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

PARTS 4—8.

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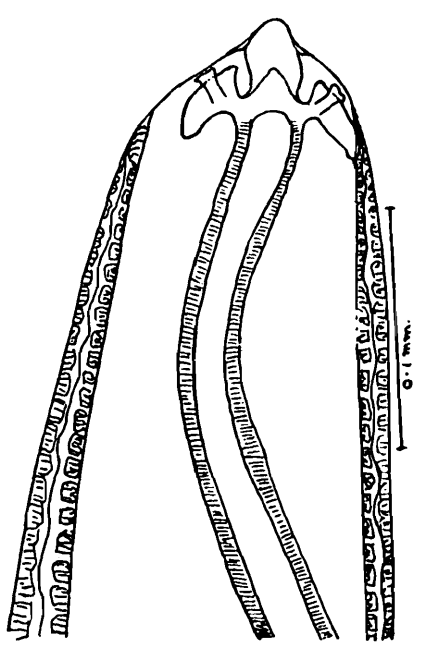
PART 4.—ACUARIINAE.

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.

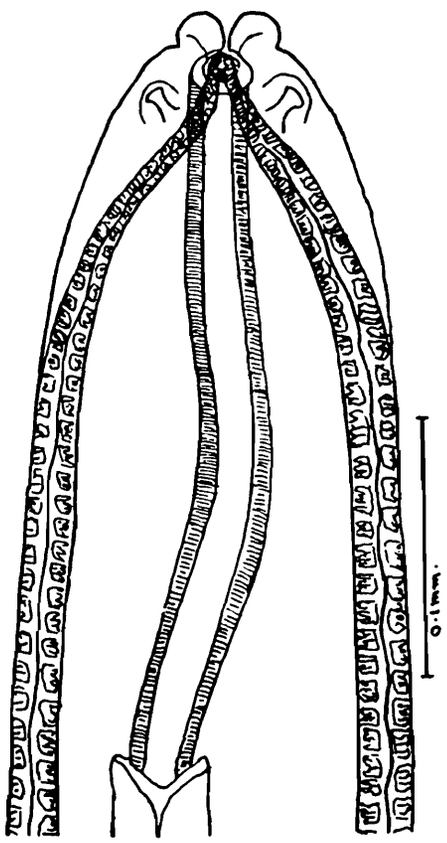


TEXT-FIG. 1.—*Acuaria anthuris*. Anterior end, lateral view.

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



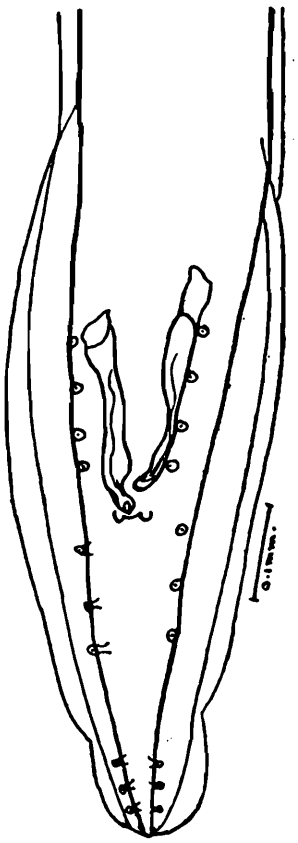
TEXT-FIG. 2.—*Acuaria anthuris.* Anterior end, dorso-ventral view.

(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).

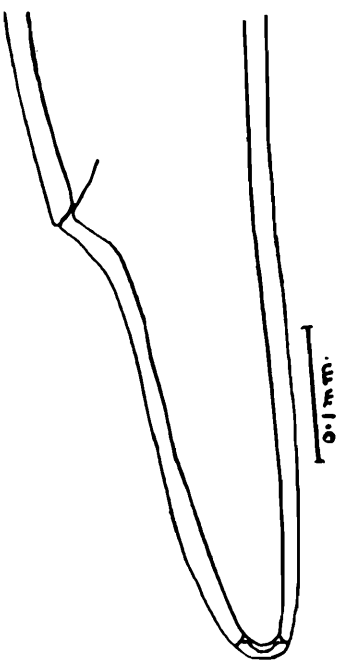
Female.—The females are about 21·3 mm. in length, and 0·32 mm. in maximum diameter. The cordons end about 7·5 mm. from the anterior end. The pharynx is 0·3 mm. in length, and the total length of the oesophagus is 4·95 mm. The vulva opens about 10 mm. from the anterior end, and the vagina and ovejector 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.



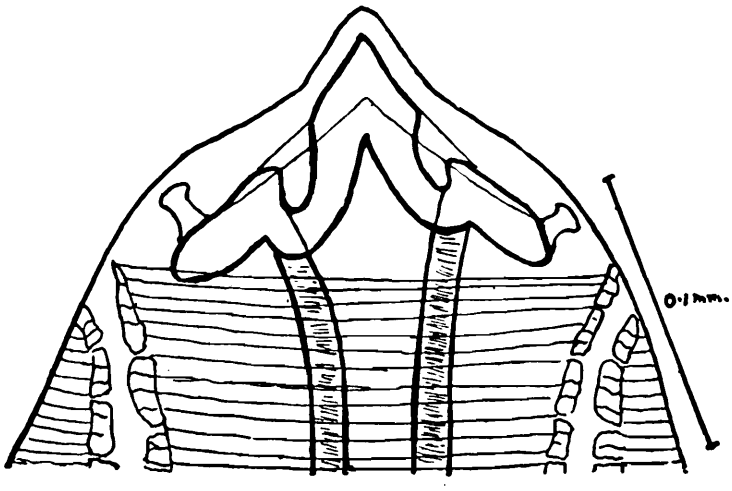
TEXT-FIG. 4.—*Acuaria anthuris.* Posterior end, female, lateral view.

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

Acuaria scutata, n. sp.

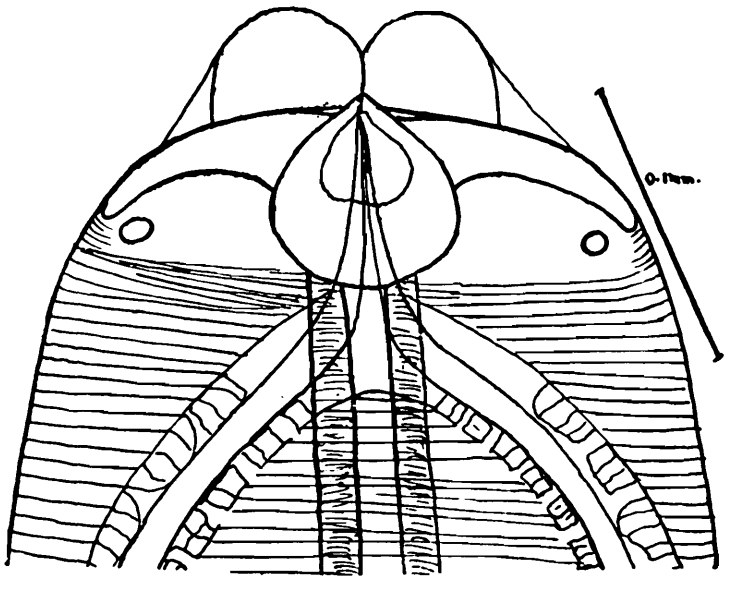
One male and one female of this species were found in the gizzard of an Indian Tree Pie (*Dendrocitta rufa*).

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

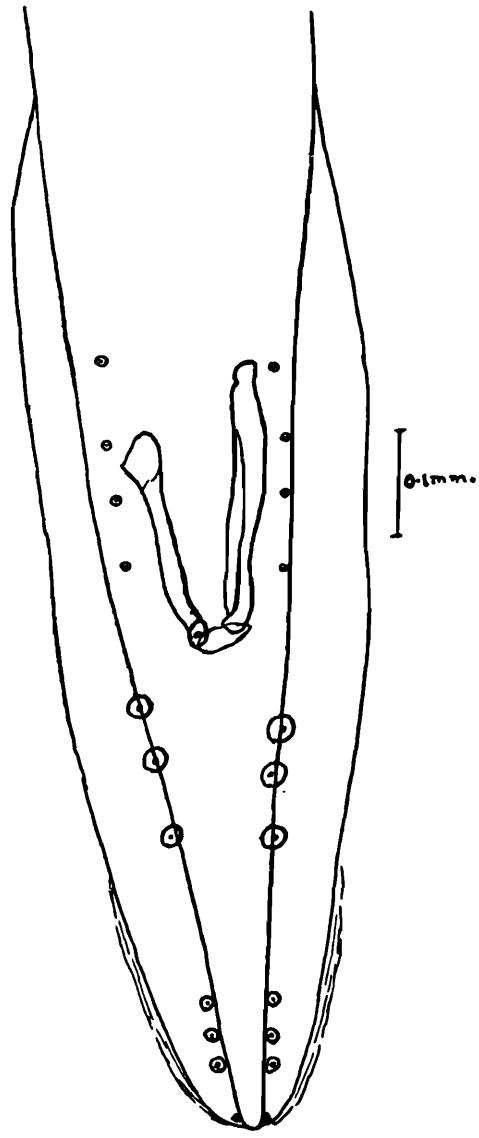


TEXT-FIG. 6.—*Acuaria scutata,* n. sp. Anterior end, dorso-ventral view.

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*

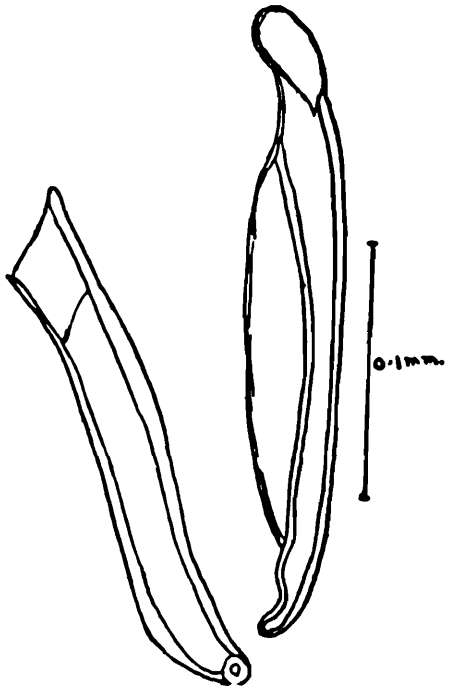


TEXT-FIG. 7.—*Acuaria scutata*, n. sp. Posterior end, male, ventral view.

(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).

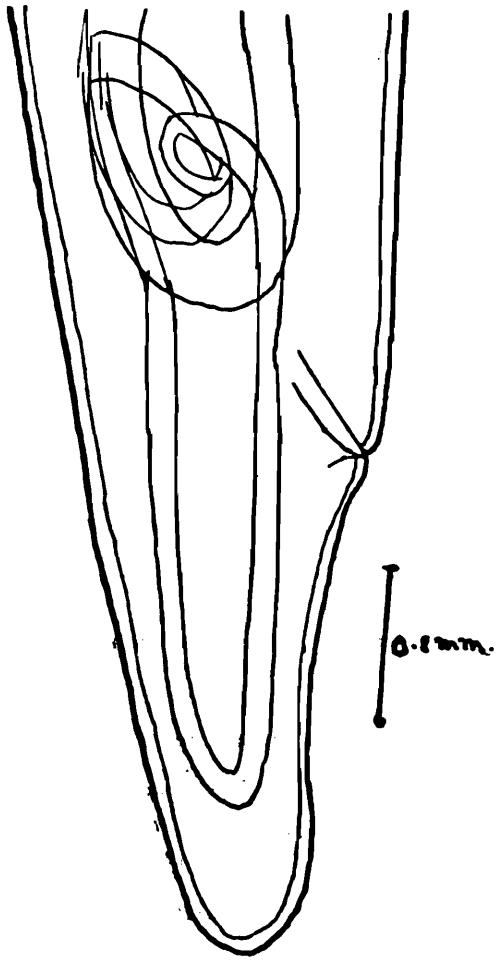
Female.—The female is 23·4 mm. in length and 0·4 mm. in maximum diameter. The length of the pharynx is 0·3 mm., the anterior part of the oesophagus 1·03 mm., and the posterior part 2·77 mm. in length. The vulva opens 11·5 mm. from the anterior end of the body, and the

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. Spicules.

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 × 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.

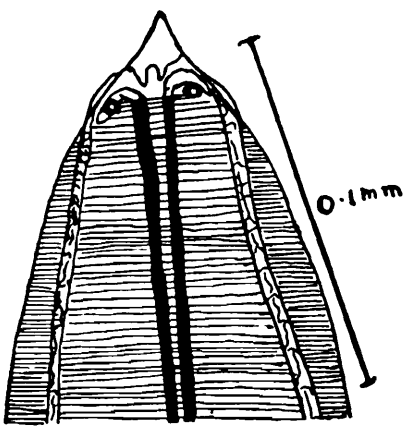
Host.—Dendrocitta rufa.

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

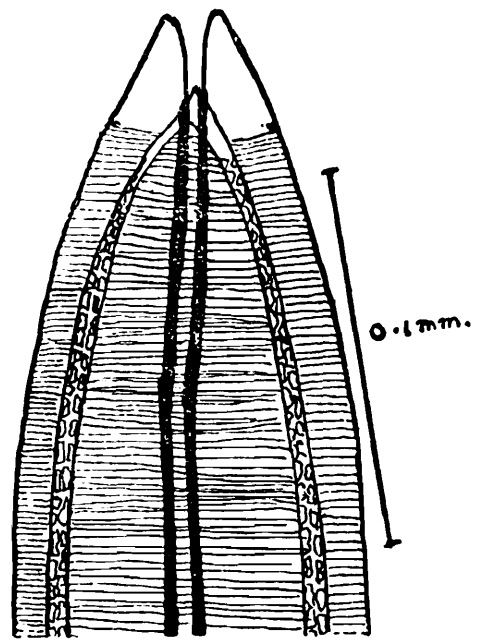


TEXT-FIG. 10.—*Acuaria conica*, n. sp. Anterior end, lateral view.

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).

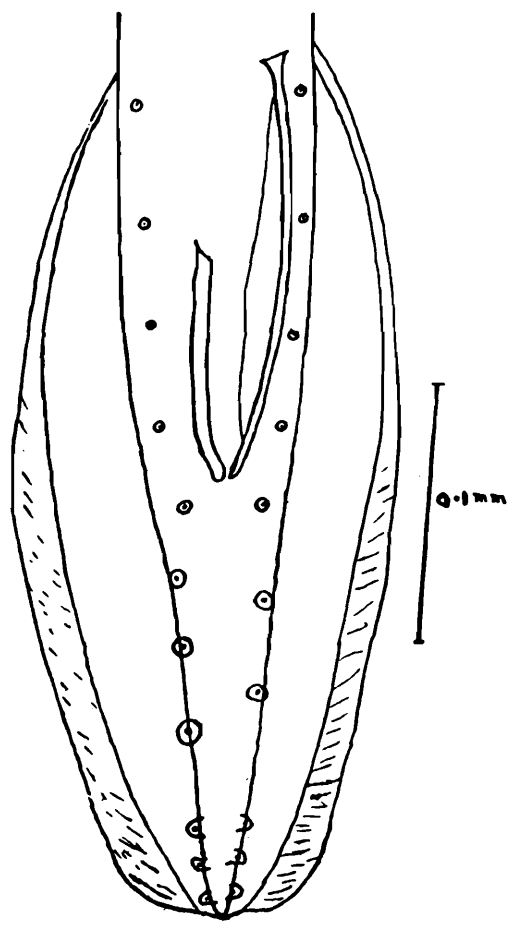
Male.—The male is 6—6·7 mm. in length, and 0·092—0·1 mm. in maximum diameter. There is a thick-walled pharynx with fine transverse striations, and it is 0·18 mm. in length. The oesophagus consists of two parts, the anterior part being 0·3 mm. and the posterior part 0·69 mm. in length. The caudal alae 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 × 0·016—0·018 mm.

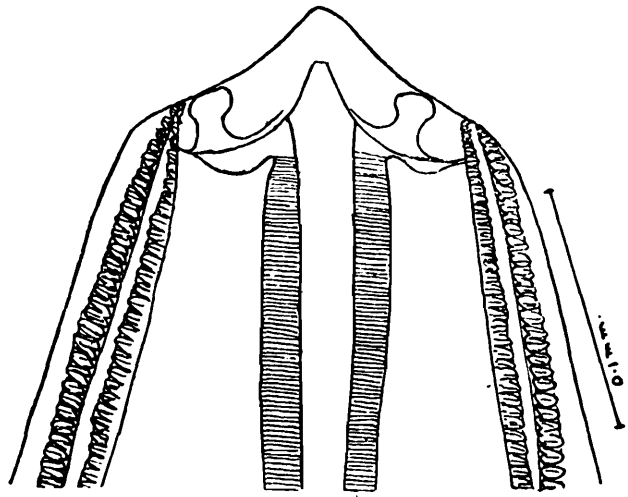
This worm appears to be close to *A. gracilis*, but it differs from it in most of its dimensions and the lips appear to be longer and more pointed, therefore it is proposed to name it *Acuaria conica*, n. sp.

Host.—Copsychus saularis.

Type-specimens are in the Indian Museum, Calcutta.

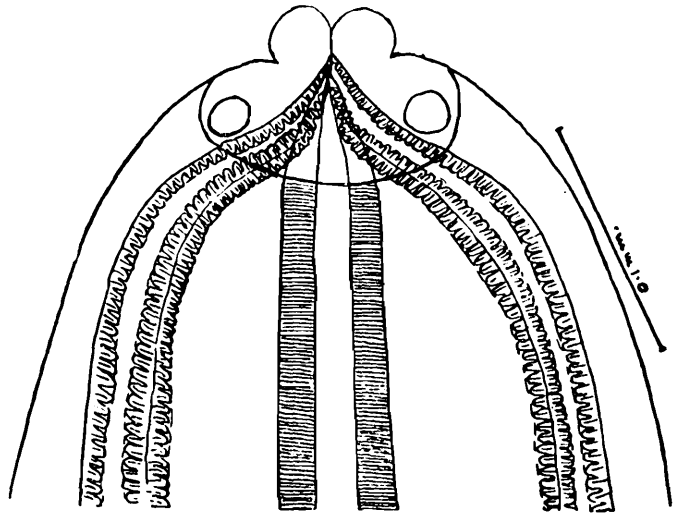
Acuaria lata, n. sp.

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.

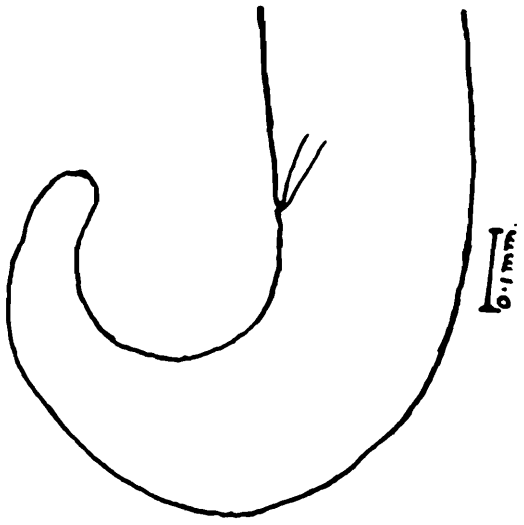
The worms are 28·5—29 mm. in length and 0·65—0·7 mm. in maximum diameter. The mouth is bordered by a pair of lateral triangular lips,



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—0·040 × 0·024—0·026



TEXT-FIG. 15.—*Acuaria 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 *Acuaria* in its relatively great thickness and the long distance which the cordons run towards the posterior. It is therefore proposed to name it *Acuaria lata*, n. sp.

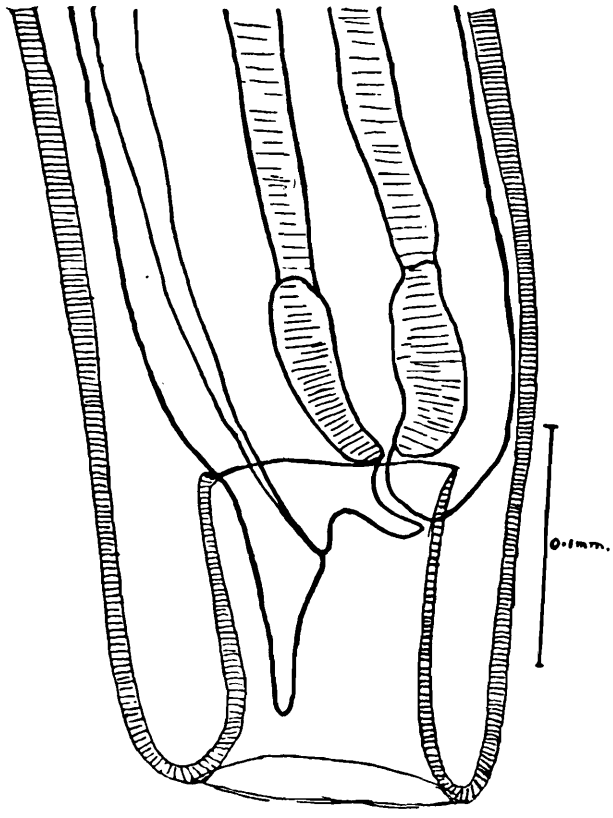
Host.—Rollulus roulroul.

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

Acuaria (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.

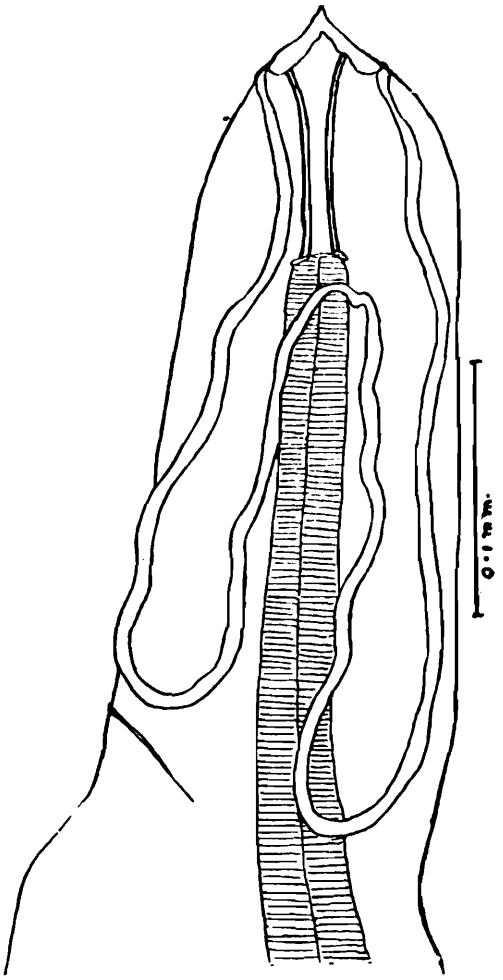
Acuaria (Synhimantus) nana, n. sp.

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.

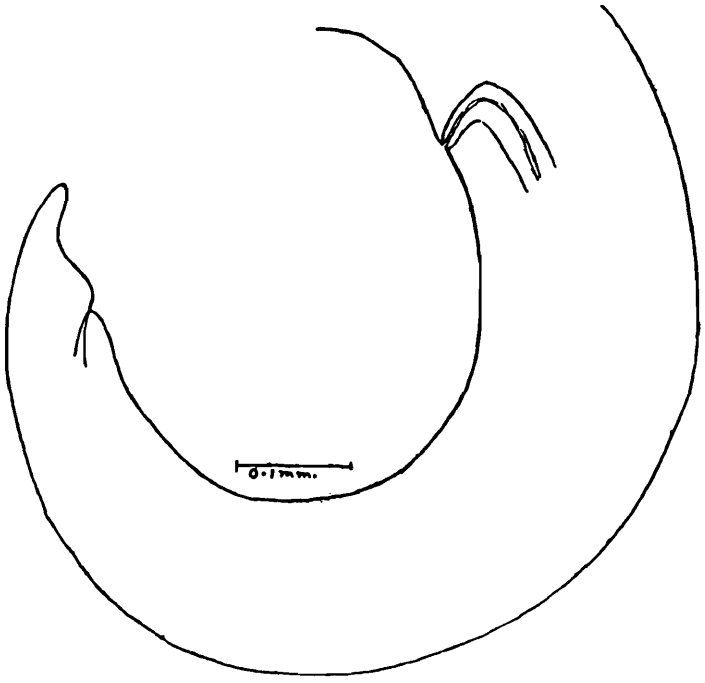
This species is much smaller than any known member of the *Synhimantus* group of the *Acuaria* and an especially characteristic point is the

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.

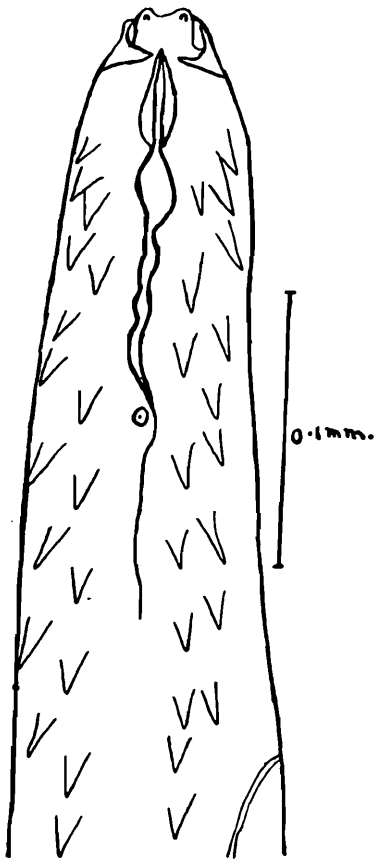


TEXT-FIG. 18.—*Acuaria* (*Synhimantus*) *nana*, n. sp. Posterior end, female, lateral view

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.

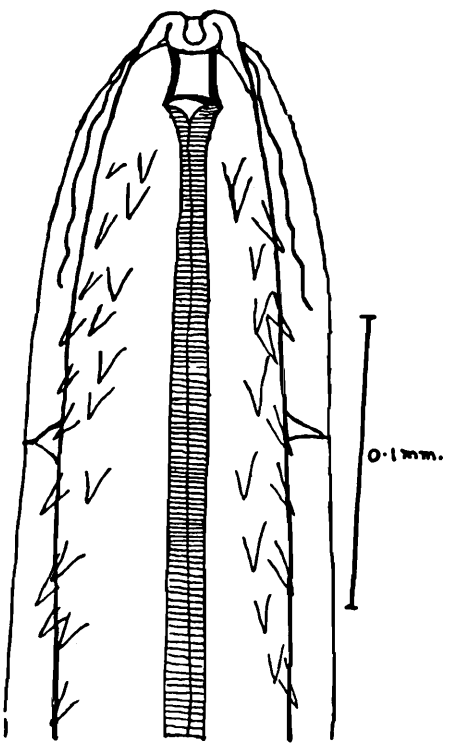
There are two thick bi-lobed lateral lips each of which have two papillae (fig. 19). Immediately behind the lips there are two triangular



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

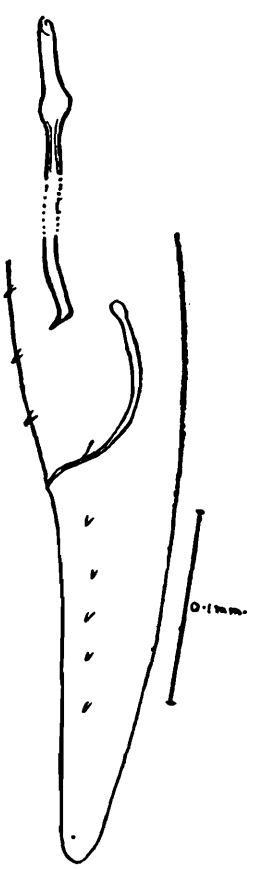
chitinous plates on each side of the head. The apices of these structures appear to fuse with the anterior end of the vestibule, and their bases coincide with the dorsal and ventral borders of the head (fig. 19). The cordons arise from elongate oval prominences on each side of the head from which they 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.

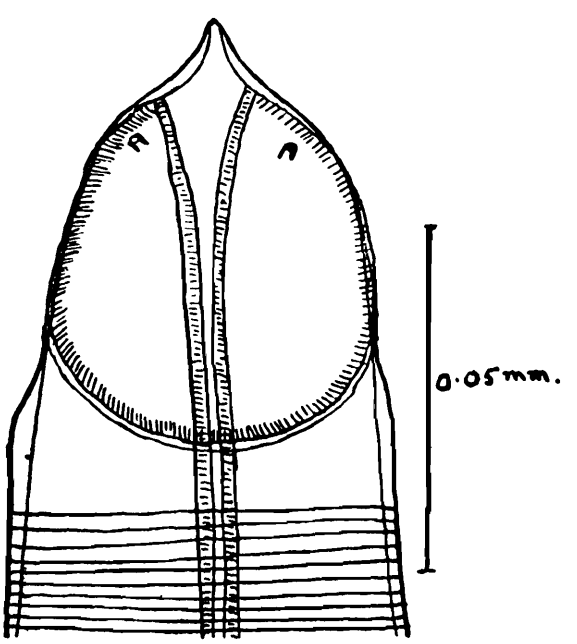
Host.—Aythya ferina.

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*).

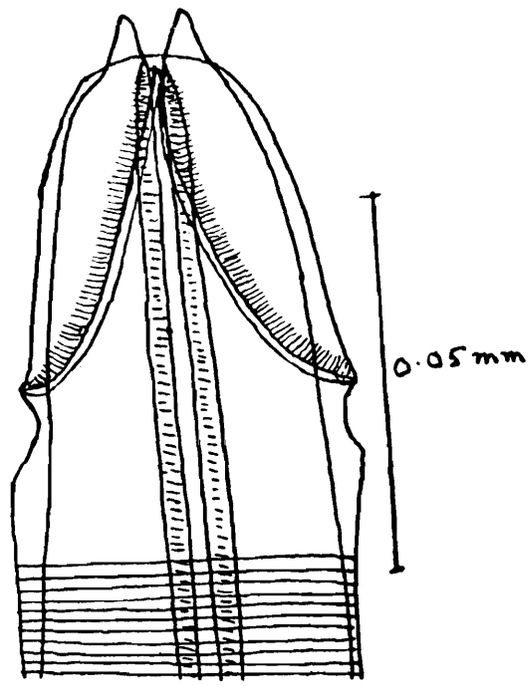
The body is attenuate anteriorly, and the cuticle is transversely striated. The mouth has two prominent lateral lips ending in conical points, and there are two papillae on each lip (fig. 22). The cordons arise



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

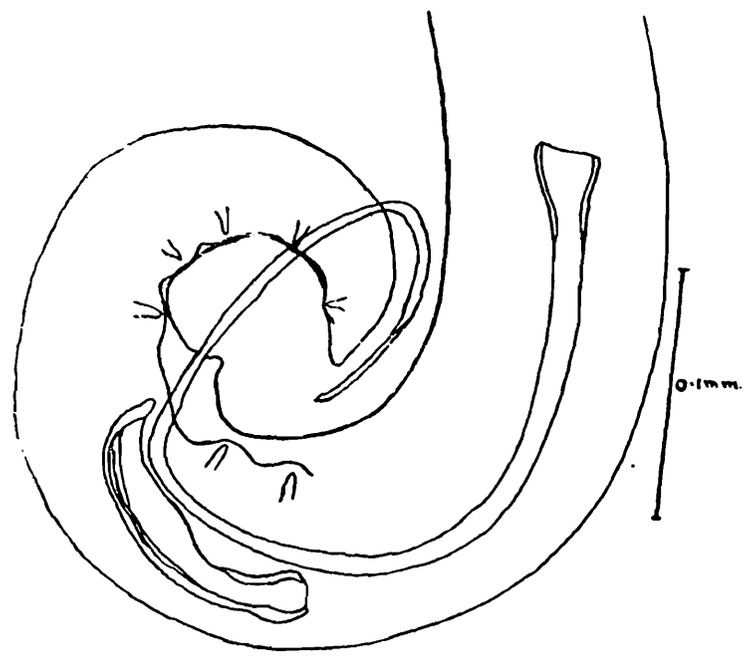
curves. They have concentric striations. Immediately behind the cordons there is a transverse groove in the cuticle which is most marked laterally on account of the narrow lateral flanges (figs. 22 and 23). Cervi-



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

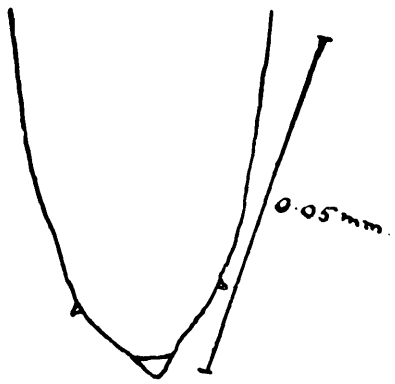


TEXT-FIG. 24.—*Rusguniella brevis*, n. sp. Posterior end, male, lateral view.

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.

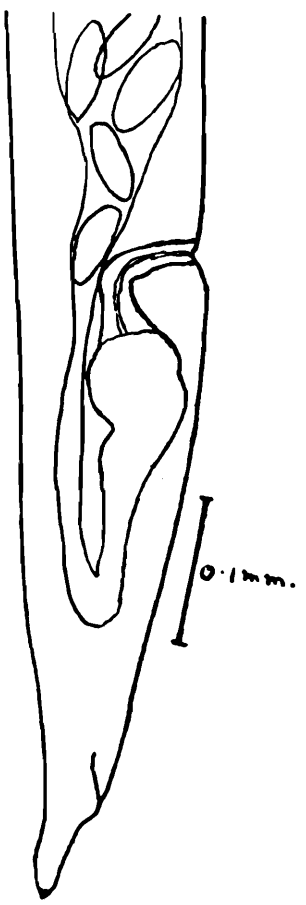
The papillae support caudal alae, but the shape of these structures could not be determined as the worm could not be rolled to obtain a ventral view of the tail, on account of its curve. The spicules are very unequal and dissimilar. The short spicule is stout and curved and it is 0·14 mm. in length. 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.

REFERENCES.

Baylis, H. A. and Daubney, R. (1922). Report on the Parasitic Nematodes in the Collection of the Zoological Survey of India. *Mem. Ind. Mus.* Vol. VII, p. 264.

Baylis, H. A. and Daubney, R. (1926). A Synopsis of the Families and Genera of Nematoda. *Brit. Mus. (Nat. Hist.).*

Cram, E. B. (1927). Bird Parasites of the Nematode Suborders Strongylata, Ascaridata, and Spirurata. *U. S. Nat. Mus. Bulletin* 140.

Travassos, L. (1914). Contribuicoes para o conhecimento da fauna helmintolojica brazileira. 3. Sobre as especies brazileiras do genero *Tetrameres* Creplin, 1846. *Mem. Inst. Oswaldo Cruz*, Vol. VI, p. 150.

Williams, O. L. (1929). Revision of the Nematode Genus *Rusguniella* Seurat with a Description of a New American Species. *Univ. California Pub. in Zool.* Vol. XXXIII, No. 1, p. 1.

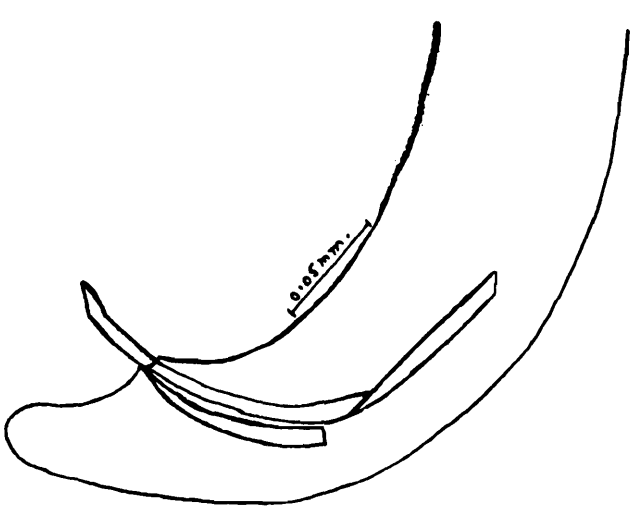
PART 5. FILARIIDAE.

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