

SUCKERED ROUND-WORMS FROM INDIA AND CEYLON.

BY

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RAILLIET and Henry(1)(2) have classified the suckered nematodes together as the *Heterakidæ* and have pointed out that they fall into two groups. In the one the sucker has a chitinous ring, but there is no accessory piece; and in the other, while the sucker has no chitinous ring, an accessory piece is present.

In the former group, the *Heterakinæ* sensu stricto (sub-fam. nov.), the writers place *Heterakis*, *Ascaridia* and *Aspidodera*, with *Strongyluris* as a sub-genus of *Heterakis*. The latter group, the *Kathlaniinæ* (sub-fam. nov.) contains the genera *Dacnitis*, *Subulura*, and *Cissophylus* to which the present communication adds the genus, *Kathlania* as its type. In the matter of classification the writer ventures to lay more stress than has been hitherto done on the number of caudal papillæ in the male as an important indication of natural affinities, and to further express the definite opinion that, at least in the case of nematodes having a comparatively small number of these papillæ, their actual number will not vary within the genus. It is necessary to make the proviso that two papillæ may be blended together to form a double papilla. A careful examination will, however, show the two nerve endings in these cases. This apparent blending is nothing exceptional and may be seen even in the case of bursate nematodes. In the case of the *Kathlaniinæ* it is believed that the number of papillæ is always definitely 11, while in the case of the *Heterakinæ* it varies for the different genera.

This fact appears to be of some value in confirming the proposal to consider the *Kathlaniinæ* as a natural sub-family, and it is used as one

of the reasons for the formation of the genus *Ganguleterakis*. I am indebted to Mr. T. Southwell, A.R.C.sc. (Lond.), F.L.S., F.Z.S., Deputy Director of Fisheries, Bengal, for the two species of *Kathlania* described below, and the designation of *Heterakis putaustralis* is intended as an acknowledgment of this. It had been intended to include in this paper the description of some species of *Dacnitis* very kindly sent me by Mr. Southwell. Since however this might, under existing circumstances, involve some delay, it has been thought better to keep them back for a subsequent publication. For the material comprising *H. bosia* I am indebted to the kindness of Mr. Bose, the Superintendent of the Calcutta Zoological Gardens. The rest of the material I have collected myself.

I am further greatly indebted to Professors Railliet, von Linstow, and J. W. W. Stephens for much kind help in the literature, while the recent paper(2) of the first, published in collaboration with Henry, must be known to any one who wishes to work on this group.

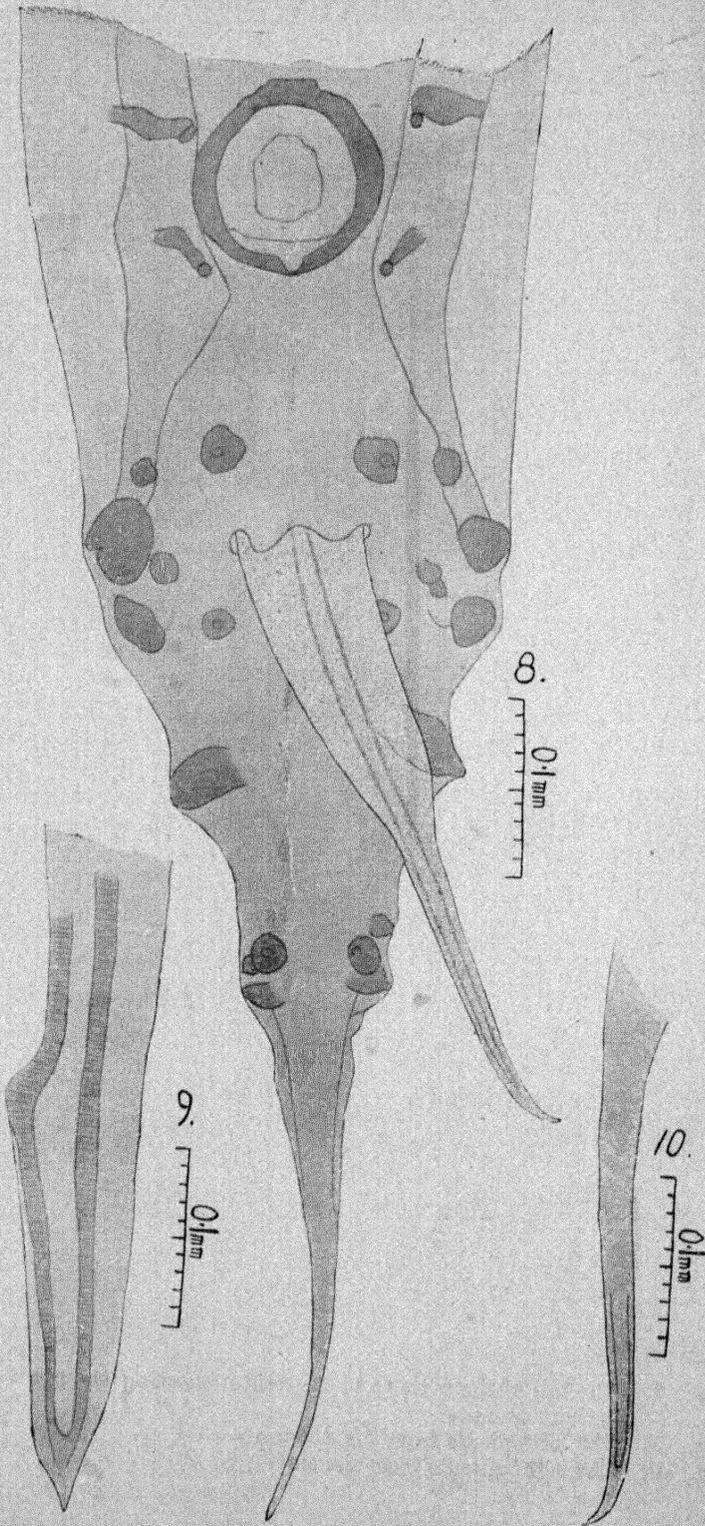
The drawings have all been made with a Zeiss's camera lucida. The outlines may be taken as correct, but the shading is not necessarily so.

HETERAKIS.

Generic Diagnosis.—This genus was instituted by Dujardin in 1845 and he took as its type *Heterakis vesicularis* of the fowl. He gave the generic characters (modern terms being employed) as follows:—The mouth is surrounded by three somewhat feebly pronounced lips. The œsophagus is divided into three parts of which the first is separated from the second by pieces of chitin, while the third is very much swollen. The tail of the male is provided with alæ and a sucker. The spicules are unequal, the vulva is distant from the cephalic end, and the vagina divides into two opposing uteri.

To these Railliet and Henry(1) have added the following points. There are often two cervical alæ, there is no accessory piece, the sucker has a chitinous ring, the vulva is near the equator, the eggs have a thick shell with a clear granulation at one pole.

The writer makes the following alterations and modifications. The members of the genus are small with a fine transverse striation, lateral alæ and no neck. The cephalic end is bent dorsad. In the male there are 12 pairs of caudal papillæ. Of these 2 lie beside the sucker. There is further a paracloacal group of 4 lateral and 2 ventral papillæ, and a caudal group of 2 lateral and one ventral papillæ, while between



CLAYTON LANE—Suckered Round Worms.

PLATE LXXIV.

Heterakis bosia—

- Fig. 8. The tail of the male from the venter showing the point of the right spicule.
- Fig. 9. The left spicule from the dorsum.
- Fig. 10. The right spicule from the side.

these 2 last groups there lies a solitary lateral papilla. The vagina, after a short but possibly complicated cephalad turn, runs caudad. Turning again cephalad after some distance, it divides in the neighbourhood of the vulva into 2 uteri, of which one continues the direction and line of the vagina, while the other, turning very sharply, runs caudad. The thick-shelled ova have an unsegmented yolk.

HETERAKIS BOSIA, n. sp.

Habitat.—The gut (? cæcum) of the Tragopan pheasant, *Cerionis satyra*, Calcutta Zoological Gardens.

Description.—The male worms average 8·1 and the females 9·5 mm. in length, by about 0·4 mm. in breadth. The cephalic end is more or less curved dorsad. The cuticular striation is 0·002 mm. wide. The lateral alæ begin 0·2 mm. from the tip of the head and run caudad, in the male to near the sucker, and in the female to a point 0·03 mm. from the tip of the tail. The first part of the œsophagus measures 0·1, the second 1·0, and the third 0·45 mm. in length. The nerve collar is 0·33 and the cervical papillæ 0·65 mm. from the cephalic extremity. The excretory pore is large, lies 0·6 mm. from the same point, and from it 2 large vessels pass caudad to the lateral lines.

THE MALE (Figs. 8, 9 and 10) has a sucker of 0·25 mm. in diameter, the distance from its caudad end to the cloacal opening is 0·35 mm., from this point to the most caudad papilla 0·6 mm. and thence to the tip of the tail 0·7 mm. Of the lateral papillæ of the paraclacal group, that nearest to the head and the next but one to this, are small, the other 2 much larger, while the ventral papillæ are wide apart. The solitary intermediate papilla is large. The 2 lateral papillæ of the caudal group are close together, and the more caudad is only slightly larger than the other. The right spicule is 1·6 mm. long. For its last 0·5 mm. it expands into a portion shaped like a spear-head, which however is not quite symmetrical, measures 0·075 mm. in width, narrows sharply and is then projected into a fairly long sharp point. The left spicule is 0·9 mm. long. At a point about a quarter of its length from the point, it expands abruptly on one side only, so that a one-sided barb is formed.

THE FEMALE measures 9·5 mm. long, and is slightly wider than the male. The vulva opens just behind the equator. As a rule the cuticle beside it is plane, but caudad of it there may be a series of 5 or 6 cuticular tubercles, and one or two cephalad. The first cephalad curve of the vagina may be simple or duplicated. The caudad extremity of its loop

lies 1·6 mm. cephalad of the anus. It bifurcates at the level of the vulva. The ova measure 0·075 by 0·035 mm. The anus lies 1·5 and the caudal papillæ 0·8 mm. from the tip of the tail.

These worms were sent me by Mr. Bose.

HETERAKIS PUTAUSTRALIS. n. sp.

Habitat.—Cæcum of domestic fowl, Berhampore, Bengal.

Description.—Small worms with the usual dorsad curve at the cephalic end, characteristic of the genus. The males average 7·6 by 0·3 mm. and the females 8·2 by 0·35 mm. The cuticular striation measures 0·003 mm. The lateral alæ begin 0·1 mm. from the head end and run caudad, in the male to near the region of the sucker, and in the female to close to the tip of the tail. The first part of the œsophagus measures 0·06, the second 0·58, and the third 0·27 mm. The nerve collar is 0·27, the cervical papillæ 0·5 and the excretory pore 0·38 mm. from the head end.

IN THE MALE (Figs. 4, 5, 6 and 7) the sucker is circular and has a diameter of 0·08 mm. ; the distance from its caudad edge to the cloacal opening is 0·12 mm., from the cloacal opening to the most caudad papilla 0·22 and from thence to the tip of the tail 0·28 mm. Of the lateral papillæ of the paracloacal group the most cephalad and the next but one to it are very much smaller than the others. The ventral papillæ of this group are fairly far apart. The solitary papilla is of medium size. The 2 lateral papillæ of the caudal group are set far apart and the more cephalad one is very small. The right spicule is 0·55 mm. long, and gradually tapers from its base to a blunt conical point. The left spicule is 0·26 mm. long. It is provided with wide lateral alæ which are not quite symmetrical. When seen from the side the point of this spicule is blunter, and the curves much less abrupt than in *H. vesicularis*. The caudal alæ do not meet as a cuticular thickening cephalad of the sucker.

IN THE FEMALE the vulva opens just caudad of the equator, the cephalad curve of the vagina is complicated, its caudad loop turns cephalad 1·6 mm. from the anus. This structure lies 0·83 mm. from the tip of the tail, and the caudal papillæ 0·5 mm. from the same point. The ova measure 0·65 by 0·37 mm.

The worms were collected by the writer. The species is named after Mr. Southwell.

HETERAKIS BERAMPORIA. n. sp.

Habitat.—Cæcum of domestic fowl, Berhampore, Bengal.

PLATE LXXV.

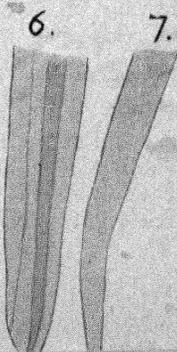
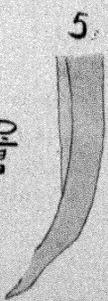
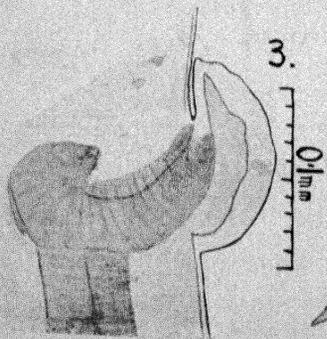
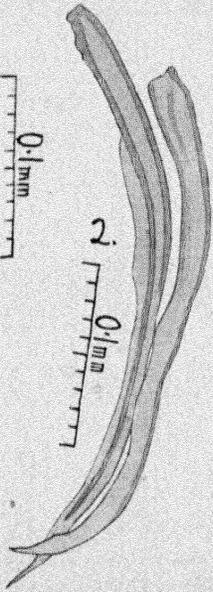
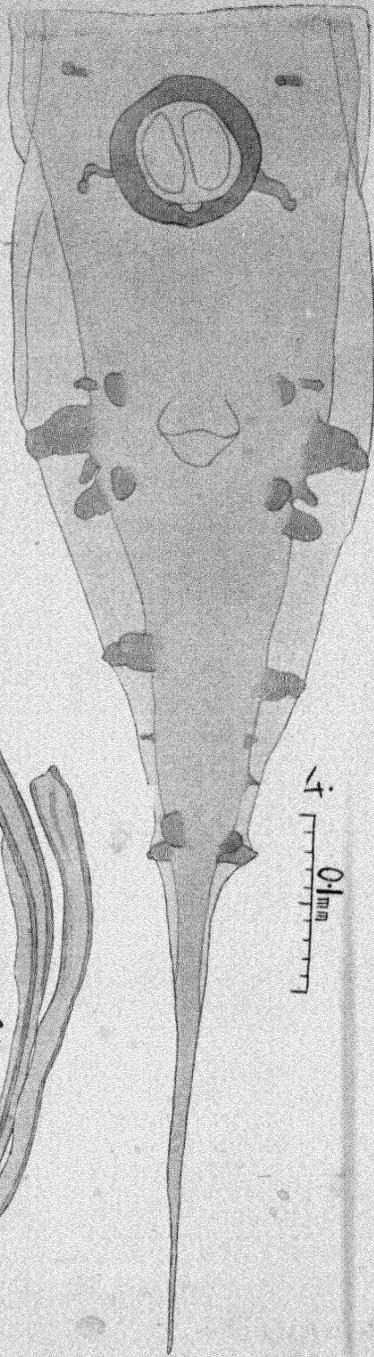
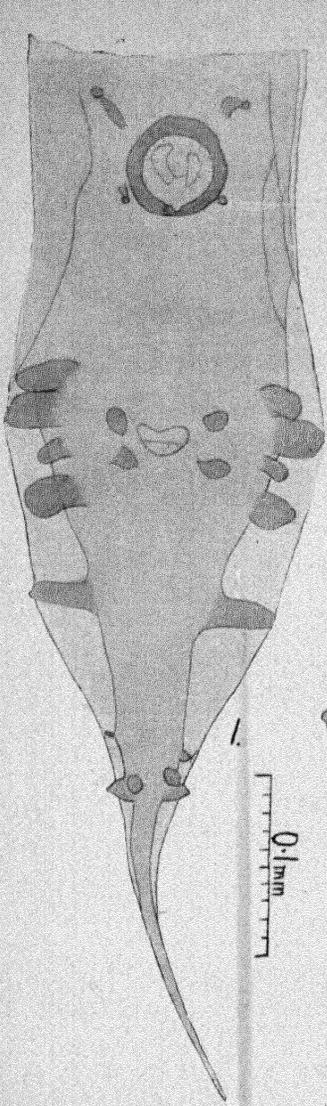
DESCRIPTION OF PLATES.

Heterakis beramporia—

- Fig. 1. The tail of the male from the venter.
- Fig. 2. Spicules from the left side.
- Fig. 3. The vulva of the female.

Heterakis putaustralis—

- Fig. 4. The tail of the male from the venter.
- Fig. 5. The left spicule from the side.
- Fig. 6. The left spicule from the venter.
- Fig. 7. The right spicule.



Description.—Small worms, the males straight, with the exception of a dorsad curve at the head end. The females have a similar cephalic dorsad curve, but about the level of the vulva they, somewhat abruptly, start a ventrad curve. The cuticular striation measures 0·002 mm. The lateral alæ begin 0·8 mm. from the tip of the head, and run caudad, in the male to near the sucker, and in the female nearly to the tip of the tail. The first part of the œsophagus measures 0·045 mm., the second 0·5 mm., and the third 0·2 mm. long. The nerve collar is 0·225 and the cervical papillæ 0·38 mm. from the cephalic end. The excretory pore lies 0·35 mm. from the same point.

THE MALE measures 5·5 mm. long by 0·24 mm. broad at its widest part. The sucker (Figs. 1 and 2) is circular and has a diameter of 0·55 mm. The distance from its caudad end to the cloacal opening is 0·25 mm. from the cloacal opening to the most caudad papilla 0·4 mm. and thence to the tip of the tail 0·33 mm. Of the lateral papillæ of the paracloacal group, the papilla nearest to the head, and that next but one to it, are fairly stout, particularly the first mentioned; and the ventral papillæ of this group lie close together. The solitary intermediate papilla is of moderate size. The lateral papillæ of the caudal group are relatively at some distance from one another, and the more caudad is considerably the larger of the two. The spicules are of nearly equal length but of different shape. The right is 0·7 mm. long and 0·015 mm. wide near its base, and has a tapering point with a slight ventrad curve. The left is of the same width, but is 0·6 mm. long, expands in its peripheral third, and bears near the point a prominent angle on its ventrad aspect.

THE FEMALE measures 6·6 mm. long with a maximum diameter of 0·3 mm. The vulva (Fig. 3) opens practically at the equator, at the point where the somewhat sharp ventrad curve of the body begins. Immediately caudad of the vulva is a valvular flap which projects cephalad over the opening. The cephalad curve of the vagina is very short. Its course is that characteristic of the genus. The ova measure 0·05 by 0·03 mm. The anus lies 0·66 and the caudal papillæ 0·33 mm. from the tip of the tail. The worms were collected by the writer.

Discussion.—This parasite and *H. putaustralis* inhabit the lumen of the cæcum of the common fowl, often as a mixed infection. They do not produce, so far as my experience goes, any lesion of the cæcal wall, as does *H. isolonche*(3) and (4), and both forms occur in the same host. This

characteristic, as well as the difference in size and shape of the spicules, and the absence of a series of cuticular eminences about the vulva serve to distinguish *H. beramporia* from *H. isolonche*. *Heterakis putaustralis* has a considerable superficial resemblance to *H. vesicularis*, but may be distinguished by the difference in the length of the spicules, by the fact that the cuticular thickening cephalad of the sucker does not end abruptly in the Indian form and that in the profile view of the point of the left spicule the curves are much more abrupt in *H. vesicularis* than in *H. putaustralis*. The shape of the spicules of *H. bosia* are so characteristic that they serve to distinguish this form from other species. *Heterakis pusilla*(5) cannot be identified with *H. putaustralis*.

GANGULETERAKIS, n. g.

Description.—Fine worms with fine striation and lateral alæ. The mouth has 3 fairly marked lips each bearing 2 papillæ. The male has a projecting sucker with a marked cuticular ring. The caudal alæ are prominent. There are ten pairs of caudal papillæ which are disposed as follows:—Two lie beside the sucker; there is a paracloacal group of 3 lateral and 2 ventral papillæ, and a caudal group of 2 lateral and 1 ventral papillæ. There is a 3-fold cuticular swelling ventral of the tail end. The spicules are equal or sub-equal and similar. The female has a long and fairly sharp tail. The vulva lies about the equator. The vagina divides into 2 opposing uteri.

Discussion.—The main points of difference between this genus and *Heterakis* in the restricted sense are:—The presence of only ten pairs of caudal papillæ in the male, the equal and similar spicules, the pedunculation of the sucker and the great ventral cuticular thickening on the tail of the male.

This genus is named after Sub-Assistant Surgeon Monoranjan Ganguli as a token of my appreciation of the ungrudging manner in which he helped me in human helminthological investigation.

GANGULETERAKIS GANGULA, n. sp.

Type species.

Habitat.—Lumen of the cæcum of *Mus decumanus*, Berhampore, Bengal.

Description.—The males average 9.4 by 0.33 mm. and the females 12.9 by 0.37 mm. The worms are straight, with the exception of a dorsal

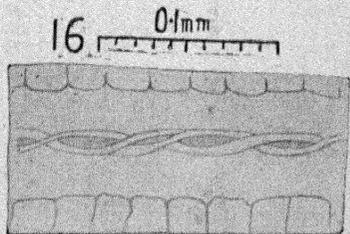
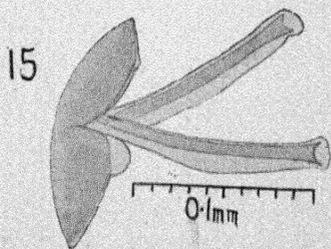
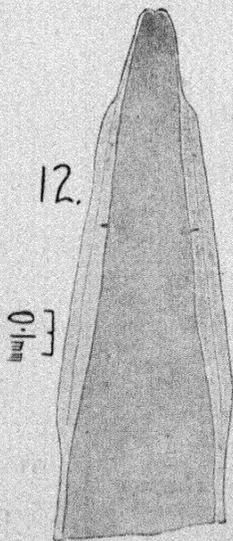
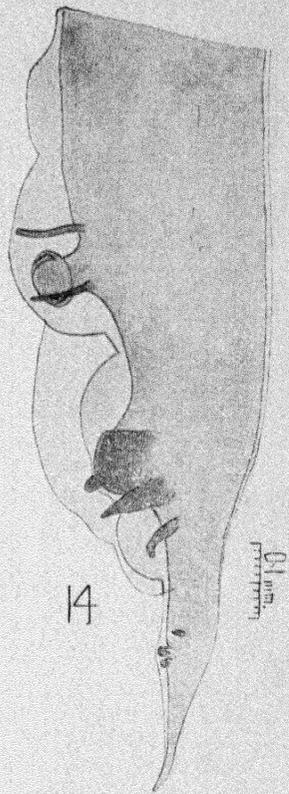
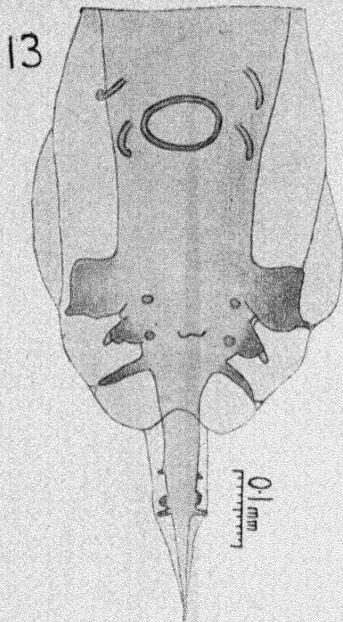
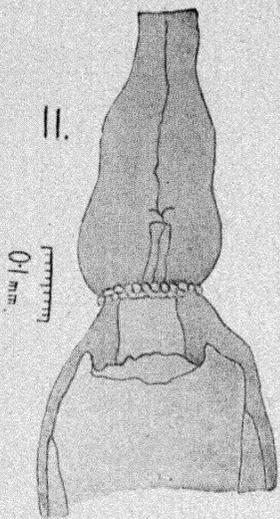


PLATE LXXVI.

Gangulaterakis gangula—

- Fig. 11. The junction of the cesophagus and chyle-intestine.
- Fig. 12. The cephalic end from the venter.
- Fig. 13. The tail of the male from the venter.
- Fig. 14. The tail of the male from the side.

Ascaridia hamia—

- Fig. 15. The tips of the spicules from the side.
- Fig. 16. The cuticle over the lateral lines.

curve at the head end. The cuticular striation is 0.01 mm. wide. The lateral alæ (Fig. 12) begin abruptly 0.2 mm. from the head end and immediately widen to 0.07 mm.; they remain of this size for a distance of 0.75 mm., that is still near the termination of the œsophagus, and then as rapidly diminish, but they continue in lesser depth, in the male to the level of the sucker, and in the female to the tip of the tail. Each lip bears 2 papillæ. There is also a pair of lateral head papillæ 0.04 mm. from the head end. The lateral cervical papillæ lie 0.5 mm. and the nerve commissure 0.33 mm. from the same point.

There is a small oral cavity. The œsophagus measures 1 mm. long. At a point 0.05 mm. from the caudad end of the œsophagus, its cavity appears to change from a cylindrical to a triradiate one. For the first three-quarters of its length the outline of the œsophagus gradually increases in diameter from 0.35 to 0.8 mm. It then abruptly widens in the form of a pear-shaped bulb containing a triple valve and having a maximum diameter of 0.2 mm. The junction of the œsophagus and chyle-intestine is surrounded by a circlet of spherical cells. The first part of the chyle-intestine is dilated, and its chitinous lining extremely thickened (Fig. 11). The excretory pore lies about 0.45 mm. from the head end.

THE MALE (Figs. 13 and 14) has a sucker raised prominently on a pedicle, the pedicle being 0.04 and the sucker 0.06 mm. high. The latter is oval with its long diameter transverse, and measures 0.1 by 0.075 mm. The 2 caudal papillæ situated beside the sucker are long and thin. The lateral paracloacal papillæ are all of about the same length; the most cephalad is, however, by far the widest, measuring 0.09 mm., the second is about half the width of the first, the third is still narrower. The cuticle on the ventral surface is much thickened in parts at the caudal end. The thickening begins 0.12 mm. cephalad of the sucker. Caudad of the sucker is a deep depression, but the cuticle again thickens forming a prominence cephalad of the cloacal opening. Caudad of this the cuticle again swells into a marked bullous prominence opposite the third paracloacal lateral papillæ. 2 ventral papillæ lie in this group one beside and one shortly cephalad of the cloacal opening. The members of the caudal group of papillæ are short; there are 2 lateral and 1 ventral papillæ, the last being the largest. This group lies about half way between the tip of the tail and the most caudad of the paracloacal papillæ. The spicules are similar and equal, and measure 0.37 mm. in length; they are sharp-pointed, tapering gradually from base to apex.

IN THE FEMALE the vulva lies immediately caudad of the equator; cephalad and caudad of this lies a series of prominences consisting both of cuticle and sub-cuticle, but without tactile papillæ. They have no regular disposition. After a short cephalad course the vagina runs caudad for 1·6 mm.; it then again turns cephalad for 0·5 mm. at which point it divides into the 2 opposing uteri. The ova measure 0·065 by 0·045 mm. The shell is about 0·005 mm. in thickness, and the granular yolk is apt to be retracted from the shell at one end. The tail of the female is 0·9 mm. long, and the caudal papillæ lie 0·45 mm. from its tip.

The worms were collected by the writer with the aid of Sub-Assistant Surgeon Monoranjan Ganguli, after whom they are named.

Discussion.—In 1866(8) Schneider described from the cæcum of *Mus decumanus* in Berlin *Heterakis spumosa* as follows:—"♀ 9 mm.; ♂ 7 mm. kopt dreilippig. Lippen sehr klein—seitenmembran beginnt in einem kleinen Abstand vom kopf, läuft zuerst breit, dann schmaler werdend bis zum schwanz—vulva in der köpermitte. Bursa des ♂ dreimal blasig aufgetrieben. 9 Papillen." I have been unable to obtain any specimens of *H. spumosa* from Europe. The difference in length makes it reasonable to conclude that this is a different species from that now described. The Indian species is designated as type of the new genus.

ASCARIDIA Dujardin, 1845.

Railliet and Henry give the generic diagnosis as follows:—"Mouth with 3 lips; œsophagus in continuity; often two lateral membranes; male with feeble lateral alæ; spicules equal or sub-equal; no accessory piece; female with vulva near the equator; uteri opposed; ova with thick shell, and within it a clear granulation at one pole; intestine of birds." To this may be added the item of ten pairs of caudal papillæ in the male, and the similarity of the spicules.

ASCARIDIA HAMIA, n. sp.

Habitat.—Small intestine of the domestic fowl, Berhampore, Bengal.

Description.—The male worms average 70 by 0·9 mm. and the females 90 by 1·25 mm. The worms have no fixed curves; the cuticular striation is 0·02 mm. wide; there are no projecting lateral alæ, but the place of each is taken by a band of cuticle 0·06 mm. wide, plain at the margin, and with a peculiar rope-like twist in its centre (Fig. 16). The

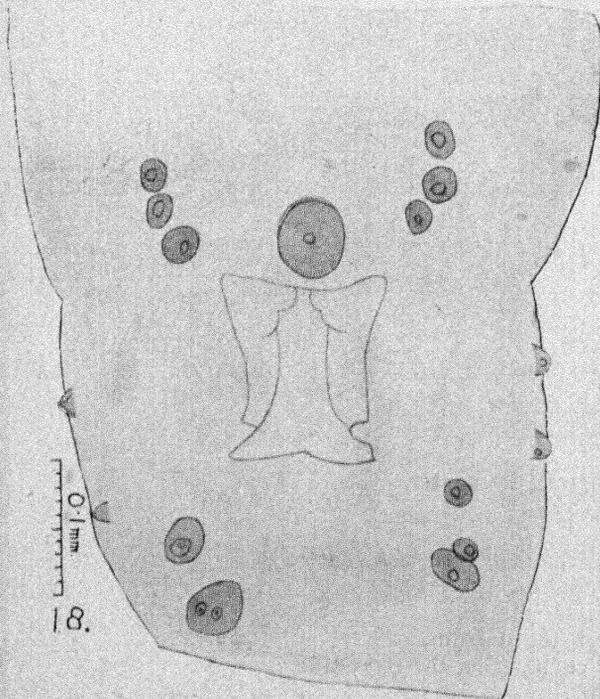
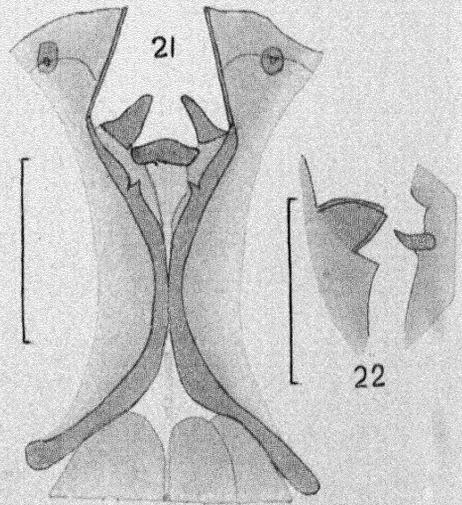
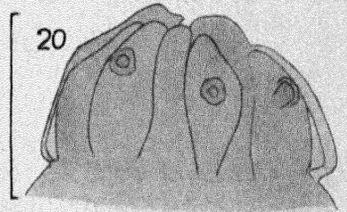
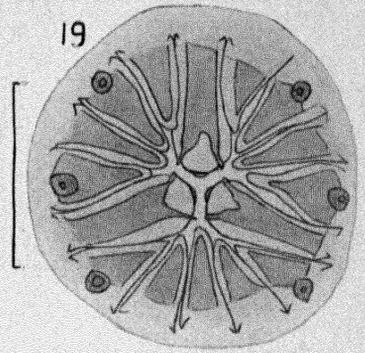
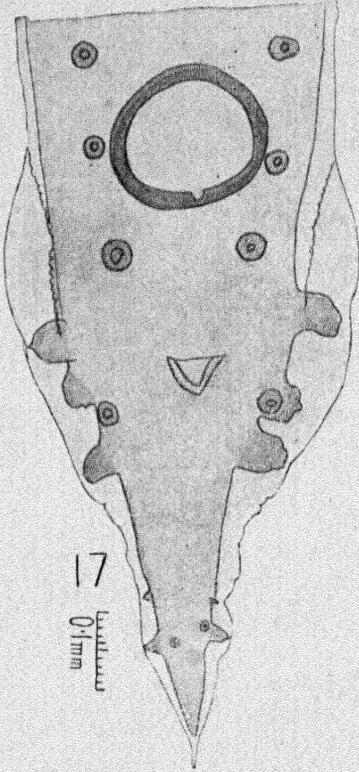


PLATE LXXVII.

Ascaridia hamia—

Fig. 17. The tail of the male from the venter.

Kathlamia kathlena—

Fig. 18. The cloacal region of the male from the venter.

Fig. 19. The head viewed "end-on."

Fig. 20. The head from the right side.

Fig. 21. The oral cavity from the dorsum.

Fig. 22. The base of the oral cavity from the right side.

head is separated from the body by a slight neck. The three lips are large and well formed, consisting of a central mass with a convex margin, and a lateral flap on each side. Each lip bears two papillæ, those on the dorsal lip being considerably larger than the others. On the axad surface each lip bears a sharp horizontal ridge which appears, when seen from the periphery, as a wavy line. There are no interlips. The œsophagus is simple and not divided definitely into parts. Its outline, however, varies as follows. The first portion, 0.25 mm. in length, is cylindrical, and measures 0.15 mm. in diameter. The outline then becomes fusiform, the maximum diameter of this portion being 0.2 mm. and its termination being at the nerve-collar, 0.6 mm. from its cephalic end. Thence the outline regularly expands till just before its caudad end it reaches a width of 0.34 mm. Its total length is 3.1 mm. A circular cuticular valve with a fringed edge projects from the œsophagus into the chyle-intestine. The excretory pore lies 0.9 mm. from the tip of the head. The lateral cervical papillæ lie 1.1 mm. from the same point. Close to the head there are 5 or 6 small nuchal papillæ on each side.

THE MALE.—The tail has a lateral cuticular fringe and ten pairs of papillæ (Fig. 17) of which 5 are lateral and 5 ventral. The most cephalad of the lateral papillæ is on the level of the cloacal opening, and forms one of a group of 3 large and conspicuous papillæ. The other 2 lateral papillæ lie about half way between the most caudad of the first group and the tip of the tail. The more cephalad of these is very small. Of the ventral papillæ, 3 form a line on each side of the sucker, one being cephalad of, one beside, and one caudad of the level of this organ. The fourth lies just caudad of the level of the cloacal opening, and the fifth beside the most caudad of the lateral papillæ. The spicules are narrow equal and similar, are 2 mm. long and end in rounded points (Fig. 15). The sucker measures 0.2 mm. in diameter. The distance from it to the cloacal opening is 0.2 mm. and thence to the tip of the tail 0.5 mm.

THE FEMALE.—The vulva lies at the equator. The vagina runs cephalad for 1 mm. turns caudad for 1.5 mm. and then divides into the 2 divergent uteri. The ova in the vagina are surrounded by a thick smooth shell. They measure 0.065 by 0.04 mm. The shell is 0.005 mm. in thickness, and the granular unsegmented yolk is somewhat retracted from this. The tail is 1.3 mm. long and the lateral caudal papillæ lie 0.5 mm. from its tip. The worms were collected by the writer.

Discussion.—Three species of *Ascaridia* seem to have been described from the East, all by von Linstow. They are *Heterakis circularis* from *Centropus sinensis* in Siam, *Heterakis granulosa* from the domestic fowl *Gallus gallinaceus* in Colombo, and *Heterakis trilabium* from the intestine of the jungle crow *Centropus sinensis* Ceylon. All these species appear to belong to the genus *Ascaridia*.

In *H. circularis*(6) the male and female measure 31 and 52 mm. respectively, the spicules 1.75 in length, and the ova 0.073 by 0.042 mm. The worms are much smaller than *A. hamia* and the position of the eight pairs of papillæ described does not correspond to that existing in the latter.

In *H. granulosa*(5) the male and female measure 27 and 55 mm. respectively. The sucker is long and oval and surrounded by granulations, characters absent in *A. hamia*; as are the peculiarities of the 3 pre-anal and 6 post-anal papillæ described, namely, that the most anterior is transversely elliptical, and the 4th, 7th and 9th spherical and marginal. The spicules are not mentioned. The ova measure 0.78 by 0.04 mm.

In *Heterakis trilabium*(7) the female measures 89 mm. long; in the description of the worm, kindly furnished me in manuscript by Professor von Linstow the size of the male is 26 and of the female 39 mm. Of the ten pairs of caudal papillæ mentioned, one pair lies sub-median just behind the cloacal opening, and the relative sizes and disposition of the other papillæ, particularly of the 3 most caudad, are very different from those of *A. hamia*.

KATHLANIA, n. g.

Generic diagnosis.—Fairly small worms; the head separated from the body by a neck (Figs. 20 and 35). The body increases in width caudad from the head to a maximum at a point about $\frac{1}{3}$ of the total length from this point. The tails of both sexes are long and sharply pointed; the cuticular striation very fine, the cuticle raised into a lateral alar membrane on either side, beginning near the neck and ending, in the female, about the level of the vulva, and in the male 3 to 6 diameters cephalad of the cloacal opening.

The mouth is axial and surrounded by 3 main lips (Fig. 19), one dorso-median, and 2 ventro-submedian. They are wider near their free ends than at their bases, and each contains 2 minute papillæ on the axad surface; between the dorsal and each ventral lip are 4 subsidiary

lips, while between the 2 ventral lips there are 5 subsidiary lips. The subsidiary lips are wedge-shaped, the point of the wedge being axad. The cephalic papillæ lie in the bases of certain subsidiary lips, the 2 lateral papillæ in those just dorsad of the 2 main ventro-submedian lips, the 2 submedian ventral papillæ in the subsidiary lips immediately ventrad of the same main lips, and the 2 dorso-submedian papillæ in the pair of subsidiary lips next but one dorsad to those bearing the lateral papillæ. The subsidiary lips bearing the lateral papillæ have wider bases than have any of the others.

The oral cavity is triangular in transverse section, the angles corresponding to the 3 main lips, and being rounded off by chitinous thickenings projecting convexly axad. At the base of the mouth cavity proper are 3 chitinous thickenings, one dorsal and 2 ventral; they vary in shape in the different species.

The mouth cavity is joined to the œsophagus by a long œsophageal funnel (Fig. 21).

The œsophagus consists of 3 parts (Fig. 34). The first part is at first slightly spindle-shaped until it reaches the level of the nerve-collar, and then merges into a long uniform cylinder, the second forms a short cylinder about $1\frac{1}{2}$ times as wide as the adjoining portion of the first part, and but little longer than it is wide, and the third a wider sub-globular swelling containing the œsophageal valves.

The chyle-intestine begins with a bulbous dilatation and, narrowing, then takes a straight course to the rectum. Its walls are thin and simple.

The cervical papillæ lie in the lateral alæ far caudad of the nerve-collar.

THE MALE has a sucker lying slightly cephalad of the cloacal opening. It is without a cuticular ring (Figs. 29 and 34). There are 23 caudal papillæ. One is median and unpaired, and lies immediately cephalad of the cloacal opening, the others are paired, eight pairs being post- or ad-anal and 3 pre-anal, the most cephalad lying beside the sucker. The post-anal are smaller than are the pre-anal, and certain adjacent ones may be fused to form double papillæ. The accessory piece is bifurcate cephalad, has a ventral median projection, hook-shaped in profile, and at its caudad end projects freely from the general level of the surface of the body forming a prominence at the caudad edge of the cloacal opening. The spicules vary enormously in size in the 2 known species, are sub-equal, and appear to consist of a flanged tube. The ejaculatory duct passes cephalad into a marked vesicula seminalis

(Fig. 34). The testicular tube coils cephalad to near the bulb of the chyle-intestine, the coils then turn caudad ending blindly near the seminal vesicle.

IN THE FEMALE the 2 caudal papillæ lie just caudad of the anus. The vulva is situated caudad of the equator. The general direction of the vagina is cephalad and dorsad. The two uteri are divergent, but the cephalad-running uterus shortly turns caudad, and both of them run coiling side by side in this direction to a point just caudad of the anus. They then turn cephalad, coiling similarly, till, near their point of origin, they become straight tubes and pass into the 2 ovaries. These coil cephalad on opposite sides of the chyle-intestine. At the bulb of the latter they cross over and reverse positions and then run caudad till they reach the region of the uterus. Here they again turn cephalad and, after a short further course, end close to the utero-ovarian junction. The ova in the vagina contain a coiled embryo. The thin colourless shell shows a fine striation in optical section.

TYPE SPECIES.—*Kathlania kathlena*.

KATHLANIA KATHLENA, n. sp.

Habitat, gut of *chelone midas*, Ceylon.

Description.—The male measures 13×0.6 mm., the female 15×0.7 mm.

The head (Figs. 19 and 20) measures from 0.08 to 0.1 mm. long by 0.17 to 0.21 mm. broad at its base. The margin of the caudad end of the head, where it turns round into the cervical furrow, has a rounded edge, and the cuticle of this part is not greatly thickened, its depth being about 0.01 to 0.0175 mm. The transverse cuticular striæ are 0.002 mm. apart. The lateral alæ begin 0.55 to 0.65 mm. from the cephalic end, and measure 0.01 to 0.025 mm. in depth. Of the cuticular thickenings at the base of the mouth cavity (Figs. 21 and 22) the 2 ventral are similar, and differ markedly from the dorsal. They project into the cavity as flattened pyramidal masses. The dorsal thickening is elongated from side to side with a sinuous cephalad and nearly straight caudad edge. When seen from the side the ends of this thickening appear to project into the oral cavity. The œsophageal funnel measures 1.6 mm. long. The first portion of the œsophagus measures 3.75 mm., the second part 0.12, and the third 0.2 mm. long. The nerve collar is 0.6 mm. and the cervical papillæ 4 mm. from the cephalic end.

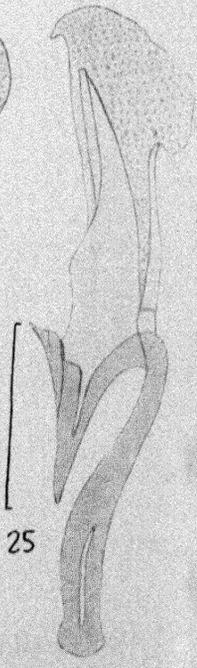
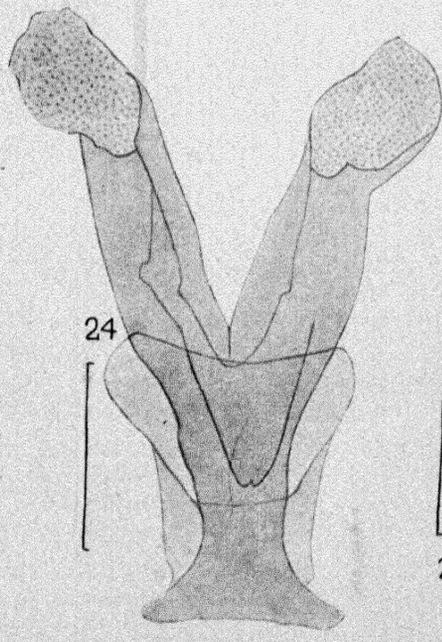
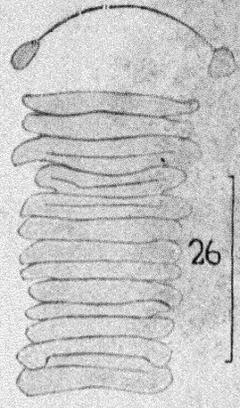
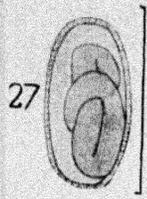
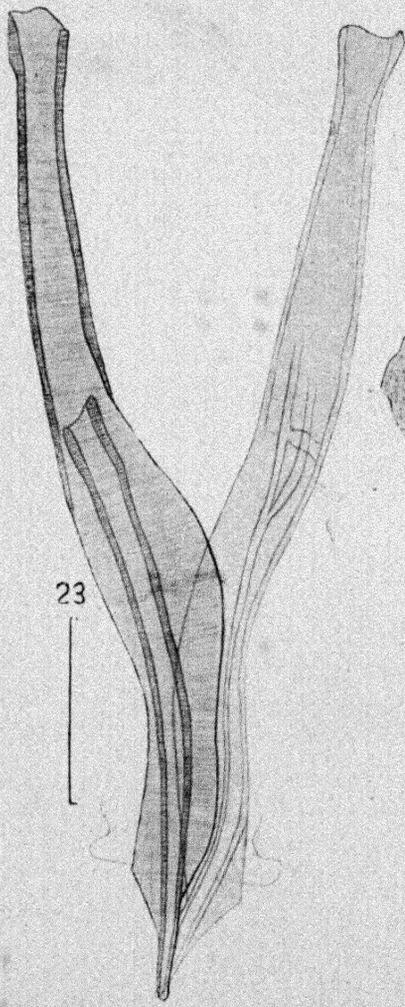


PLATE LXXVIII

Kathlania kathlena—

- Fig. 23. The spicules from the venter.
- Fig. 24. The accessory piece from the venter.
- Fig. 25. The accessory piece from the left side.
- Fig. 26. The vulval region seen from the venter.
- Fig. 27. An ovum.

PLATE LXXIX.

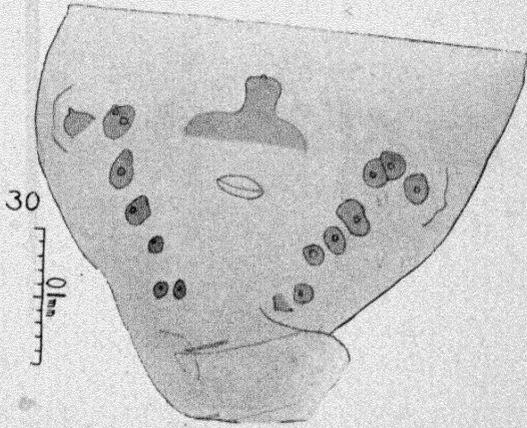
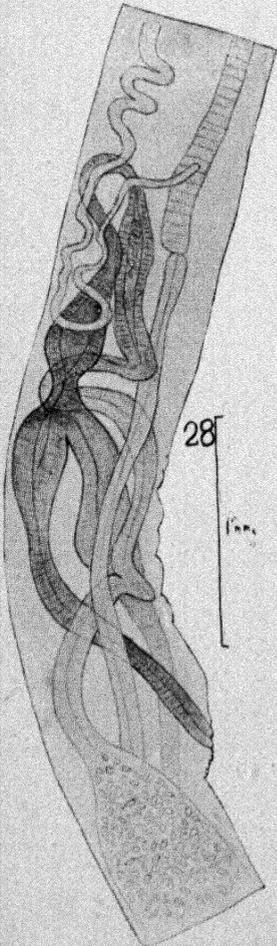
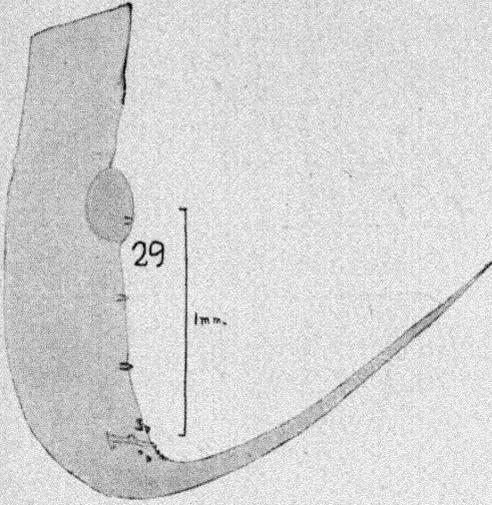


PLATE LXXIX.

Kathlenia kathlenia—

Fig. 28. The vaginal region from the right side.

Fig. 29. The tail of the male from the right side.

Kathlenia tonaudia—

Fig. 30. The cloacal region of the male from the venter.

THE MALE.—The tail measures 2 mm. long (Fig. 29); it is bent ventrad to a varying extent but is not sharply curved against the body. The sucker measures 0·4 mm. long and is situated 1 mm. cephalad of the cloacal opening. Of the caudal papillæ the 3 most caudad form a group of which the 1st and 2nd may coalesce to form a compound papilla (Fig. 18), they project ventrad; the 4th and 5th lie further dorsad and laterad than any of the others and are small; the 6th, 7th and 8th form a pre-anal group. The median papilla, lying just cephalad of the cloacal opening, is larger than any of those yet mentioned. The other 3 papillæ are considerably larger and more prominent, one lies about half way between the cloacal and the caudad end of the sucker, the next about half way between that just mentioned and the caudad end of the sucker and the last just cephalad of the caudad end of the sucker.

The accessory piece (Figs. 24 and 25) is strong and massive, 0·35 mm. long; about half of the length is occupied by the bifurcated and about half by the non-bifurcated portion. The ventral median projection is strong and very prominent, and has a spear-head shape in optical section when seen from the side. The portion which projects ventrad beyond the cuticular surface of the worm has marked lateral cornua from which a fine cuticular membrane runs to the edge of the cloacal opening. The spicules (Fig. 23), especially when seen laterally, have their more solid portions arranged in such a manner as to give the impression, at first sight, of there being 2 spicules on each side, one dovetailed into the other. Their length is about 0·55 mm. and their greatest breadth, which lies about their equator, is about 0·06 mm. The flange springs in an oblique line from close to the tip of the spicule.

THE FEMALE.—The tail measures 4·5 mm. from its tip to the anus, the lateral caudal papillæ lying 0·5 mm. caudad of the latter.

The vulva opens 8·5 mm. from the tip of the tail. Immediately caudad of it the cuticle is raised into a series of from 7 to 15 transverse ridges (Fig. 26) forming, when seen from the venter, a ladder-like patch 0·1 mm. wide and from 0·07 to 0·18 mm. long. The vagina (Fig. 28) measures from 1 to 1·75 mm. long, and takes a slightly curved course to its point of bifurcation, just before reaching which it may be somewhat dilated. The first part of each uterus may also be dilated, and if so contain spermatozoa, and evidently functions as a seminal receptacle. The cephalad uterus makes its first turn caudad after a course of about 1 mm. The ova in the uterus or vagina measure 0·09 by 0·015 mm.

KATHLANIA TONAUDIA, n. sp.

Habitat, gut of *Chelone midas*, in Ceylon.

Description.—THE MALE measures 11·5 mm. long with a maximum width of 0·6 mm. The head is 0·08 mm. long by 0·2 mm. broad at its base (Fig. 35). The margin of the caudad end of the head, where it turns round into the cervical furrow forms a sharp angle, the cuticle there being much thickened and measuring 0·025 mm. in depth. This projection of the cuticle into a clear sharp edge at the hinder part of the head forms a ready means of distinguishing this species under a low power and in uncleared specimens from *K. kathlena*. The transverse cuticular striæ are 0·002 mm. apart. The lateral alæ begin 0·5 to 0·7 mm. from the cephalic end of the worm, and have a maximum depth of 0·025 mm.

The 3 cuticular tooth-like thickenings at the base of the oral cavity are of similar shape (Fig. 36). The œsophageal funnel measures 0·11 mm., the three parts of the œsophagus 3 to 3·5, 0·2, and 0·3 to 0·35 mm. respectively, the whole measuring about 4 mm. The nerve-collar is 0·5 and the cervical papillæ 2·5 mm. from the head end. The length of the tail of the male (Fig. 34) is 1·5 mm. This structure has a characteristic double curve, being first bent sharply ventrad and then slightly dorsad. The former curve is so sharp that in order to get a satisfactory view of the caudal papillæ from the venter it has been found necessary to cut across the worm caudad of the sucker. This last measures 0·22 mm. in length, and is situated 0·5 mm. cephalad of the cloacal opening. The peri-anal papillæ (Figs. 30 and 32) do not fall into 3 groups. Starting from the tail end the first and second lie side by side. The third, fourth, fifth, sixth, and seventh form a series diverging cephalad. The first three of these progressively increase in size, while the sixth and seventh are in close contact or coalesce into a double papilla. The eighth lies outside the sixth and seventh, and is the largest of all. The median pre-anal papilla is particularly prominent, but not so large as the eighth lateral papilla, especially when seen from the side.

The accessory piece (Figs. 38 and 39) is delicate and slender; it is 0·25 mm. long and the ventral median hook-shaped projection is quite small. The spicules (Fig. 34) are the most extraordinary feature of the worm. They are extremely long and fine, measuring 12 by 0·03 mm., that is, they reach from the middle of the œsophagus to the cloacal opening when not extruded. The spicules may embrace one another, their tips are incurved, and the flange begins 0·11 mm. from the point (Fig. 31).

PLATE LXXX.

Kathania tonandia—

- Fig. 31. The tip of a spicule from the side.
Fig. 32. The cloacal region from the left side.
Fig. 33. The vaginal region from the right side.

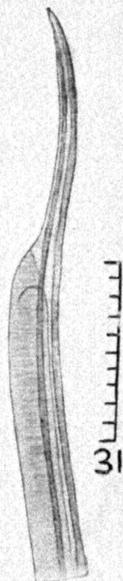
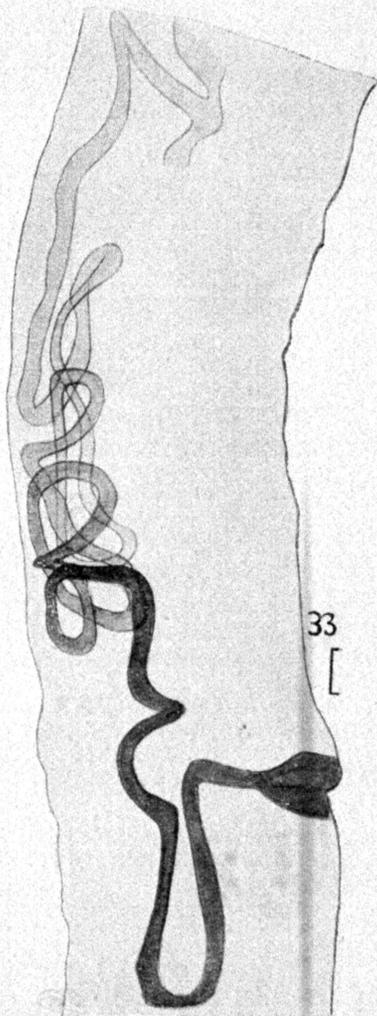
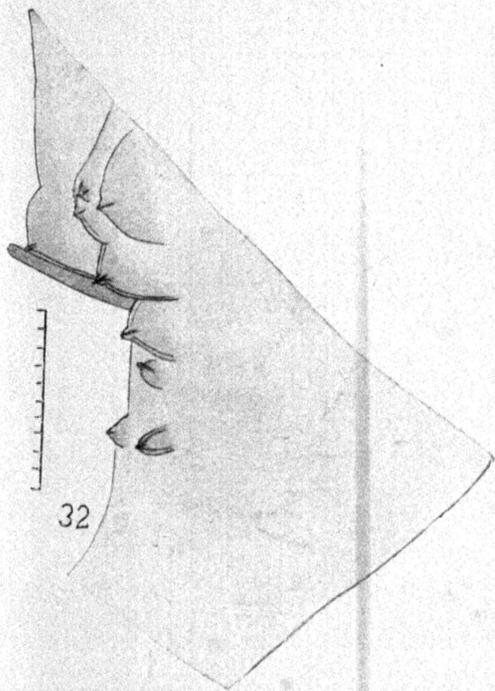
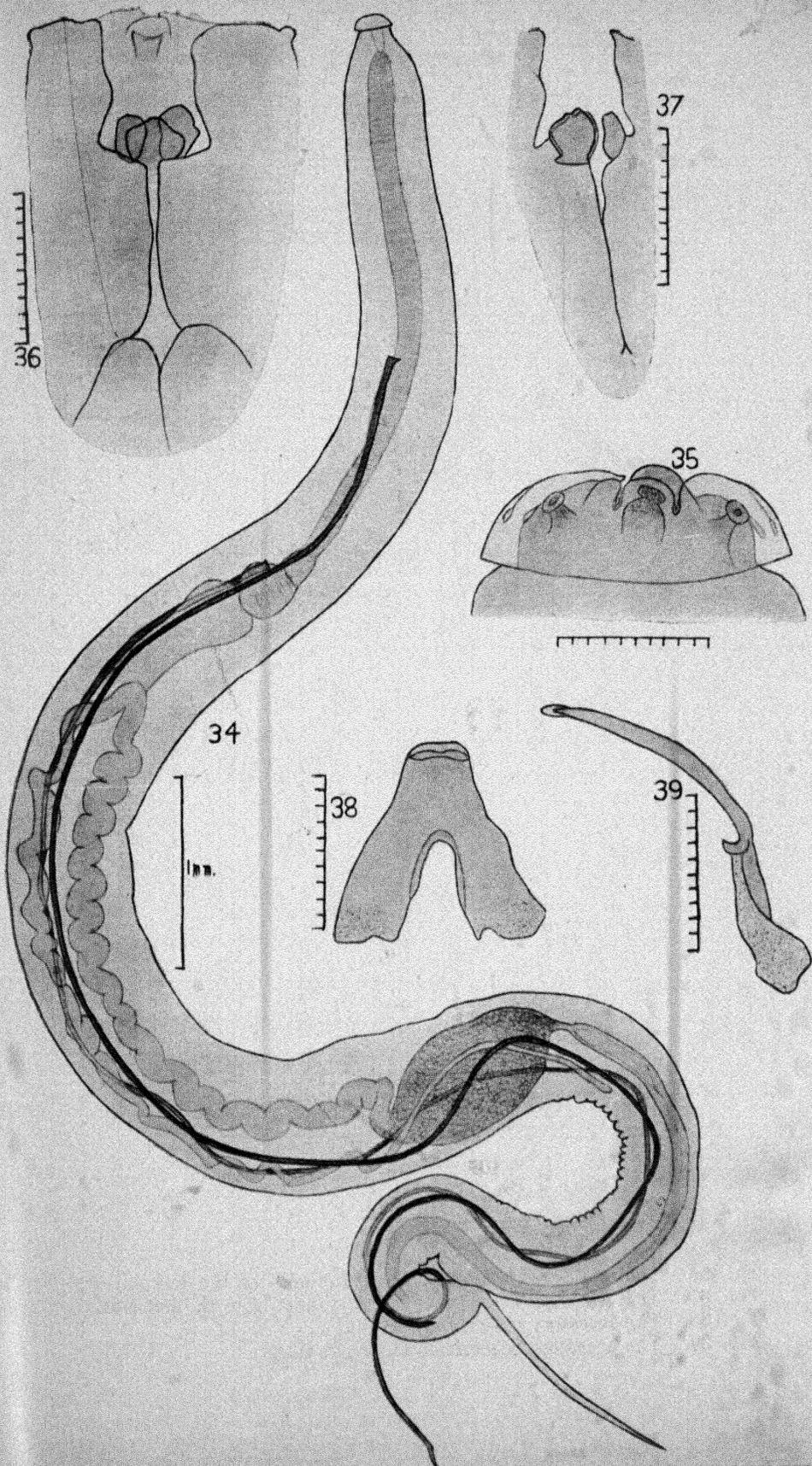


PLATE LXXXI.

Kathania tonaudia—

- Fig. 34. The male from the right side.
- Fig. 35. The head from the right side.
- Fig. 36. The oral cavity and oesophageal funnel from the dorsum.
- Fig. 37. The oral cavity and oesophageal funnel from the left side.
- Fig. 38. The accessory piece from the venter.
- Fig. 39. The accessory piece from the right side.



THE FEMALE measures 15 by 0·65 mm. The tail measures 2·5 mm. from anus to tip. The lateral papillæ lie 0·6 mm. caudad of the anus. The vulva opens at a point about 1 mm. caudad of the equator. Cephalad of it the cuticle is raised into a prominence, but caudad of it this is quite smooth (Fig. 33). The vagina is long and coiled, in evident correlation with the extraordinary length of the spicules. It measures 8 mm. long. The ova are 0·1 mm. long by 0·045 mm. broad.

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- (7) Nematodes in the Collection of the Colombo Museum. Spolia Zeylanica, Vol. I, Part IV, Feb. 1904.
- (8) Monographio der Nematoden, Anton Schneider, 1866.

Note.—Type specimens of all the nematodes described in this paper, and that entitled "Bursate nematodes from the Indian Elephant" published in Volume 2, No. 1 of this Journal will be deposited in the British Museum (Natural History), Cromwell Road, London, S. W., for reference.
Unless otherwise stated, the scales beside the figures measure 0·1 mm.