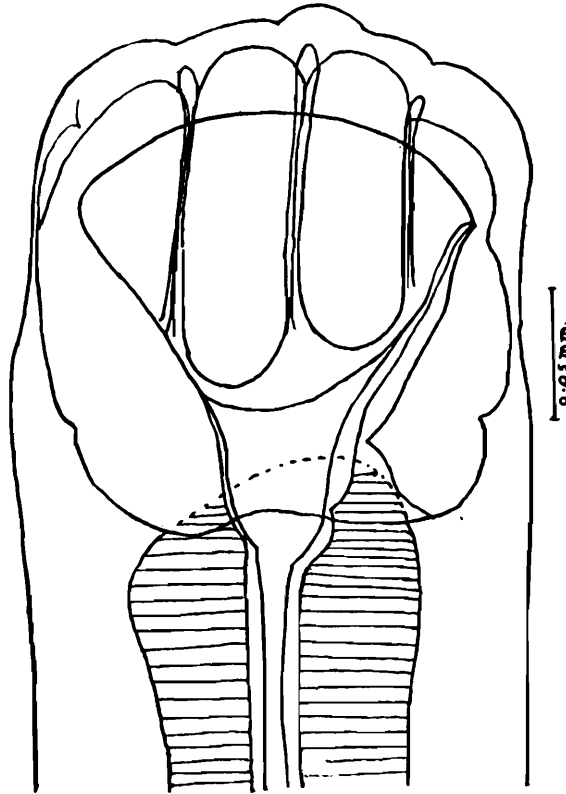
Host. *Zamenis mucosus*.

Type-specimens are in the Indian Museum, Calcutta.

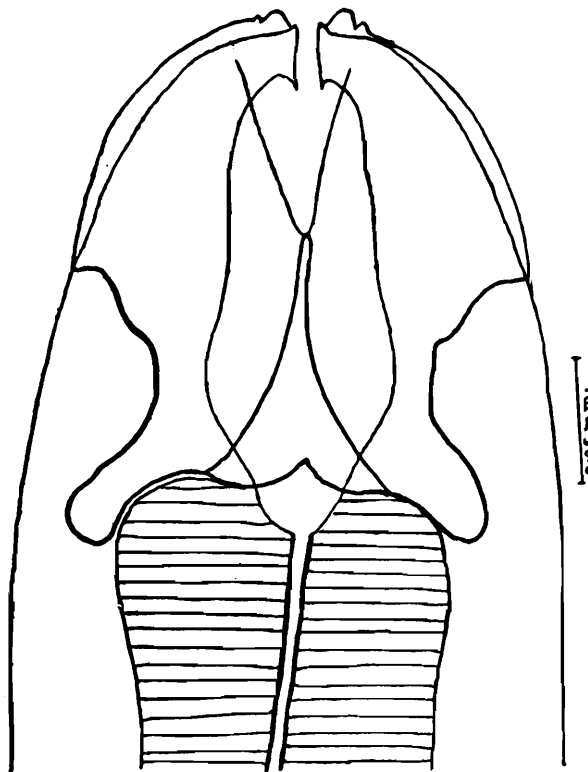
Kalicephalus naiae, n. sp.

This worm has been recovered on six occasions from the Cobra (*Naia tripudians*), and once from the Banded krait (*Bungarus fasciatus*).

It is almost identical in size with *K. minutus* Baylis and Daubney, 1922, but the shape of the buccal capsule appears slightly different on



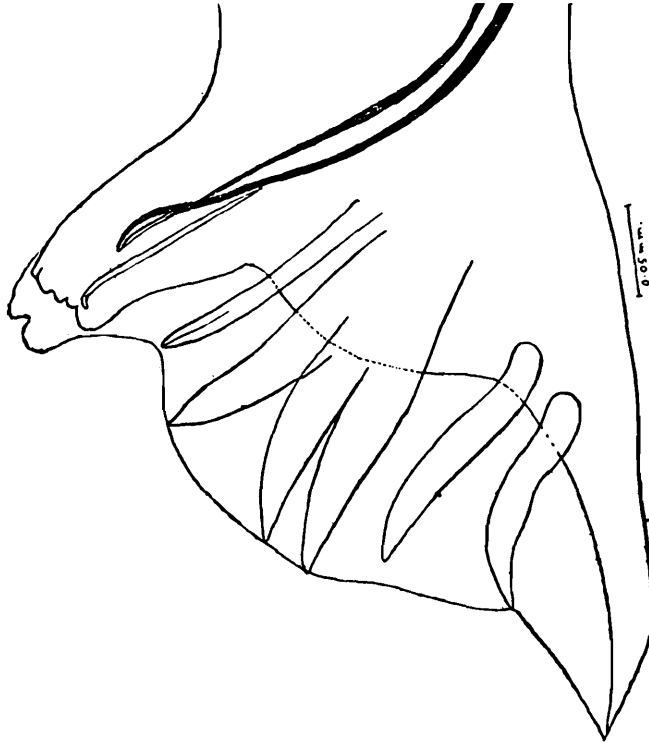
TEXT-FIG. 57.—*Kalicephalu snaiiae*, n. sp. Anterior end, lateral view.



TEXT-FIG. 58.—*Kalicephalus naiae*, n. sp. Anterior end dorso-ventral view.

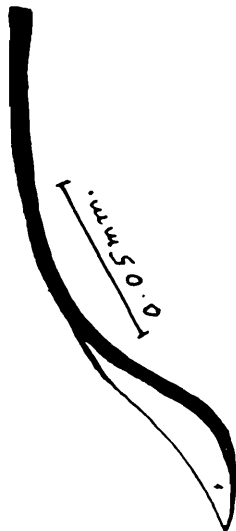
comparing my figures 57 and 58 with those of the above authors. Apart from this the only distinct differences are in the posterior end of the

male. In *K. minutus* no mention of a genital cone is made, and in my species this is a prominent structure about 0.1 mm. in length, and in *K. minutus* Baylis and Daubney say there is no gubernaculum, whereas in my species the dorsal wall of the spicule canal is chitinized for a distance of about 0.12 mm. (fig. 59). In *K. minutus* the spicules are equal,



TEXT-FIG. 59.—*Kalicephalus naiae*, n. sp. Posterior end, male, lateral view.

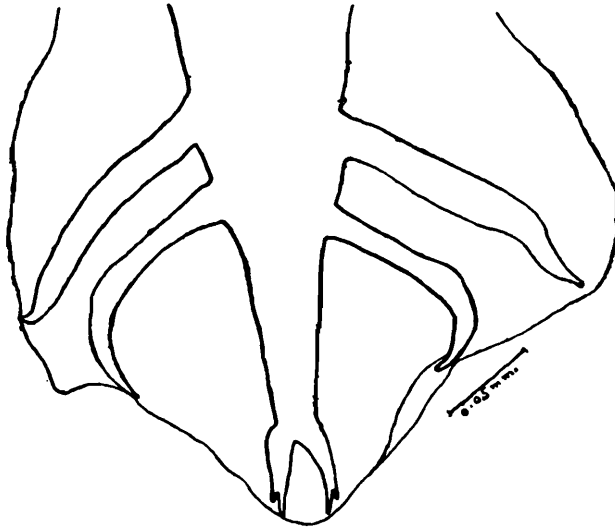
slender and recurved at their tips, and in my species the spicules are distinctly unequal. The short spicule is stouter than the long spicule, its tip is recurved and the concavity of the curve bears a membrane,



TEXT-FIG. 60.—*Kalicephalus naiae*, n. sp. Tip of short spicule.

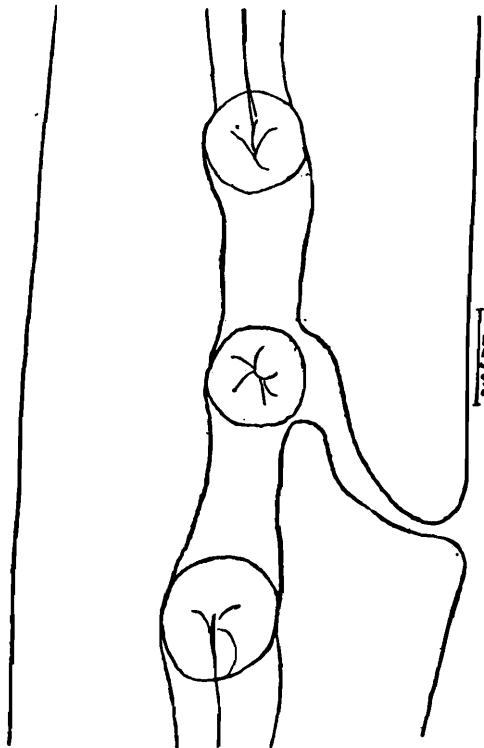
and the tip of the long spicule is straight and much finer than that of the short spicule (figs. 59 and 60). The dorsal ray is similar in both species

(fig. 61). In the female the uteri are completely divergent, in my species there are two circular muscular ejaculatory organs within the



TEXT-FIG. 61.—*Kalicephalus naiae*, n. sp. Male bursa, dorsal ray.

ovejectors a short distance from the vagina (fig. 62). The detailed description of this portion of the worm is not given by Baylis and



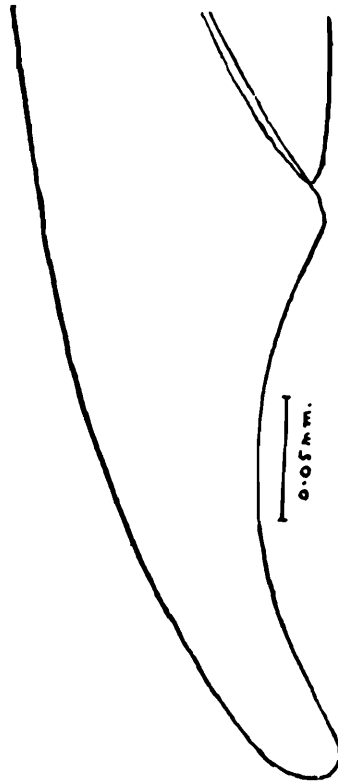
TEXT-FIG. 62.—*Kalicephalus naiae*, n. sp. Vulval region.

Daubney, so it is not possible to say whether the structure is similar to mine or not.

Although there is a very close similarity in these species the spicules and the posterior end of the male present distinct differences so it is necessary to consider mine as a new species, for which the name *Kalicephalus naiae*, n. sp. is proposed.

Type-host. Naia tripudians.

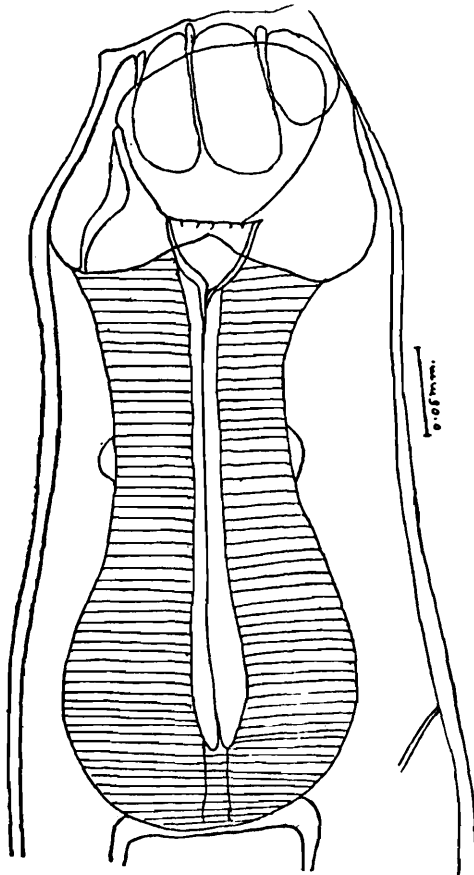
Type-specimens are in the Indian Museum, Calcutta.



TEXT-FIG. 63.—*Kalicephalus naiae*, n. sp. Posterior end, female, lateral view.

***Kalicephalus longior*, n. sp.**

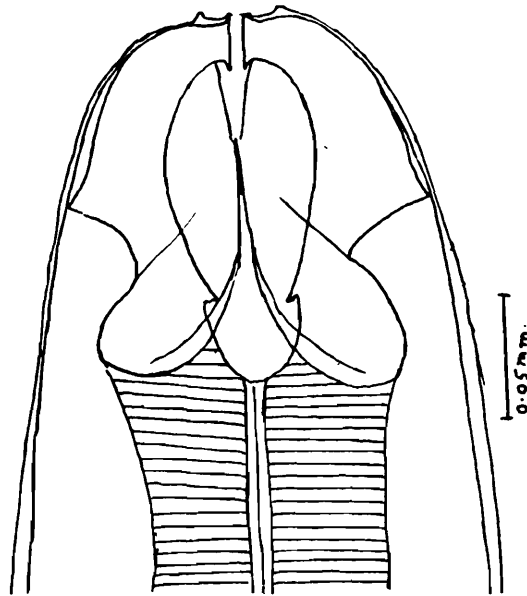
On two occasions specimens of this worm were found in the intestine of Cobras (*Naia tripudians*), and on one occasion in a Banded krait



TEXT-FIG. 64.—*Kalicephalus longior*, n. sp. Anterior end, lateral view.

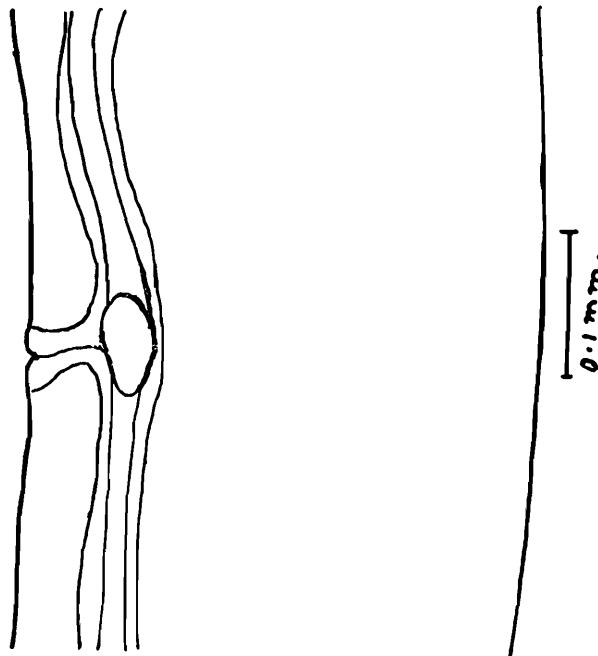
(*Bungarus fasciatus*). Only female worms were found on all occasions, and they were never in company with other worms.

The worms are distinctly larger than *K. naiae*, and the buccal capsule and oesophagus are considerably smaller than in this species (figs.



TEXT-FIG. 65.—*Kalicephalus longior*, n. sp. Anterior end, dorso-ventral view.

64 and 65). The uteri are completely divergent as in *K. naiae*, but no muscular enlargements in the ovejectors could be made out (fig. 66).

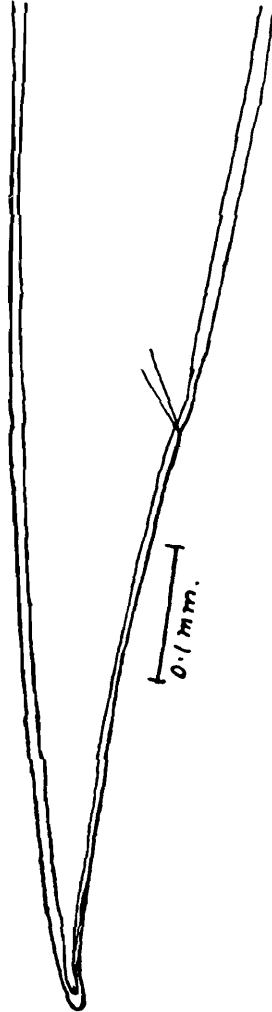


TEXT-FIG. 66.—*Kalicephalus longior*, n. sp. Vulval region.

The vulva is relatively much further forward in this species than it is in *K. naiae*, the distance from the anus to tip of tail is much longer, and this portion of the worm is of different shape (fig. 67).

This worm resembles *K. willeyi*, which is discussed below, regarding the proportion into which the vulva divides the body of the worm, but in *K. willeyi* the buccal capsule is set obliquely in the anterior end of

the worm as well as the mouth opening being slightly oblique as it is in this species (fig. 64). Another difference is that the present species is only half the length of *K. willeyi*. It is accordingly proposed to name it *Kalicephalus longior*, n. sp.



TEXT-FIG. 67.—*Kalicephalus longior*, n. sp. Posterior end, female, lateral view.

Male unknown.

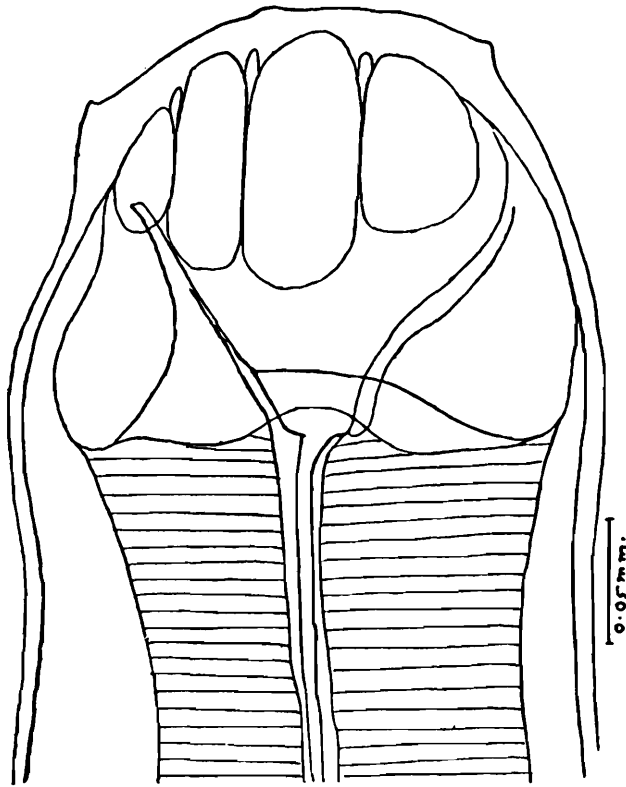
Type-host. *Naia tripudians*.

Type-specimens are in the Indian Museum, Calcutta.

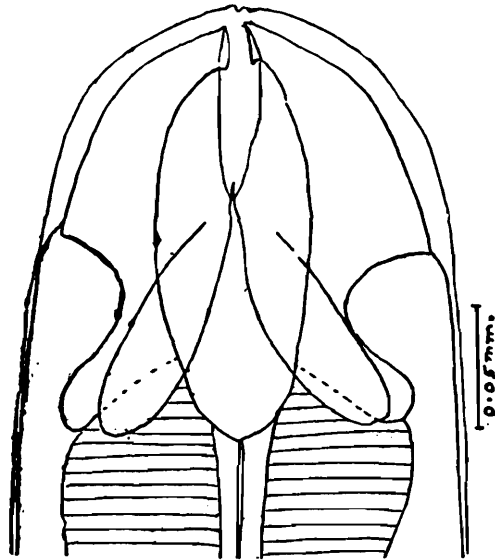
***Kalicephalus gongylophis*, n. sp.**

Two female specimens of this worm were obtained from the intestine of a Sand snake (*Gongylophis conicus*).

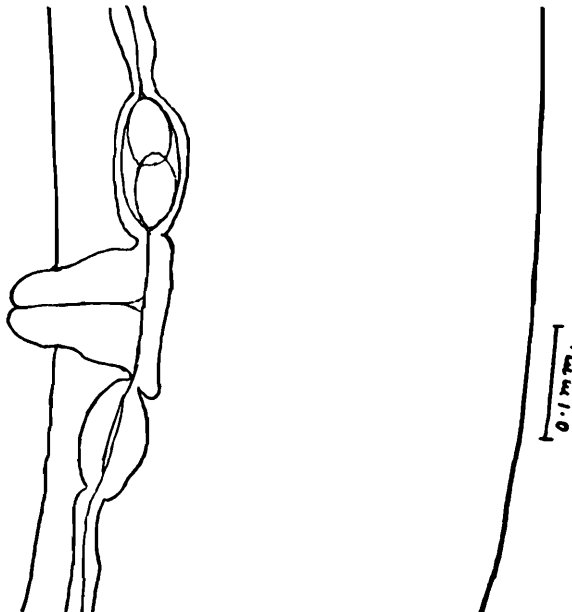
This worm is very like *K. longior* but both specimens are somewhat larger than the largest specimen of this species. The mouth opening, however, looks directly forwards (figs. 68 and 69), the vulva is markedly prominent, and the vagina is much more muscular. The ovejectors are divergent and in immediate contact with the vagina there are two large muscular ejaculatory organs, one of which contains two eggs (fig. 70). These structures are not present in *K. longior* in which the ovejectors are in the form of simple tubes without special ejaculatory



TEXT-FIG. 68.—*Kalicephalus gongylophis*, n. sp. Anterior end, lateral view.

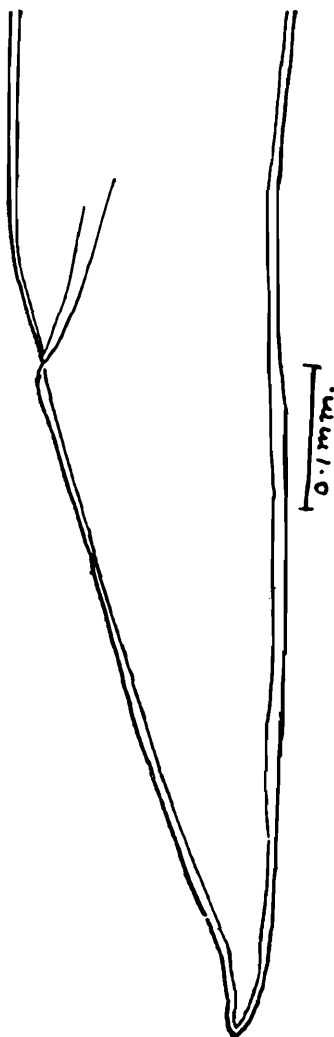


TEXT-FIG. 69.—*Kalicephalus gongylophis*, n. sp. Anterior end, dorso-ventral view.



TEXT-FIG. 70.—*Kalicephalus gongylophis*, n. sp. Vulval region.

organs (fig. 66). It is accordingly proposed to name this worm *Kalicephalus gongylophis*, n. sp.



TEXT-FIG. 71.—*Kalicephalus gongylophis*, n. sp. Posterior end, female, lateral view.

Male unknown.

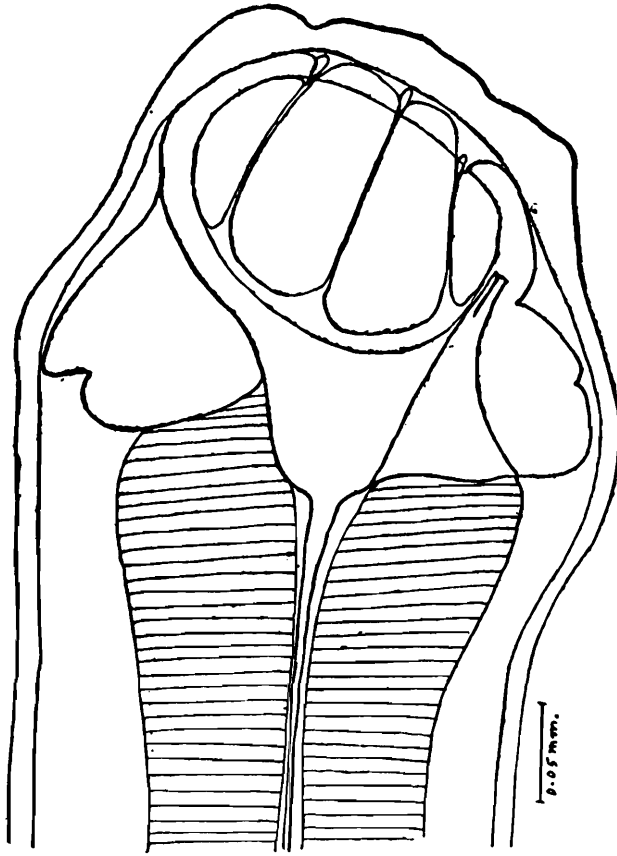
Type-specimens are in the Indian Museum, Calcutta.

***Kalicephalus willeyi* Linstow, 1904.**

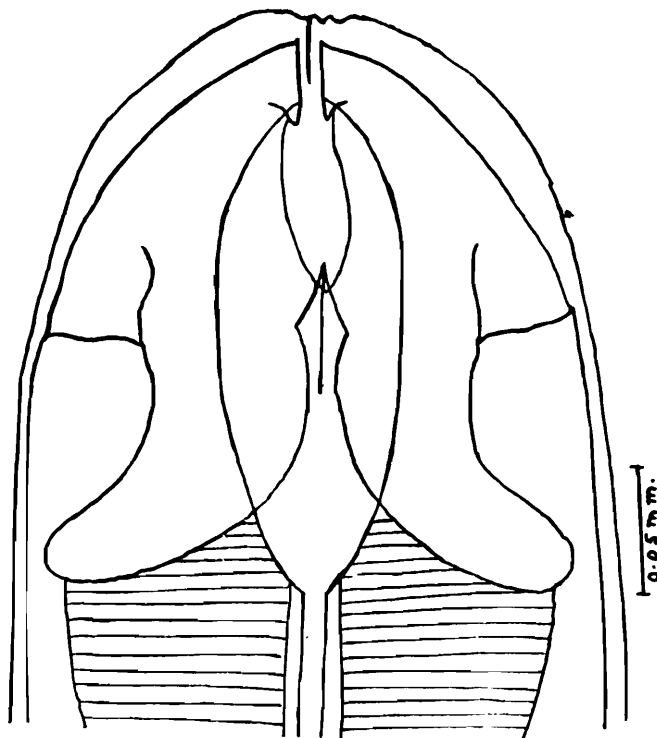
Two large collections of this worm were recovered from the intestine of Russell's vipers (*Vipera russelli*), and as in the case of previous workers only females were found.

This worm was originally described by von Linstow (1904), and Ortlepp (1923) points out the doubt that exists as to the correctness of von Linstow's description, which doubt is confirmed as a result of his own examination of this species, and that of Baylis and Daubney (1922). The latter authors have given a description of the worm under the title "*Diaphanocephalus* sp.", but they give no drawings. No satisfactory drawings of this worm are in existence and also a certain amount of confusion has been caused owing to Baylis and Daubney (1922), and Daubney (1923) having described and figured as *K. willeyi*, a worm which Ortlepp (1923) has shown to be a distinct species, and for which he has erected the genus *Occipitodontus*. It is therefore considered worth while to draw and describe this worm afresh.

The mouth capsule is of the usual *Kalicephalus* type (figs. 72 and 73), but although the anterior portion of the worm looks straight forwards,



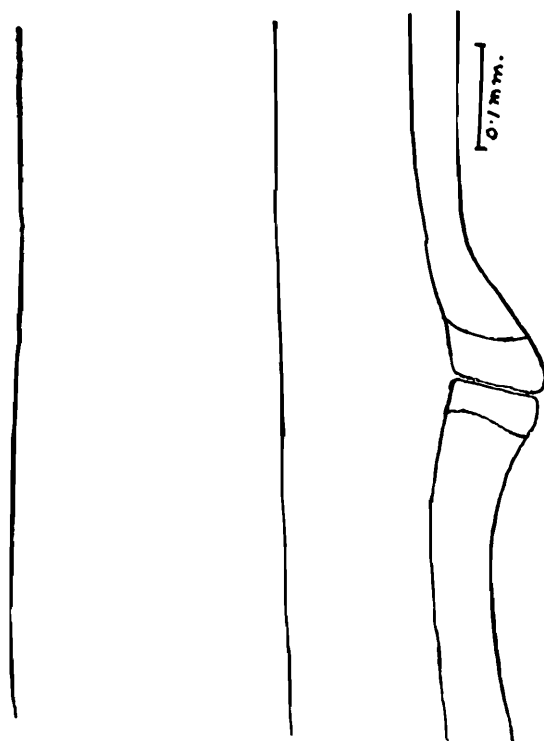
TEXT-FIG. 72.—*Kalicephalus willeyi*. Anterior end, lateral view.



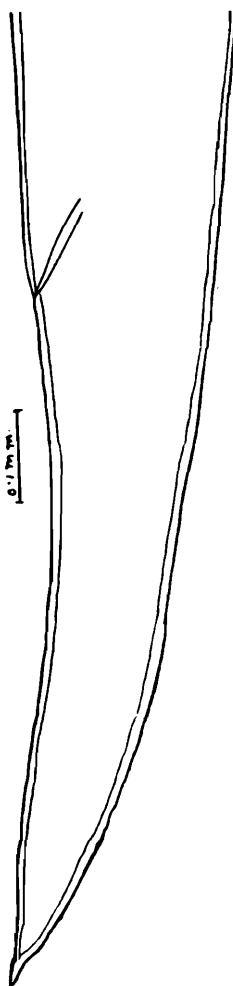
TEXT-FIG. 73.—*Kalicephalus willeyi*. Anterior end, dorso-ventral view.

the buccal capsule lies obliquely within the body, so the buccal cavity and the mouth opening faces towards the dorsal surface (fig. 72). The vulva is slightly prominent and a short vagina divides into completely divergent ovejectors in which no special ejaculatory organs could be

made out (fig. 74). The tail is relatively long and it ends in a cuticular point (fig. 75).



TEXT-FIG. 74.—*Kalicephalus willeyi*. Vulval region.



TEXT-FIG. 75.—*Kalicephalus willeyi*. Anterior end, female, lateral view.

Kalicephalus fimbriatus (Ortlepp, 1923).

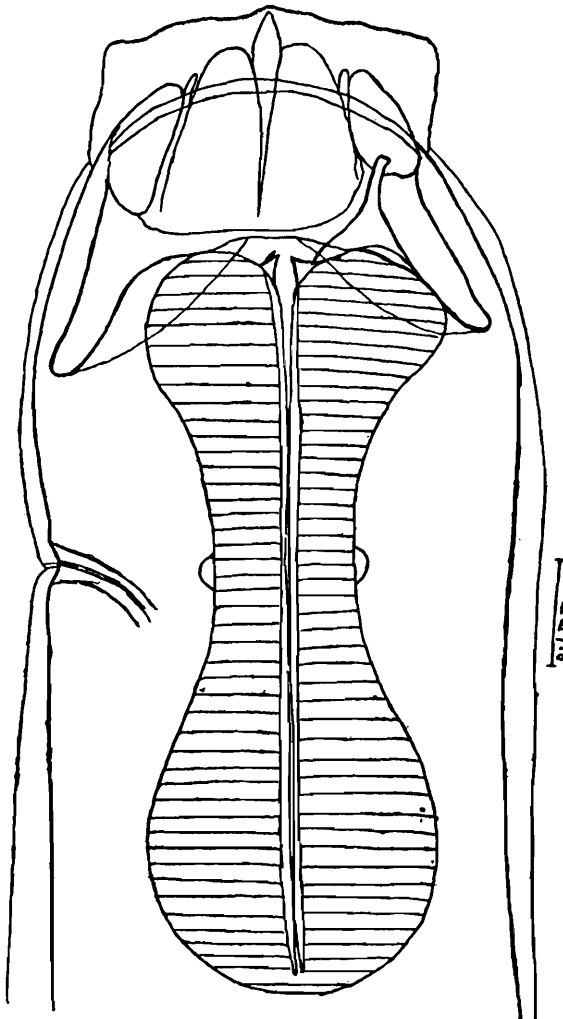
Synonym *Occipitodontus fimbriatus*, Ortlepp, 1923.

This worm, which is typically found in the Banded krait (*Bungarus fasciatus*), was differentiated from *K. willeyi*, which usually occurs in Russell's viper, by Ortlepp, (1923) who, on account of its distinctive characters, created for it the genus *Occipitodontus*, but he gives an incomplete description of the worm and no definition of the genus. Baylis and Daubney (1922) give a figure of the head in lateral view, and Daubney (1923) gives a fuller description of the worm, but no drawings except those of the anterior end. Moreover, the worm on both these occasions has been described under the name *K. willeyi*, and this is liable to lead to confusion unless the paper by Ortlepp (1923) is consulted.

Baylis and Daubney (1926) place *Occipitodontus* as a synonym of *Kalicephalus* on the ground that the corona radiata is very minute in this species, and that traces of this structure occur in other members of the genus *Kalicephalus*, and they further point out that teeth in the oesophageal funnel may or may not be present in species of the genera *Oesophagostomum* and *Globocephalus*. Their objection seems well founded, and it is followed by me in the present instance.

A single collection of this species has been found in the intestine of a Banded krait, and as the only adequate descriptions and drawings exist under an incorrect name it is proposed to give the following brief description.

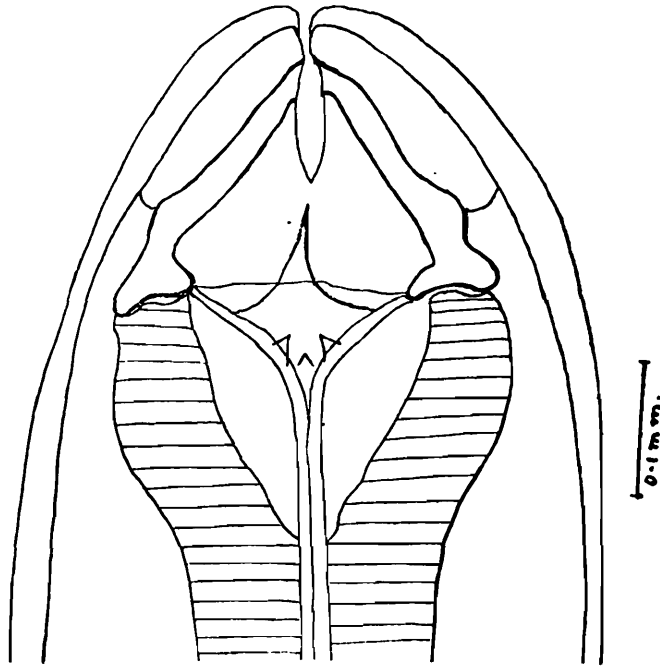
The buccal capsule differs somewhat from the type usually seen in *Kalicephalus*, as chitinous prolongations extend backwards dorsally and



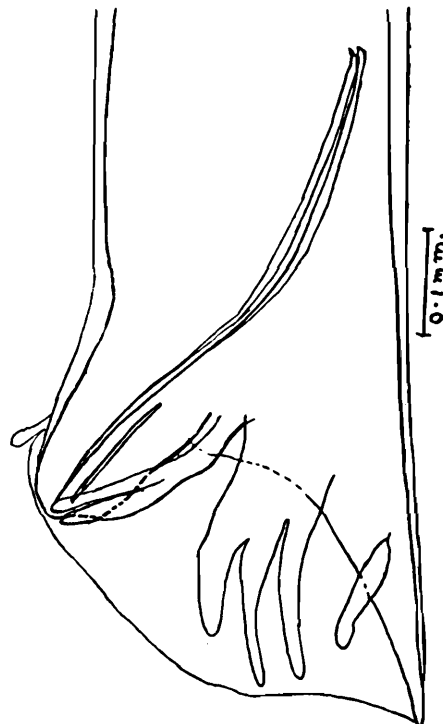
TEXT-FIG. 76.—*Kalicephalus fimbriatus*. Anterior end, lateral view.

ventrally over the expanded anterior end of the oesophagus (fig. 76). There is a very minute corona radiata situated on the inner surface of the two large rectangular cuticular lips, and the lateral papilla is much larger than the subventral and subdorsal papillae. There are two subventral teeth and one dorsal tooth projecting forwards from the anterior end of the chitinous lining of the oesophagus (figs. 76 and 77). Viewed from the dorsal aspect, the mouth cavity and the lining of the oesophageal funnel form a rhomboidal figure (fig. 77). The oesophagus is almost dumbbell-shaped as it has both anterior and posterior expansions with a narrower central portion. The excretory pore is large and it opens relatively far forwards, being opposite the nerve ring (fig. 76).

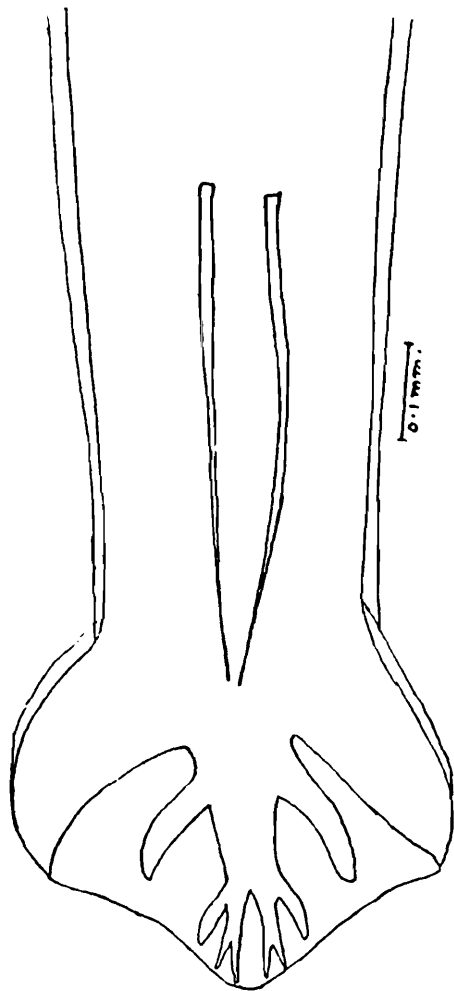
Male.—There is a prominent genital cone, and the bursal rays are arranged as shown in figs. 78 and 79. The spicules taper evenly from



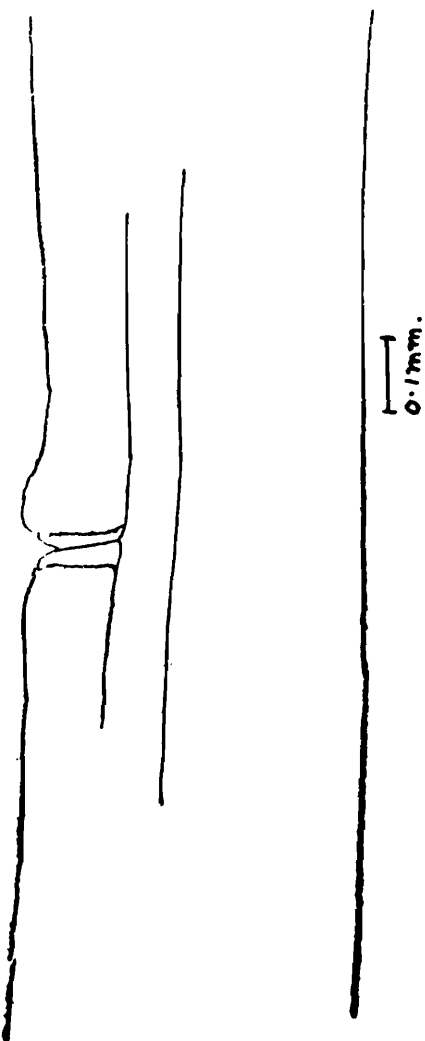
TEXT-FIG. 77.—*Kalicephalus fimbriatus*. Anterior end, dorso-ventral view.



TEXT-FIG. 78.—*Kalicephalus fimbriatus*. Posterior end, male, lateral view.



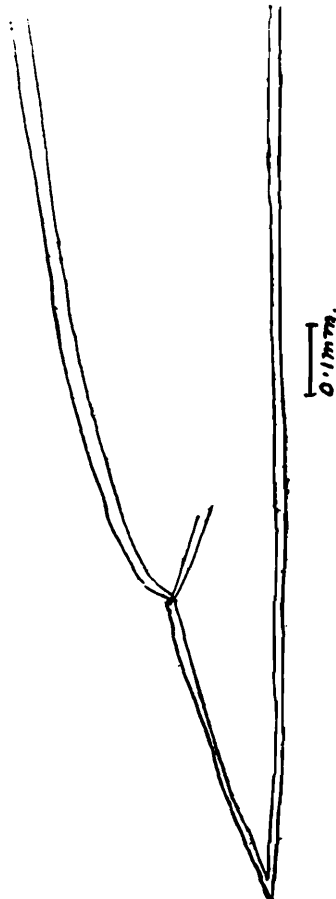
TEXT-FIG. 79.—*Kalicephalus fimbriatus*. Posterior end, male, dorsal view.



TEXT-FIG. 80.—*Kalicephalus fimbriatus*. Vulval region.

base to tip, and the posterior end of the spicule canal is chitinized along its dorsal wall, forming an indistinct gubernaculum.

Female.—The lips of the vulva are very slightly prominent and a short vagina leads into completely divergent ovejectors, which are in the form of simple tubes (fig. 80). The tail is relatively short and it ends in a straight tapering point (fig. 81).



TEXT-FIG. 81.—*Kalicephalus fimbriatus*. Posterior end, female, lateral view.

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DIMENSIONS OF THE SPECIES OF THE GENUS *KALICEPHALUS* MENTIONED IN THIS PAPER.

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	<i>K. indicus</i>		<i>K. elongatus</i>		<i>K. brachycephalus</i>	<i>K. naiae</i>		<i>K. minutus</i> (Baylis and Daubney)	
	♂	♀	♂	♀	♀	♂	♀	♂	♀
Length .	4.2—6.2	6.4—9.2	7.8—8	10.9—12.7	9.2—10.4	4.5—5.4	4.5—6.2	4.9—5.0	5.1—5.3
Diameter, maximum .	0.188—0.32	0.32—0.39	0.277—0.297	0.356—0.426	0.356	0.237—0.247	0.237—0.297	0.2	0.21
Dorso-ventral diameter, head	..	..	0.237	0.277—0.317	0.455—0.515	..	..	..	..
Lips, width	0.14—0.16	0.140—0.188	0.116—0.128	0.128—0.164	..	0.158	0.198—0.22	..	..
Buccal caps, length	0.128—0.138	0.136—0.16	0.1—0.108	0.128—0.140	0.396—0.495	0.188—0.218	0.198—0.218	..	..
Oesophagus, length .	0.267—0.297	0.27—0.33	0.287—0.297	0.336—0.356	0.614—0.654	0.455—0.475	0.495—0.554	0.45	..
Oesophageal bulb, diameter	0.128—0.148	0.128—0.188	0.12—0.136	0.132—0.172	0.277	0.188	0.198—0.208	0.15	..
Nerve ring from ant. end, oesoph.	0.07—0.08	0.08—0.1	0.088—0.1	0.104—0.124	0.148	0.16	0.16—0.18	0.09	..
Ex. pore from ant. end, oesoph.	0.14—0.19	0.2—0.29	0.208	0.208—0.24	0.22—0.25	..	0.416—0.436	0.38	0.44
Genital cone, length	..	..	0.2	..	..	0.1	..	..	..
Spicules, length .	0.35—0.47	..	0.416—0.436	..	..	0.317—0.327 and 0.415—0.515	..	0.255—0.275	..
Gubernaculum, length	0.12—0.13	..	0.14—0.148	..	..	0.12	..	..	..
Vulva to tip of tail	..	0.99—1.9	..	2.03—2.65	3.06—3.38	..	1.3—1.8	..	..
Proportion into which vulva divides body length.	..	5:1—4:1	..	4.3:1—3.8:1	2:1	..	2.2:1—2.4:1	..	2.5:1
Anus to tip of tail . .	..	0.138—0.198	..	0.614—0.673	0.317	..	0.218—0.277	..	0.28—0.3
Eggs . . .	..	0.068—0.08 × 0.036—0.04	..	0.068 × 0.044	0.076 × 0.060	..	0.08 × 0.04	..	0.068 × 0.031

Records of the Indian Museum.

[Vol. XXXIII,

DIMENSIONS OF THE SPECIES OF THE GENUS *KALICEPHALUS* MENTIONED IN THIS PAPER.

	<i>K. longior</i>	<i>K. gongylophus</i>	<i>K. willeyi</i>		<i>K. fimbriatus</i>			
			(Self)	(B. & D).	(Self)		(Daubney)	
	♀	♀	♀	♀	♂	♀	♂	♀
Length	7.38—10.5	11.1—12	19.2—19.7	16—18	9.7—12.2	12.3—17.3	10.5—11.5	15—17
Diameter, maximum	0.22—0.37	0.436—0.495	0.554—0.594	0.46—0.51	0.396—0.436	0.544—0.614	0.35	0.5
Dorso-ventral diameter, head	..	0.237	0.297—0.317	..	0.435—0.455	0.515—0.594	0.45	..
Lips, width	0.188	..	0.237—0.257	0.225	0.297	0.356	..	..
Buccal caps, length	0.128—0.144	0.178	0.218—0.228	0.21	0.218	0.257—0.297	..	0.23
Oesophagus, length	0.3—0.34	0.396	0.495—0.515	..	0.752—0.772	0.872—0.89	0.87—1.1	..
Oesophageal bulb, diameter	0.172—0.180	0.188—0.198	0.277	0.22	0.237—0.297	..	..	0.3
Nerve ring from ant. end, oesoph.	0.118—0.12	0.118	0.198	0.14	0.217—0.237	0.237—0.257	..	0.24
Ex.pore from ant. end, oesoph.	0.25	0.237	0.396	0.19	0.217—0.237	0.237—0.257	..	..
Genital cone, length	..	..	..	..	..	..	..	..
Spicules, length	..	..	..	..	0.495	..	0.435	..
Gubernaculum, length	..	..	..	..	0.136	..	..	..
Vulva to tip of tail	2.65—4.2	4.4—4.7	7.1—7.7	..	..	4.5—6.2	..	..
Proportion into which vulva divides body length.	1.6:1—1.5:1	1.5:1	1.7:1—1.5:1	1.5:1	..	1.8:1—1.7:1	..	2.1:1
Anus to tip of tail	0.336—0.396	0.475—0.495	0.792—0.852	0.72—0.75	..	0.396—0.416	..	0.37
Eggs	0.080 × 0.044	0.076 × 0.040 —0.042	0.070—0.072 × 0.040	0.080—0.048	..	..	..	0.07 × 0.55

1931.]

P. A. MAPLESTONE: *Parasitic Nematodes.*

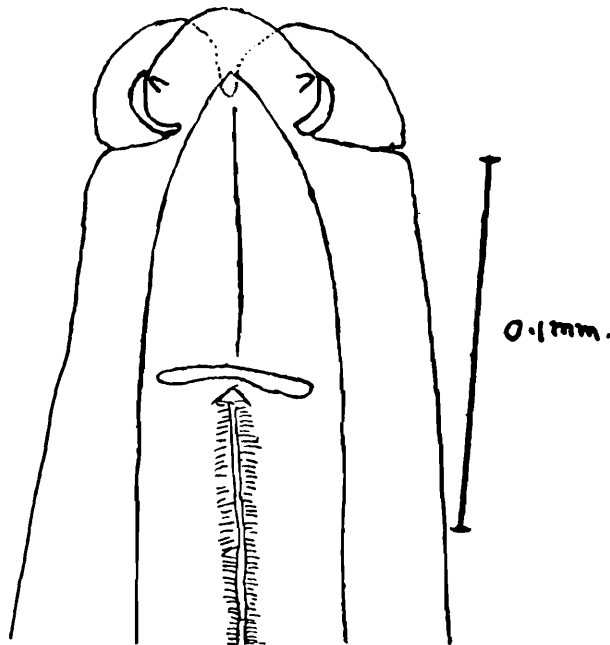
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PART 7. OXYUROIDEA.

Heterakis longespiculum, n. sp.

Specimens of this worm were obtained from the intestine of a Red-crested Wood-quail (*Rollulus roulroul*).

The head is furnished with three lips separated from the body by a deep groove. The dorsal lip is triangular with rounded angles and it bears two papillae. The ventral notch separating the sub-ventral lips is relatively deep and narrow (fig. 82). The anterior part of the oeso-



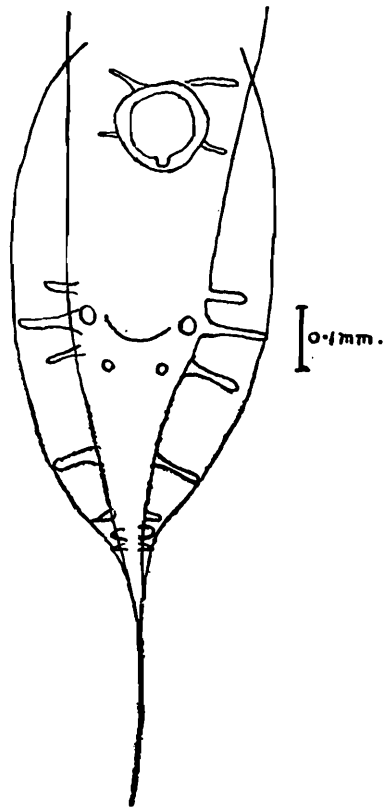
TEXT-FIG. 82.—*Heterakis longespiculum*, n. sp. Anterior end, dorsal view.

phagus is of different structure from the rest of this organ which exhibits transverse striations, and the two parts are separated from each other by a chitinous plate. The oesophagus terminates in the usual bottle-shaped enlargement typical of the genus. There are no lateral flanges.

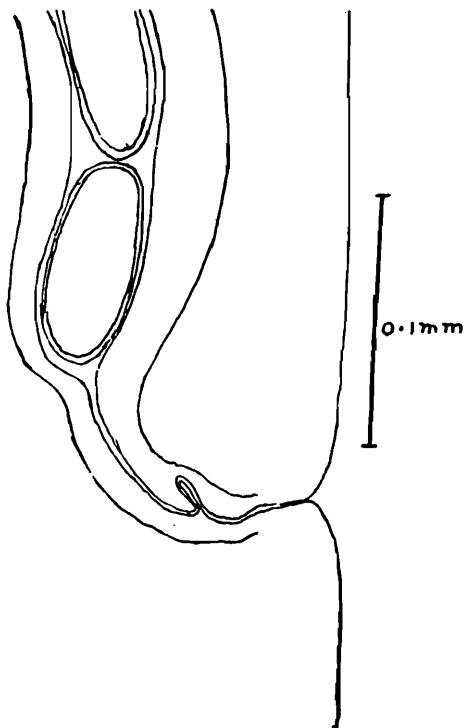
Male.—The males are 8.6 mm. in length and 0.4 mm. in diameter. The anterior portion of the oesophagus is 0.09 mm. in length, and its total length is 1.2 mm. The caudal alae are symmetrical semilunar structures, and the tail ends in a long fine point (fig. 83). The sucker is 0.068 mm. in diameter and it has a notch on its posterior border. The posterior border is 0.18 mm. anterior to the cloaca, and the distance from the cloaca to the tip of the tail is 0.455 mm. There are eleven pairs of caudal papillae whose arrangement can be seen in fig. 83. The spicules are very long, unequal and dissimilar. The long spicule is 4.1 mm. in length and is thin and straight. The short spicule is 2.08 mm. in length; it is relatively thick and it ends in a sharp point; it has relatively broad alae on each side for the whole of its length.

Female.—The female is 8.79 mm. in length and 0.4 mm. in diameter. The anterior portion of the oesophagus is 0.096 mm. in length, and its total length is 1.5 mm. The vulva opens 4 mm. from the tip of the tail. There is a short vagina curving inwards and forwards, which opens into a long ovejector (fig. 84). On account of the large number of eggs present

in all the specimens its division into the two uteri could not be made out. There is a cuticular rectum 0.218 mm. in length, and its junction with



TEXT-FIG. 83.—*Heterakis longespiculum*, n. sp. Posterior end, male, ventral view.



TEXT-FIG. 84.—*Heterakis longespiculum*, n. sp. Vulval region.

the intestine is clearly marked. The tail ends in a long straight tip, and the distance from the anus to the tip of the tail is 1.5 mm. The eggs are oval with parallel sides and bluntly rounded ends, they are 0.072×0.036 mm.

The great length of the spicules clearly differentiates this species from all other members of the genus *Heterakis*, and another uncommon character which it possesses is the groove separating the lips from the rest of the body. It is accordingly proposed to name this worm *Heterakis longespiculum*, n. sp.

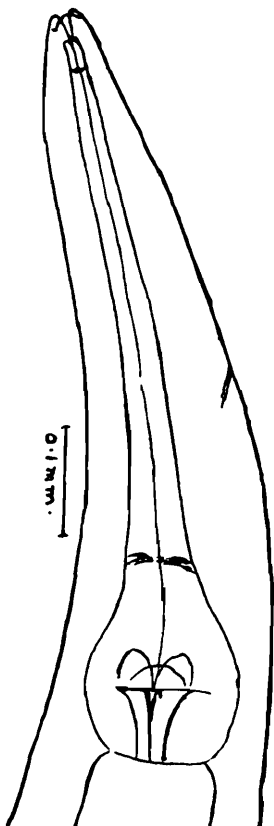
Host.—*Rollulus roulroul*.

Type-specimens are in the Indian Museum, Calcutta.

***Heterakis parva*, n. sp.**

These worms were obtained from a Silver pheasant (*Euplocamus nycthemerus*) along with some specimens of *Heterakis longicaudata*.

The mouth is surrounded by three broad semicircular lips all of the same size and shape, and each bearing a papilla. The lips are not divided from the body by a groove. There are no lateral flanges (figs. 85 and 86).

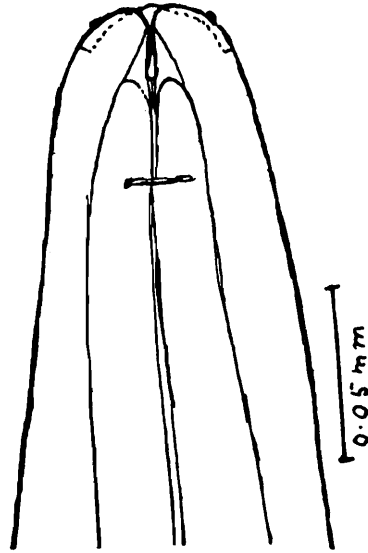


TEXT-FIG. 85.—*Heterakis parva*, n. sp. Anterior end, lateral view.

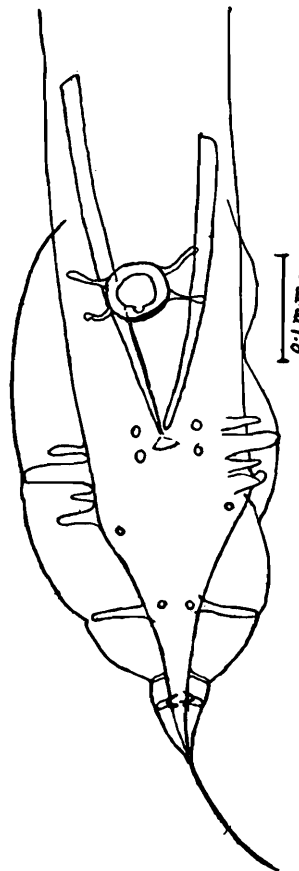
Male.—The male is 4.68 mm. in length and 0.247 mm. in maximum diameter. The oesophagus including the bulb is 0.634 mm. in length, and the short anterior portion is 0.044 mm. in length. The sucker is circular with a notch on its posterior border, which is 0.118 mm. anterior to the cloaca; it is 0.062 mm. in diameter. The tail is 0.356 mm. in length. There are broad caudal alae, and fourteen pairs of papillae, whose size and arrangement can be seen in fig. 87. The spicules are similar in shape but unequal, one being 0.317 and the other 0.277 mm. in length.

Female.—The female is 6.03 mm. in length and 0.376 mm. in maximum diameter. The oesophagus is 0.673 mm. in length including the

bulb. The vulva opens with slightly prominent lips 2.65 mm. from the tip of the tail. A stout vagina runs directly inwards from the vulva for a distance of 0.090 mm., where it divides into divergent uteri. The distance from the anus to tip of tail is 0.594 mm. The eggs measure $0.060-0.062 \times 0.032-0.034$ mm.



TEXT-FIG. 86.—*Heterakis parva*, n. sp. Anterior end, ventral view.



TEXT-FIG. 87.—*Heterakis parva*, n. sp. Posterior end, male, ventral view.

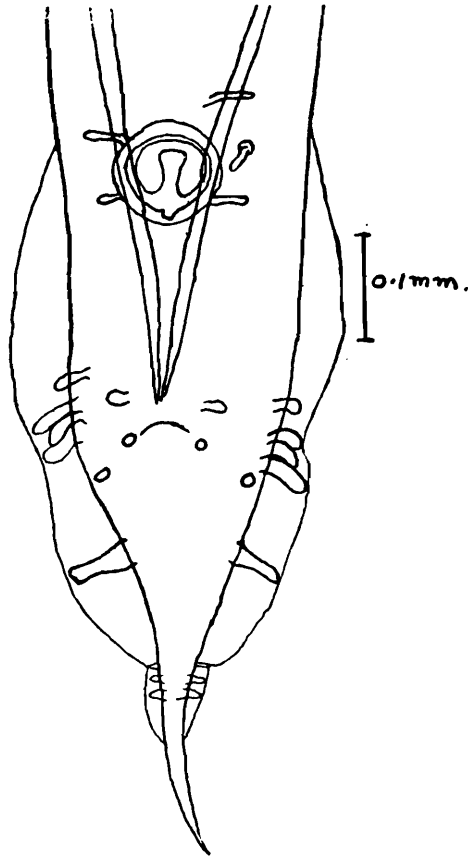
This worm differs from all the other species of *Heterakis* so it is proposed to name it *Heterakis parva*, n. sp.

Host.—*Euplocamus nychtemerus*.

Type-specimens are in the Indian Museum, Calcutta.

***Heterakis variabilis* Chandler, 1926.**

Chandler (1926) described this species from the Peacock pheasant (*Polyplectrum bicalcaratum*) which died in the Calcutta Zoological Gardens. I have recently obtained some specimens from the same host and the same locality, which agree in all essential particulars with Chandler's description. He describes and figures a rather unusual arrangement of the paracloacal papillae. The anterior pair of this group are said to be placed further forward than is usual and they are asymmetrical; a further peculiarity is that the left papilla of this pair is split in two. Chandler does not say how many males he examined, so it is not clear if this arrangement was constant in several specimens, or was only present in a single example.



TEXT-FIG. 88.—*Heterakis variabilis*. Posterior end, male, ventral view.

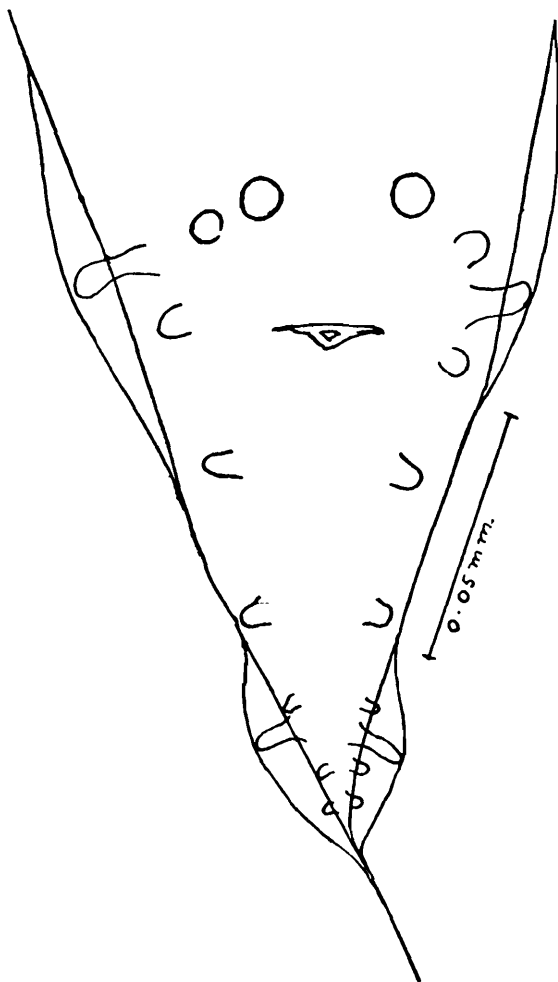
My collection obtained from several birds of the same species contains a number of males, and in most of them the anterior pair of paracloacal papillae are situated close in front of the remaining papillae of this group, and neither of them are bifurcated. In the specimen from which fig. 88 has been drawn it will be noted that there is an accessory papilla on the left side anterior to the sucker. This is clearly an abnormality for it is only present in two of my specimens, and I have a single specimen in a large collection of males of "*Ganguleterakis*" *spumosa*, which exhibits a similar accessory papilla. In some of my specimens there is a third pair of sessile papillae slightly behind and external to the two pairs of sessile paracloacal papillae normally present. It might be thought that these differences in papillae indicate a new species, but this is not considered to be the case, for none of the differences noted appeared constant in any single collection of worms, and they are identical with the

type in all other characters and dimensions, therefore it seems that Chandler has described as the type, what is really only an abnormality, and that the papillae of this species are subject to considerable individual variation.

***Allodapa multipapillata* Chandler, 1926.**

Specimens of this worm have on several occasions been obtained from the Red-crested Wood-quail (*Rollulus roulroul*), the host from which Chandler (1926) originally described it.

My material agrees in all points with Chandler's description, but as he apparently did not obtain a ventral view of the tail of the male he failed to notice the presence of two pairs of narrow caudal alae, and in consequence did not fully appreciate the arrangement of the caudal papillae. One pair of alae is opposite the cloaca and each one is supported by a single pedunculate papilla. In ventral view these papillae are seen to be just anterior to the cloaca, but in the curved lateral view figured by Chandler they seem to be behind the cloaca. The second pair of alae is situated near the tip of the tail and they are also each supported by a single pedunculate papilla (fig. 89). It is obvious that



TEXT-FIG. 89.—*Allodapa multipapillata*. Posterior end, male, ventral view.

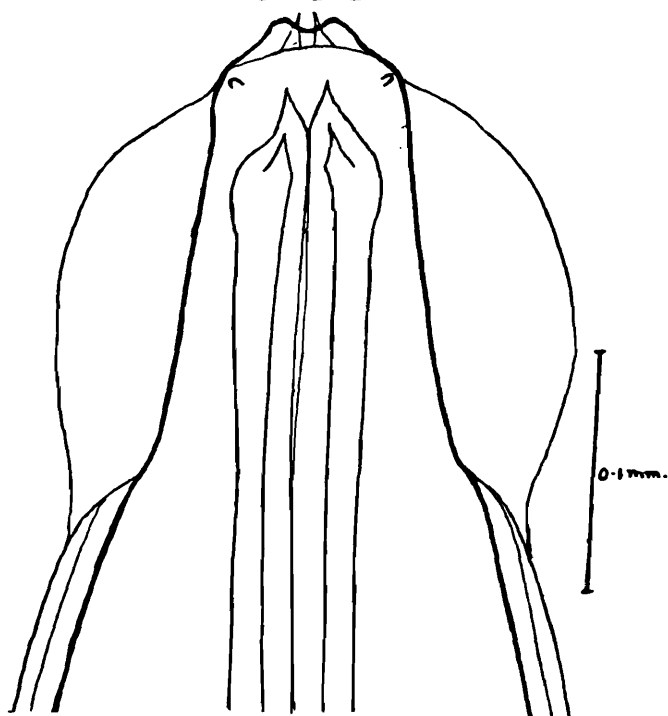
these four pedunculate papillae supporting the four alae are the ones described by Chandler as follows. "One pair of lateral papillae is situated at the level of the anus while the other is at the level of the fourth

ventral postanal." The row of preanal papillae agree in my material with Chandler's description and drawing.

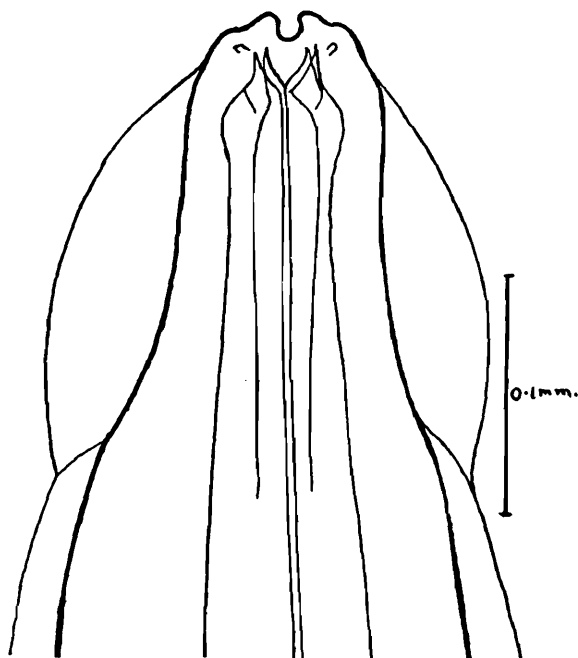
***Syphaciella indica*, n. sp.**

These worms were obtained from the intestine of a Sand grouse (*Pterocleres exustus*).

These small worms have a distinct cuticular inflation and lateral flanges. The body of the worm becomes suddenly wider opposite the termination of the cuticular inflation. The mouth is bounded by three bilobed lips. The dorsal lip bears two finely pointed structures on its inner surface, and they project beyond the lip anteriorly. On the external surface of the dorsal lip there are two papillae (fig. 90). The sub-ventral lips each bear a single papilla (fig. 91). The anterior end of

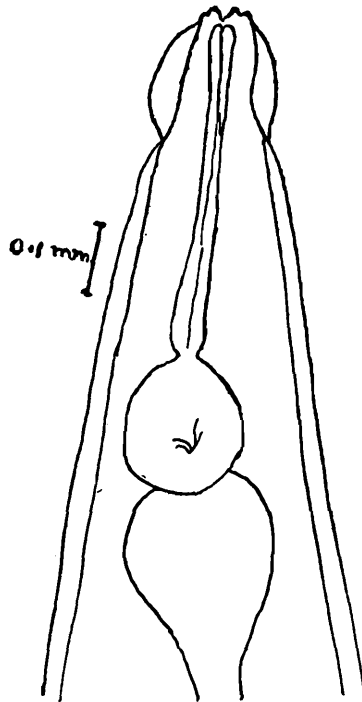


TEXT-FIG. 90.—*Syphaciella indica*, n. sp. Anterior end, dorsal view.

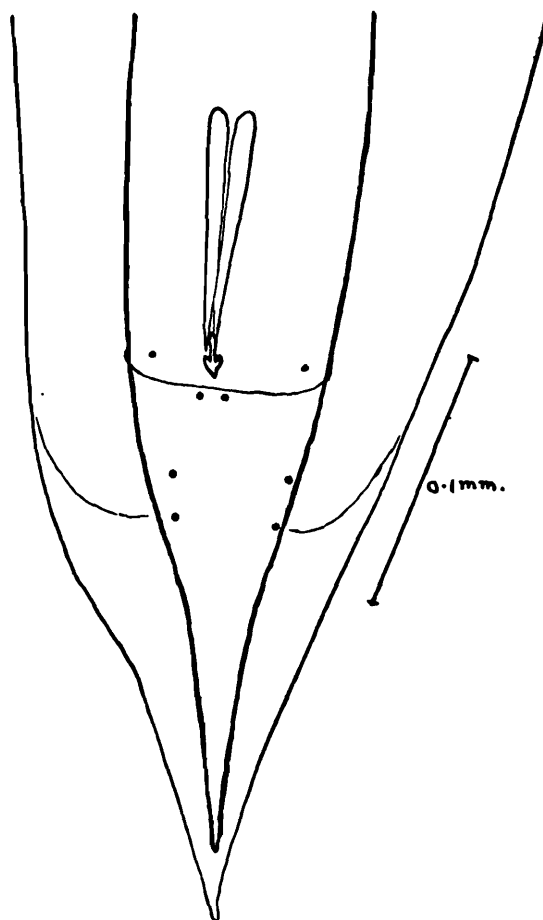


TEXT-FIG. 91.—*Syphaciella indica*, n. sp. Anterior end, ventral view.

the oesophagus is slightly expanded, and it is armed with a pair of pointed teeth on each side of its anterior end. The posterior end of the oesophagus is slightly expanded and this expansion is separated from a glo-



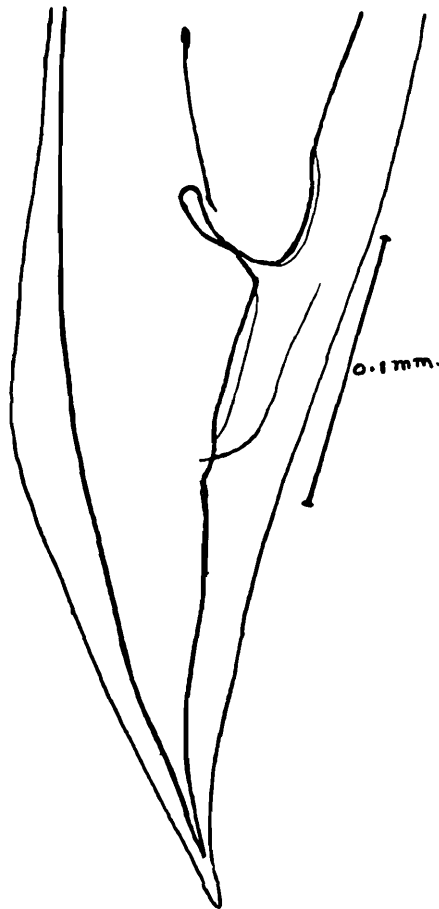
TEXT-FIG. 92.—*Syphaciella indica*, n. sp. Anterior end, low power to show oesophagus.



TEXT-FIG. 93.—*Syphaciella indica*, n. sp. Posterior end, male, ventral view.

bular bulb by a constriction. The intestine has an inverted bottle-shaped expansion at its junction with the oesophagus (fig. 92).

Male.—The males are 3.4 mm. in length with a diameter of about 0.29 mm. The total length of the oesophagus is 0.49-0.51 mm. The tail is straight and pointed and it has on each side relatively broad lateral alae, which are in direct continuation with the lateral flanges. The caudal alae, becoming narrower towards the tail, meet in a sharp point posterior to its tip (fig. 93). There are four pairs of very small papillae on the ventral surface whose position can be seen in fig. 93. The spicules are delicate and straight, their proximal ends are rounded, from which they taper to end in fine points. The gubernaculum is more heavily chitinized, and in lateral view it is seen to be a slightly curved structure, which tapers from base to tip in a similar manner to the spicules (fig. 94). The spicules are 0.084 mm. in length and the gubernaculum is 0.037 mm. in length.

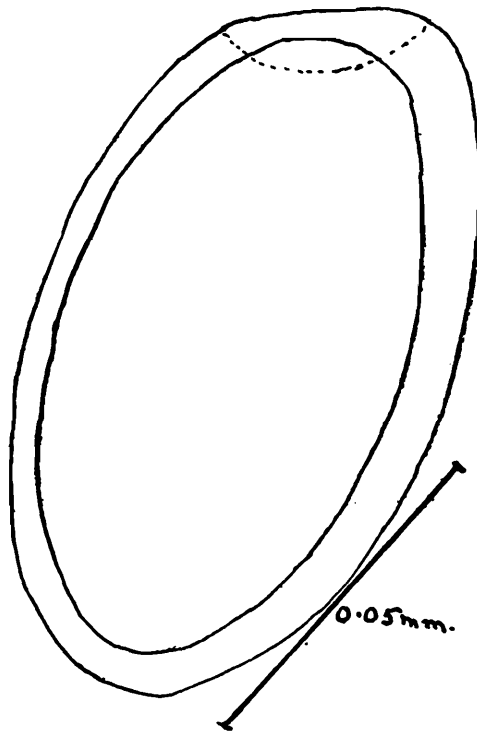


TEXT-FIG. 94.—*Syphaciella indica*, n. sp. Posterior end, male, lateral view.

Female.—The females are 5.5 to 6.6 mm. in length and 0.38 to 0.4 mm. in diameter. The cephalic inflation is 0.168 to 0.184 mm. in length, and the oesophagus is about 0.67 mm. in length. The tail ends in a long fine point and the distance from the anus to the tip is about 1 mm. The vulva is situated about 1.4 mm. from the anterior end. The eggs are oval and thick-shelled, appearing slightly thicker on one side than on the other. The shell is very finely striated and at one pole, where there is an operculum, it is slightly flattened (fig. 95).

This worm is very similar in size and in many of its other characters to *S. capensis* Monnig, 1924, which is the only other species of the genus

hitherto described, but it differs in the possession of a cephalic vesicle, and in the arrangement of the papillae on the tail of the male. It is therefore proposed to name it *Syphaciella indica*, n. sp.



TEXT-FIG. 95.—*Syphaciella indica*, n. sp. Egg.

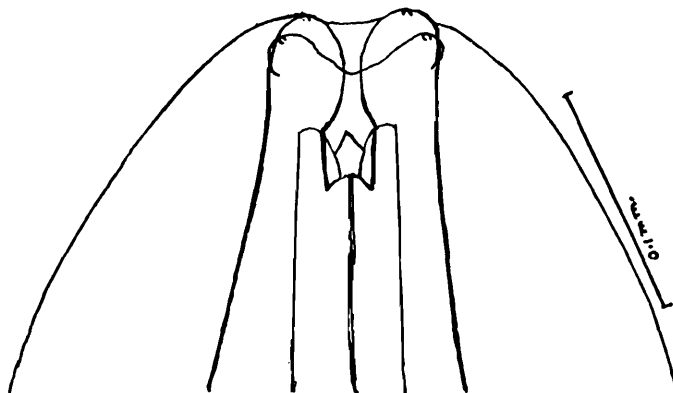
Host.—*Pterocleres exustus*.

Type-specimens are in the Indian Museum, Calcutta.

***Subulura turnicis*, n. sp.**

These worms were found in the intestine of a Little Quail (*Turnix dussumieri*).

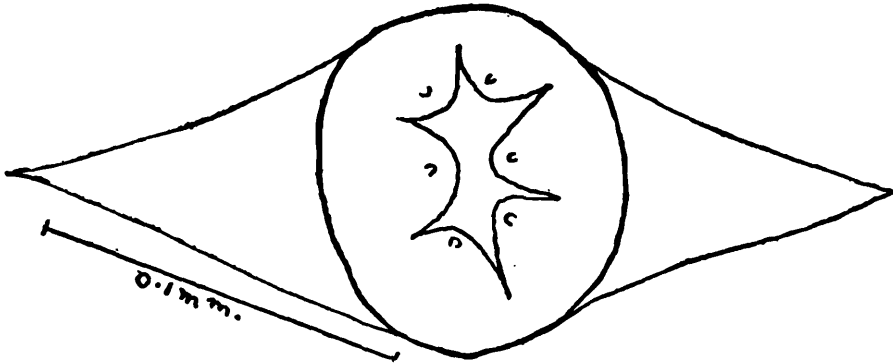
The mouth is surrounded by six broad lips each of which bears a papilla, or two lateral tri-lobed lips (figs. 96 and 97). There are broad



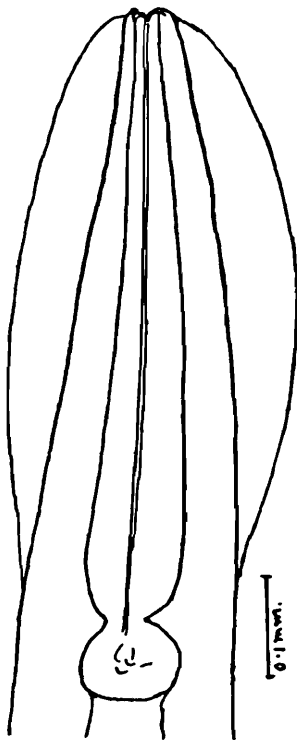
TEXT-FIG. 96.—*Subulura turnicis*, n. sp. Anterior end, dorsal view.

cervical alae on each side of the head; they arise from the bases of the lips and extend posteriorly to about opposite the junction of the anterior part of the oesophagus with its bulb (fig. 98). The oesophagus consists of a relatively long anterior portion separated from a terminal bulb by

a constriction. The mouth leads into a thinly-chitinized vestibule the posterior part of which is within the anterior end of the oesophagus, it is 0.056 mm. in depth and 0.032 mm. in diameter, and three broad teeth arise from its base (fig. 96).



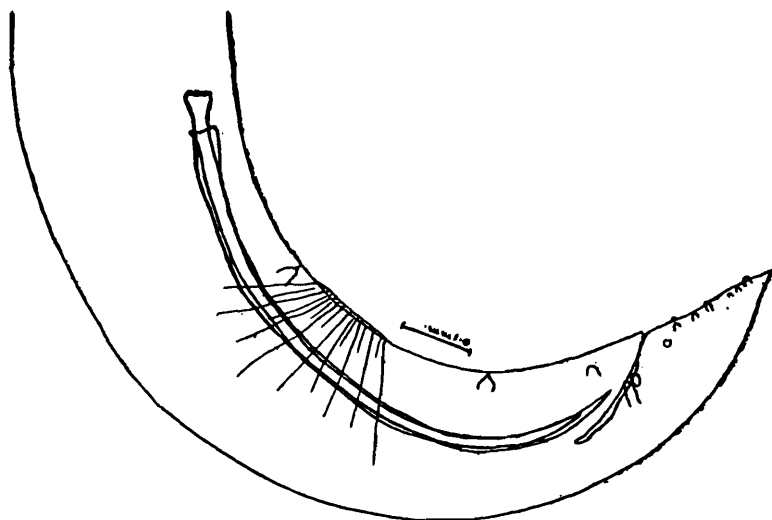
TEXT-FIG. 97.—*Subulura turnicis*, n. sp. Anterior end, end-on view.



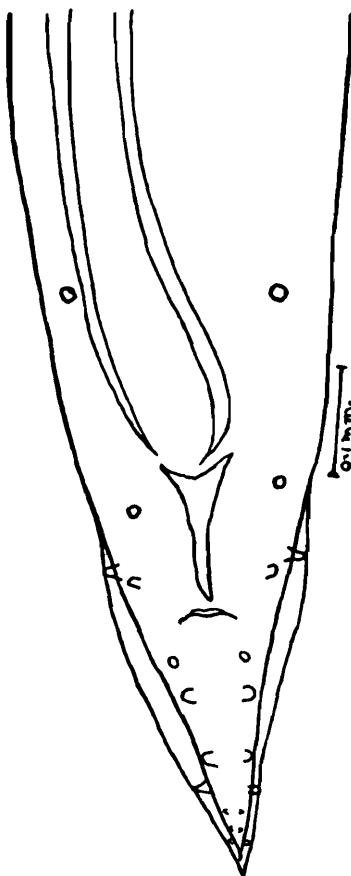
TEXT-FIG. 98.—*Subulura turnicis*, n. sp. Anterior end, low power to show oesophagus.

Male.—The males are 13 mm. in length and 0.42 mm. in maximum diameter. The cervical alae are about 0.8 mm. in length. The total length of the oesophagus is about 1 mm., the bulb being 0.17 mm. in diameter. The posterior end of the worm is curved ventrally (fig. 99). There is an ill-defined oval sucker about 0.120 mm. in length with its posterior border about 0.36 mm. in front of the cloaca. The cloaca is 0.22 mm. from the tip of the tail. There is a pair of narrow caudal alae which extend from a little in front of the cloaca to meet in a point beyond the tip of the tail (fig. 100). There are twelve pairs of caudal papillae, which may be conveniently described in three groups. The first group consists of three large precloacal papillae in a row, the most anterior being just in front of the sucker. The second group consists of three pairs of pedunculate papillae supporting the caudal alae, one of these is just anterior to the cloaca and the other two pairs are near the tip of the

tail. The third group consists of six pairs of sessile papillae more centrally placed on the sub-ventral surface, one pair of this group is precloacal the remainder lying in a row behind it (fig. 108). The spicules are equal and curved ending in sharp points, they are 0.84 mm. in length (fig. 99). The gubernaculum is triangular in ventral view and it is 0.14 mm. in length (fig. 100).



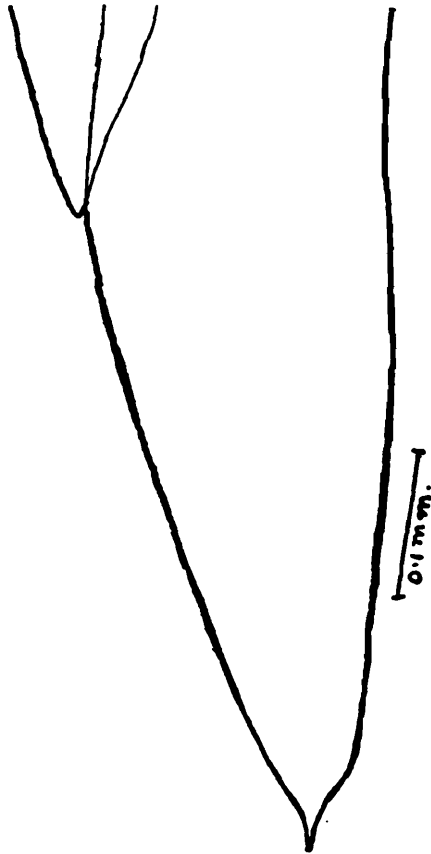
TEXT-FIG. 99.—*Subulura turnicis*, n. sp. Posterior end, male, lateral view.



TEXT-FIG. 100.—*Subulura turnicis*, n. sp. Posterior end, male, ventral view.

Female.—The females are 17.5 mm. in length and 0.42 mm. in maximum diameter. The cervical alae are about 1 mm. in length, and the oesophagus is 1.2 mm. in total length, the bulb being about 0.18 mm. in

diameter. The vulva opens about 7.8 mm. from the anterior end. The tail is straight and ends in a fine cuticular point, becoming suddenly narrower near its tip (fig. 101). The anus is 0.5 mm. from the tip of the tail and the sensory papillae are about 0.13 mm. anterior to the latter. The eggs are thin-shelled and measure $0.068-0.074 \times 0.056$ mm.



TEXT-FIG. 101.—*Subulura turnicis*, n. sp. Posterior end, female, lateral view.

This worm shows a superficial resemblance to *S. galloperdicis* Baylis and Daubney, 1922, as many of the dimensions are very close. These authors did not describe the vestibule in detail, but examination of the material of this species in the Indian Museum shows that its vestibule is divided into two parts, a character which, according to some authors, distinguishes between the genera *Allodapa* and *Subulura*, although Baylis and Daubney (1926) and Cram (1927) follow Barreto (1919) in regarding this only as a specific character. At all events this point clearly serves to distinguish between the present material and *S. galloperdicis*. My material is possibly identical with two damaged females obtained from a *Turnix* sp. in the Calcutta Zoological Gardens, and imperfectly described by Baylis and Daubney (1922). They were unable to classify the worms further than to say they belonged to a *Subulura* species, but, as many of the measurements given agree with mine, it seems probable the worms are identical. My specimens differ from other members of the genus *Subulura* by the possession of broad cervical alae and twelve pairs of caudal papillae in the male, most species of this genus having eleven pairs. It is therefore proposed to name this worm *Subulura turnicis*, n. sp.

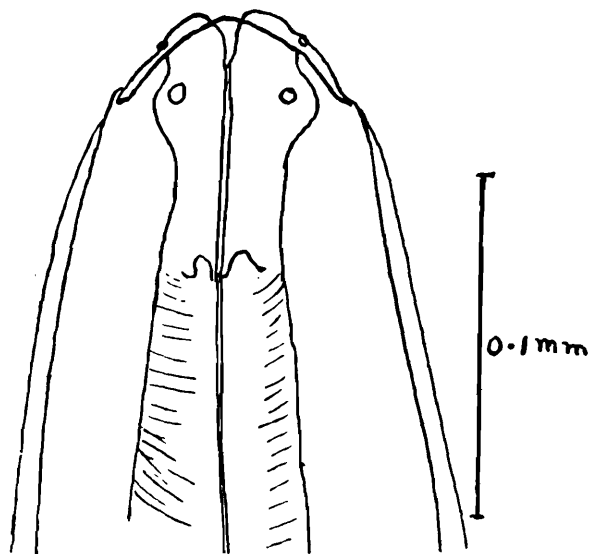
Host.—*Turnix dussumieri*.

Type-specimens are in the Indian Museum, Calcutta.

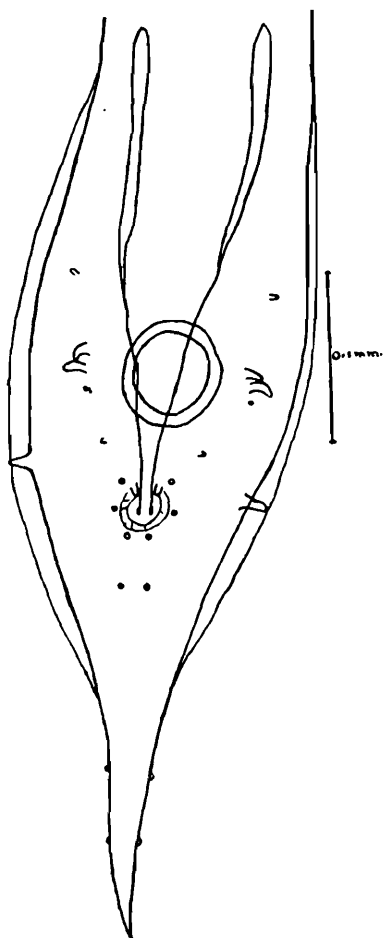
***Africana varani*, n. sp.**

These worms were obtained from the intestine of a Bengal monitor (*Varanus bengalensis*).

The worms are slightly attenuate anteriorly and there are narrow lateral flanges. The mouth is bounded by three lips. The dorsal lip is broad and conical and it bears two papillae, the sub-ventral lips are narrower and each bear a single papilla (fig. 102). The oesophagus is



TEXT-FIG. 102.—*Africana varani*, n. sp. Anterior end, dorsal view.

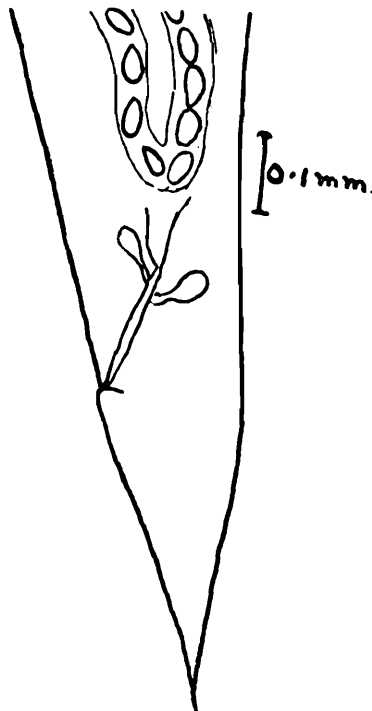


TEXT-FIG. 103.—*Africana varani*, n. sp. Posterior end, male, ventral view.

divided into two portions, a short anterior part without striations and a long posterior part distinctly striated. The oesophagus terminates in a rounded bulb containing a valvular apparatus.

Male.—The males are about 4 mm. in length and 0.192 mm. in diameter, and the lateral flanges are about 0.016 mm. in breadth. The excretory pore is about 0.49 mm. from the anterior end and the total length of the oesophagus is 0.83 mm. The posterior portion of the worm exhibits a fusiform swelling the greatest diameter of which is opposite the sucker (fig. 103). From this point it narrows rapidly and ends in a sharp pointed tail which is strongly curved towards the ventral surface. There are thirteen pairs of papillae some of which are large and pedunculated, and some of which are small and sessile, and in addition there is a small unpaired papilla anterior to the sucker. The size and arrangement of the papillae can be seen in fig. 103. There are a pair of long narrow caudal alae supported by a single large papilla on each side. There is a large circular sucker in front of the claca, and the latter opening is surrounded by a circular sphincter muscle in which radial striations are visible. The spicules are equal and about 0.34 mm. in length. The proximal half of the spicules is relatively stout and the distal half is thin and whip-like. There is no gubernaculum (fig. 103).

Female.—The females are about 6 mm. in length and 0.35 mm. in diameter. The cervical papillae are 0.43 mm. from the anterior end and the length of the oesophagus including the bulb is 1.01 mm. The tail is straight and pointed and the anus is situated 0.376 mm. from its tip (fig. 104). The vulva opens 2.7 mm. from the anterior end of the worm



TEXT-FIG. 104.—*Africana varani*, n. sp. Posterior end, female, lateral view.

and the vagina runs posteriorly from it. Owing to the large number of eggs present the division of the vagina into the two uteri could not be made out. The eggs are oval and measure $0.668-0.072 \times 0.036-0.041$ mm.

Taylor (1924) gives a table of differences of the known species of this genus, and the present species differs from all of them in several

particulars, therefore it is proposed to name the worm *Africana varani*, n. sp.

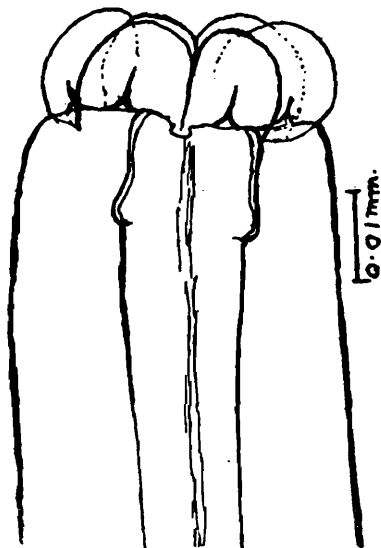
Host.—*Varanus bengalensis*.

Type-specimens are in the Indian Museum, Calcutta.

***Probstmayria simiae*, n. sp.**

This worm was found in enormous numbers in the mucus scraped from the upper part of the small intestine of a Hoolock (*Hylobates hoolock*).

The cuticle is transversely striated and there are six large semi-globular lips (or three bilobed lips), and into each lobe a central pointed core runs (fig. 105). No external papillae are visible on the lips, which

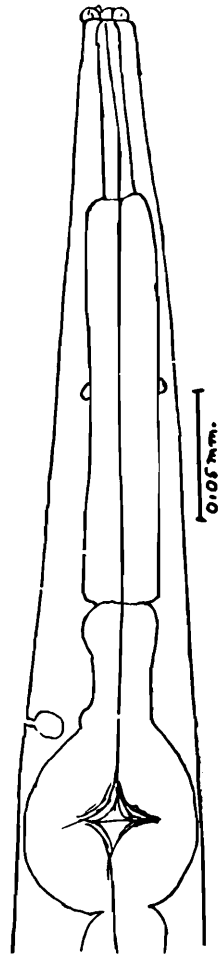


TEXT-FIG 105.—*Probstmayria simiae*, n. sp. Anterior end, dorsal view.

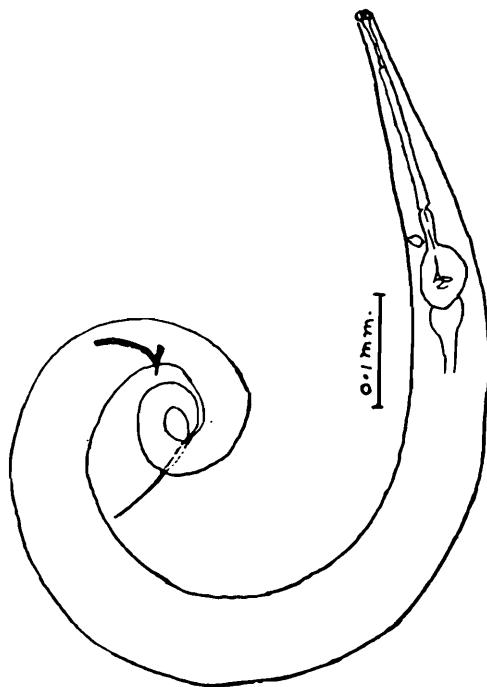
are about 0.010-0.012 mm. in length. There is a chitinous vestibule or pharynx, 0.060-0.065 mm. in length and 0.015 mm. in diameter, under the high power it is seen to be finely striated. The anterior portion of the pharynx for a distance of 0.012 mm. is of slightly greater diameter than the remainder and it is lined with cuticle (fig. 105). The oesophagus consists of two parts, the anterior part is cylindrical, about 0.17 mm. in length and 0.015 mm. in diameter, the posterior part is flask-shaped, being 0.11 mm. in length and terminating in a spherical bulb 0.060 mm. in diameter. The bulb is furnished with a powerful valvular apparatus. Under the oil immersion the cusps of this valve are seen to be covered with fine concentric ridges so it appears possible that it may have a grinding function, like a gizzard (fig. 106). The nerve ring is 0.148 mm from the anterior end, and the excretory pore opens just in front of the oesophageal bulb (fig. 106). It is exceptionally distinct as it leads into a relatively large globular vesicle.

Male.—The males are curved ventrally in their posterior half (figs. 107 and 108). They are 1.5—1.6 mm. in length, and 0.076 mm. in diameter. The tail ends in a fine tapering point about 0.036 mm. posterior to the cloaca. There are four pairs of papillae posterior to the cloaca and no precloacal papillae (fig. 109). The spicules are unequal and

dissimilar. One is short, straight and relatively thick, it is 0.04 mm. in length, the other is more delicate and curved like a sabre blade, it is 0.08 mm. in length. There is no gubernaculum.

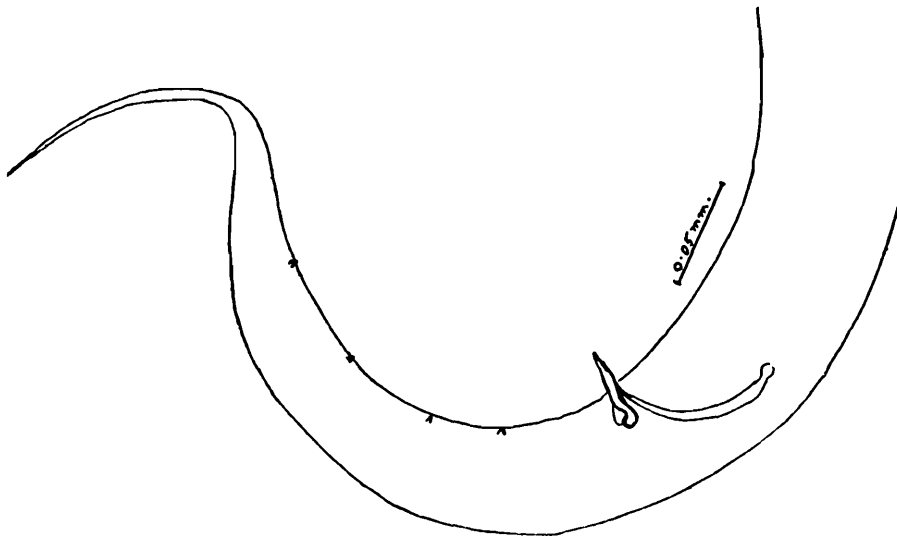


TEXT-FIG. 106.—*Probstmayria simiae*, n. sp. Anterior end, low power to show oesophagus

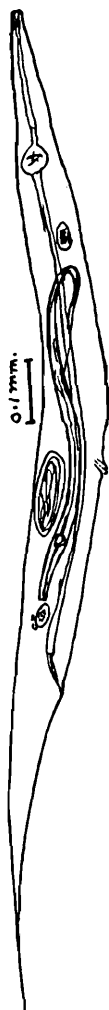


TEXT-FIG. 107.—*Probstmayria simiae*, n. sp. Male, whole worm.

Female.—The females are straight and fusiform, as they taper from the centre towards both ends (fig. 109). Mature worms, judged to be so by the presence within them of large coiled embryos, are 1.6—1.8 mm. in length, and 0.12—0.13 mm. in diameter. The vulva has prominent lips, and it is situated just anterior to the middle of the body. The

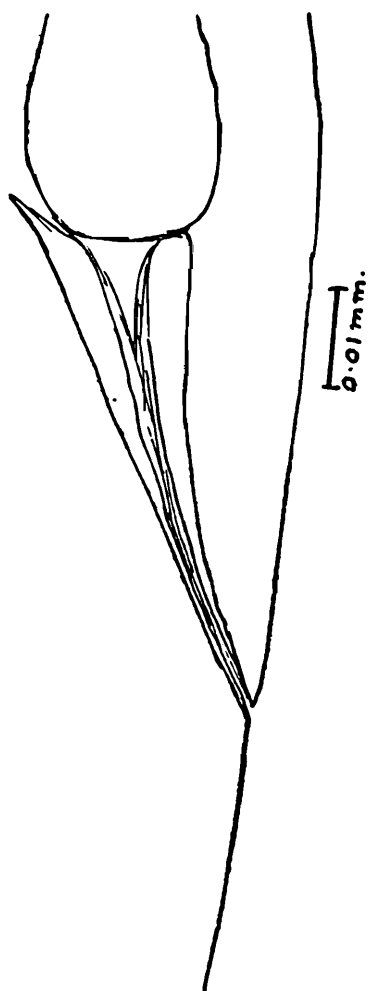


TEXT-FIG. 108.—*Probstmayria simiae*, n. sp. Posterior end, male, lateral view.



TEXT-FIG. 109.—*Probstmayria simiae*, n. sp. Female, whole worm.

tail is long and straight, and it ends in a fine point (fig. 109). The distance from the anus to the tip of the tail is 0.45—0.5 mm. The rectum is lined with a thick funnel-shaped portion of cuticle (fig. 110). The uterus



TEXT-FIG. 110.—*Probstmayria simiae*, n. sp. Anal region, female.

is composed of two divergent branches, and in mature specimens the central portion is occupied by one or perhaps two well-developed embryos, with perhaps a partly developed embryo coiled within its sheath or "egg shell", there is also a partly developed egg at each end of the uterus with two or three minute buds of immature eggs near them (fig. 109). In one specimen, with the embryo partly emerged from the parent worm, the former measured 0.93 mm. in length and 0.041 mm. in diameter. The embryos contain a well-developed oesophagus of the adult type, and they apparently reach maturity without any change in morphology, because all stages from embryos just escaped from the uterus and with no trace of genitalia up to fully mature specimens were encountered, and the only difference in the various stages was in their size.

This worm, with its exceptional method of reproduction and morphology, is very similar to *Probstmayria vivipara* the only known species of the genus, but it differs from this worm in several anatomical details, so it is without doubt a different species. It is therefore proposed to name it *Probstmayria simiae*, n. sp.

Host.—*Hylobates hoolock*.

Type-specimens are in the Indian Museum, Calcutta.

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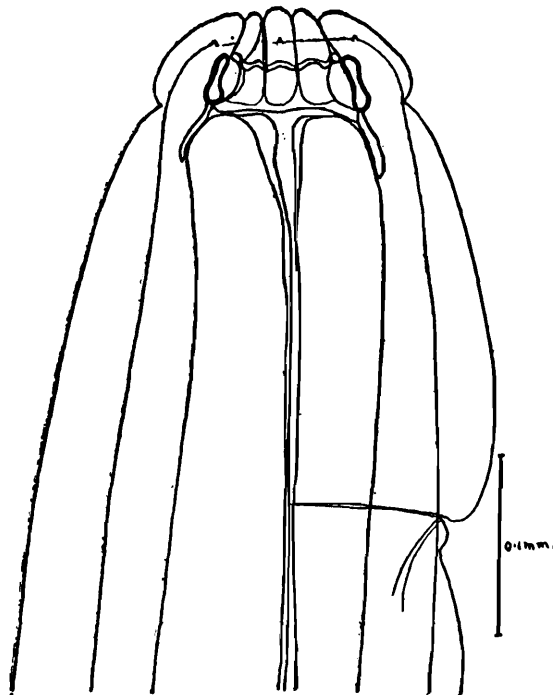
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Part 8. OESOPHAGOSTOMINAE AND NECATORINAE.

Oesophagostomum indicum, n. sp.

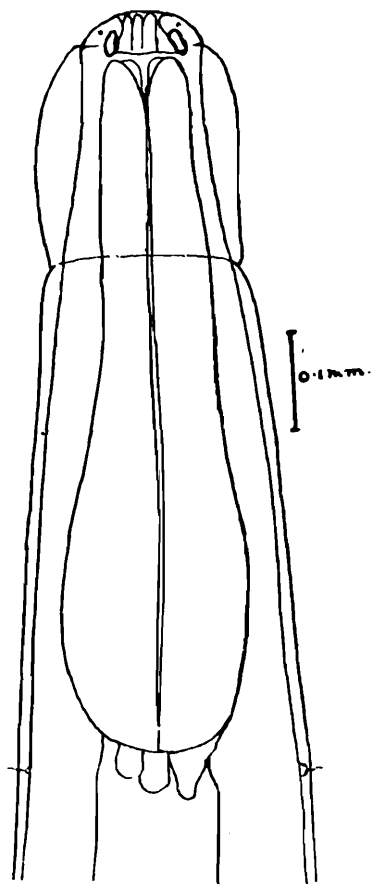
These worms were found in the large intestine of a Hog deer (*Cervus axis*).

They are similar to *O. dentatum* in general appearance, as the cephalic vesicle is the same shape. There is a distinct mouth collar with three papillae on each side, the lateral pair being larger than the subdorsal and subventral papillae. The cervical papillae are just posterior to the oesophagus (figs. 111 & 112). The buccal capsule is circular and there is

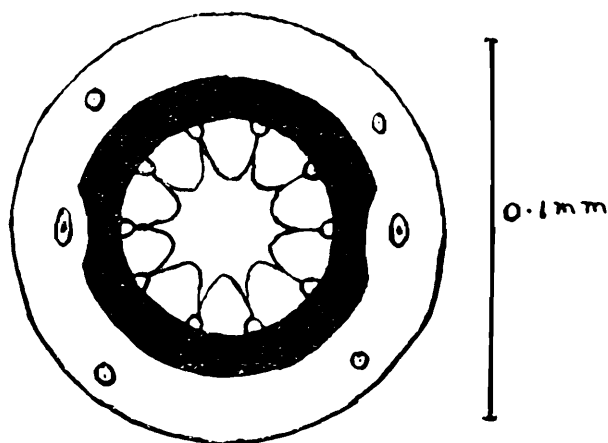


TEXT-FIG. 111.—*Oesophagostomum indicum*, n. sp. Anterior end, lateral view.

a broad shallow longitudinal groove on each side of it, which is only visible in and end-on view (fig. 113). There are two leaf crowns each of which



TEXT-FIG. 112.—*Oesophagostomum indicum*, n. sp. Anterior end, ventral view.

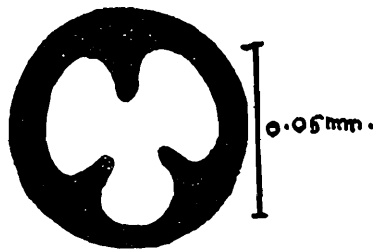


TEXT-FIG. 113.—*Oesophagostomum indicum*, n. sp. Buccal capsule, end-on view.

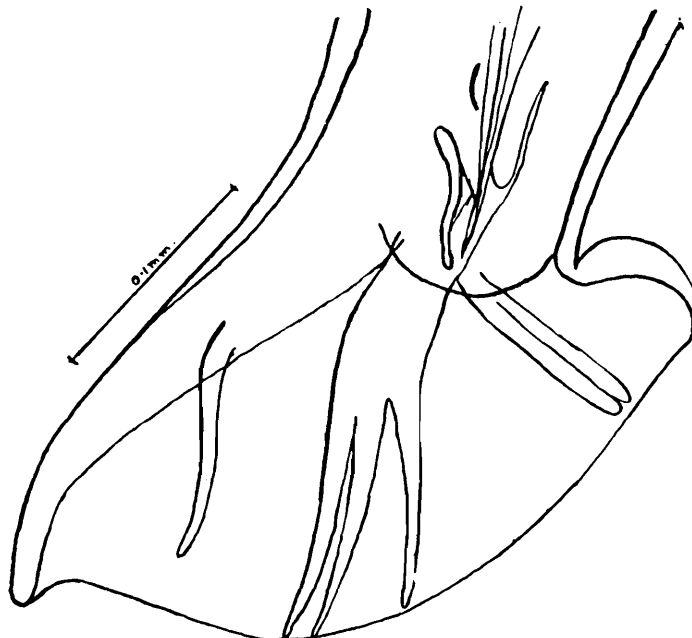
consists of ten broad elements. The external leaf crown arises from the base of the capsule, from which it sweeps inwards and forwards. The internal leaf crown consists of very short coarse elements, which in optical section appear as a double-contoured wavy line running across the capsule at its anterior end (fig. 111.) The anterior end of the oesophagus is lined with a thick chitinous layer, from which three longitudinal ridges project into the slightly-dilated oesophageal funnel (fig. 114).

Male.—The male bursa is composed of two broad lateral lobes. The ventral rays are cleft almost to their bases, the lateral rays arise from a common trunk, the externo-lateral being slightly separated from the other laterals. The externo-dorsal ray arises from a common trunk

with the dorsal, and it does not reach the border of the bursa (fig. 115). The dorsal ray is bifurcate for slightly more than half the distance from

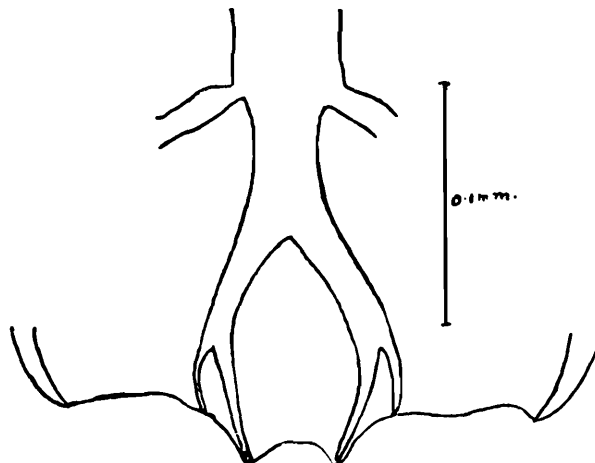


TEXT-FIG. 114.—*Oesophagostomum indicum*, n. sp. Oesophageal funnel, optical section end-on view.



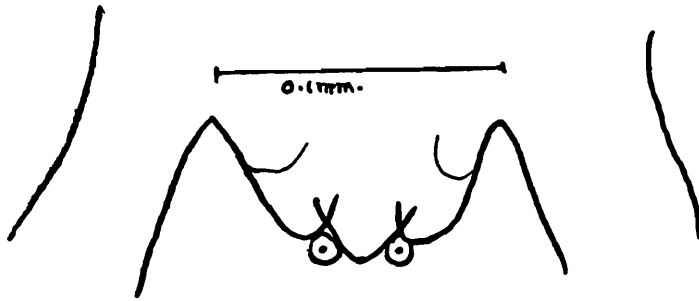
TEXT-FIG. 115.—*Oesophagostomum indicum*, n. sp. Posterior end, male, lateral view.

its tips to the origin of the externo-dorsal rays. Each tip is divided into a longer internal and a shorter external branch, which both curve inwards towards those of the opposite side (fig. 116). The genital cone



TEXT-FIG. 116.—*Oesophagostomum indicum*, n. sp. Male bursa, dorsal ray.

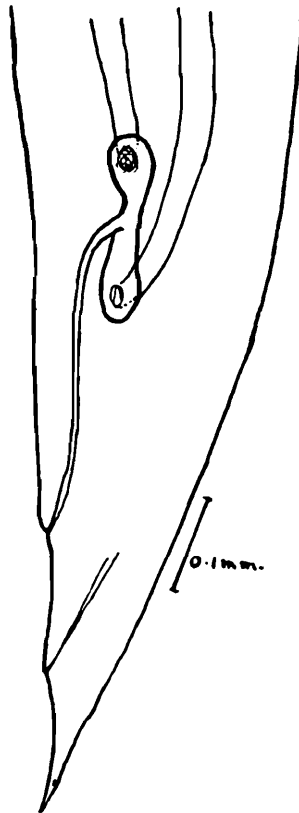
consists of a central conical body with broad papillae on each side of its base, and two smaller papillae more centrally placed (fig. 117). The



TEXT-FIG. 117.—*Oesophagostomum indicum*, n. sp. Genital cone, male.

spicules are equal and alate, and the gubernaculum is of the usual shape seen in the genus (fig. 116).

Female.—The tail ends in a sharp straight point, and the vulva opens a little distance anterior to the anus. There is a long vagina, which curves forwards to end in a typical hour-glass shaped ovejector which receives the uteri (fig. 118).



TEXT-FIG. 118.—*Oesophagostomum indicum*, n. sp. Posterior end, female, lateral view.

Comparison of the characters of this worm together with the dimensions given in the table below (p. 153), with those of the known species of the genus *Oesophagostomum*, indicate that it is different in several particulars, therefore it must be considered a new species for which the name *Oesophagostomum indicum*, n. sp. is proposed.

Type-host. *Cervus axis*.

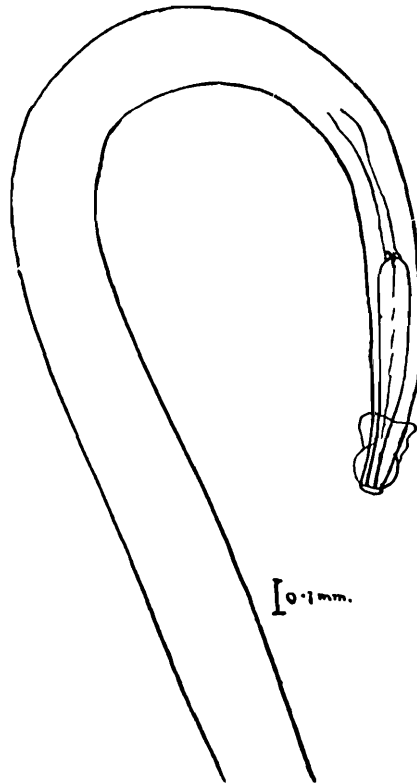
Since the discovery of the original material, worms which agree in all anatomical details with *O. indicum* have been found in the large intestine of a Red deer (*Cervus elaphus*), but these worms are slightly larger, the males being 10.5 mm. and the females 12.2 mm. in length.

Type-specimens are in the Indian Museum, Calcutta.

***Oesophagostomum curvatum*, n. sp.**

This species was found in the large intestine of a Hog deer in company with *O. indicum*.

The most striking character of this worm is the shape of the anterior end, which is bent in the shape of a shepherd's crook, similar to *O. radiatum*. (fig. 119.) There is a well-marked mouth collar in the form of a ring with rounded edges, which curves forwards laterally (fig. 120). The cephalic inflation is in two portions marked off from each other by a constriction similar to that of *O. radiatum*; behind the constriction

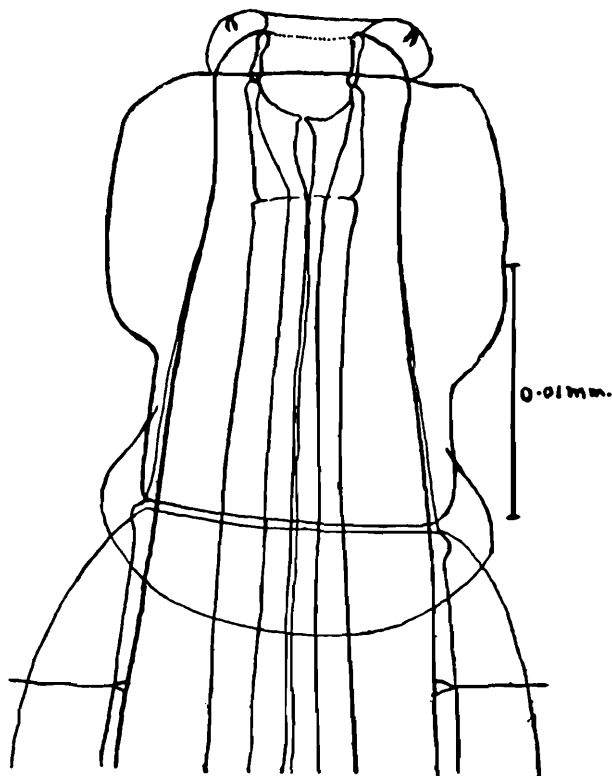


TEXT-FIG. 119.—*Oesophagostomum curvatum*, n. sp. Anterior end, lateral view.



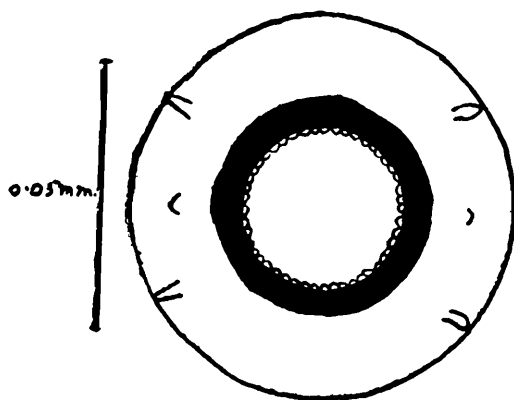
TEXT-FIG. 120.—*Oesophagostomum curvatum*, n. sp. Anterior and, lateral view.

the inflation is composed of two rounded cuticular flaps, which unite on the dorsal and ventral surfaces (figs. 120 & 121). Well-developed lateral flanges arise at the level of the cervical groove, and the long cervical papillae arise a short distance behind this (fig. 121). The buccal

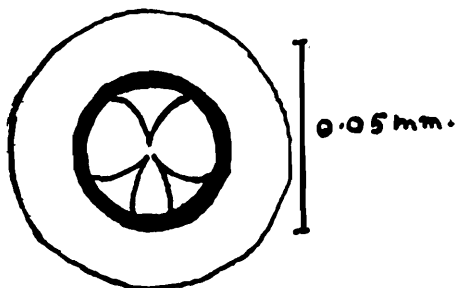


TEXT-FIG. 121.—*Oesophagostomum curvatum*, n. sp. Anterior end, dorsal view.

capsule is circular and cylindrical, and there is no external leaf crown, but the anterior border of the capsule bears at least fifty small points representing the internal leaf crown (fig. 122). The anterior portion of the oesophagus is thinner than the rest of the organ with the result that there is a oesophageal funnel without any external enlargement of



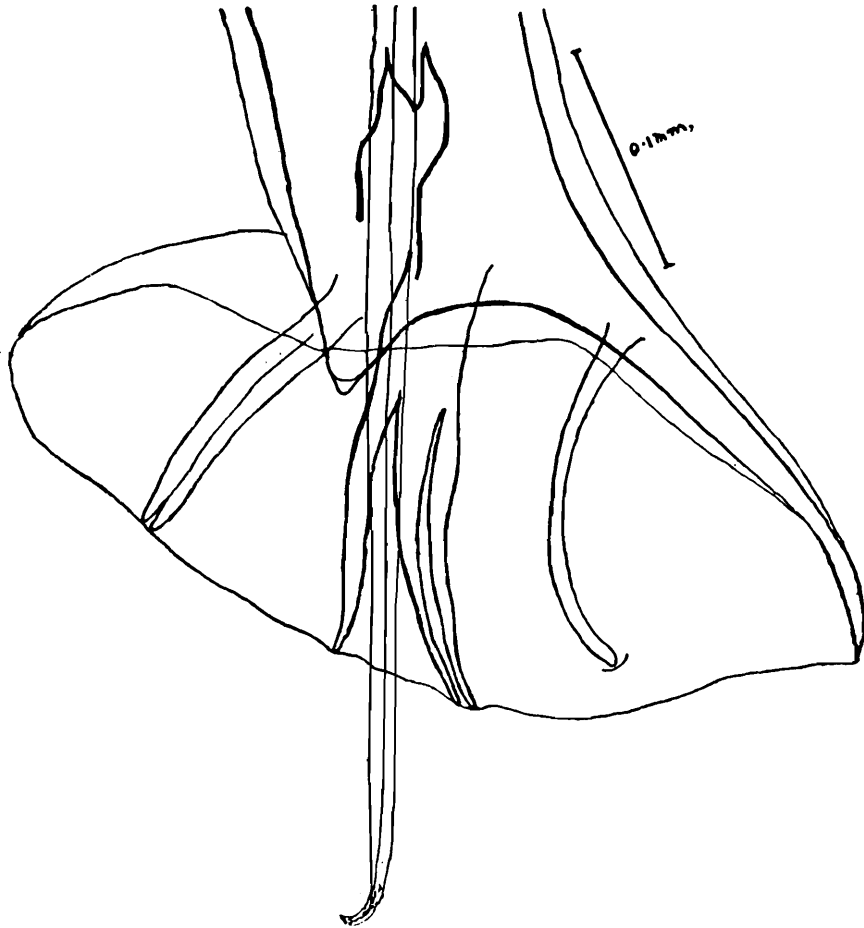
TEXT-FIG. 122.—*Oesophagostomum curvatum*, n. sp. Buccal capsule, end-on view.



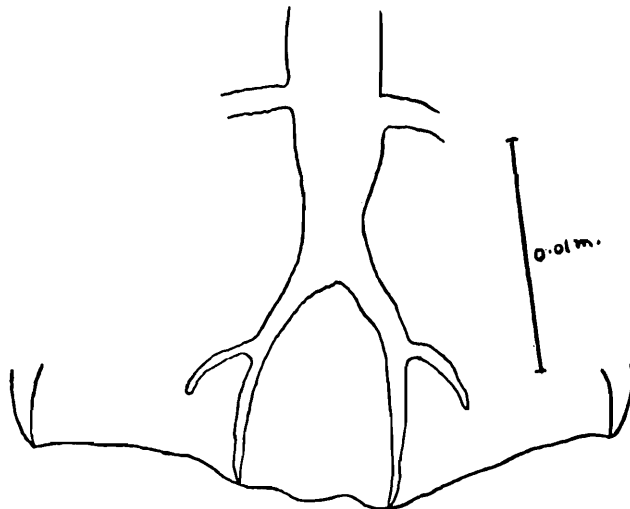
TEXT-FIG. 123.—*Oesophagostomum curvatum*, n. sp. Oesophageal funnel, optical section, end-on view.

the anterior end. The funnel is marked off from the rest of the oesophagus by a transverse line, and its chitinous lining is furnished with three sharp longitudinal ridges which might almost be regarded as teeth (figs. 121 & 123).

Male.—The bursa consists of two broad lateral lobes. The ventral rays are cleft almost to their bases, the lateral rays arise from a common trunk, the externo-lateral being separated from the other two lateral rays, which lie close together. The externo-dorsal rays arise from a common trunk with the dorsal ray, they are long and thin and do not reach the edge of the bursa (fig. 124). The dorsal ray is bifid for



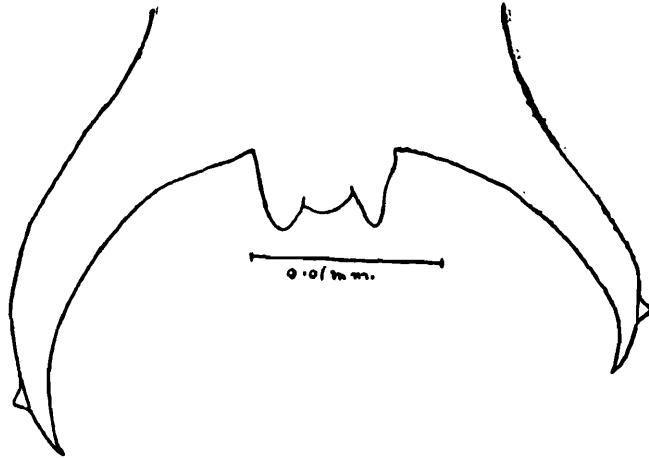
TEXT-FIG. 124.—*Oesophagostomum curvatum*, n. sp. Posterior end, male, lateral view



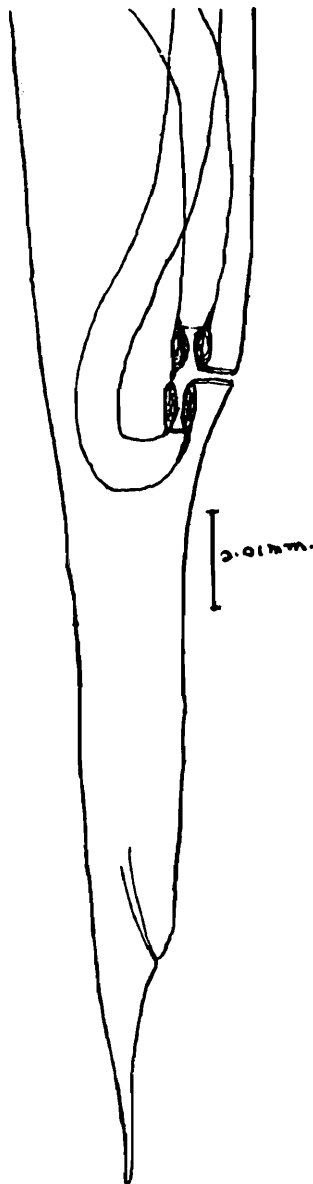
TEXT-FIG. 125.—*Oesophagostomum curvatum*, n. sp. Male bursa, dorsal ray.

about half its length from the origin of the externo-dorsal rays, and each branch is divided into two, the external branch being the shorter (fig. 125). The genital cone is composed of a central rounded papilla with a single coarse papilla on each side of it (fig. 126). The spicules are long and straight with the tips curving ventrally. The gubernaculum is in the form of a deep trough in which the spicules lie (fig. 124).

Female.—The tail of the female ends in a straight tip. The vagina is short and it runs directly inwards, and from its inner end two short



TEXT-FIG. 126.—*Oesophagostomum curvatum*, n. sp. Genital cone, male.



TEXT-FIG. 127.—*Oesophagostomum curvatum*, n. sp. Posterior end, female, lateral view.

muscular ovejectors arise, which diverge at right angles (fig. 127). This portion of the female genital apparatus is very similar to that of *O. radiatum*.

In its general characters this worm is very similar to *O. radiatum*, according to the description by Goodey (1924), but it is smaller in all its dimensions. Other more reliable differences are that the mouth collar is not so inflated, and the number of elements in the internal leaf crown is greater in my species than it is in *O. radiatum*. In the male the genital cone and gubernaculum differ in the two species, and in the female the tail is straight in my species and curved ventrally in *O. radiatum*. It is therefore proposed to name my species *Oesophagostomum curvatum*, n. sp.

Host.—*Cervus axis*.

Type-specimens are in the Indian Museum, Calcutta.

***Oesophagostomum radiatum* (Rud. 1803).**

The typical host of this species is domestic cattle, and its distribution is world-wide. I have recovered specimens of this worm from a hybrid bison (*Bos frontalis* and *Bos taurus*).

TABLE OF MEASUREMENTS.

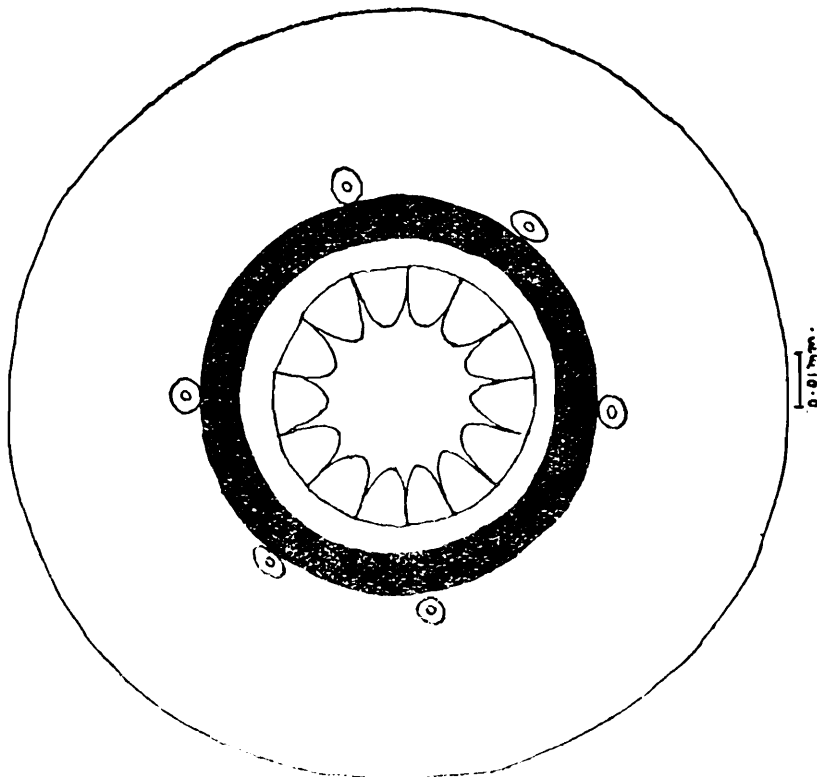
	<i>O. indicum</i> .		<i>O. curvatum</i> .	
	Male.	Female.	Male.	Female.
Length	7.6—9.1	9.9—10.4	8.4—9.6	12.5—14.8
Diameter, maximum	0.034—0.036	0.038	0.29—0.32	0.36—0.42
Mouth collar, diameter	0.13	0.14	0.075	—
Buccal capsule, diameter—				
Anterior	0.05	0.052—0.06	0.028—0.032	0.032
Posterior	0.066	0.072		
Cervical papillae from ant. end.	..	..	0.28	..
Cervical groove from ant. end.	0.26	0.28	0.21	0.22
Oesophagus, length	0.713	0.713	0.57—0.61	0.65—0.79
Oesophageal funnel, depth.	..	..	0.044	..
Spioules, length	1.3—1.36	..	0.49—0.59	..
Gubernaculum, length	0.084	..	..	..
Vulva to anus	..	0.18	..	0.57—0.75
Anus to tip of tail	..	0.13—0.14	..	0.22—0.26
Eggs	..	0.068—0.076 × 0.036—0.042	..	0.072—0.076 × 0.04

Oesophagostomum apiostomum (Willach, 1891).

Worms which I have tentatively referred to this species have been found on three occasions in the stomach of the Hoolock (*Hylobates hoolock*). There were never more than three or four specimens on any occasion and they were always free in the lumen of the stomach.

Ihle (1922) gave a redescription of this species, but he omitted to mention several important structures, which are present in all Oesophagostomes. The size given by Ihle is 10—12·8 mm. for males and 11·5—16 mm. for females, whereas my specimens measured 16·8 mm. for males and 19—20·8 mm. for females. This difference is not considered sufficiently great to indicate a difference of species, for it is a general rule to find considerable variation in length in a species of this genus if a large number of specimens are measured. For example, forty females of *O. dentatum* measured by Maplestone (1930) varied between 9·69 and 14·48 mm. in length.

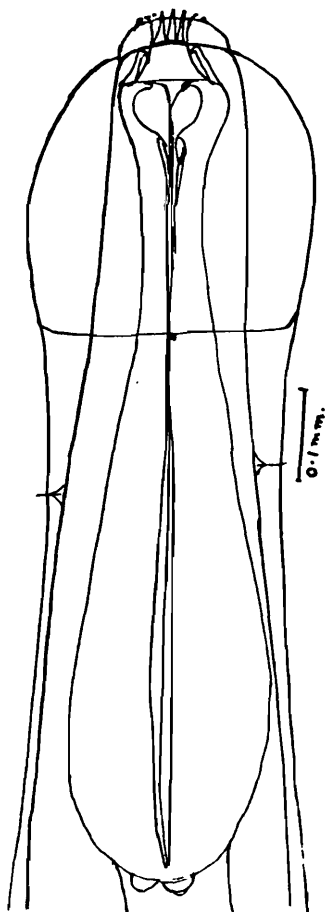
Ihle states that there are twelve elements in the leaf crown, and that he found one specimen with thirteen elements. When examined lying on a slide⁵I could only count twelve elements in all my specimens, but when I obtained an end-on view of the head of one of these specimens I found there were really fourteen. It therefore seems probable that one element is missed on each side when focussing up or down to follow the curve of the buccal capsule when the worms are lying on a slide, and that the true number of elements in the leaf crown is fourteen (fig. 128).



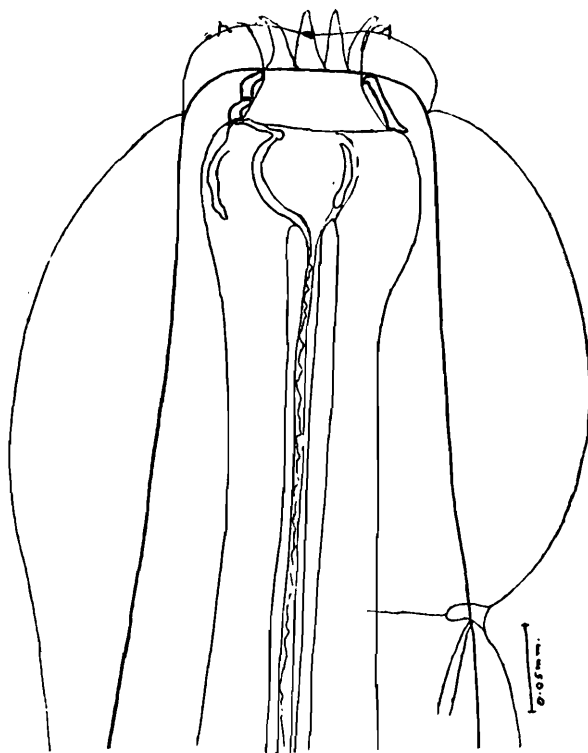
TEXT-FIG. 128.—*Oesophagostomum apiostomum*. Buccal capsule, end-on view.

The buccal capsule is slightly narrower anteriorly than it is posteriorly, and a small portion of the dorsal wall appears to be shorter than the rest of the capsule, as well as being divided into two parts in the mid-dorsal

line (fig. 130). When examined from the dorsal surface this appearance is seen to be due to notches on the anterior and posterior borders of the

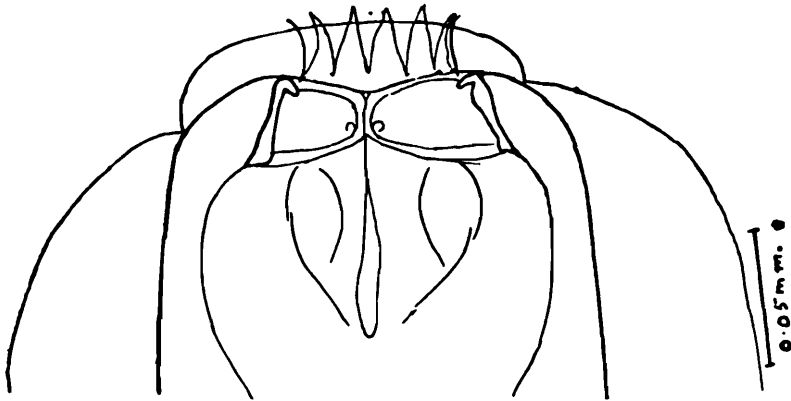


TEXT-FIG. 129.—*Oesophagostomum apistomum*. Anterior end, ventral view.



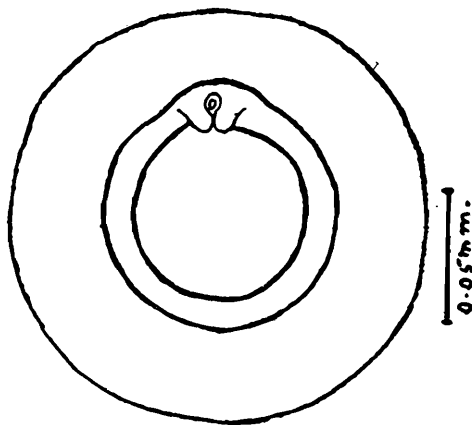
TEXT-FIG. 130.—*Oesophagostomum apistomum*. Anterior end, lateral view.

capsule through which the duct of the dorsal oesophageal gland runs antero-posteriorly (fig. 131). This organ is exceptionally clearly defined



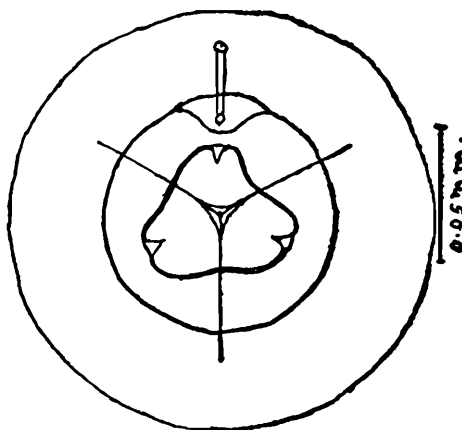
TEXT-FIG. 131.—*Oesophagostomum apiostomum*. Anterior end, dorsal view to show dorsal wall of buccal capsule.

in this species and in an end-on view of the capsule at a plane slightly below the opening of the duct it is seen to be surrounded by a special portion of the capsule, which projects slightly into its lumen (fig. 132).



TEXT-FIG. 132.—*Oesophagostomum apiostomum*. Optical section, through middle of buccal capsule.

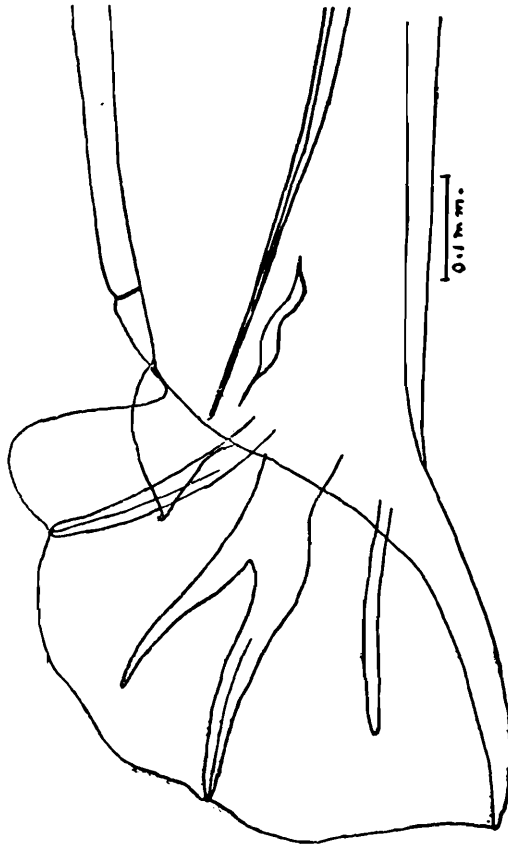
This projection is even more marked further posteriorly in an optical section of the oesophageal funnel at the level of the teeth (fig. 133).



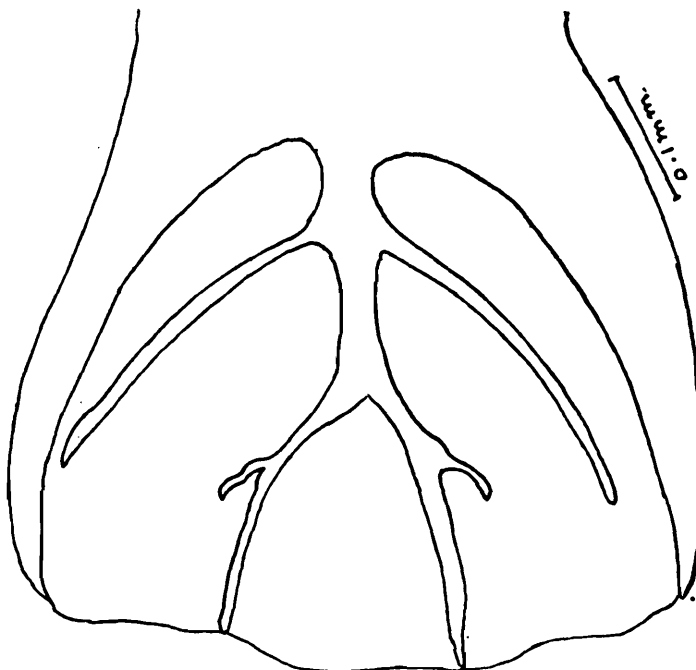
TEXT-FIG. 133.—*Oesophagostomum apiostomum*. Optical section through oesophageal funnel at level of teeth.

The teeth in the oesophageal funnel vary from rounded knobs to sharply pointed structures. The genital cone in the male is a simple conical body ending in a nipple-like point and without any accessory papillae.

The male bursa is typical, and there is a pair of prebursal papillae, and a curved gubernaculum (figs. 134 & 135).

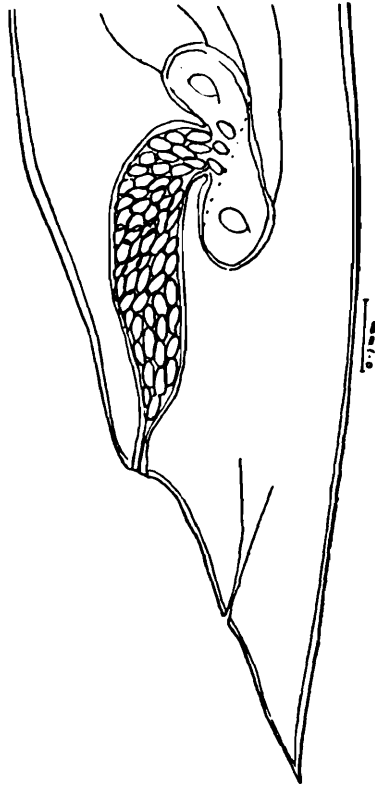


TEXT-FIG. 134.—*Oesophagostomum apiostomum*. Posterior end, male, lateral view.



TEXT-FIG. 135.—*Oesophagostomum apiostomum*. Male bursa, dorsal ray.

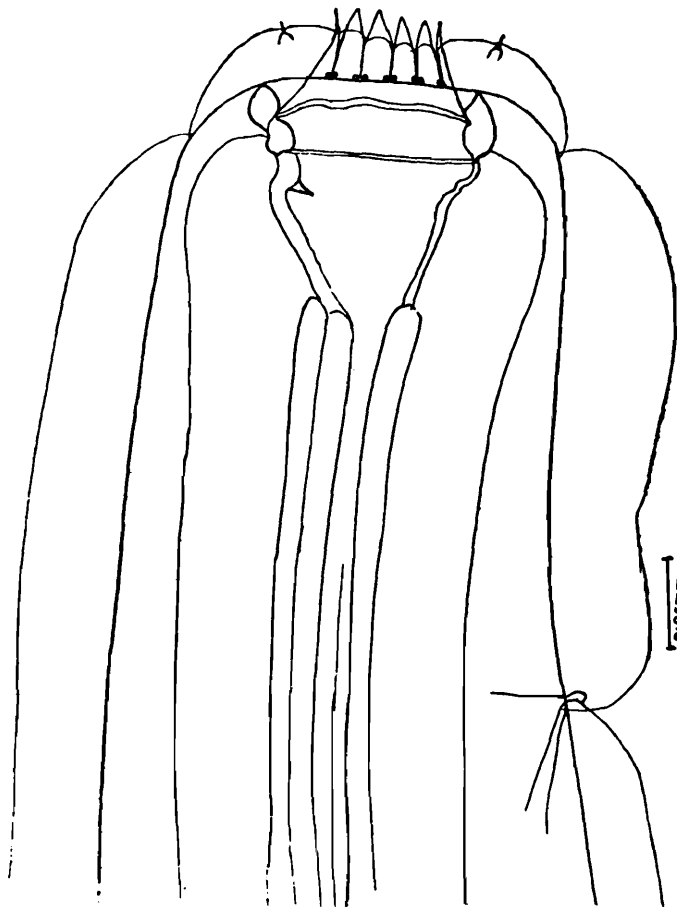
The vagina in the female is large, and it curves anteriorly from the vulva to end in a typical "hour-glass" ovejector, from each end of which the uteri arise. In the specimen from which fig. 136 is drawn the vagina is crowded with eggs.



TEXT-FIG. 136.—*Oesophagostomum apiostomum*. Posterior end, female, lateral view.

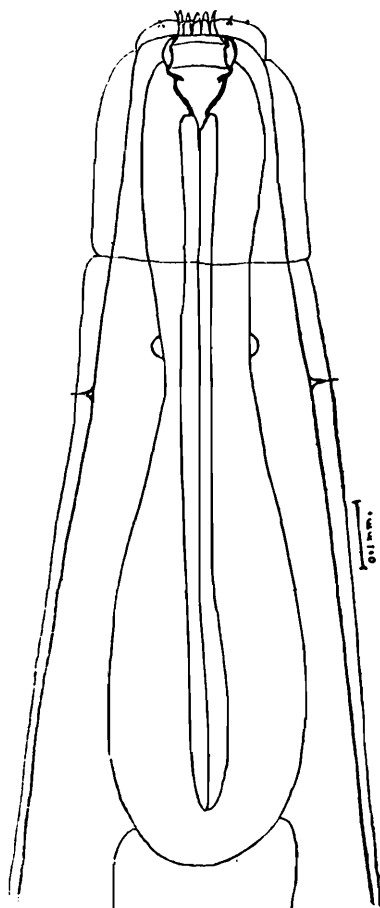
***Oesophagostomum blanchardi* Railliet & Henry, 1912.**

This worm was briefly described by Railliet and Henry (1912) from the Orang outhan, and a single male and female apparently belonging to this species have been obtained by me from the stomach of a Hoolock monkey.



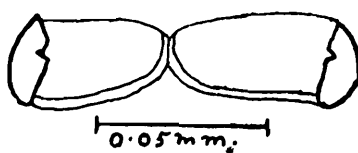
TEXT-FIG. 137.—*Oesophagostomum blanchardi*. Anterior end, lateral view.

The worm is closely allied to *O. apiostomum* but it exhibits several distinct differences. The cephalic inflation is not so globular as in *O. apiostomum* and the buccal capsule is of different shape (figs. 137 and 138), but it shows the same notches on the anterior and posterior bor-



TEXT-FIG. 138.—*Oesophagostomum blanchardi*. Anterior end, dorsal view.

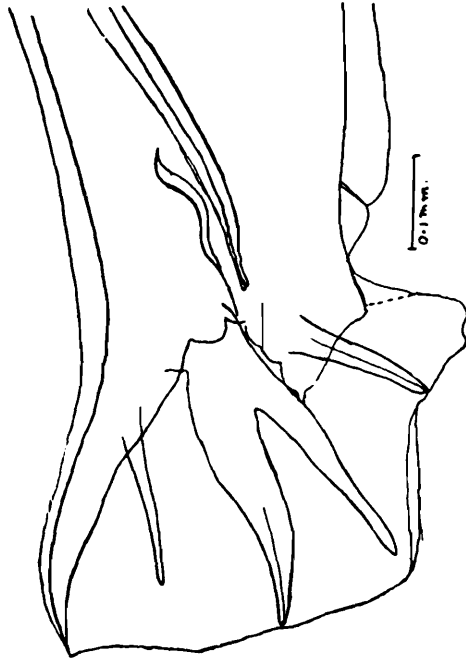
ders of the capsule in the mid-dorsal line (fig. 139). There are said to be sixteen elements in the external leaf crown in *O. blanchardi* but I



TEXT-FIG. 139.—*Oesophagostomum blanchardi*. Buccal capsule, dorsal wall.

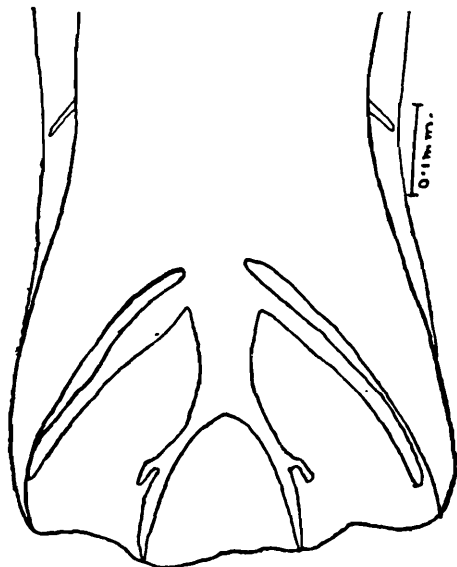
was only able to count fourteen. It seems probable that two are not visible in lateral view as in the case of *O. apiostomum*, but I was unable to confirm this as there was not enough material to warrant sacrificing

a specimen to obtain an end-on view. At the point where the leaf crown projects beyond the anterior end of the capsule a small thickening is visible on each side of the base of each element, which probably represents a rudimentary internal leaf crown (fig. 137).



TEXT-FIG. 140.—*Oesophagostomum blanchardi*. Posterior end, male, lateral view.

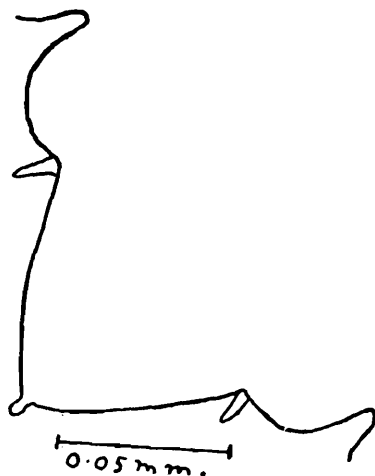
In the male the bursa is typical and prebursal papillae are present (figs. 140 and 141). The gubernaculum is similar to that of *O. apiosto-*



TEXT-FIG. 141.—*Oesophagostomum blanchardi*. Male bursa, dorsal ray.

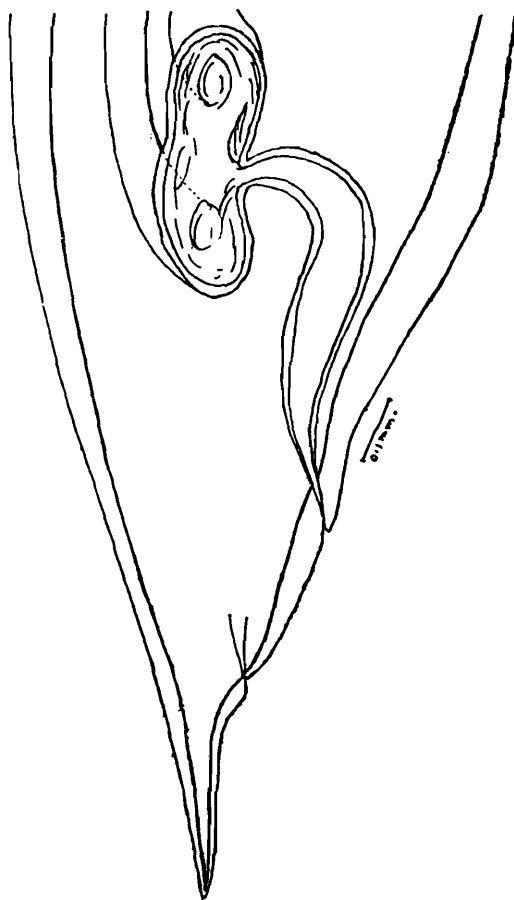
mum, but the genital cone consists of a central conical body ending in a nipple-like point; on each side of the base of this cone there is a broad

rounded mass, and a pair of fine papillae arise in the angles formed between these basal structures and the central cone (fig. 142).



TEXT-FIG. 142.—*Oesophagostomum blanchardi*. Genital cone, male.

The tail of the female and the terminal portions of the genital tubes are similar to those of *O. apiostomum* (fig. 143).



TEXT FIG. 143.—*Oesophagostomum blanchardi*. Posterior end, female, lateral view.

Both of these worms may be new species, but owing to the imperfect descriptions of *O. apiostomum* and *O. blanchardi* it is not possible to be definite on this point, so it appears preferable to place them in the above species rather than to make new species on doubtful grounds, especially as the data given here will enable anyone in possession of specimens of the above species to decide the matter.

MEASUREMENTS OF *O. apiostomum* AND *O. blanchardi* FROM MY MATERIAL.

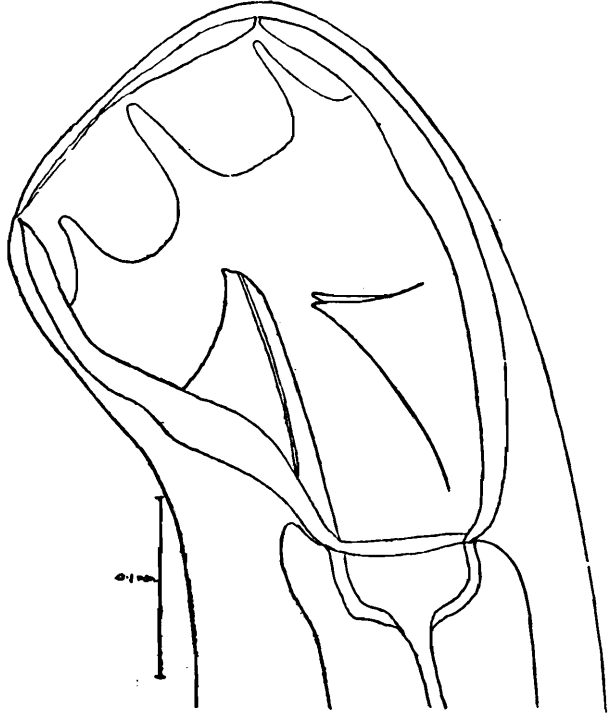
	<i>O. apiostomum.</i>		<i>O. blanchardi.</i>	
	Male.	Female.	Male.	Female.
Length	16.8	19—20.8	15.3	19.2
Diameter	0.614	0.673—0.672	0.654	0.83
Trans. groove . from ant. end.	0.297	0.336—0.376	0.356	0.396
Cervical pap. from ant. end.	0.416	0.455—0.515	0.536	..
No. of elements in leaf crown.	14	14	16?	16?
Mouth caps—				
Ant. diameter.	0.064—0.076	0.068—0.076	0.112	0.120
Post. diameter	0.088—0.096	0.088—0.096	..	..
Depth	0.022—0.024	0.028	0.039	0.041
Oesophagus, length	0.812	0.891—0.951	1.05	1.1
Min. diameter	0.088	0.088—0.096	0.152	0.164
Max. diameter	0.208	0.200—0.300	0.288	0.300
Spicules, length	1.56—1.58	..	1.98	..
Gubernaculum, length	0.158—0.160	..	0.200	..
Vulva to anus	..	0.218—0.297	..	0.297
Anus to tip of tail	..	0.196—0.237	..	0.277
Vagina, length	..	0.297—0.396	..	0.535
Ovejector, length	..	0.297—0.336	..	0.416
Caudal pap. from tip of tail.	..	0.052	..	0.092
Eggs	..	0.064 × 0.040	..	0.068 × 0.044

Bunostomum bovis, n. sp.

These worms have been found on three occasions in collections of nematodes taken from the abomasum of cattle which died at the Government Experimental Farm at Gauhati, Assam. They were never present in large numbers, on one occasion they were the only worms present, and on the two other occasions a few worms of this species were found among many hundreds of specimens of *Mecistocirrus digitatus*.

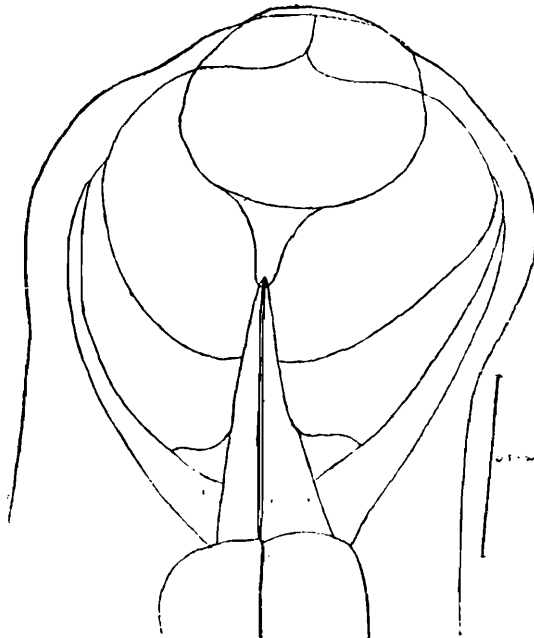
The males and females are approximately the same size, being 15—16 mm. in length, and about 0.5 mm. in maximum diameter. The anterior end is bent dorsally, and the cuticle is marked by coarse transverse

striations. The excretory pore is situated about 0.7 mm. from the anterior end, and immediately anterior to this point the worms become suddenly narrower to a diameter of 0.22 mm., which extends forwards almost to the mouth opening, which is slightly broader. The buccal capsule is elongate and funnel-shaped and it bears a pair of ventral teeth in its depth; the duct of the dorsal oesophageal gland is borne on a prominent cone, which projects into the mouth cavity for more than half-way up its depth (fig. 144). The ventral wall of the buccal capsule



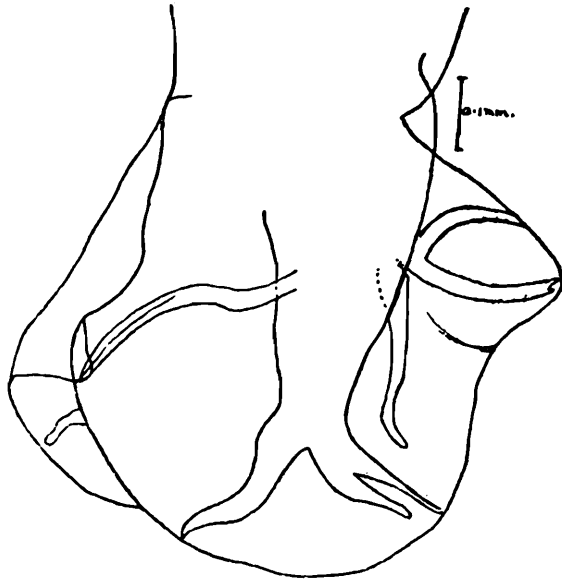
TEXT-FIG. 144.—*Bunostomum bovis*, n. sp. Anterior end, lateral view.

is slightly curved. When seen from the dorsal aspect the mouth opening is circular with a deep notch in its dorsal border, and its ventral side is guarded by a pair of narrow curved cutting plates (fig. 145).



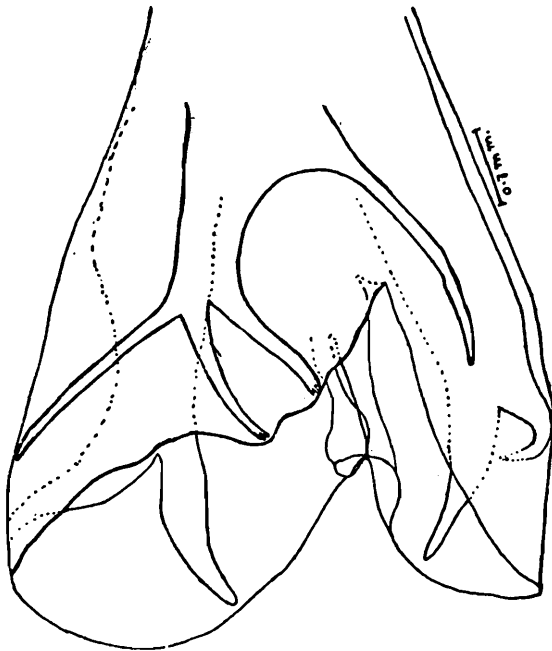
TEXT-FIG. 145.—*Bunostomum bovis*, n. sp. Anterior end, dorsal view

Male.—The male bursa is composed of two relatively long narrow lateral lobes, which are united ventrally, and the dorsal-lobe is only slightly developed. The ventral rays are long and thin and they arise from the ventral borders of the common trunks of the lateral rays, they are cleft for about half their length. The trunk of the lateral rays is long and stout, the externo-lateral is widely separated from the other laterals which lie closer together (fig. 146). The externo-dorsal rays



TEXT-FIG. 146.—*Bunostomum bovis*, n. sp. Posterior end, male, lateral view.

arise asymmetrically from a common trunk with the dorsal ray, they are long and thin and do not approach the edge of the bursa. The dorsal ray is bifurcate as far forward as the origin of the left externo-dorsal, and each branch ends in two or three small points (fig. 147).



TEXT-FIG. 147.—*Bunostomum bovis*, n. sp. Posterior end, male, dorsal ray.

The spicules are thin and tapering, and about 4.5 mm. in length. They lie close together for their whole length and end in fine straight points, which are fused and surrounded by a membranous sheath. There is no gubernaculum.

Female.—The vulva is an inconspicuous slit a little in front of the middle of the body, being about 8.5 mm. from the posterior end. The short vagina divides into divergent uteri, which in turn pass into ovaries running towards the anterior and posterior ends of the body. The tail ends in a blunt straight point 0.34 mm. posterior to the anus. The eggs have thin shells and contain a morula, they are $0.072\text{--}0.076 \times 0.044\text{--}0.046$ mm.

The points whereby this species is distinguished from other members of the genus are given in a table at the end of the description of *B. cobi* below (p. 168). It is proposed to name this worm *Bunostomum bovis*, n. sp.

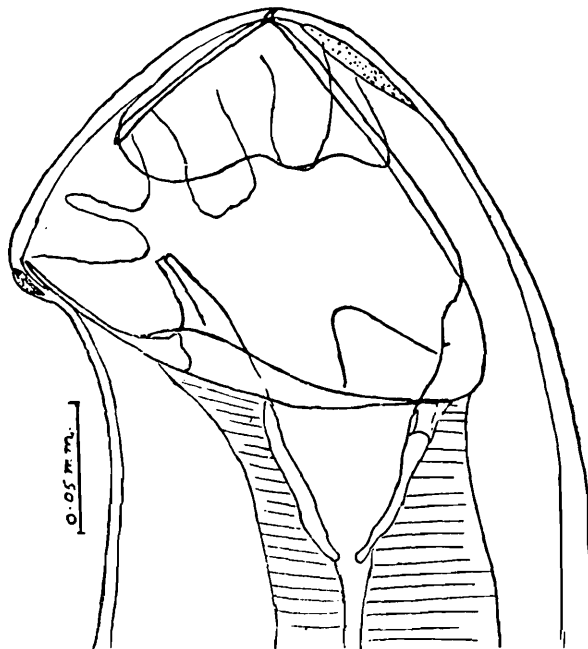
Host.—*Bos indicus*.

Type-specimens are in the Indian Museum, Calcutta.

***Bunostomum cobi*, n. sp.**

A large collection of these worms were recovered from a Water buck (*Cobus ellipsiprymnus*), from the Calcutta Zoological Gardens.

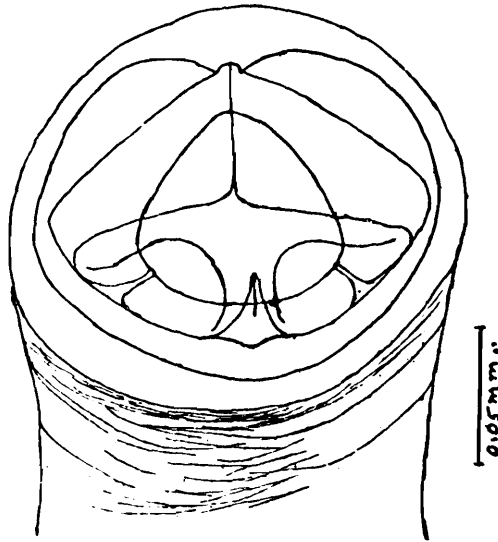
The anterior end is bent dorsally and the cuticle is transversely striated. In its lateral aspect the buccal capsule is distinctly funnel-shaped, being 0.164—0.176 mm. in depth and 0.124—0.128 mm. across its base, which coincides with the mouth opening. The ventral wall is remarkably straight and it forms almost a right-angle with the plate that runs dorsally along the ventral border of the mouth opening. When seen from the side the ventral cutting plates are triangular with a wavy free border and they lie across the angle formed by the two parts of the ventral wall of the capsule (fig. 148). The duct of the dorsal oesophageal



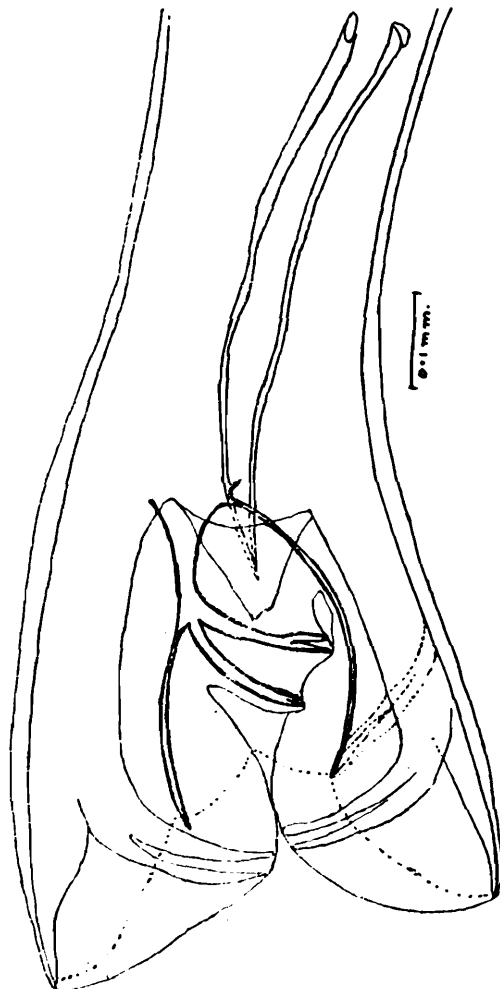
TEXT-FIG. 148.—*Bunostomum cobi*, n. sp. Anterior end, lateral view.

gland is borne on a well-developed cone, which ends in a square-cut blunt tip; the dorsal wall of the cone is only about half the length of the distance from the tip of the cone to the mouth opening. There is a single pair of broad rounded sub-ventral lancets, which may or may not have sharp points on their summits (fig. 148). When viewed from the

dorsal aspect the buccal capsule is slightly oval, being about 0.168 mm. in transverse diameter and about 0.148 mm. dorso-ventrally. The cutting plates are large and in the form of right-angled triangles with the angles rounded. The dorsal cone is pyramidal and it projects beyond the edge of the mouth opening. The mouth opening is pyriform with the apex directed ventrally, and it has a pair of very distinct papillae in its sub-dorsal border (fig. 149). The oesophagus is of the usual club-shaped type, and it is about 0.18—0.2 mm. in length.

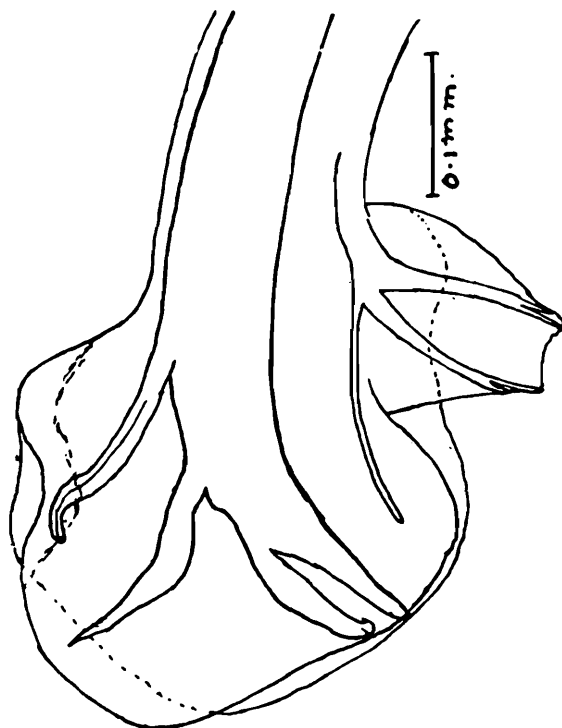


TEXT-FIG. 149.—*Bunostomum cobi*, n. sp. Anterior end, dorsal view.

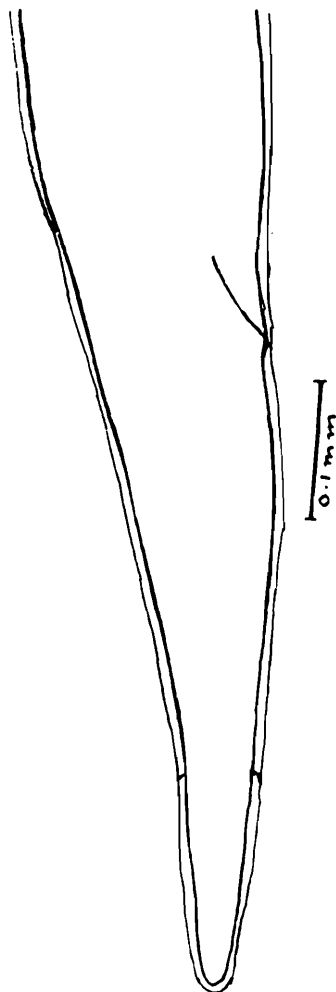


TEXT-FIG. 150.—*Bunostomum cobi*, n. sp. Posterior end, male, dorsal view.

Male.—The males measures 8.8—11.4 mm. in length, and 0.29—0.32 mm. in maximum diameter. There is a distinct genital cone surmount-



TEXT-FIG. 151.—*Bunostomum cobi*, n. sp. Posterior end, male, lateral view.



TEXT-FIG. 152.—*Bunostomum cobi*, n. sp. Posterior end, female, lateral view.

ed by rounded papillae of varying appearance in different specimens. The bursal rays are typical (figs. 150 and 151), but the dorsal lobe is clearly defined (fig. 151). The spicules are similar to those of *B. trigonocephalum* described by Cameron (1923), and they measure 0.55—0.66 mm. in length (fig. 150).

Female.—The females are 15—16 mm. in length, and 0.45—0.5 mm. in maximum diameter. The vulva has slightly prominent lips and it opens 4.2—5.7 mm. from the anterior end. The vagina is short and the uteri are divergent. The tail ends in a straight blunt point 0.37—0.46 mm. posterior to the anus, and the sub-ventral papillae are about 0.15 mm. from its tip (fig. 152). The eggs measure 0.058—0.060 × 0.036 mm.

The characters whereby this species may be distinguished from the other members of the genus are given in the table below. On account of these differences it is proposed to name this worm *Bunostomum cobi*, n. sp.

Host.—*Cobus ellipsiprymnus*.

Type-specimens are in the Indian Museum, Calcutta.

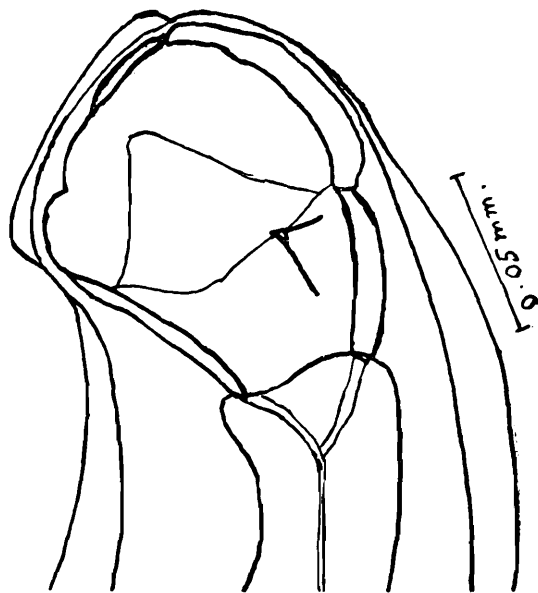
Cameron (1923) carefully revised the genus *Monodontus*, which is now regarded as a synonym of *Bunostomum* and he came to the conclusion that the only two recognizable members of the genus are *B. trigonocephalum* and *B. phlebotomum*. The table has been compiled from Cameron's descriptions and those of my two new species, as it seems the most convenient way of indicating the differences.

	<i>B. trigonocephalum</i> .	<i>B. phlebotomum</i> .	<i>B. bovis</i> .	<i>B. cobi</i> .
Dorsal cone	Pointed ; duct opens sub-ventral to tip & dorsal wall longer than distance from tip of cone to mouth opening.	Shorter & blunter ; duct opens at tip. Dorsal wall slightly shorter than dist. from tip to mouth opening.	Similar to <i>trigonocephalum</i> in shape, but dorsal wall shorter than dist. from tip to mouth opening.	Tip flat & blunt, and duct opens in centre of tip. Dorsal wall about half dist. from tip to mouth opening.
Teeth	Arise from ventral wall & sometimes a pair of smaller sub-ventral lancets present.	Ventral & sub-ventral lancets always present.	Only ventral lancets present, long & pointed.	A single pair of lancets only, sub-ventral in position.
Ventral cutting plates.	Obtuse angled	?	Narrow with curving free border.	Deep and right-angled.
Mouth opening	Oval ; and dorsal cone projects beyond its border.	?	Nearly circular, with dorsal notch into which cone projects.	Pyriform ; and dorsal cone projects beyond border.
Spicules, length	0.65 mm.	3.5—4 mm.	4.5 mm.	0.55—0.60 mm.
Bursa	Dorsal rays run towards right, no dorsal lobe.	Dorsal rays run towards left. Small dorsal lobe.	Dorsal rays run towards right, dorsal lobe indistinct.	Dorsal rays run towards right, distinct dorsal lobe.

***Uncinaria longespiculum*, n. sp.**

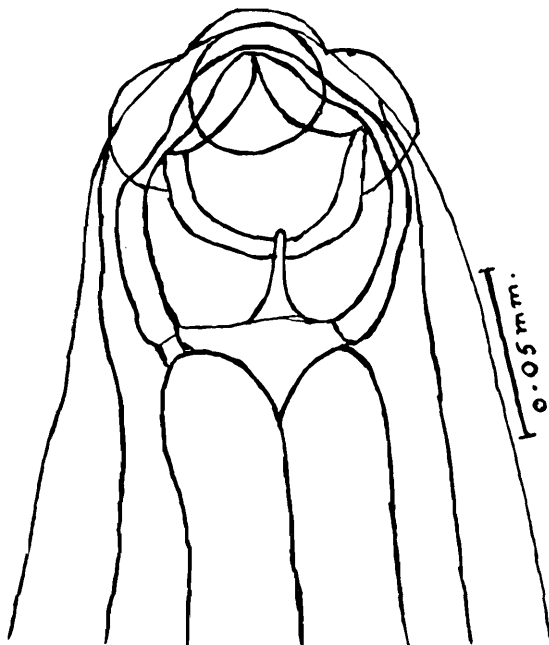
Two males and one female of this species were found in the small intestine of a Civet cat (*Viverricula malaccensis*).

The worms are short and relatively thick, and the head is bent dorsally (fig. 153). The buccal capsule is broad and somewhat funnel-



TEXT-FIG. 153.—*Uncinaria longespiculum*, n. sp. Anterior end, lateral view.

shaped. When viewed laterally the ventral wall of the capsule is seen to consist of three articulated plates, and articulations are also visible

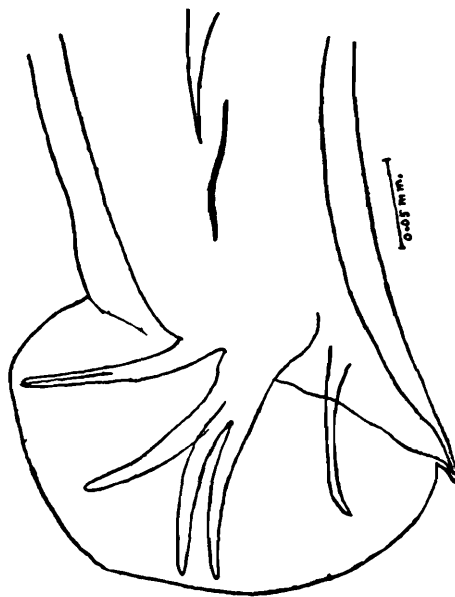


TEXT-FIG. 154.—*Uncinaria longespiculum*, n. sp. Anterior end, dorsal view.

in the lateral walls of the capsule. The mouth opening is circular and it is guarded by two ventral cutting plates. The duct of the dorsal

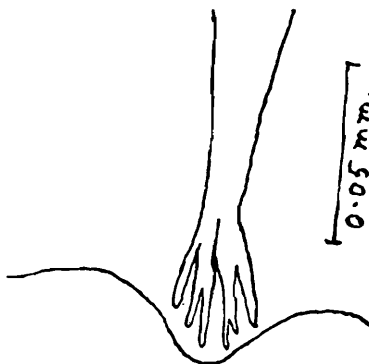
oesophageal gland opens in the dorsal wall of the capsule about half-way from its base (fig. 154). There are two well-developed triangular teeth arising subventrally from the base of the capsule (fig. 153). The oesophagus is relatively stout and muscular and it ends in a typical bulbar enlargement.

Male.—The bursa consists of two broad lateral lobes and a small dorsal lobe imperfectly differentiated. The rays are typical, the ventral rays are cleft for about half their length, the lateral rays arise by a common trunk, and the externo-lateral ray is somewhat widely separated from the two other laterals. The externo-dorsal rays are delicate and they arise by a common trunk with the dorsal. The dorsal ray is bifurcate at its tip and each branch shows three unequal digitations (figs. 155 and



TEXT-FIG. 155.—*Uncinaria longespiculum*, n. sp. Posterior end, male, lateral view.

156). The spicules are long, straight and equal, and there is a gubernaculum.



TEXT-FIG. 156.—*Uncinaria longespiculum*, n. sp. Male bursa, dorsal ray.

Female.—The vulva opens a little behind the middle of the body and the uteri are divergent. The tail ends in a blunt tip surmounted by a fine hair-like point. The eggs are oval with thin shells.

TABLE OF MEASUREMENTS.

	Male.	Female.
Length	3.3	4
Diameter, maximum	0.24	0.36
Head, diameter	0.08	0.09
Oesophagus, length	0.42	..
Spicules, length	1.19	..
Gubernaculum, length	0.088	..
Tail, length	..	0.25
Vulva, distance from tip of tail	..	1.7
Eggs	..	0.060 × 0.032

This worm is much smaller than the species *U. criniformis* and *U. stenocephala*. Size alone is not, however, a reliable guide but there are other differences by which it may be distinguished. For example the curve of the ventral wall of the buccal capsule is much more marked in the present species, the spicules are relatively much longer, and there is a well developed gubernaculum. Schwartz (1925) described a third species of *Uncinaria* viz. *U. lotoris*, which differs from my species in the same point as do the above two species. It is therefore proposed to name my species *Uncinaria longespiculum*, n. sp.

Host.—*Viverricula malaccensis*.

Type-specimens are in the Indian Museum, Calcutta.

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DESCRIPTIONS OF INDIAN OLIGOCHAETA.

II.

By J. STEPHENSON, M.B., D.Sc., F.R.S., Lieut.-Col., I.M.S. (ret.),
British Museum (Natural History).

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INTRODUCTION.

The greater part of the present paper consists of a description of a collection of Oligochaete worms from Burma, sent to me by Prof. Gates of Rangoon. I had previously received a number of worms from him, of which, along with others from various parts of the world, an account

is given in a recent paper (Stephenson, '31) ; had I known that the present collection was to follow so soon, I should have described all these Burmese worms together.

The present worms, like those previously received, are all of small size,—only one to two mm. in diameter ; nevertheless, the principal mode of investigation must be by dissection, not by sectioning ; naturally, worms gathered under such circumstances as these have not had the gut cleaned, and the contained earth, more often than not, both tears the sections to pieces when they are being cut, and ruins the knife. Moreover, the identification in a number of genera depends largely on the characters of the penial setae, which are entirely broken up and unrecognizable in sections. I did, however, get passable sections of *Ramiella cultrifera*, which were a useful supplement to the dissection of this diminutive worm. The Enchytraeid is of course in a different category,—its anatomy is described almost wholly from sections.

Only five species of Enchytraeids have hitherto been made known from the Indian region (I exclude Beddard's "*Henlea*" *lefroyi*, and, with Michaelsen, unite my *Fridericia carmichaeli* with *F. bulbosa*). This is a striking contrast to the north temperate and arctic regions, where Enchytraeids are so extraordinarily numerous. *Enchytraeus rangoonensis* forms an addition to this small company.

The representative of the genus *Plutellus* is the first to be recorded from Burma. The distribution of the genus appears not very unlike that of *Drawida*, consisting of one area in S. India (including one species in Ceylon), and another round the head of the Bay of Bengal (Darjeeling District, the Abor country in Assam, and now Burma—the new locality being about 350 miles south of the Abor country).

Endemic species of *Perionyx* are already known from several places in Burma (Akyab, Inle Lake, Pyapon Dist.). *P. ditheca* from Thandaung, about 160 miles north of Rangoon, on the Shan Plateau but not in the Shan States, therefore does not extend the known range of the genus.

The genus *Ramiella* has a very scattered distribution ; the four species which were first known occupy stations on a slightly curved line which extends from north to south, Saharanpur to Coorg, through the western part of India. Two Burmese species are now known ; the one which is described in the present paper comes from two localities 500 miles apart.

The genus *Eudichogaster* appears not to have hitherto been recorded from within the political limits of Burma. Of the two species recorded below, *E. chittagongensis*, previously known from Rangamati, now appears as a peregrine form which has spread widely in Burma,—in the Chindwin Valley, in the Moulmein District, Rangoon, and Shwegyin (nearly 100 miles north of Rangoon) ; while *E. yeicus*, described for the first time, is, so far as is yet known, confined to the Moulmein District. Here again, therefore, the known limits of the genus are extended.

Small peregrine species of *Dichogaster* appear to be common throughout Burma :—*D. bolawi* ; *D. curgensis* (previously described from Coorg by Michaelsen, '21, and now found to be represented by a variety at Kutkai and Lashio in the Shan States) ; *D. modiglianii* ; *D. saliens* ; *D. sinuosus*, in a minor degree peregrine, being found in several places in the Shan

States, or at any rate on the Shan plateau (Thandaung, though not in the Shan States, being on the plateau). The last-mentioned worm is related to *D. floresiana* and *D. affinis*, both (especially *D. affinis*) widely spread.

In a recent letter Prof. Gates, who had previously ('30) expressed the opinion that my *Pheretima lignicola* might be identical with Beddard's *Amyntas alexandri*, suggested to me that if Beddard's type was in the British Museum I should examine it and so settle the point. The unique example of *P. alexandri* is in fact in the museum, and I have carried out Prof. Gates's suggestion. Since Beddard's account is incomplete in certain respects I give below a full description, from which it will be seen that there is no doubt whatever of the identity of the two worms. The name *Pheretima lignicola* Steph. is therefore to be replaced by *P. alexandri* (Bedd.).

Prof. Gates also thinks that Beddard's original specimen of *Perionyx m'intoshi* (from Akyab in Burma ; Beddard, '83) cannot safely be identified with the worms from India which he (Beddard) later ('92) called by the same name, since the Akyab specimen was immature and moreover differed from them in certain features. Beddard's account of these later worms is particularly brief and unsatisfying, and it is difficult to understand, being mixed up with descriptions of several other species and proceeding largely by means of a comparison with *P. intermedius* ; even the locality is not certain, for while, in the paper itself (Beddard, '92) they appear to be from Seebpore (Sibpur), in his Monograph (Beddard, '95) Beddard speaks of them as being from either Seebpore or Darjeeling, the uncertainty being due to his having mislaid his notes.

In the descriptions of the Akyab and Seebpore (?) worms, however, there seems to me to be nothing *against* the identification of the two (except, naturally, the incompleteness of the accounts). The differences concern :—

- (i) The male area,—sucker-like and sunk below the general level in the Seebpore specimens, not depressed in the worm from Akyab. The depression is probably due to retraction by muscular bands, and would be less or absent in a worm which was not (as the Akyab specimen) fully mature.
- (ii) For “ testes ” in the account of the first worm (A'kyab) written in 1883, we must now read “ seminal vesicles ” ; these are said to be in xi and xii, each united to its fellow (across the middle line). The “ sperm-sacs ” (seminal vesicles) of the second batch (Seebpore) are said to be in x-xii, but this is a mistake (see my examination of one of these specimens *post.*),—they are here also in xi and xii (though not conjoined in the middle line).
- (iii) The prostates in the first worm are large, the “ atria ” of the second are limited to a single segment. This is scarcely a contradiction ; in the specimen of the second batch which I have examined the prostates are at least of moderate size, and though limited to segm. xviii cause the septa in front of and behind it to bulge away from each other.

- (iv) The Akyab specimen is longer (15 inches, or 370 mm.) than the others (249 and 320 mm.), but this degree of difference might easily fall within the limits of individual variability.

Unfortunately the first specimen, that from Akyab, to which the name *Perionyx m'intoshi* was first given, does not seem to have been preserved,—at least it is not in the British Museum. The second batch, from Seebpore (or Darjeeling ?), consisted, as far as can be inferred (*cf.* the footnote in Beddard, '92, p. 689) of two specimens, of which one only is in the Museum, and this has been mutilated in the male genital area (xviii and neighbouring segments). Seeing that Beddard's description is very incomplete, I give in the body of the paper an account of the anatomy of this example, as far as it can now be determined.

As to the question of nomenclature, Gates suggests to me that *Perionyx m'intoshi* should be regarded as an invalid species, and a new name given to the (Seebpore or Darjeeling) worms which differ from them. Beddard, however, who had had both worms under examination, thought they were the same, though he certainly admitted the contrary possibility ; and as said above I cannot find any definite point of difference. Indeed the shape of the spermathecal duct (no diverticulum, but a bulging on one side of the duct, (compare Beddard, '83, pl. viii, fig. 8 with fig. 6 in the present paper), and the description of the prostates, which consist in the Akyab worm of a number of small lobules, while in the specimen described below they are cut up on the surface into small lobules so as to present almost a shaggy appearance, give some positive ground for supposing that they are really identical.

Specimens of all, and the types of the new species here described, are in the British Museum (Natural History), to the authorities of which my best thanks are due for the facilities kindly accorded me.

The following notes may be of use regarding the locality of some of the smaller places referred to :—

In the Chindwin Valley, above Monywa and below Homalin (not very far from the Assam border),

Paungbyin or Pongbyin (highest up the valley).

Kalewa.

Kindat.

Masein.

Mawlaik.

In the Northern Shan States, along the Mandalay-Lashio railway line or to the north of it,

Lashio.

Maymyo.

Kyaukme.

Kutkai.

Namkham.

In the Moulmein District (the word " District " is used in its technical sense as an administrative area),

Chaungson.

Kya-In.

Ye.

In the Mergui District,

Mergui.

Labaw.

In the Sandoway District,

Sandoway.

In the Toungoo District,

Thandaung, on the Shan plateau but not in the Shan States, about 160 miles N. of Rangoon.

Lastly Shwegyin and Nyaunglebin are not far from each other, about 100 miles north-east of Rangoon.

SYSTEMATIC.

Family ENCHYTRAEIDAE.

Genus **Enchytraeus** Henle em. Mich.

Enchytraeus rangoonensis, sp. n.

Rangoon; in tube along with *Dichogaster bolawi*, *Eudichogaster chittagongensis*, and *Ramiella cultrifera*. Five specimens, three with signs of sexual maturity.

The worms are very small; length 5 mm.; diameter 0.3 mm. Segments 35, 34, 31, 24+ (injured), 24.

The prostomium is blunt and rounded. There is a large head-pore on the prostomium, but dorsal pores are absent.

The setae are enchytraeinae in form, regularly two per bundle throughout the body, larger at the hind than at the front end.

The clitellum embraces segment xii and nearly half of xiii; it stops just in front of the setal zone of xiii (confirmed also in sections).

Sections show segmentally arranged bands of gland cells in the epidermis at the level of the setal bundles; in tangential sections, which remove only a thin superficial slice of the body-wall, the whole of the nuclei of the surface epithelium are seen to be much elongated transversely, and arranged in a succession of transverse rings.

The coelomic corpuscles are apparently in part metamorphosed into a coagulum, which is present in some amount in the body-cavity. Individual corpuscles can however be recognized of an average length of about 24μ , and oval or fusiform in shape; no normal, scarcely any distinctly recognizable, nuclei are to be seen within the corpuscles, but what appear to be traces of degenerate nuclei are visible both within the corpuscles and in the coagulum.

Septal glands occupy segments iv, v and vi. Salivary glands are present as small, quite short, twisted tubes, immediately behind the pharynx, occupying only a part—not the whole length—of segment iv; they present a number of dilatations, and so are of very irregular diameter; they are branched, and their walls show few nuclei.

There are no oesophageal pouches. There is a moderate and fairly sudden dilatation of the oesophagus to form the intestine in segment x; this division of the two portions of the alimentary tract is quite distinct

in most of the specimens ; in one of the sectioned worms, however, it is less so. There are no "chyle cells" (cells with intracellular canaliculi) in the intestine.

The dorsal vessel begins in the clitellar region, in segment xiii.

The preseptal portion of the nephridia, as seen in sections of the anterior region of the body, is of some size, two-thirds or three-quarters as long as the postseptal, but not so high (dorso-ventrally, in sagittal sections) ; the lumen undergoes a number of windings in this portion of the organ. A very narrow neck passes through the septum. The post-septal portion gives off the duct from its lower surface some little distance in front of the hinder end ; the duct goes at first rather backwards, sometimes markedly so, then bends downwards and sometimes slightly forwards.

Sperm morulae and ripening spermatozoa are present in segment xi. The male funnels (fig. 1) are small, 60μ in diameter at their widest

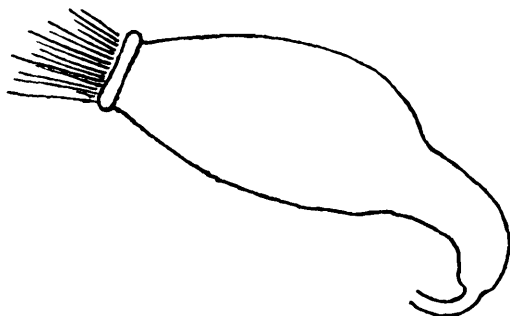


FIG. 1. *Enchytraeus rangoonensis* ; male funnel, semi-diagrammatic.

part, and three times as long as wide. The anterior end, 33μ in diameter, is formed by a thickened rim or collar ; the main portion of the funnel consists of two layers ; the inner layer, which lines the central lumen, consisting of low quadratic cells, the external of much elongated gland cells, of a more spongy texture, with nuclei near their outer ends. The posterior third of the funnel is much narrower than the rest, only 25μ in diameter, and consists of only one kind of cells, the gland cells.

The narrow vas deferens, only 7μ in diameter, forms a small close coil in the anterior part of segment xii. Its ectal end is thickened and surrounded by a few gland cells, some of which form a special defined aggregate on its inner side. There are no other masses of gland cells round the male aperture, and no penial body.

The ova may get forwards into segments xi, x and ix, and backwards into xv. The opening of the oviduct on the surface is well seen in sections, sagittal and tangential, though how the huge ova get out through such a small aperture is not evident ; the oviduct, too, appears as merely a short and narrow cord of connective tissue and cells, with no visible lumen.

The spermathecae are remarkable. The ampullae (?) are small rounded sacs in segment v, 44 by 52μ in diameter, the longer diameter being (? always) transverse, the shorter antero-posterior ; their epithelium is low and irregular ; there is no patent communication with the alimentary canal, but these chambers lie close against the oesophagus and there may be a continuity of tissue between them ; occasionally there may be spermatozoa in this portion of the apparatus and its ental

extension (*v. inf.*). The duct, 20μ in diameter, is a very regular narrow cylindrical tube, which with one or two bends in its course leads forwards, becoming rather narrower towards the body-wall and ending on the surface in furrow 4/5 ; it has a cubical epithelium, muscular coat, and peritoneal covering ; there are no gland cells round its termination.

The ental extension of the spermathecal apparatus, alluded to above, is tubular in form, of some length, and passes from the dilatation (called the ampulla above) backwards into segment vi or forwards into iv. Its course is irregular, and its diameter also ($20-30\mu$) ; it does not branch, and ends internally in a dilated portion, which however is elongated, irregular and indefinite in form, not a simple ovoid chamber. These structures gave me considerable trouble before I understood them ; they are scarcely visible in specimens mounted whole, and it is difficult at first to follow out narrow tubular structures, such as these, which wind irregularly, in serial sections ; for a long time I confused them with the salivary glands. The ental extension may perhaps represent a diverticulum ; or possibly the whole of the apparatus except the duct,—the ental extension as well as what I have called the ampulla, should be considered as the ampulla.

No copulatory glands (Bauchmarkdrüsen) were seen.

Family MONILIGASTRIDAE.

Subfamily MONILIGASTRINAE.

Genus *Drawida* Mich.

Drawida vulgaris Gates.

Prof. Gates kindly sent me four sexually mature specimens of his recently described *Drawida vulgaris* (Gates, '30), from Kalewa, Burma. I will only note that, while Prof. Gates considers the male pore to be at the tip of the flap which projects on each side from the posterior margin of segment x, I (examining the specimens before I had received his description) supposed the pores to be in furrow 10/11, bounded in front by a much swollen and "glandular" anterior lip (*i.e.*, the "flap") and behind by an inconspicuous posterior lip.

There is a slight slip in Gates's description of the testis sacs ; these are, as usual, suspended by septum 9/10, not 10/11, and project into segments ix and x.

Family MEGASCOLECIDAE.

Subfamily MEGASCOLECINAE.

Genus *Plutellus* E. Perrier.

Plutellus inflexus, sp. n.

Kalewa. A number of specimens.

External Characters.—The preserved specimens show in general a rather characteristic hooking of the anterior end, the middle of the bend being in the clitellum, so that this region cannot be straightened out.

Length 40-55 mm. ; diameter usually about 1.5 mm., with perhaps a maximum of 2 mm. Colour a rather pale pinkish grey, flesh-coloured ; the anterior end may be a darker grey, the clitellum a fairly light brown to deep purple. Segments (of the longest specimen) 150.

The prostomium is slightly epilobous, coming to a blunt angle behind, whence a faint longitudinal groove is continued back half-way through segment i ; this segment is of some length, longer than segment ii, from which it is well marked off.

Dorsal pores begin in furrow 7/8.

The setae are paired, the lateral less closely than the ventral ; in the middle of the body $aa=4ab=1\frac{1}{4}bc$, while cd is nearly twice ab ; behind the clitellum $aa=1\frac{1}{3}bc$, while cd is quite twice ab ; these latter ratios hold also in front of the clitellum ; dd is equal to half the circumference throughout the body.

The clitellum is saddle-shaped, coming down on each side to just above the line of setae b , and extends over segments xiii-xix ($=7$) ; it varies in colour as described above.

The male pores are on xviii, on small indefinite papillae, the middle of the papilla being in line with seta a .

The female pores are on xiv, on a slightly elevated transverse area which takes up the whole length of the segment and extends across the mid-ventral interval unoccupied by the clitellum ; the apertures are minute, just in front of setae a .

The spermathecal apertures were not seen externally ; from internal dissection they are four pairs, opening in furrows 5/6—8/9 in line with the ventral setae.

Genital markings are present as median papillae, transversely oval in shape, in furrows 11/12 and 12/13, extending over the intersetal interval aa ; that in 11/12, or both, may be wanting.

Internal Anatomy.—Septum 5/6 is somewhat thickened, 6/7, 7/8 and 8/9 considerably and 9/10 moderately so, 10/11 is somewhat strengthened, 11/12 slightly so, 12/13 scarcely at all.

There is a square, moderately firm gizzard in segment v. The oesophagus is very vascular, with transverse blood-channels in its wall, in

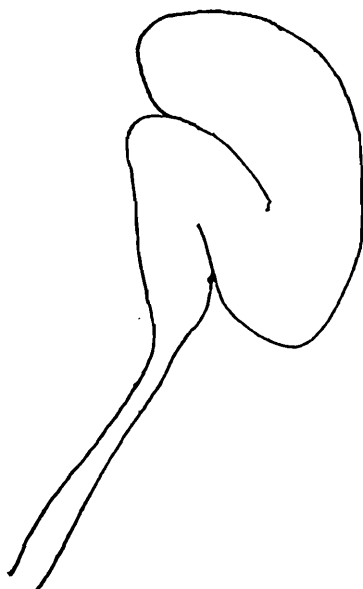


FIG. 2. *Plutellus inflexus* ; prostate.

segments ix-xii (most markedly so in xi-xii), but there are no set-off calciferous glands. The intestine swells out in xiv.

The last hearts are in segment xii.

The excretory system is meganephridial.

The testes and funnels are free in segments x and xi. Seminal vesicles are present in xi and xii as small lobed masses.

The prostates (fig. 2) are compact-looking structures, but are really tubular, the glandular part being folded on itself so that the apposed loops appear at first to be a compact mass. The duct is quite straight, runs inwards and slightly forwards, is shiny and of moderate length, with the ectal portion broader than the ental.

The relatively large ovaries and their funnels are in xiii. Ovisacs are present in xiv.

The spermathecae (fig. 3) are four pairs, in segments vi-ix; the ampulla is an ovoid sac of regular shape; a duct can scarcely be described,

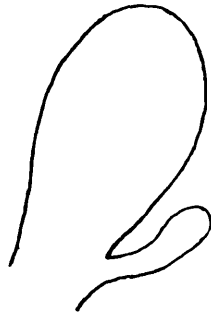


FIG. 3. *Plutellus inflexus*; spermatheca.

since the sac merely narrows somewhat towards its attachment to the body-wall. A single short diverticulum, one-third as long as the ampulla, rather club-shaped, is attached near the junction of the sac with the body-wall.

The penial setae (fig. 4) are 0.4—0.45 mm. in length, nearly 4μ thick at the middle of the shaft, and 5μ near the proximal end. The greater

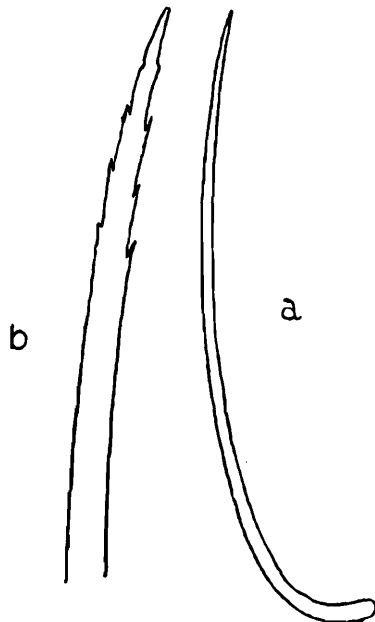


FIG. 4. *Plutellus inflexus*; penial seta; a. whole seta, $\times 160$; b. distal end, $\times 1000$.

portion of the shaft, including the distal end, is only slightly bowed, but the proximal end is considerably curved. The distal end tapers gently, and the tip is pointed; just above the tip there are a few—about half a dozen—fairly conspicuous spines.

Genus **Pheretima** Kinb.

Pheretima alexandri (Bedd.).

British Museum Collection. A single specimen (type); locality given as "India."

External Characters.—For the reasons that have led me to describe this specimen see the Introduction.

Length 148 mm.; diameter 5 mm. Colour pale, ochraceous; no apparent difference between dorsal and ventral surfaces. Segments 130; setal zones in some of the preclitellar segments elevated, but no definite secondary annulation.

Mouth large, terminal, buccal mucous membrane protruding; no prostomium distinguishable, but a number of longitudinal grooves radiate from the margin of the mouth almost as far as the hinder border of segment i; the prostomium may be the area enclosed between the dorsal-most couple of these grooves, but there is no anteriorly projecting lobe overhanging the mouth.

Dorsal pores from furrow 12/13.

The setae are in rings; the dorsal break is very slight ($zz = \text{ca. } 1\frac{1}{4} yz$), and the ventral break in front of the clitellum is somewhat irregular but always small,—largest in the most anterior segments; behind the clitellum the ventral break is either very small and irregular or altogether indistinguishable. The setae are largest at the two ends of the body, especially at the anterior; they are not markedly closer set dorsally or ventrally. The following numbers were counted:—33/v, 44/ix, 50/xii, 62/xix, and 60 in the middle of the body.

The clitellum extends over segments xiv-xvi (=3); it is smooth, but the position of the dorsal pores is indicated, though they are not pervious; there is a faint indication of the position of the setae ventrally on xiv.

The male apertures, on xviii, are small but easily visible, in the centre of large circular papillae, which extend on to xvii and xix—almost to the setal zone of xix, but not quite so far on xvii; each papilla is slightly depressed in the centre, and is crossed transversely by a couple of grooves, one in front of and one behind the male pore; of these the posterior groove on each side is much the better marked,—both longer and deeper than the anterior. The anterior border of the papilla is more sharply delimited than the rest of its extent. The pores are about two-sevenths of the circumference apart; twelve setae intervene.

The female pore is single, on xiv, in a small sub-circular area in the setal zone.

The spermathecal apertures are not visible externally.

There are no other genital markings.

Internal Anatomy.—Septum 4/5 is somewhat strengthened, 5/6 considerably so, 6/7 is much thickened and 7/8 most of all; 8/9 and 9/10 are absent, 10/11 is somewhat thickened, 11/12 and one or two more slightly and diminishingly so.

The gizzard, behind septum 7/8, is large, firm, shortly cylindrical, narrowing slightly at its anterior end. Just behind the gizzard is a collar surrounding the alimentary tube, doubtless, as in the specimens which I called *P. lignicola* (Stephenson, '16), composed of blood-glands (in the paper just referred to "behind the pharynx" (on p. 335) should read "behind the gizzard"). The intestinal caeca, originating in xxvii and extending forward to xxii, are slender and smooth.

The last hearts are in xiii.

The micronephridia are extremely numerous and small.

The anterior pair of testis sacs are sessile on the interior surface of septum 10/11; the posterior pair are large, taking up the whole length of segment xi, enclosing the seminal vesicles and hearts of the segment, and uniting in the middle line dorsally beneath the dorsal vessel. The posterior seminal vesicles, in xii, are rather small, smooth and only very slightly lobed.

The prostates are large, extending through segments xvii-xx, and much cut up into lobes. The duct, at first relatively thin and soft, becomes firmer, thicker, and shining; it has an irregular twisted course, but its main part forms a considerable loop, directed forwards; the ectal limb of the loop is uniformly thick, more than twice as thick as the initial part of the duct.

The ovaries and funnels are in xiii; there are no ovisacs.

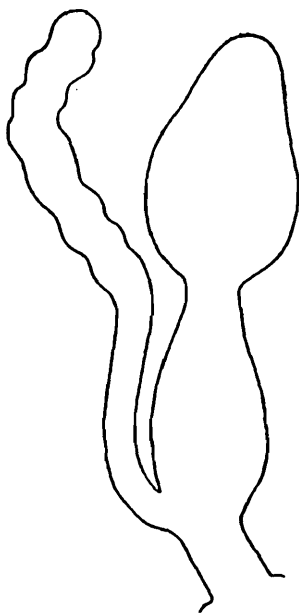


FIG. 5. *Pheretima alexandri*; spermatheca.

The spermathecae (fig. 5) are four pairs, discharging in furrows 5/6-8/9. The ampulla is of a flattened oval or inverted pear shape. The duct, rather longer than the ampulla, narrower entally, widening below, is muscular and shining; the terminal portion, where it is about to enter the body-wall, is when fully displayed in dissection a little softer and less shining than the rest, rather narrower again, and set at a small angle to the rest of the duct. The widest part of the duct is two-thirds as broad as the ampulla or more,—it may be fully as broad; the ratio depends on the width of the ampulla, which is variable. The diverticulum is single,

elongated, tubular, extending as far as or even some distance beyond the end of the ampulla ; it is given off near the junction of the duct with the body-wall, at the slight bend in the course of the duct ; its ectal portion is smooth and shining, the ental portion being rather wider, and somewhat moniliform.

Remarks.—The specimen is said by Beddard ('00) to have been sent to him from Kew Gardens (near London), having been imported from the neighbourhood of Calcutta. Beddard did not count the setae (except on segment ii), since he was unwilling, as he says, to injure his only specimen ; counting the setae should hardly, I think, be a very dangerous process. The only septum stated by Beddard to be absent is 8/9 ; 9/10, however, is also wanting. I had considered the presence of 9/10 in *P. alexandri* and its absence in my *P. lignicola* as one of the distinctions between them. Moreover, in saying that "the sperm sacs (*i.e.*, the seminal vesicles) in xi and xii are not in any way remarkable," Beddard overlooks the fact that the vesicles of xi are contained within the testis sacs of that segment. My statement (in the "Fauna of British India" volume, Stephenson, '23) that the prostatic duct forms a simple loop and is of equal diameter throughout, was an inference from Beddard's figure ; it is not borne out by my examination of the specimen.

Genus **Perionyx** E. Perrier.

Perionyx m'intoshi Bedd.

British Museum Collection. A single specimen, labelled "*Perionyx macintoshii*—India." From the measurements it is evidently the specimen referred to in the footnote in Beddard's paper, '92, p. 689. The whole worm is softened ; the ventral body-wall has been removed over segments xvii-xx, *i.e.*, the male field and its immediate neighbourhood (cut out, presumably for microscopic examination) ; the hinder end has been opened for the last 15 mm., and the corresponding part of the intestine removed. Beddard had left the organs of the right side comparatively undisturbed, and I also have interfered with them as little as possible.

External Characters.—Length 325 mm. ; diameter *ca.* 8 mm. Colour rusty, a light reddish-brown. Segments *ca.* 240 ; no secondary annulation apparent.

Prostomium very slightly and very faintly epilobous, almost probolous ; the transverse groove in front of the very short tongue, behind the projecting lobe of the prostomium, is shallow and ill-marked.

Dorsal pores from furrow 5/6.

The setae are very small relatively to the size of the worm, and are very difficult to count,—*ca.* 78/v, *ca.* 87/ix, *ca.* 83/xii (this number is very doubtful), *ca.* 86/xxii, and 90-95 in the middle of the body. The ventral break is indistinguishable ; the dorsal break is small in the posterior region (on the average *ca.* 2yz, but irregular), while anteriorly it is very small or absent. The setae are closer set ventrally than dorsally.

The clitellum is not very well marked, and its limits are not sharply defined ; it embraces segments xiii-xx (=8) ; though Beddard gives its extent as xiii-xix, there can scarcely be any doubt that in this specimen

an additional segment is included. Intersegmental furrows are present and even well marked in the anterior part of the region, though there is some smoothing out, especially over segments xvi-xx.

The body-wall has been removed in the male area, so that the characters of the male field cannot be given. The female pore is conspicuous, mid-ventrally situated on xiv, between the setal zone and the anterior margin of the segment. The spermathecal pores are inconspicuous, in furrows 7/8 and 8/9, very close to the middle line.

Internal Anatomy.—Septum 4/5 is present, thin; 5/6 is thin, 6/7 slightly and 7/8 moderately thickened; succeeding septa are somewhat thickened, the thickening decreasing but slightly perceptible even as far back as segment xx.

The gizzard is in vi, of moderate size but soft.

The last hearts are in segment xiii.

The testes, which are bushy, and funnels are free in segments x and xi. The seminal vesicles (called "testes" by Beddard, '83), situated in xi and xii (none in x), are of moderate size, lobed, and then further divided up on the surface into minute lobules, so that they have a granular appearance.

The prostates are of moderate size, lobed and lobulated, so that the appearance is almost shaggy; they are confined to segment xviii, causing the septa which limit the segment to bulge apart. The duct leaves the middle of the inner surface of the gland, but most of it on one side, and all on the other, has been cut away with the ventral body-wall; the small portion which is left on one side is soft and narrow; it appears to have been directed straight inwards. The terminal portion of the vas deferens is almost as thick as the prostatic duct.

The ovaries are in xiii; the funnels were not distinguishable. There are no ovisacs.

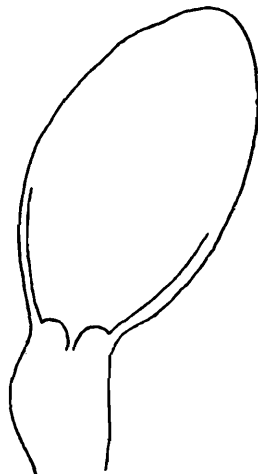


FIG. 6. *Perionyx m'intoshii*; spermatheca.

The spermathecal ampulla (fig. 6) is a simple sac. The duct is rather broad, soft, bulging considerably on its inner side, this bulging portion shining, almost iridescent, as if spermatozoa were contained within; it is one-third as long, and where thickest half as wide, as the ampulla; and it projects into the ampulla somewhat like the os uteri into the vagina.

Perionyx ditheca, sp. n.

Thandaung. Four specimens.

External Characters.—Length 55-70 mm. ; maximum diameter $1\frac{1}{2}$ -2 mm. Segments of the longest specimen 106. Colour a slightly pinkish grey.

Prostomium epilobous *ca.* $\frac{1}{2}$ or less ; tongue broad, not cut off behind, the lateral limiting grooves not very distinct. The general annulation of the body is very pronounced in all the specimens.

Dorsal pores begin in furrow 5/6.

The setae are arranged in rings, and are small, especially in the anterior part of the body. There is no ventral break ; in most segments there is a very slight dorsal interruption ($zz=ca. 1\frac{1}{4} yz$). The setae are set rather wider dorsally than ventrally. The following numbers were counted with difficulty ; all the numbers are approximate only :—38/v, 38/ix, 42/xii, 38/xix, and 32 in the middle of the body.

The clitellum extends over segments xiii-xviii (=6) ; it is ring-shaped, swollen, and reddish in colour ; setae and dorsal pores are visible.

The male area, on segment xviii, appears as a mid-ventral depression in which are situated a pair of small rounded papillae, contiguous or nearly so in the middle line, turned somewhat towards each other and looking therefore not directly downwards but inwards as well ; the antero-posterior extent of the papillae is less than the length of the segment, and they are bounded by two transverse grooves, one in front of and one behind the pair of papillae. The male pores are one in the centre of each papilla.

The female aperture is apparently situated in a conspicuous and moderately deep mid-ventral depression close to the anterior margin of segment xiv, which has the form of a transverse groove deepest in the middle, or a star-shaped pit with about four radiating furrows.

The spermathecal apertures are a single pair, near the middle line in furrow 7/8. One or more of the neighbouring furrows, 6/7 and 8/9, may, though indistinctly, appear to contain pores, and sometimes (*v. inf.*) actually do so.

There are no other genital markings.

Internal Anatomy.—No septa are much thickened, though perhaps 6/7—9/10 are slightly so. In the first specimen dissected there was no appreciable gizzard ; the somewhat quadratic segment of the alimentary canal in v seemed to be neither broader nor firmer than the neighbouring parts of the tube ; in a second example, however, this part seemed to be slightly firmer, and one might speak of a very vestigial gizzard in segment v. The alimentary canal swells out either behind the prostatic region, or in segment xvii, to form the intestine.

The last hearts are in segment xii.

The excretory system is meganephridial ; there is no alternation in the position of the nephridiopores.

Testes and funnels are free in segments x and xi. In one specimen seminal vesicles were present in xi and xii as small lobulated masses, each a transverse row of rounded lobules ; in a second, the vesicles were small in xi, of moderate size and racemose in xii, and there was a third pair, small and lobulated, in xiii.

The prostates are small and compact, confined to segment xviii, and not causing the septa to bulge apart. The duct is narrow, slightly shining, generally transverse in direction but somewhat twisted.

There are no penial setae.

The ovaries are relatively large, in xiii, which also contains the funnels. Small ovisacs are present in xiv.

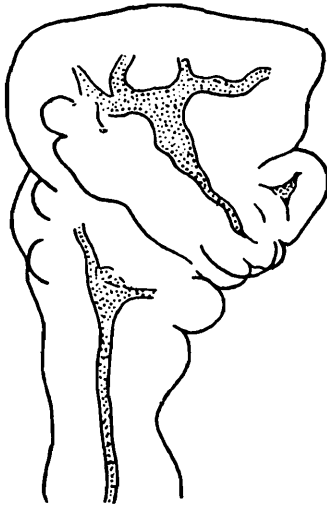


FIG. 7. *Perionyx ditheca* ; spermatheca.

The spermathecae (fig. 7) in the first specimen dissected are a single pair, in segment viii, discharging in furrow 7/8 ; the ampulla is on the whole roundish in form, though very irregularly so owing to the presence of small bulgings, almost lobulations. The diverticula, if any are present, are difficult to distinguish in dissection from these lobulations or sacculations ; possibly there are two, conjoined, at the base of the ampulla. The duct is short, of moderate thickness,—as long as and half as wide as the ampulla. When examined under the microscope the diverticula are still not definitely to be distinguished from the sacculations of the ampulla, and the whole appears as a mass of rounded chambers of various sizes.

In the second specimen spermathecae were present in segment viii on both sides, and in vii only on the left side. The shape was as just described, the lobulation of the ampulla perhaps not quite so marked. In the organs of segment viii none of the lobules could be specially singled out as representing a diverticulum ; but in the single organ in segment vii it might possibly be allowable so to distinguish one small sacculation at the ental end of the duct.

Subfamily OCTOCHAETINAE.

Genus *Ramiella* Steph.

Remiella cultrifera, sp. n.

Rangoon. July 1930. A number of specimens, many mature.

Rangoon. No date. A single specimen.

Kalewa. Three small specimens, one not fully mature.

The specimens of the first batch from Rangoon may be considered as typical, and will be first described.

External Characters.—The longest specimens measure 20 mm. ; maximum diameter 1 mm. Colour pale grey, anterior end lighter, unpigmented. Segments 84, 82.

Prostomium epilobous about $\frac{1}{3}$, with square-cut hinder border.

Dorsal pores from furrow 8/9.

Setae paired ; in the middle of the body *ab* is somewhat less than *cd*, and *aa* and *bc* are about equal, though in some places *bc* is rather the larger ; $ab = \frac{2}{5}aa = \frac{2}{5}bc$, and *dd* is slightly less than half the circumference. In front of the clitellum the setae are too small to be properly seen.

The clitellum is saddle-shaped, a narrow ventral region being free from thickening ; it includes the segments from xiii backwards to nearly the hinder limit of xvii (=nearly 5).

The prostatic pores are on xvii (at the hinder end of the segment) and xix, in line with setae *ab*, and are connected by almost straight (slightly convex inwards, or very faintly irregular) seminal grooves, which are limited on each side by slightly swollen white walls.

The spermathecal apertures are in furrows 7/8 and 8/9, in line with seta *b* or just below this (internal to this).

Internal Anatomy.—As the specimens were so small, they were examined by longitudinal sections (two specimens) as well as by dissection.

Septa 5/6—8/9 are somewhat thickened, 9/10—11/12 slightly so.

In the dissected specimen the gizzard, round and shining but rather soft, was in segment vi ; in one of the sectioned specimens it was in vi, in the other in vii. Calciferous glands are absent. The intestine begins in segment xiv.

The last hearts are in xii.

The number of nephridia is small,—apparently two only on each side in each segment.

Testes and funnels are free in segments x and xi. There is a single pair of seminal vesicles, relatively large, rounded and transversely oval in shape, in xii, nearly touching each other in the middle line.

The prostates are two pairs, tubular in form ; the glandular portion is rather flocculent-looking and very friable, bent twice or more in one plane as it lies on the body-wall, the loops one behind the other. The duct is narrow, straight, of some length, and runs transversely in the segment ; the penial setal sacs are prominent.

The ovaries are present in segment xiii. No ovisacs were seen.

The spermathecae (fig. 8, *a* and *b*) are situated in segments viii and ix. The ampulla is sac-like or slightly irregular in shape ; the duct is fully as long as the ampulla, bent irregularly to a greater or less degree, moderately stout—about a quarter as wide as the ampulla—the ental end being slightly thicker than the ectal. The diverticulum is an ovoid chamber of some size, almost sessile and marked off by only a slight constriction from the upper end of the duct just below the ampulla ; its size varies,—it may be about two-fifths as long and half as wide as the ampulla, or it may be somewhat smaller than this, or occasionally it may be altogether

absent. The ampulla is usually bent over on to the duct as in fig. 8 *a*, but duct and ampulla may be in the same line as in fig. 8 *b*.

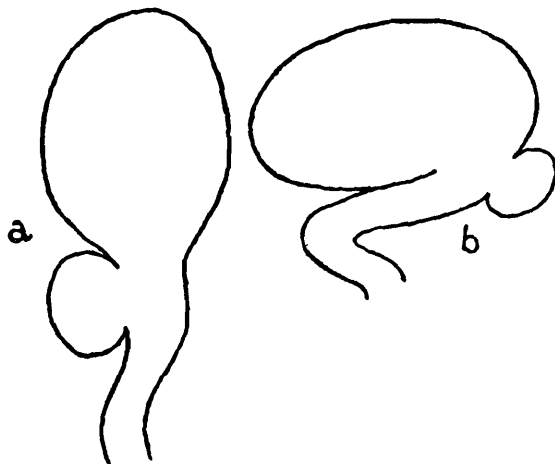


FIG. 8. *Ramiella cultrifera* ; *a* and *b*, two examples of spermathecae.

The penial setae are of two kinds, one of each kind being present in each bundle. (*a*) The first form (fig. 9) is 0.54-0.57 mm. long measured

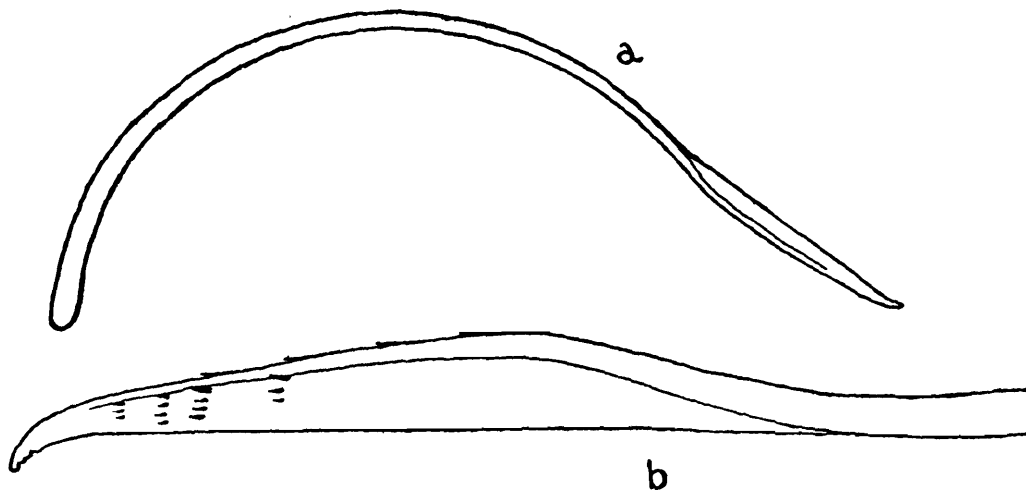


FIG. 9. *Ramiella cultrifera* ; penial seta, first form ; *a*. whole seta, $\times 160$; *b*. distal end, $\times 550$.

across the curve, 12μ in diameter at the middle of its length, and rather swollen towards the base ; the shaft is curved in an arc of about a third of a circle, the distal end, one-fourth or a little more of the total length, is not curved but continues the direction of the shaft tangentially ; the tip is bluntly pointed, and evidently soft, being somewhat bent and crinkled ; the distal (straight) portion of the seta forms a blade-like expansion, $18-19\mu$ in width, one border, the edge, being turned outwards, the other border, which constitutes a thickened rib, the continuation of the shaft of the seta, being towards the inside of the curve of the shaft. A few spines are seen on this thickened border, and a few fine markings, in short irregular transverse rows, are present on the distal part of the flattened blade.

(b) The second form of penial seta (fig. 10) has the same length, thickness, soft tip, and curve as the former,—except that the distal end



FIG. 10. *Ramiella cultrifera* ; penial seta, second form ; distal end, $\times 375$.

may be bent slightly outwards. There is no blade-like expansion, but the distal fourth of the seta is ornamented by about ten sparse and irregular circles of small spines, sometimes scarcely standing off at all from the shaft and difficult to see ; the number of spines in a circle is few—perhaps four,—or sometimes scarcely more than two lateral rows of spines along the borders of the seta may be seen.

The specimens from Kalewa differ somewhat from the above description, and may perhaps constitute a separate variety.

Length 25 mm. ; diameter 1 mm. Colour pinkish-grey. Segments 85.

Prostomium nearly tanylobous, tongue not closed behind ; but the grooves bounding the prostomium are very faint, and one specimen would ordinarily be described as zygalobous.

Dorsal pores from furrow 6/7.

The setal intervals in the middle of the body have the ratios $ab = \frac{1}{4}aa = \frac{1}{3}bc = \frac{2}{3}cd$, while $dd =$ half the circumference ; thus aa is greater than bc , and cd is greater than ab . In front of the clitellum aa and bc are more nearly equal, and are equivalent to $3ab$.

Clitellum xiii-xvii (=5), brown in colour, smooth, dorsal pores visible, ring-shaped (? completely) except on xvii. The seminal grooves can scarcely be said to be limited by walls, but the margins of the grooves are slightly puckered and possibly a little swollen. The female pores, not seen in the former specimens, are in front of and internal to setae a .

Septum 5/6 is thin, 6/7, 7/8 and 8/9 are much strengthened, 9/10 moderately and the following three septa slightly thickened. The gizzard, in vi, is barrel-shaped, firm, and of moderate size. In front of septum

5/6 the oesophagus is iridescent, with shining longitudinal muscle fibres, and slightly swollen ; this portion has not a well defined anterior limit, and is much narrower and shorter, as well as softer, than the gizzard in vi ; it is thus a strengthened part of the oesophagus, not a second gizzard.

The two nephridia on each side of a segment (behind the clitellum) are one dorsal to seta *d*, and one in the interval *cd*.

There are ovisacs of moderate size in segment xiv.

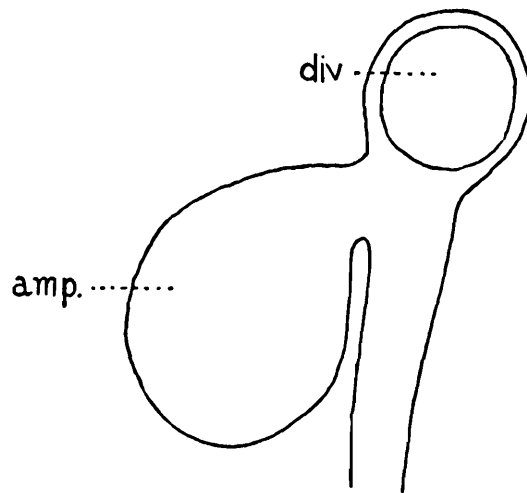


FIG. 11. *Ramiella cultrifera* ? var. ; spermatheca ; *amp.*, ampulla ; *div.*, diverticulum.

The spermathecae are shown in fig. 11 ; the main axis of the organ appears to be constituted by the straight duct and the diverticulum, the latter a subspherical chamber tensely full of a glittering mass of spermatozoa, slightly contracted at its base where it is continued into the duct. The ampulla appears as a lateral appendage, a sac, constricted at its base of attachment to the duct just below the diverticulum.

The two varieties of penial setae are not unlike those described above ; in the first variety (fig. 12), the flattened portion has a thickened border

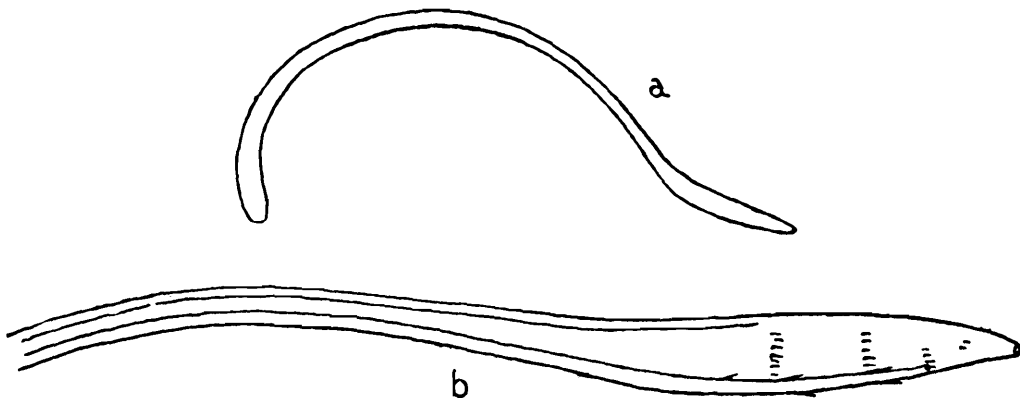


FIG. 12. *Ramiella cultrifera* ? var. ; penial seta, first form ; *a.* whole seta, $\times 100$; *b.* distal end, $\times 425$.

along part or the whole of what is there a sharp edge, and the neighbouring portion of the shaft appears to be grooved, but I am not quite certain

as to the interpretation. The tip of the second variety (fig. 13) has an angular appearance, and the spines are fewer and smaller than in the



FIG. 13. *Ramiella cultrifera* ? var. ; penial seta, second form ; distal end, $\times 425$.

Rangoon specimens ; the part which is bent outwards is shorter than in the setae with flattened ends.

In the single specimen of the second batch from Rangoon the prostomium was epilobous $\frac{1}{2}$, the rather broad tongue being open behind. Dorsal pores began in furrow 7/8. As to the setae, *aa* is greater than *bc*, and *ab* is rather less than *cd* ; *dd* is a little more than half the circumference. The clitellum, extending over *xiii* in front and two-thirds of *xvii* behind, is ring-shaped, though the mid-ventral region is lighter and thinner, so that it might almost be described as saddle-shaped. The penial setae are of the type of those of the other Rangoon specimens.

Genus *Octochaetus* Bedd.

Octochaetus (*Octochaetoides*) *fermori* Mich.

Sandoway. Two specimens.

The species occurs in India from north to south, from east to west ; I have recently found it in a consignment of worms from the Malay Peninsula. It is therefore markedly peregrine.

Genus *Eudichogaster* Mich.

Eudichogaster chittagongensis Steph.

Rangoon. July 1930. A single specimen.

Rangoon. No date. Several specimens.

Moulmein. Aug. 1930. A number of specimens.

Ye. Aug. 1930. Four specimens.

Kya-In. Aug. 1930. Three specimens.

Kalewa. A number of specimens.

Poungbyin. Two specimens.

Kindat, Masein, Mawlaik. Ten specimens.

Shwegyin. Sept. 1930. Several specimens.

The following notes will help to complete our knowledge of this species.

The dorsal pore in furrow 11/12 may be quite large, or it may be small and rudimentary, or it may be altogether absent.

The clitellum is ring-shaped, and ordinarily embraces segments *xiii*-*xvii* ; but part of *xvii* may be excluded.

In most specimens the male field takes up the length of segment *xvii*, and consists of a rather narrow transverse groove extending across the segment between the lines of setae *b* ; the anterior and posterior lips meet and fuse outside the line of *b*, and after fusing are continued a little further out. In a number of specimens from Rangoon, which I did not recognize

on external examination, owing to the different and more marked characters of the male field, a considerable depression, or shallow pit, included the hinder end of xvii and a small portion of the anterior end of xviii ; it was bounded in front by the hinder end of the clitellum and laterally by the male papillae, while the more shelving posterior wall of the fossa stopped short of the setal zone of xviii.

The male papillae bear each a short, rather oblique groove ; the prostatic pore is presumably at the anterior end of the groove, on xvii, and the opening of the vas deferens at its hinder end, apparently about the level of furrow 17/18. On internal dissection the vas deferens is difficult to see, but it does, pretty certainly, pass external to the end of the prostatic duct and pierces the parietes a little behind the level of the entry of the prostatic duct into the body-wall.

I found no sign of testis sacs in segment x in three specimens from different localities which I dissected ; x was either apparently quite empty of genital organs, or contained a small mass of iridescent spermatozoa on the floor of the segment, with or without small funnels in addition. In one of the specimens from Rangoon, however, I found an explanation of my original statement (Stephenson, '17) concerning the presence of conjoined testis sacs and seminal vesicles in x ; a well defined mass of male cells occupied the segment, attached deeply on each side, probably to the testis. On freeing this and examining it in glycerin it was found to be a solid mass of sperm morulae and spermatozoa, with a definite outline but no enclosing membrane ; it is just possible, however, that such an enclosing membrane may have existed earlier (as for example in some species of *Enchytraeus*, where it breaks down later), and so may have been present in my original specimens.

In previous examples an ornamentation of the penial setae has gone unnoticed (Stephenson, '17), or (Stephenson, '31) has consisted only of slight irregularities of outline. In one of the specimens from Kya-In in which these setae were examined they might almost be described as serrated.

A knob-like excrescence low down on the tubular spermathecae probably represents the diverticulum (*cf.* also the figure of spermatheca (fig. 32b) in Stephenson, '17).

***Eudichogaster yeicus*, sp. n.**

Ye. Aug. 1930. Four specimens.

Chaungson. Aug. 1930. Five specimens.

Kya-In. Aug. 1930. Four specimens.

(All localities in Moulmein District).

External Characters.—Length 45 mm. or less ; maximum diameter (at clitellum) 2 mm. Colour a medium grey ; clitellum a little darker. Segments *ca.* 150.

Prostomium pro-epilobous or slightly epilobous, with rounded posterior border ; no distinct groove continued back from hinder angle of prostomium dorsally on segm. i, at most a very slight triangular depression. Segment i indistinctly separated from ii.

Dorsal pores begin in furrow 11/12.

The setae, larger in the hinder part of the body, are paired, but not closely. In the middle of the body $ab = \frac{1}{2}aa$ (sometimes more, or less)=

$\frac{3}{4}bc$, while bc is very little greater than cd ; dd =half the circumference. Behind the clitellum $ab=\frac{1}{2}aa$ or less, $=\frac{1}{2}-\frac{3}{5}bc, =\frac{2}{3}-\frac{3}{4}cd$; in front of the clitellum $ab=\frac{1}{2}aa=ca$. $\frac{2}{3}bc=\frac{2}{3}-\frac{3}{4}cd$.

The clitellum extends over segments xiii-xvii (=5), is ring-shaped, and sharply defined.

The male area is a transversely extended rectangle, narrow in its antero-posterior extent, surrounded on all sides by a low lip, the whole taking up the hinder part of xvii, xviii, and all xix, and extending on each side to a little outside the line of setae b . The prostatic pores, on xvii and xix, in line with the setae b , are small transverse slits bounded by slight anterior and posterior lips. The seminal grooves join the outer ends of the slits, and have a slightly irregular course or are convex inwards, the pores and grooves of the two sides presenting somewhat the appearance of a pair of square brackets []. The prostatic pores of each segment are joined by a transverse furrow, and there is also a slight furrow across the middle of segment xviii. The endings of the vasa deferentia were not distinguished.

The female pores were, when visible, situated in front of and internal to setae a of segment xiv, on a slight common transverse elevation.

The spermathecal pores are very indistinct, but appear to be in furrows $7/8$ and $8/9$, in or just below the line of setae b .

Internal Anatomy.—Septa $4/5$ and $5/6$ are very thin, $6/7$ is represented only by a few strands or a very tenuous membrane behind the second gizzard; from $7/8$ or $8/9$ the septa as far as $12/13$ are slightly thickened as compared with the rest, though they are still thin.

There are two gizzards, in v and vi, firm, of relatively considerable size, narrowing posteriorly. The calciferous glands, in x, xi and xii, are ovoid in shape, broadly attached to the oesophagus, and all of about the same size. The intestine begins in xv.

The last hearts are in segment xii.

The micronephridia are small twisted tubes, three on each side per segment; one occupies the interval bc on the body-wall, one is situated in or just above the line of setae d , and one is placed more dorsally. Occasionally there are four on a side, the ventralmost of the three being divided into two.

In the first specimen to be dissected (from Ye), testis sacs were present in segment x, transversely elongated in shape, and containing the male funnels and testes (or at least, though the testes were not definitely recognized, some opalescent sperm masses); in segment xi the funnels were free (testes not recognized). Seminal vesicles were present in ix only, small, of a rounded oval in shape. In a second dissected specimen (from Chaungson), though the external marks of sexual maturity were present, and the ovaries and ovisacs were fully developed, the anterior male organs were not to be made out,—neither testes, funnels, nor seminal vesicles; probably their period of functioning was over. The male organs seem, in some of these *Eudichogasters*, to be very temporary in their duration (cf. *E. chittagongensis*).

The prostates are two pairs, small tubular organs, short and twisted, each confined to its own segment; the duct is short, straight, and soft, and runs transversely inwards.

Ovaries are present in xiii, and ovisacs in xiv.

The spermathecae (fig. 14) are two pairs, in form not very unlike those of *E. chittagongensis*. They are long and tubular, and may be consider-



FIG. 14. *Eudichogaster yeicus* ; spermatheca.

ably bent in their course ; there is no distinct division into ampulla and duct, but the rather narrower part, about one-sixth of the whole, below the attachment of the diverticulum is probably to be considered as the duct ; the ental end is slightly and ovoidally dilated. The diverticulum is a small entirely sessile rounded chamber near the base of the organ, containing spermatozoa.

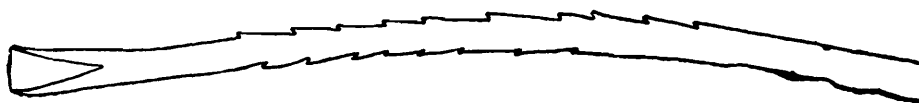


FIG. 15. *Eudichogaster yeicus* ; penial seta, distal end, $\times 1000$.

The penial setae (fig. 15) are 0.4 mm. in length, and 4μ in diameter at the middle ; they are curved in a gentle bow either along their whole length, or only in their distal half or less. The distal end tapers slightly ; the tip, as seen sideways, is pointed, but seen on the flat is expanded and thin,—or rather is forked, and the interval between the prongs is occupied by a delicate web ; the webbed portion is 4μ broad, the shaft just above the web 2.5μ in diameter. The distal 120μ is ornamented with a number of small serrations, somewhat irregularly arranged, and those of the two sides not necessarily opposite.

No copulatory setae were discovered in the spermathecal region.

Subfamily *DIPLOCARDIINAE*.

Genus *Dichogaster* Bedd.

Dichogaster bolau (Mich.).

Namkham, Shan States. April 1930. Four specimens.

Rangoon. July 1930. A single specimen.

Rangoon. (No date). A number of specimens.

Mergui. Three specimens.

Maymyo. A number of specimens.

In the present collection there are a considerable number of tubes of small worms the correct determination of which has caused me much difficulty and hesitation. Among them are some which I labelled *Dichogaster bolau*, and others which I called *D. malayana* ; and I may first note the points of distinction between these two worms as they may be

gathered from the original descriptions (Michaelsen, '91, cf. also Michaelsen, '97 ; Horst, '93). (I neglect small and unimportant differences).

According to Horst, who had specimens of *D. bolawi* from Michaelsen for comparison, this worm is slenderer than *D. malayana*, and the anterior segments are not longer than the rest (in *malayana* the first five segments are longer than succeeding ones). The clitellum is saddle-shaped in *bolawi*, ring-shaped in *malayana* (except that the space between the ventral setae of the posterior clitellar segments seems not to be glandular). The female pore is single on a circular papilla in *bolawi*, or as it is put by Horst, "surrounded by an oval wall, of which there is not any trace in our species" (i.e., in *malayana*) ; there is no direct statement that the female pore is double in *malayana*, though apparently we are to infer it. The hooked form of penial seta has about 8 teeth in *bolawi*, 4 in *malayana*.

D. bolawi varies considerably in size, being 20-40 mm. in length (up to 60 mm. when living), and this, as well as the possibility of varying degrees of contraction, renders the slenderer habit of *D. bolawi* of very doubtful value as a distinction ; different degrees of contraction might perhaps also account for an apparent difference of length of the anterior segments. We are left with the clitellum, the female pore, and the spines of the penial setae.

I may now give some account of the worms in the present collection, some of which I at first called *D. bolawi*, others *D. malayana* ; sometimes I was doubtful, sometimes I revised my first judgment.

In all, the first segment is not distinctly demarcated from the second.

The clitellum is always well defined, and includes segments xiii-xx, neither more nor less (*D. bolawi* xiii or xiv-xviii, xix or xx, "Tierreich") ; in many it is certainly ring-shaped, not very thick, very smooth, rather lighter and apparently somewhat thinner below, with the furrows still present. In many I noted it as saddle-shaped, and these were referred to *D. bolawi* ; but re-examination in practically every case showed that there was undoubtedly some thickening mid-ventrally also, though the inter-segmental furrows were still present there ; the clitellum in these specimens was thicker than in the others, and it seems now to me that this condition represents a more advanced stage ; with continued development the thickness increases, except ventrally, where it remains moderate in amount,—and hence the appearance of a saddle-shaped clitellum with a longitudinal mid-ventral groove between the swollen edges. In many the clitellum is apparently definitely absent on segment xx ventrally.

The female pore is single, on a papilla which is sometimes hardly raised at all, but which is delimited by a groove ; the groove is perhaps less definite laterally than in front and behind. The papilla takes up the whole length of segment xiv, and may include the ventral setae on each side.

There is very frequently a longitudinal groove in the middle line between the two seminal grooves on xvii-xix ; such a median groove is noted for *D. bolawi* by Michaelsen in the "Tierreich." (The statement in the "Tierreich" that the seminal grooves are convex towards the middle line in *D. malayana* is an inference from the figure ; in Horst's text they are described as "longitudinal oval.")

Dorsal pores are often visible on the clitellum in the situation of furrow 13/14 or 14/15.

Seminal vesicles may be present in xi and xii,—small and racemose in form, or vestigial. (In *D. bolawi* Michaelsen gives one pair of vesicles in xi, rudimentary.)

I examined a large number of penial setae of these specimens, some with the oil immersion lens, but could not separate the two species by this means ; on the contrary, these setae showed a remarkable uniformity. The number of spines on the hooked variety does, however, vary from four to six ; often two spines lie side by side. The two kinds of penial setae of *bolawi* are said to be of the same diameter (5μ) ; in all my slides, however, the hooked form is notably the thicker,— 6.4μ as compared with 4.7μ (measured with the oil immersion) in diameter at the middle ; the length of the hooked setae is 0.35 mm., that of the scalpel-shaped 0.32 mm.

I cannot doubt that in spite of the differences in the clitellum all these specimens belong to the same species. If I am right in my explanation of the differences in the appearances of the clitellum, the form characteristic of *D. malayana* is merely an earlier stage than that which is described for *D. bolawi*. The number of teeth of the penial setae in my specimens is as a rule intermediate between those assigned to the two species by their authors. I cannot, however, explain the difference in the descriptions of the female pore or pores.

On the whole, I believe that the distinction between *D. bolawi* and *malayana* cannot be maintained ; *D. bolawi* is widely spread in the warmer regions of the globe,—is in fact circummundane. *D. malayana* was recorded by Horst from a number of places in the Malayan Archipelago, and thus, like *D. bolawi*, is peregrine. I have just recently received from the Philippine Islands some small Dichogasters, among them one which presents the characters of the above worms from Burma,—clitellum extending all round but thinner ventrally, etc.

***Dichogaster curgensis* Mich. var. *unilocularis* Steph.**

Kutkai. A number of specimens.

Lashio. Five specimens.

I have recently described this variety from Lashio (Stephenson, '31). The following notes mostly concern points of difference from the type of the species (Michaelsen, '21).

In length the specimens measured 21-30 mm. The colour is slightly purplish on the dorsum, with a median dark stripe. Dorsal pores begin in furrow 5/6 (once 4/5). The setal interval *dd* is equal to two-thirds of the circumference.

The clitellum extends over xii or xiii-xx, and is ring-shaped, but the ventral surface of xii and xx is not included in the thickening ; when the clitellum extends on to xii (as it does in most specimens) it is the lateral portions of the segment that are included. In some specimens the clitellum appears (possibly because development is not complete) saddle-shaped.

Seminal vesicles are present in all specimens dissected, small in xii, and small or absent in xi.

The spermathecae (fig. 16) differ a little from my former description. The ampulla is elongated, twice or three times as long as broad ; the duct

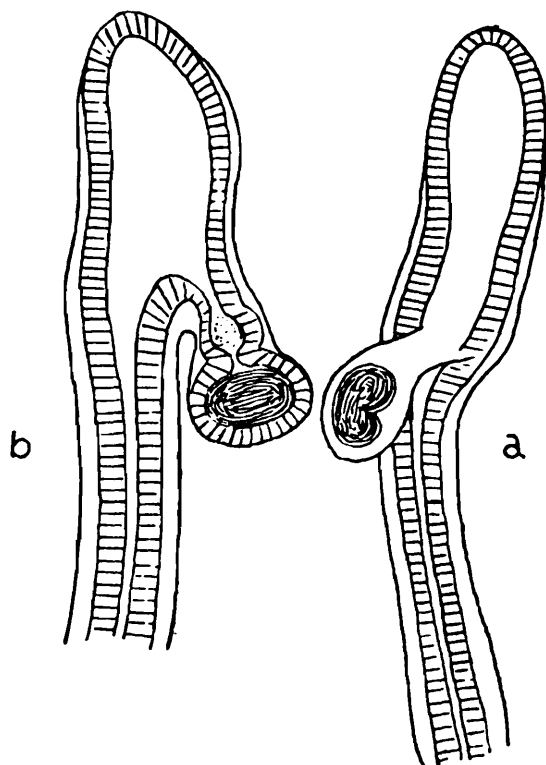


FIG. 16. *Dichogaster curgensis* var. *unilocularis* ; two spermathecae, diagrammatic.

is cylindrical, rather longer than the ampulla and three-fourths as broad, not sharply delimited. The diverticulum is as a rule single, stalked, hanging down, coming off from the base of the ampulla (not from the duct) ; the chamber is rounded and contains a mass of spermatozoa. In half the cases (six out of twelve) there is, as in the example shown in fig. 16a, a small second chamber, possibly occasionally even a third (so that the diverticulum is then not strictly 'unilocular'), above that containing the spermatozoa ; these accessory chambers are usually empty or at most contain only a little granular matter.

The penial setae, two per bundle, are, or may be, quite obviously of different sizes ; *e.g.*, one of the two may be 0.84 mm. in length and 5μ in diameter at the middle, the other 0.73 mm. long and 4μ in diameter at the middle ; their form is as previously described (Stephenson, '31). However this difference in size does not seem to be universal.

***Dichogaster modiglianii* (Rosa).**

Lashio. Two specimens.

Mergui. A number of specimens.

Rangoon. Several specimens.

Nyaunglebin, Pegu. K. John. Sept. A number of specimens.

The worms from all the above localities which I now identify as *D. modiglianii* (Rosa) are identical with my *D. doveri*, the description of which is now appearing in the *Journal of the Federated Malay States Museums*. The supposed differences between *D. modiglianii* and my *D. doveri* are as follows :—

D. doveri is a larger worm (up to 60 mm. long, with 115-118 segments, as against 22 mm. and 76 segments for *D. modiglianii*) ; it is non-pigmented (*modiglianii* is dark grey) ; segments i and ii are not, or only

faintly, demarcated (this is not noted for *modiglianii*) ; in *modiglianii* the anterior segments are especially elongated, which is not the case in *doveri*. The dorsal pores in *modiglianii* begin in 4/5, in *doveri* in 5/6 (occasionally, perhaps, in 4/5,—there may at any rate be a pit here in some specimens). A chief difference seems to be the clitellum,—ring-shaped in *doveri*, saddle-shaped (“incomplete ventrally”) in *modiglianii* except on xiii where it is complete. Transverse sulci are present on xvii and xix in *modiglianii* in front of the anterior and behind the posterior prostatic pores respectively. In the variety of penial setae with thicker tip the end is cut off squarely and perhaps very slightly broadened in *doveri*, while in *modiglianii* the end is described as knobbed, and shown in the figure as swollen and rounded.

The chief differences between the two descriptions concern the clitellum and the thicker kind of penial setae ; I think also that the very slight or non-existent delimitation of segment i from ii, which is a feature of *doveri*, would have been noted by Rosa in his worm if it had existed. I am not inclined to lay much stress on any other difference.

I have had great difficulty in coming to a conclusion regarding the identity or otherwise of the two species. What has finally caused me to unite them is (i) the fact that I a short time ago (Stephenson, '31) recorded *D. modiglianii* under that name from Mergui,—one of the localities from which I now receive these worms which are identical with my *D. doveri*. A re-examination of the penial setae of the earlier batch shows that in this respect the worms are identical with my *D. doveri*, though the clitellum is saddle-shaped (as stated for *modiglianii*), not ring-shaped (as in *doveri*).

(ii) Within the last few days I have received a number of worms from the Philippine Islands which have the penial setae of *D. doveri* and a clitellum which is ring-shaped over segments xiv-xvi at least, though lighter in colour and perhaps thinner below on xiii and xx (the male field comes in ventrally on xvii-xix). In one specimen however the clitellum might fairly be described as saddle-shaped.

These specimens seem to show that the clitellum may vary in appearance at different times, possibly (as perhaps in *D. bolawi*, v. *ant.*) owing to continued growth of the dorsal and lateral portions after the ventral region has reached a standstill, the apparently saddle-shaped clitellum being thus a later stage ; certainly in *D. bolawi* it is the less developed and thinner clitella (“*D. malayana*”) that are obviously ring-shaped. What I have written, in the paper which is now appearing (in the *Journ. F. M. S. Mus.*), on *D. doveri* may be taken as completing our knowledge of *D. modiglianii*, the original description of which is, perhaps, according to present standards, somewhat brief.

Dichogaster saliens (Bedd.).

Kutkai. Numerous specimens.

Namkham. April 1930. A number of specimens.

Maymyo. Aug. 1930. K. N. Sharma. Five specimens.

Maymyo. Numerous specimens.

Lashio. A number of specimens.

Thandaung. Numerous specimens.

In the Kutkai specimens the dorsal pores begin in 4/5 (small or rudimentary), or 5/6. The clitellum is saddle-shaped ; it is however always

wanting over more or less of segment xx ; in extent it falls short of furrow 20/21 oftener than not, including only two-thirds or three-fourths of the segment, though sometimes all of xx is included dorsally and laterally. There is a small transverse groove-like depression in 15/16,—sometimes only a slight deepening of the intersegmental furrow for a short distance, or a small transversely oval papilla surrounded by a slight moat.

Septum 4/5 is thin, but quite distinct. There are four longitudinal rows of nephridia on each side, but sometimes also a small fifth nephridium is to be seen ventrally in the segment. The spermatheca is illustrated in fig. 17 ; transverse muscle fibres begin on the duct immediately below the attachment of the diverticulum.

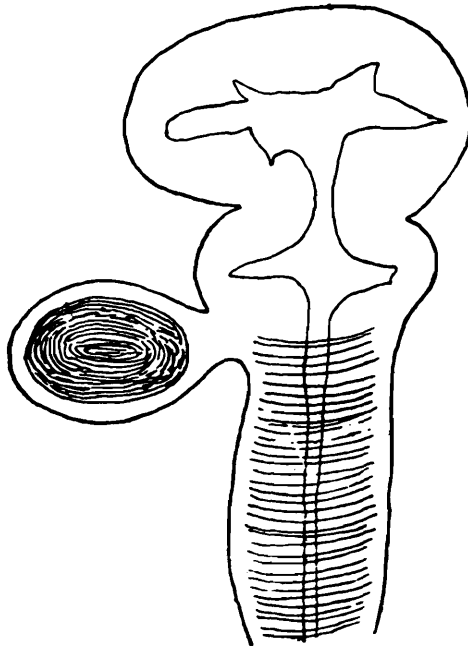


FIG. 17. *Dichogaster saliens* ; spermatheca.

The two penial setae of a bundle differ markedly. The longer is 0.71 mm. in length and 10μ thick at the middle of the shaft, the last 0.185 mm. being markedly undulating, with about three small jagged markings or teeth to each undulation. The smaller is 0.54 mm. long, 6μ thick at the middle of the shaft, the undulation extremely slight, hardly distinguishable, and no teeth or markings visible with the ordinary high power.

Specimens from Namkham were very similar.

The above notes have reference to the characters in which *D. saliens* was supposed to differ from *D. crawi* ; I have recently (Stephenson, '31) proposed to unite the two, and have discussed in some detail the supposed differences between them.

***Dichogaster sinuosus* Steph.**

Kyaukme. May 1930. Two specimens.
 Namkham. April 1930. Five specimens.
 Maymyo. Aug. 1930. Three specimens.
 Lashio. Three specimens.
 Labaw. Three specimens.

I described this worm recently (Stephenson, '31) mainly on the basis of specimens from Labaw. I add a few notes principally derived from a detailed examination of examples from Namkham.

The length may be as much as 60 mm., and the number of segments about 127. A groove, as before, extends back from the hinder end of the prostomium for a little distance. Segments i and ii are not marked off from one another.

In the middle of the body $aa=bc$, and dd is equal to two-thirds of the circumference. In front of the clitellum aa is less than bc , and dd is three-quarters of the circumference.

In these specimens (as in the former ones) it occasionally happens that a part of segment xxii is included in the clitellum.

The female pores are situated on a transversely oval papilla, and the setae of xx on a slightly raised area.

The copulatory papillae on 7/8, 8/9, and 9/10 vary in distinctness, and one or more are sometimes absent; those on 7/8 and 8/9 may be very well marked, taking up the mid-ventral interval between the spermathecal apertures, the central portion or crest of each being enclosed within a groove.

The spermathecal ampulla, in the specimen from Namkham which I dissected, was in most of the organs broader transversely than long, and thus wider than the duct below it. The duct is very obviously divided into two parts by a constriction; there is in fact one constriction below the ampulla and another between the two parts of the duct. There may be masses resembling spermatophores in the ampulla (as in previous examples).

The sinuosity and toothing of the smaller variety of penial setae are very slight; the toothing is invisible with the ordinary high power.

The two species to which the present shows most affinity are *D. floresiana* (Horst) and *D. affinis* (Mich.). The penial setae of the present species and of *D. floresiana* seem to be practically identical (though in Michaelsen's key in the "Tierreich" *D. floresiana* is classified under forms which have only one kind of penial setae). The seminal grooves of the latter worm, however, are bracket-shaped { }, "a character by which this species can be easily distinguished from other congeners" (Horst), and there are no genital papillae; other differences include the absence in *floresiana* of the groove on the dorsal surface of segment i which prolongs backwards the hinder angle of the prostomium; the commencement of dorsal pores in 6/7; and the relatively greater extent of aa as compared with bc .

From *D. affinis*, which has similar copulatory papillae, the chief difference consists in the penial setae, which are in that species of one kind only, shorter, only about a quarter as thick as the larger penial setae of *D. sinuosus* (1.6μ against 6μ), and without teeth or thorns.

Family LUMBRICIDAE.

Genus *Bimastus* H. F. Moore.

Bimastus parvus Eisen.

Maymyo. A single specimen.

Thandaung. A single specimen.

In the specimen from Thandaung I cannot find any dorsal pores in front of furrow 9/10, and even this one is small (normally the pores begin in 5/6).

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ON THREE NEW GREGARINES, *BHATIELLA MORPHYSAE*, n. g.,
n. sp., *FERRARIA CORNUCEPHALI*, n. g., n. sp., AND
EXTREMOCYSTIS DENDROSTOMI, n. g., n. sp.,
FROM INDIAN POLYCHAETES.

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(Plates V, VI.)

In the following pages I have placed on record certain observations that were made by me during the past summer on some new genera of protozoon parasites. While on a short tour to Port Blair in the Andamans in connection with fishery work (1930), I also carried out observations on the intestinal protozoa of two species of polychaetes, which I found to be infected with the parasites described herein. Owing, unfortunately, to the occurrence of two gregarines in the same host, two different kinds of cysts and spores were encountered very near to each other in the same smear. I shall refer to the sporocysts and the spores under a separate heading as I am not at present able to associate satisfactorily the sporocysts with the adult stages, and so cannot definitely establish the life-cycle. From the known characters of the adult trophozoites, however, I have been able to establish two new genera. I am unaware of any previous observations regarding the occurrence of the gregarines in the hosts in question.

***Bhatiella morphysae*, nov. gen., nov. spec.**

(Pl. V, figs. 1-2.)

Host.—*Morphysa sanguinea* Montague. (= *M. furcellata* Crossland).

Habitat.—Mid-gut.

Location.—Port Blair, Andamans.

This form, together with the next species, occurred in the intestine of *Morphysa sanguinea* and is apparently an extremely common intestinal parasite.

Several specimens of this remarkable parasite were obtained and were studied both in the living condition and in permanent preparations. The total length of the trophozoite is variable, from quite young to adult specimens being found together. The full-grown trophozoite measured 200μ from base to tip and 103μ across its greatest width. The smallest specimen observed was 100μ in length and 40μ in breadth and differed from the full grown form in size only. The trophozoites are solitary and rather small. The body is generally pear-shaped, being widest at the base and tapering towards the apex. The average ratio of length of body to total length of trophozoite is about $\frac{3}{4} : 1$. The characteristic feature of this species is the epimerite and the absence of segmentation in the trophozoite. The parasites, during the time that I was examining them on the slides, did not betray any sign of activity.

The well marked epimerite in this species is of rather unusual structure. It consists of two parts, a long slender deeply-staining style and a small bulb which is borne at the apex of the style. The style is narrowed at the apex, but broad at the base. Its total length is one-fourth the length of the animal.

There is no clear differentiation of the protoplasm. The endoplasm is highly vacuolated, the largest vacuole being 6μ in diameter. The nucleus is ellipsoidal and cannot be detected in the living specimen. It lies in the middle of the body, in the lower half. There is one large (*i.e.*, large in comparison with the size of the nucleus) karyosome present, which is slightly eccentric in position. The accompanying camera lucida drawings show the general structure of the trophozoite (Plate V, fig. 1). In Plate V, fig. 2 the parasite is represented without the epimerite.

Measurements in microns were made from specimens taken at random.

Number.	Entire length.	Length of body.	Length of Epimerite.	Width of body.	Nuclear diameter.	Karyosome diameter.
1	123	85	38	40	$27 \times 22\frac{1}{2}$	Not visible.
2	157	126	31	67	21×18	10×10
3	160	128	32	64	19×16	12×12
4	171	130	41	67	20×15	10×10
5	180	150	30	80	17×16	$12\frac{1}{2} \times 12\frac{1}{2}$
6	220	180	40	103	22×18	10×10

Systematic position.

After a careful comparison with the accounts of all the species hitherto figured and described, I am unable to refer the present species to any known genus.

The important features of this gregarine are as follows :—Solitary ; non-septate ; pear-shaped body widest just posterior to middle. Epimerite in the form of a distinct bulb-like structure at the extreme tip of a long rigid style. Dehiscence by simple rupture, no sporoducts. Present in the digestive tract of a polychaete.

The characters enumerated above seem to be sufficient to place the gregarine in the family Lecudinidae Kamm (nov. nom. for Dolio-cystidae Labbe), which includes non-septate gregarines inhabiting the digestive tract of polychaetes.

The present specimens differ materially from others and are so sufficiently distinct as to warrant one in concluding that they represent a new genus. I have great pleasure in associating this genus with the name of my teacher, Prof. B. L. Bhatia, as a token of gratitude for the great help and suggestions that I have received from him.

***Ferraria cornucephali*, nov. gen., nov. spec.**

(Pl. V, figs. 3, 4, 5 ; Pl. VI, fig. 1.)

Host.—*Morphysa sanguinea* Montagu (= *M. furcellata* Crossland).

Habitat.—Mid-gut.

Location.—Port Blair, Andamans.

This parasite, along with the one described in the preceding pages, was found abundantly in the same host. The trophozoites with epimerites are quite commonly attached to the intestinal wall or lie free in the lumen of the gut.

Trophozoites solitary, never associated, rather stout bodied. Length of the largest trophozoite 300μ and 91μ in width. Ratio length of protomerite : total length of trophozoite 1 : 4 ; width of protomerite : width of deutomerite 1 : 1.6.

The protomerite is hemispherical to sub-globular in shape ; there is no constriction at the septum, the position of which is indicated in the adult trophozoite by a clear area between the protoplasm of the protomerite and deutomerite ; the protomerite is widest in the region of the septum.

The deutomerite is very elongated, cylindrical and ovoidal ; it is widest about the middle and is well rounded posteriorly (Plate V, fig. 3).

The nucleus is large and spherical with a single large central karyosome.

The epimerite (Plate V, fig. 4) is characteristic and consists of a wide-mouthed, funnel-like structure on a long slender tubular stalk. It is transparent and measures 18μ in length.

The protoplasm of the trophozoite is dark and finely granular and not very dense in either the protomerite or the deutomerite. The epicystal striations are thin and visible under high powers only.

Measurements in microns.

Number.	Length of Trophozoite.	Breadth of Trophozoite.	Epimerite.	Proto-merite.	Deuto-merite.	Nucleus.	Karyosome.
1	243	81	13	54	176	23×22	9×9
2	263	90	16	67	180	27×27	9×9
3	265	90	13	54	198	29×27	11×11
4	297	90	24	58	215	31×31	11×11

Systematic position.

As the complete life-history has not been worked out, the genus is assigned tentatively to the family Polyrhabdinidae. It has several characters in common with the other genera of the family, *e.g.*, polycistid nature of the body and its occurrence in the digestive tract of a polychaete.

The form here described cannot be placed in any of the genera, of which up to the present three are reported. The cysts and spores of all three genera are still unknown.

The gregarine in question differs from those previously recorded in several points. There is a very marked difference in the size and shape of the trophozoite and in the character and structure of the epimerite. A new genus is therefore created to contain the species from *Morphysa sanguinea* Montagu.

Cysts and spores.

Two distinct types of cysts and spores were encountered in the mid-gut of the worm (*Morphysa sanguinea* Montagu). I am not able to associate satisfactorily the cysts and spores with the adult stages. One type is represented by spherical cysts, which measure between 90μ and 100μ in diameter. These cysts are full of oval spores which measure 10μ in length and $4\frac{1}{2}\mu$ across (Plate V, fig. 5). The spores escape by rupture of the cysts.

The other type of cyst that I encountered in the same smear was single, but unfortunately it was damaged. I, however, have no doubt that this too is spherical. It contained a mass of very peculiar spores. Nothing similar to these has been recorded before. The spores are peculiarly shaped with rounded anterior and posterior ends. Each spore is bilaterally symmetrical and is covered by a membrane, the outer boundaries of which are thick and stain deeply with iron haematoxylin.

The spores are 20μ long and 4μ broad. They have a large well defined nucleus (Plate VI, fig. 1).

Extremocystis dendrostomi, nov. gen., nov. spec.

(Pl. VI, figs. 2-6.)

Host.—*Dendrostoma signifer* Sel and de Man.

Habitat.—Coelom.

Location.—Port Blair, Andamans.

This parasite was discovered inhabiting the various portions of the coelomic cavity of *Dendrostoma signifer*. In each smear fixed in Bouin's fluid and stained with iron haematoxylin, the parasites lie coiled and contorted among the coelomic corpuscles and the hosts genital products. I have never come across any forms attached to the coelomic epithelium of either the body-wall or the gut, nor were any cysts in evidence in this situation. The parasites revealed striking uniformity, both as regards size and general structure. An important feature of the parasite is that the adult trophozoites are always associated in pairs, the association being between equal-sized individuals and attachment being end to end. This phenomenon is a constant and not an occasional characteristic (Plate VI, fig. 2).

The body of the trophozoites is cylindrical and essentially resembles that of an elongated nematode worm with more or less parallel sides and with a tendency to taper slightly towards the two extremities. There is no difference between the two ends of a free individual (such free individuals are extremely rare) : the end that is anterior at one time becomes posterior at the next. Attachment takes place by means of one tapering

end of an individual fitting into a regular concave hemispherical depression in the other (Plate VI, fig. 3). It may be mentioned that the distinct cup-like depression seems somewhat similar to the cup described in *Ganymedes anaspides* by Huxley (1910). There is, however, nothing equivalent to the ball-end and I therefore cannot regard the union as a ball-and-socket joint.

The range in length is from 100μ to 130μ and in width from 17μ to 19μ . The length of the smallest specimen observed was 50μ and there was no difference except that of size between these and the adults. The ratio of width to length in each individual is 1 : 6.

The ectoplasm is not clearly differentiated from the endoplasm. The endoplasm has a coarsely granular and light coloured structure and the stream of endoplasmic granules of the two individuals flows very swiftly and uniformly from one end of the parasite to the other, going backwards and forwards in a straight line. In the course of these movements, the body of the parasite alternately lengthens and shortens, being at the same time narrowed and broadened respectively. The ectoplasm is thin and does not show myoneme striations.

In each trophozoite there is an ellipsoidal and very greatly elongated nucleus, which lies more or less near the united ends. The nucleus measures 17μ by 6μ and lies with its long axis parallel or slightly inclined to the sides of the body. The presence of a definite nuclear membrane was demonstrated in several specimens ; in others it is indistinct and not visible, due probably to some action of the fixative. The nucleus contains one large eccentrically placed karyosome with a varying number of deeply-staining granules.

The associating pairs become short and pear-shaped. They undergo complete cytoplasmic fusion and during my observations I encountered hundreds of these pear-shaped pairs, as also pairs which had succeeded in rounding themselves of (Plate VI, fig. 5), but in no case was a cyst with spores encountered. The attachment at this stage did not seem to be very secure for I came across solitary individuals both pear-shaped and rounded, which had become detached in course of preparation of the smear. I am not sure whether the time of the year has any effect on the processes of the life of the parasite. Since the trophozoites occur associated with the genital products of the host, it seems reasonable to infer that the cysts and the spores escape with the genital products when the discharge of ova and sperms takes place ; and the formation of cysts and spores perhaps also takes place at that stage.

I came across a few spores floating in the coelomic cavity. They are spindle-shaped structures with the two ends finely pointed and the nucleus of the spore has the form of an aggregation of granules which stain deeply.

Length of the spore 29μ — 35μ .

Width of the spore 6.4μ .

Nucleus of the spore $7.2\mu \times 4.8\mu$.

Diagnostic characters.

Gregarine parasites found floating in the coelom of *Dendrostoma* (a polychaete). No organ for attachment to the cells of the host. Adult

trophozoites elongated, nematocystis-like, always associated in pairs ; attachment being end to end, by one end of an individual fitting into a concave depression of the other, thus effecting a very close union of two individuals.

The dimensions of the trophozoites in microns are as follows :—

Pair Number.	Length of Trophozoite.	Breadth of Trophozoite.	Nuclear diameter.	Karyosome diameter.	Length of Trophozoite.	Breadth of Trophozoite.	Nuclear diameter.	Karyosome diameter.
1	70	14	16 × 6	4 × 4	80	14	16 × 7	4 × 4
2	100	15	17 × 6	4 × 4	73	12	16 × 6	4 × 4
3	102	16	19 × 6	4 × 4	103	16	19 × 6	4 × 4
4	128	19	Not visible	Not visible	118	16	20 × 7	4½ × 4½

Systematic position.

In order to determine the systematic position of this parasite, the following genera have to be considered : namely, *Nematocystis* Hesse (1909) and *Monocystis* Stein (1848) of the family Monocystidae and the genera *Zygocystis* Stein (1848) and *Pleurocystis* Hesse (1909) of the family Zygocystidae.

It will be noted that the parasite of *Dendrostoma* in point of general outline, shape of the nuclei and movement of the endoplasmic granules resembles very much a *Nematocystis*. Each individual of the pair of parasites has all the morphological characters of this genus, but the genus as described by its author has certain other well defined characters which preclude us from placing the present parasite in it. The parasites also can not be referred to either of the two genera of the family Zygocystidae. It resembles them so far as the habit of the parasite to occur in pairs is concerned. It should, however, be noted that these genera are only described from Oligochaetes and the host in the present instance is a Polychaete.

This new form is of interest as showing a remarkable combination of characters exhibited by the genus *Nematocystis* of the family Monocystidae and the genera *Zygocystis* and *Pleurocystis* of the family Zygocystidae. Under the above mentioned circumstances there are two possibilities open to me : (i) that a new genus should be established for the species or (ii) that the definition of either of the genera *Zygocystis* or *Pleurocystis* should be modified in such a way that it should include forms like the one here described. The latter alternative seems uncalled for, for in the case of the gregarines from the Oligochaetes the classification, in part at least, is based on shape or body-form. In the two genera of the family Zygocystidae, referred to above, emphasis has been laid on the mode of union, i.e., the manner of adhering together in the adult condition. In one case this association is end to end and includes spherical as well as pyriform trophozoites. In the other, association is side to side and includes trophozoites which are like *Nematocystis*. The present question has regard to the classification of *Nematocystis*-like forms that are associated end to end.

Adopting the shape of the body as a distinctive criterion, Cognetti, it will be recalled, recently established a new genus *Apolocystis* by restricting the use of the term *Monocystis* to pyriform individuals only. Spherical forms, which formerly were also known as *Monocystis*, have now been relegated to the genus *Apolocystis*. Cognetti's division of these different forms into separate genera extends only to solitary forms, and it would seem desirable that a similar distinction should be drawn between the forms belonging to the family *Zygocystidae*. Here, as in the case of the solitary forms, on the basis of the characteristic shape of the body there is an indication of natural classification. I am of opinion that the family *Zygocystidae* should be classified thus :—

Zygocystis Stein.

This should include only those forms in which the adult trophozoites are permanently associated in pairs or groups of three ; spores biconical, etc. To this genus would then belong forms like *Z. cometa* and *Z. pilosa*, which otherwise agree in the main with the characters of the single forms of the genus *Apolocystis* Cognetti.

A separate genus should, I think, be established to include forms which are pyriform or oval in shape and which again in the adult condition are permanently associated in pairs. To this genus would belong forms like *Z. legeri*. This genus in the main characters of the individual would be similar to the genus *Monocystis* Stein.

Pleurocystis Hesse,

Trophozoites which in the adult condition are permanently associated in pairs ; association longitudinal and lateral, etc.

Extremocystis, nov. gen.

Lastly a new genus, for which I propose the name *Extremocystis*, should be created to include the species *dendrostomi*. This genus will include nematode-like forms associating end to end, its representatives agreeing in the main with the characters of the single individuals of Hesse's genus *Nematocystis*.

The greater part of this work was carried out in the Fisheries Laboratory, at Port Blair in the Andamans. My thanks are due to Col. M. L. Ferrar, Chief Commissioner, for facilities which I have enjoyed, without whose help the work could not have been undertaken ; to Lieut-Col. R. B. S. Sewell, Director, Zoological Survey of India for reading the manuscript of this paper and for suggestions ; and to Dr. P. Fauvel for kindly identifying the hosts.

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EXPLANATION OF PLATE V.

All figures are drawn from permanent preparations fixed with Bouins, and stained with Iron haematoxylin under Camera lucida excepting figures 4 and 5, Pl. VI, which are free-hand sketches drawn under Zeiss microscope.

Bhatiella morphysae, nov. gen., nov. spec.

FIG. 1.—An adult trophozoite showing the characteristic shape and structure of the body and epimerite, $\times 40$.

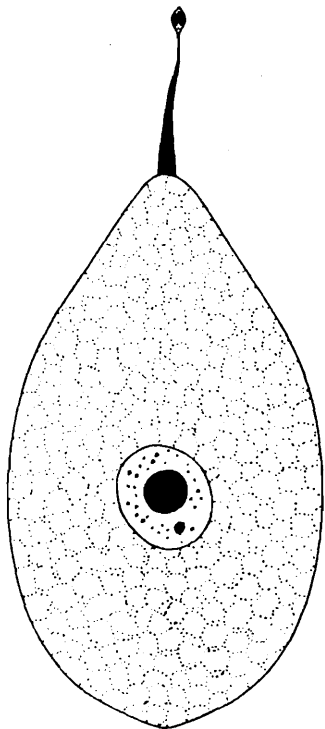
FIG. 2.—Same without the epimerite, $\times 40$.

Ferraria cornucephali, nov. gen., nov. spec.

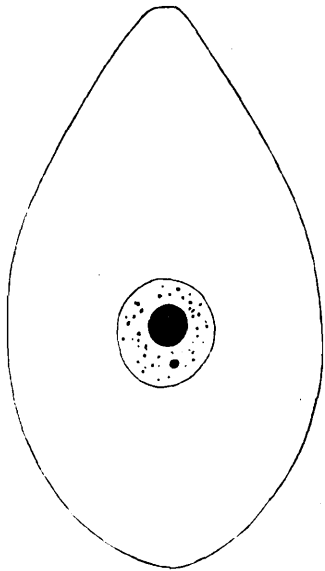
FIG. 3.—A full grown trophozoite, the chromatin in the nucleus is concentrated in a single excentrically placed karyosome, $\times 35$.

FIG. 4.—Anterior end of the same, more highly magnified to show the structure of the epimerite.

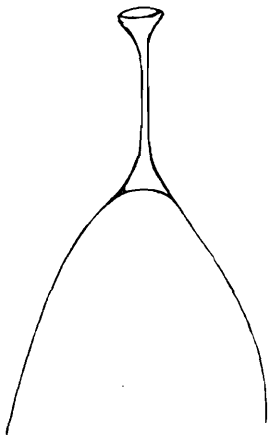
FIG. 5.—Spores. Each measuring 10μ in length and $4\frac{1}{2}\mu$ across.



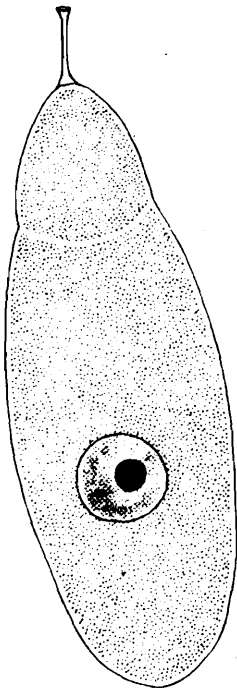
1.



2.



4.



3.



5.

EXPLANATION OF PLATE VI.

***Ferraria cornucephali*, nov. gen., nov. spec.**

FIG. 1.—Peculiar forms of spores. Front and lateral views. Each 20μ long and 4μ broad.

***Extremocystis dendrostomi*, nov. gen., nov. spec.**

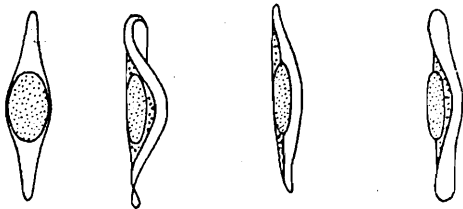
FIG. 2.—Two adult trophozoites in an end to end association, the nuclei of both lie near together, $\times 700$.

FIG. 3.—The united ends magnified to show mode of attachment, $\times 700$.

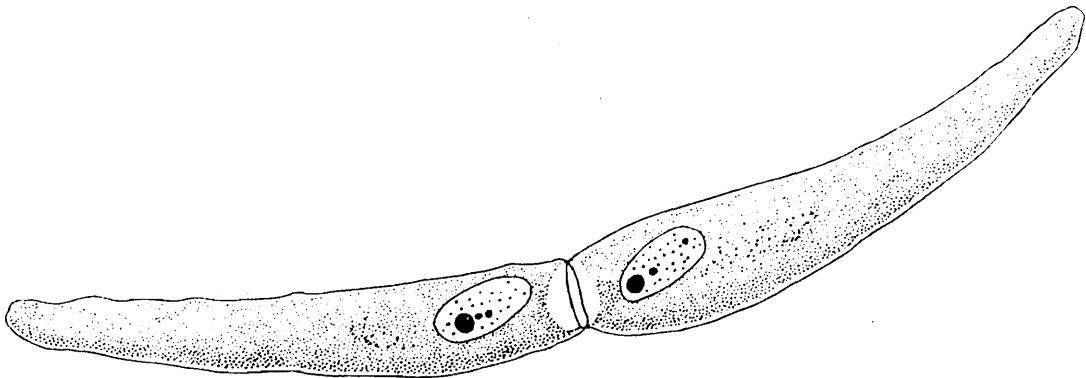
FIG. 4.—Pear-shaped individuals, prior to cyst formation, free-hand drawing.

FIG. 5.—Rounded individuals, prior to cyst formation, free-hand drawing.

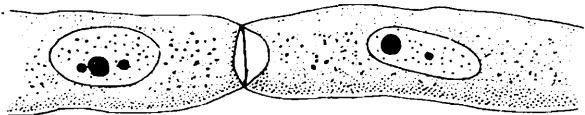
FIG. 6.—Spore highly magnified, $\times 800$.



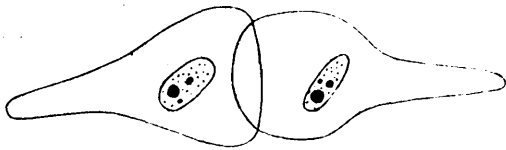
1.



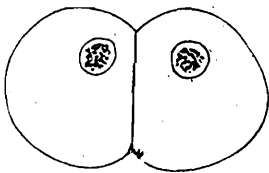
2.



3.



4.



5.



6.