NEMATODE PARASITES OF PIGS IN BENGAL.

By H. P. A. MAPLESTONE, *D.S.O., M.B., Ch.B., D.T.M.*

(*From the Hookworm Research Laboratory, School of Tropical Medicine and Hygiene, Calcutta.*)

INTRODUCTION.

The helminths enumerated below were collected from the alimentary tract of pigs slaughtered at the Calcutta abattoirs. The intestines were brought to the Laboratory intact, within two or three hours of the animals being killed, so that most of the worms were alive when collected. They were well washed in saline and immediately fixed, so they were in a good state of preservation when examined.

Despite the fact that *Ascaris lumbricoides* is known to be a very common parasite of pigs in Bengal, only a single small female was found in forty-four small intestines examined. Accordingly, if such a common parasite as *Ascaris* was only encountered once, it is probable that rarer parasites have been missed altogether, and although several new species have been added to the known parasites, the list given below is probably by no means a comprehensive one for Indian pigs.

In the following paper I have made a very free use of Baylis' "Manual of Helminthology," since this represents the most recent and most reliable summary of the present state of our knowledge regarding many of the species discussed below.

List of species found.

NEMATODA.

Ascaridae.

Ascaris lumbricoides Linn., 1758.

Cruziidae.

Cruzia orientalis, n. sp.

Trichuridae.

Trichuris suis (Schrank, 1788).

Spiruridae.

Arduenna strongylina (Rudolphi, 1819).

Physocephalus sexalatus Molin, 1860.

Gnathostomidae.

Gnathostoma doloresi Tubangui, 1925.

Strongylidae.

Oesophagostomum dentatum (Rudolphi, 1803).

Oesophagostomum longicaudum Goodey, 1925.

Oesophagostomum conicum, n. sp.

Oesophagostomum suis, n. sp.

Bourgelatia diducta Railliet, Henry and Bauche, 1919.

Globocephalus urosubulatus (Alessandrini, 1909).

Globocephalus connorfilii Lane, 1922.

Globocephalus samoensis (Lane, 1922).

ACANTHOCEPHALA.

Macracanthorhynchus hirudinaceus (Pallas, 1781).

Ascaris lumbricoides Linn., 1758.

As mentioned in the introduction one specimen of a small female of this species was found in forty-four small intestines examined.

Cruzia orientalis, n. sp.

This worm was found in twelve out of forty-nine pigs; it was always in the caecum and large intestines, and it was never present in very large numbers. The total number of worms of this species recovered was thirty-six males and seventy females.

In general appearance and in most of its anatomical details it is very similar to *Cruzia tentaculata*, which Travassos (1922) described in great detail; it is therefore proposed only to describe those points in which the present species differs from the above worm.

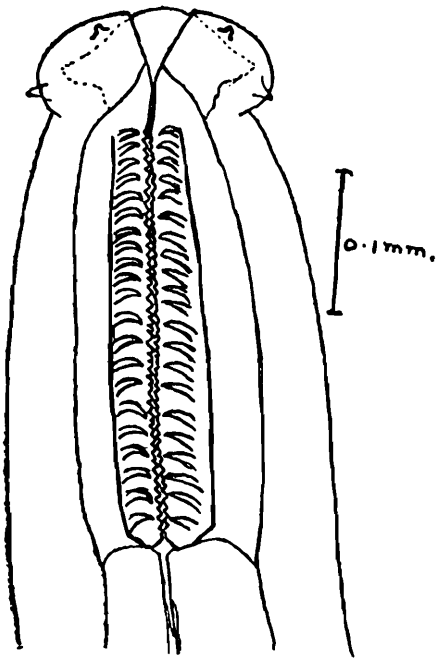

FIG. 1.—*Cruzia orientalis*, n. sp. Anterior end, ventral view.

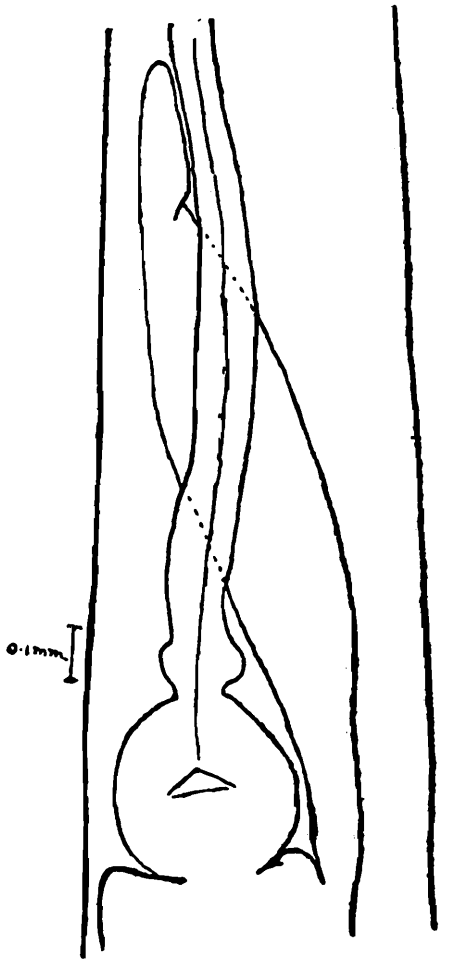

FIG. 2.—*Cruzia orientalis*, n. sp. Region of oesophago-intestinal junction, showing diverticulum.

The two subventral lips are marked off from the body of the worm by a deep groove, which is apparently not present in *C. tentaculata*. The dorsal lip is apparently the same shape as in *C. tentaculata* but its lateral borders are more deeply notched, so that the lateral angles project more markedly (fig. 1). In this species the chitinous vestibule or pharynx is of considerably greater length than it is in *C. tentaculata*, and in Travassos' figure only eleven or twelve rows of teeth are shown,

these diminish in size from before backwards, whereas in the present species there are nineteen to twenty-three rows of teeth and they all appear to be of equal size (fig. 1). The oesophagus and diverticulum are considerably longer than in *C. tentaculata* (fig. 2).

Male.—The arrangement of the caudal papillae differs slightly from that described by Travassos. This author mentions three groups of papillae each consisting of three pairs, *viz.* preanal, adanal, and postanal groups. The preanal and adanal groups in the present species are similar in position to those described and figured for *C. tentaculata.* But on each side of the tip of the tail in the material before me there are four papillae instead of three and they are arranged in two straight rows diverging from behind forwards. The most posterior pair of these papillae are pointed, and the three anterior pairs are pedunculated with enlarged tips, similar to but smaller than those of the preanal and adanal groups of *C. tentaculata* (fig. 3). The spicules and gubernaculum are identical in size and shape with those of *C. tentaculata.*

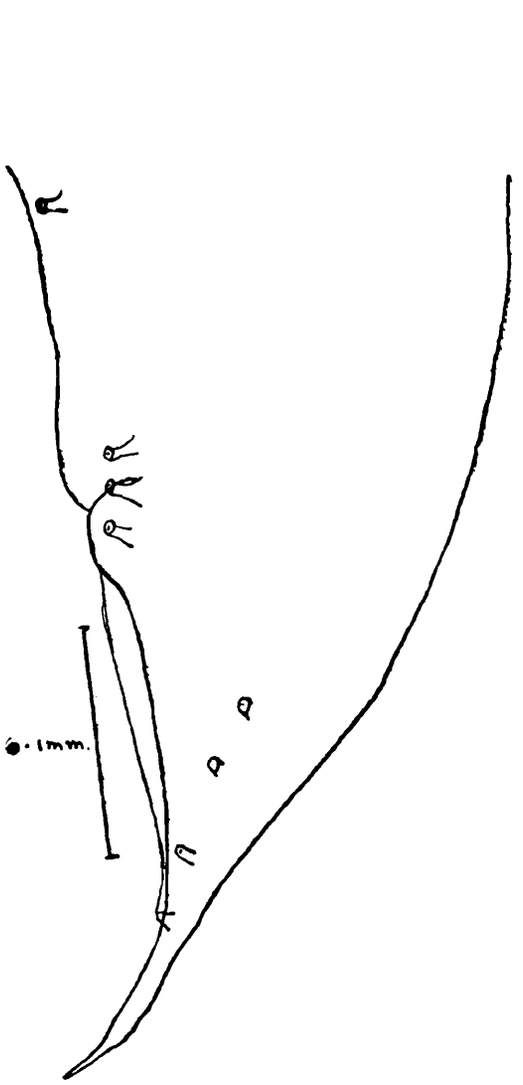

FIG. 3.—*Cruzia orientalis*, n. sp. Tail of male, lateral view. Only the most posterior of the preanal papillae is shown.

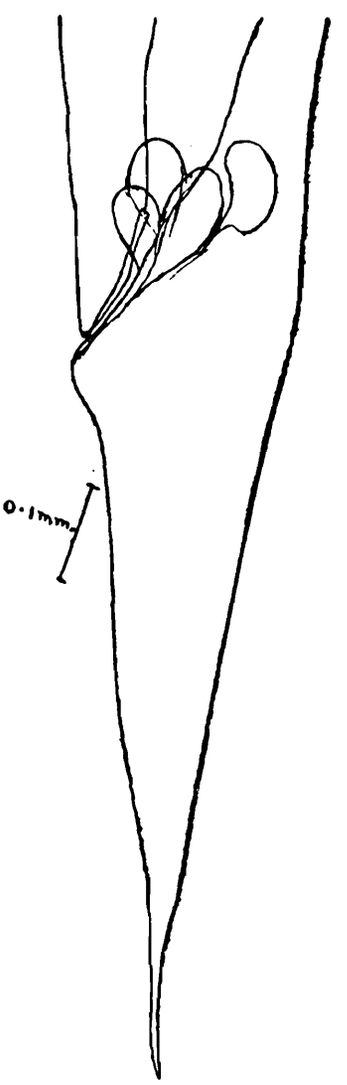

FIG. 4.—*Cruzia orientalis*, n. sp. Tail of female.

Female.—The female of this species only differs from the female of *C. tentaculata* in being slightly larger. Figure 4 has been included to illustrate the peculiar rectal glands, which are characteristic of the genus.

Discussion.—The species of this genus hitherto described are *C. tentaculata* (Rud. 1819) from *Didelphys* spp. in North and South America, and *C. mexicana* Khalil, 1927, from an unknown Mexican lizard, so that the known distribution of the genus is very limited. The present worm is very close to the other species in anatomical details, but the differences are considered sufficient to separate it from the earlier species, and, in addition to this, there is the different host in a very widely separated locality. It is, therefore, proposed to name it *Cruzia orientalis*, n. sp.

Canavan (1929) recorded what he considered to be *C. tentaculata* from *Didelphys virginiana* in the United States of America, but he mentioned a different arrangement of the papillae near the tip of the tail from that figured by York and Maplestone (1926). A more striking difference to which he does not refer, but which is evident from Canavan's figure, is that the preanal papillae are much closer together in his material than they are in *C. tentaculata* or in *C. orientalis*, for in both of these species the most anterior of these papillae is a little in front of the base of the unextruded spicule, whereas in Canavan's figure the most anterior papilla is about opposite the middle of the unextruded spicule. Some of the dimensions given by Canavan also differ from those given by Travassos (1922) for *C. tentaculata*, so it is considered that in all probability *C. tentaculata* of Canavan is a new species for which the name *C. americana* is proposed. In support of this view Travassos (1922) in a footnote says it is not improbable that the worm recorded from *D. virginiana* in North America is different from the South American species.

Type specimens of *Cruzia orientalis* from the caecum and large intestine of the domestic pig are in the Indian Museum, Calcutta.

The following table gives the principal differences between the various species of the genus *Cruzia*.

TABLE 1.

	C. tentaculata.	*C. mexicana.*	*C. orientalis.*	*C. americana.*
Length, males and females	8—16	10·5—12·5	13—17·9	9—11
Pharynx, length	0·106—0·156	0·172	0·240—0·320	0·180
No. rows teeth	12—15	?	19—22	..
Oesoph. length	1·0—1·9	1·43—1·52	2·34—2·95	..
Oesoph. bulb diameter	0·31—0·48	0·27—0·3	0·28—0·38	..
Diverticulum, length	0·9—1·2	0·7	1·09—1·96	1·07
Distance from anus to tip of tail, female.	0·8—1·0	0·78	0·69—0·71	0·8
Spicules, length	0·87—1·165	0·81	0·86—1·03	0·93—0·96
Gubernaculum, length	0·197—0·243	0·12	0·180—0·220	0·13
Eggs	0·120 × 0·056—0·063	0·065—0·049	0·120 × 0·056—0·060	..
Pairs of papillae—				
Preanal	3	2	3	3
Adanal	3	3	3	3
Postanal	3	5	4	3

NOTE.—In this and all other tables in the paper the measurements are in millimetres,

Arduenna strongylina (Rudolphi, 1819).

This species was found in the stomachs of twenty-five out of forty-nine pigs, and a total number of over three hundred worms was recovered. Although all the specimens were examined none approaching the size of the larger species *A. dentata* (v. Linstow, 1904) were found. There seems, however, to be some slight disagreement amongst various workers regarding the arrangement of the caudal papillae in the male.

In Yorke and Maplestone (1926) the figure of the tail of *A. strongylina* shows four pedunculated papillae on the right side, fairly close together in a single line some distance in front of the cloaca, and on the left side the papillae are in two pairs somewhat widely separated. They also show three pairs of small papillae on the ventral surface of the tail. In

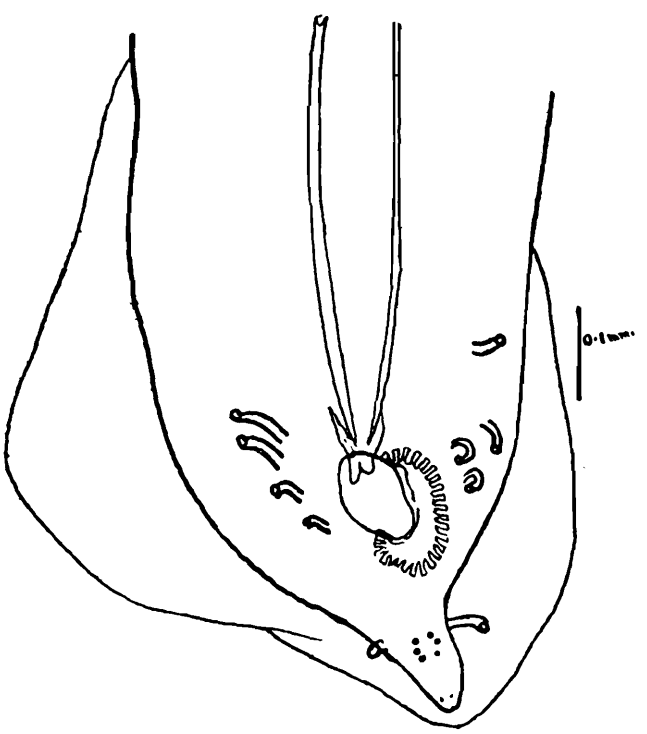

FIG. 5.—*Arduenna strongylina.* Tail of male, ventral view.

Baylis (1929) the drawing by Foster shows four pedunculated papillae much nearer the cloaca on both sides of the tail, and he does not indicate any small papillae on the tip of the tail at all. In figure 5 I have shown the condition present in my examples and it will be seen that the four papillae on the right side of the cloaca are in a row and quite close to it, and on the left side there is a group of three papillae opposite the cloaca with a single papilla somewhat further forward, while on the ventral surface of the tail proper there are four pairs of small papillae. This arrangement of papillae was observed in two specimens in which the tail was cut off for examination. The only papillae regarding which all are in agreement are the pair of pedunculated papillae situated behind the cloaca. The most reasonable explanation of this disagreement seems to be that the caudal papillae of this species are subject to a certain amount of variation.

Physocephalus sexalatus (Molin, 1860).

Specimens of this worm were found in the stomachs of twenty-six out of forty-nine pigs, and a total of over three hundred and fifty worms were examined.

The size of the worm given by Baylis (1929) is, male 6—13 mm. in length, and female 13—22·5 mm. in length. In the present collection fifteen mature female worms were found about 9 mm. in length. Detailed examination of these small specimens revealed no difference except that of size between them and the larger specimens, and the eggs they contained were of the normal dimensions. Another point is that no males of a correspondingly small size were found, therefore, it is considered that the range of size for mature females of *P. sexalatus* should be extended to 9—22·5 mm.

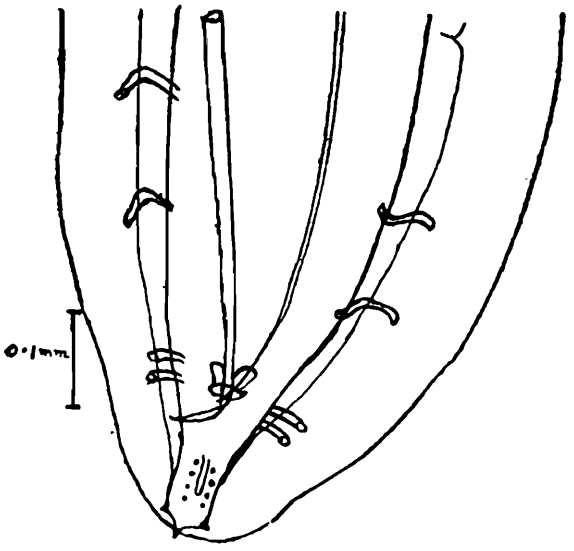

FIG. 6.—*Physocephalus sexalatus*. Tail of male, ventral view.

Baylis (1929) gives the dimensions of the eggs as 0·034—0·039 mm. by 0·015—0·017 mm., but eggs, containing embryos, taken from worms of the present material were more uniform in size and slightly smaller, measuring 0·031—0·033 mm. by 0·014—0·016 mm.

A drawing of the tail of the male has been included because none appears to be readily available, there being none in Baylis' book, and the actual appearance of the papillae is not what one would anticipate from his written description, which is as follows. " The male has four pairs of pedunculate preanal papillae and four pairs of shorter postanal papillae." The following is the description of the papillae derived from the examination of several specimens in which no variation was noted. The caudal papillae of the male consist of two pairs of pedunculate papillae on each side. One pair are fairly widely separated and lie some distance in front of the cloaca, the other pair are close together and are on a level with the cloaca. On the ventral surface of the narrow tail there are two rows of small papillae with a raised elongate oval structure between them. The tip of the tail ends in a sharp cuticular point, which projects beyond the end of the caudal alae ; and a little in front of the tip, where an angle is formed on each side by the sudden narrowing of the tail, there is a small sharp papilla (fig. 6).

Gnathostoma doloresi Tubangui, 1925.

Tubangui (1925) described *Gnathostoma doloresi*, a new species from the pig in the Philippine Islands, but he had no males in his collection. This worm is probably a fairly common parasite of pigs in the East for it was found eleven times in the stomachs of forty-nine pigs examined by me. Only one or two worms as a rule were present in each case and they were never together in one cavity as is the case with *G. spinigerum* in cats, where frequently several worms are found living in a single large thick-walled cyst. But even the small number of *G. doloresi* present must be very serious, even if not at times fatal, to their hosts as the worms cause extensive damage to the stomach wall in which they burrow deeply. Altogether ninteen mature females, seven males, and one immature female were obtained.

The males and females are similar in general appearance as the tails of both sexes curve ventrally (fig. 7). The males are smaller than the females, but this is not a certain point of distinction, because there is considerable variation in the size of both sexes so that the largest males are bigger than the smallest females. The cuticular inflation begins about the junction of the anterior and middle-thirds and it is more marked on the dorsal surface. The head bulb is surmounted by two lateral deeply trilobed lips and there are two papillae on each side of the head near its anterior border. The head bulb is armed with ten rows of backward-curving hooks ; this number of rows seems to be constant for the species, for there were ten rows in all the present specimens, and Tubangui gives the same number in his description. The body spines are essentially as Tubangui describes them, but very few with as many as seven points were seen. It is not quite correct to describe the spines of the anterior rows as having the maximum number of points ; a more accurate description is, that the first two or three rows contain spines with three or four points only ; proceeding posteriorly the number of points gradually but irregularly increases until the maximum number is reached about opposite the level of the cervical papillae, which lie about the fifteenth to the eighteenth rows of spines from the anterior end. Immediately after the cervical papillae are passed the spines become three-pointed again, with a long central point and two small lateral points. The lateral points gradually diminish as one proceeds posteriorly until they finally disappear, and the single-pointed spines become narrower and narrower until they are eventually replaced by fine hair-like spines, which continue to the extreme posterior end of the worm.

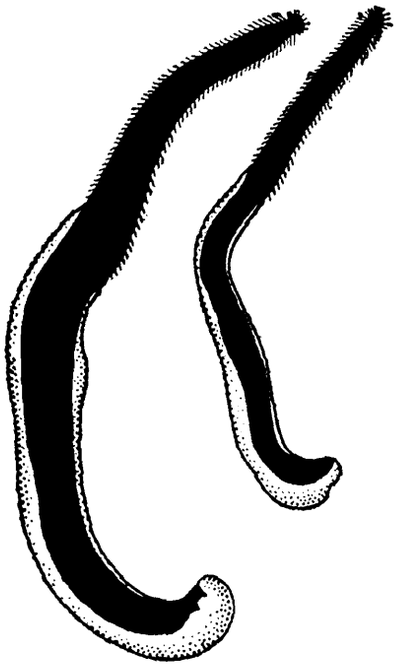

FIG. 7.—*Gnathostoma doloresi.* From a photograph of a male and female. Approximately twice natural size.

The internal anatomy of the worm is quite typical of the genus and as it has been already described by Tubangui (1925) it is not proposed to repeat it here.

Male.—The tail of the male curves ventrally, and owing to its great thickness it cannot be properly examined without cutting it off (fig. 8).

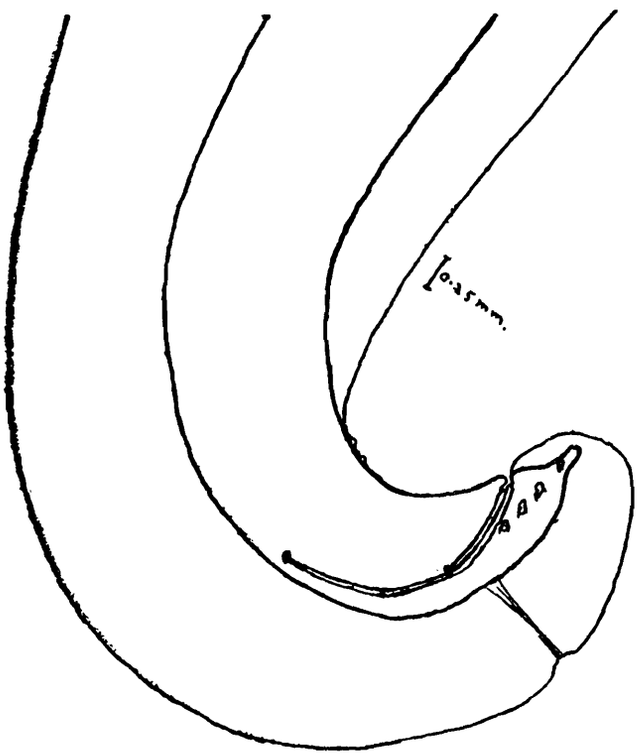

FIG. 8.—*Gnathostoma doloresi.* Tail of male, lateral view.

The ail bears a pair of narrow caudal alae supported by four very thick pedunculate papillae on each side, and there are two smaller additional papillae on each side between the bases of the second and third, and third and fourth pairs of large papillae, and there are two crescentic prominences behind the cloaca (fig. 9). This portion of the worm is

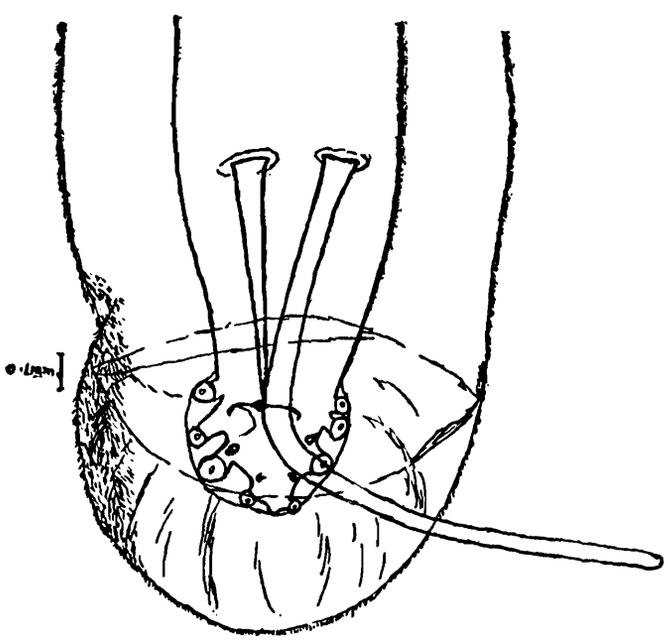

FIG. 9.—*Gnathostoma doloresi.* Tail of male, ventral view. The spines, which cover the entire surface, are only shown on the left side.

very similar to that of *G. spinigerum*, except that it is much larger and the tail is surrounded by the large cuticular inflation. The spicules are stout, curved, and unequal and they taper evenly from base to tip, ending

in blunt points. In cross section the spicules are seen to be circular, and to consist of a central core surrounded by a clear chitinous layer. There is no gubernaculum.

Female.—Tubangui (1925) has already described the female of this species from the four specimens that he had at his disposal, so I will not repeat it in detail here. Although his description of the tail, *viz.*, " Tail rounded with two terminal papillae " agrees fairly well with the appearance of my material, Tubangui's drawing of this portion of the worm shows three small points of equal size. The two appearances of the female tails as seen by me are depicted in figs. 10 and 11, the differences being apparently due to whether the tail is lying flat or whether the

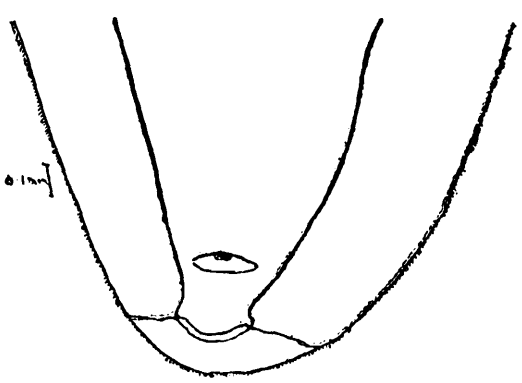

FIG. 10.—*Gnathostoma doloresi.* Tail of female, ventral view. The tail is flattened out.

lateral borders are rolled in a little on each side. The lateral view of the tail shows a deep sulcus in the cuticular inflation giving access to the anus (fig. 12).

Tubangui gives the length of the female worm as 30—41 mm. In my material there appear to be two distinct size strains of the worm, which are otherwise identical. Thirteen of the females were obtained from eight pigs and they varied from 43—52 mm. in length, and in one of the above pigs four females were accompanied by two males which measured 35 and 38 mm. in length respectively. In the other six cases in which worms were found six females, although mature, only measured 27—31 mm. in length, and the five males accompanying them were 19·7 to 21 mm. in length. In no instance were small and large worms found in the same pig. Tubangui gives the size of the eggs as 0·06—0·063 by 0·037 mm., whereas the eggs removed from the uterus of a large female of my collection measured 0·064—0·067 mm. by 0·031—0·34 mm., and in the smaller females the eggs measured 0·052—0·060 by 0·031—0·033 mm. The eggs from both small and large worms were of the same type as in Tubangui's specimens with a thickened cap at each pole, and they contained a segmented morula. This state of development applies to eggs at the time they are deposited, for one undamaged female was found with some eggs adhering to the external surface near the vulva.

The finding of two distinct sizes of worms in different pigs and the fact that small and large worms were never found together in the same host at first suggests that two species are being dealt with. But the measurements given by Tubangui for the females come exactly in the gap left between the small and large worms of my material; it is true that there are differences in the sizes of the eggs but they are not

considered of sufficient magnitude to use as a specific character. Considerable differences occur in the eggs of *G. spinigerum*, for I have found the eggs of this species to measure 0·064—0·068 by 0·032—0·036 mm., whereas Baylis and Lane (1920) give the dimensions as 0·060 by 0·035

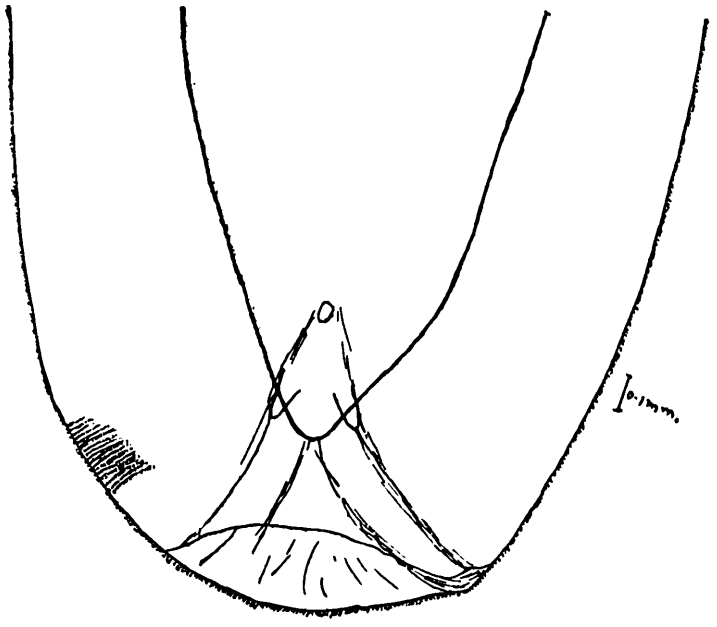

Fig. 11.—*Gnathostoma doloresi*. Tail of female, ventral view. The tip of the tail is rolled slightly inwards laterally.

mm. and Heydon (1929) finds they are 0·065 by 0·037 mm., therefore it is obvious that slight differences in size of eggs cannot be utilised as a specific character in this genus. In the males it was found that the spicules were of the same length in both the small and large specimens. In view of the above facts it is considered that *G. doloresi* is a species that shows considerable size variation.

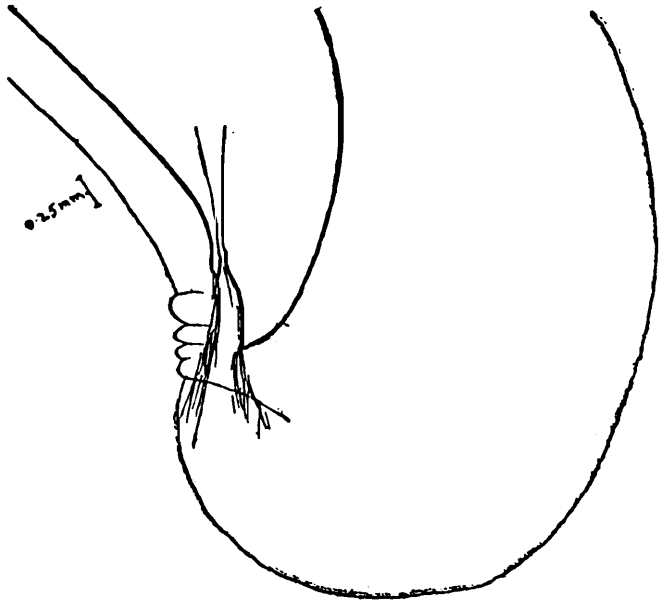

Fig. 12.—*Gnathostoma doloresi*. Tail of female, lateral view.

Heydon (1929) disagrees with Chandler (1925) and Baylis and Lane (1920) who stated that the eggs of *G. spinigerum* contain larvæ while

still in the uterus of the parent worm. I am able to support Heydon's contention regarding *G. doloresi*, because the eggs found adhering to the external surface of an undamaged female were only in the stage of early segmentation.

Specimens of *Gnathostoma doloresi* Tubangui, 1925, and the type of the male of this species are in the Indian Museum, Calcutta.

TABLE 2.

Dimensions given by Tubangui compared with the dimensions of my large and small worms.

	Tubangui, female.	Large worms.		Small worms.	
		Male.	Female.	Male.	Female.
Length	30—41	35—38	43—52	20—21	27—31
Max. diameter of worm.	..	1·4—1·66	2·6—2·8	0·9—1·2	1·3—1·5
Diameter of inflation.	3·14—3·37	1·7—2·6	2·7—4·9	1·1—1·76	1·46—2·02
Head bulb length	0·4—0·46	..	..	0·317	0·356—0·396
Diameter	0·75—0·85	0·693	0·891—1·01	0·634	0·772—0·832
Dist. from ant. end to nerve ring.	0·75	..	1·38	0·832	1·04
Oesophagus length	6—7	..	..	3·9	5·7
Dist. anus to tip of tail.	..	..	0·336	..	..
Vulva to tip of tail.	Behind middle	..	16—19	..	10·4—10·9
Spicules, length.	..	1·85—2·07 0·64—0·66	..	1·85—2·08 0·6—0·7	..
Eggs	0·06—0·063 × 0·037	..	0·064—0·067 × 0·31—0·034	..	0·052—0·06 × 0·033—0·031

Oesophagostomum dentatum (Rudolphi, 1803).

This species was found in eighteen out of forty-nine pigs examined. The number of worms was never great, as only eighty-four females and eighteen males were found altogether.

Oesophagostomum longicaudum Goodey, 1925.

The difference between this species and *O. dentatum* was not recognised at first, so that it is impossible to say how many pigs carried this parasite, but five males and seventy-one females were found among the collection originally labelled *O. dentatum*, and as there were eighteen males and eighty-four females of the latter species it is probable that *O. longicaudum* is nearly as common as *O. dentatum* in India.

In his description of *O. longicaudum*, Goodey (1925) says that the leaf crowns are exactly the same as in *O. dentatum*, although he recognises the different shape of the buccal capsule. It is true that the elements of the leaf crowns have the same number in both species, but their attachment to the buccal capsule is different. In optical section the buccal capsule of *O. dentatum* appears as a more or less rectilinear body with rounded extremities, and both leaf crowns arise from near the posterior ends of the inner surface and sweep inwards and forwards from this point. Optical section of the buccal capsule of *O. longicaudum* shows it to be larger than the capsule of *O. dentatum*, and its posterior ends are more widely separated than its anterior ends. From the anterior end a hook-like process extends inwards and backwards; this process is of course a circular ridge projecting into the lumen of the capsule. The leaf crowns arise from near the posterior end of the inner border of the buccal capsule, and from here they pass inwards and forwards to come in contact

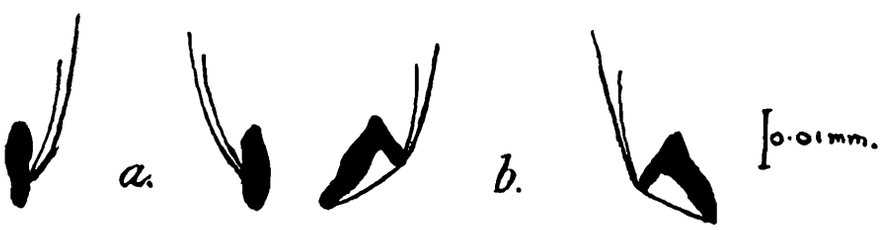

FIG. 13.—(*a*) *Oesophagostomum dentatum.* (*b*) *Oesophagostomum longicaudum.* Optical section of mouth capsules showing origin of leaf crowns.

with the edge of the anterior ridge, and it is only anterior to this point that the elements of the two leaf crowns are distinct from each other (fig. 13). The internal diameter of the buccal capsule of *O. dentatum* varies from 0·036—0·042 mm., and is uniform for the whole of its depth, whereas the internal diameter of the buccal capsule of *O. longicaudum* is 0·040—0·044 mm. at its anterior end and 0·056—0·064 mm. at its posterior end. These differences in the buccal capsules of the two species are quite distinctive and are readily recognised when they are once appreciated.

Goodey only had a few immature specimens of *O. longicaudum* to examine, and they were among a collection of *O. dentatum* which were also immature, so he expresses the view that his measurements of the new species are probably smaller than the corresponding dimensions would be in adult worms, but from the following table 3, in which the measurements of the species given by Goodey (1924 and 1925) and those found by me in the present collection are compared, it is seen that Goodey's measurements for the new species are correct for mature worms.

Goodey notes that the handle of the gubernaculum in *O. longicaudum* is shorter than it is in *O. dentatum* in relation to the length of the blade, the two portions being approximately in the proportion of 1 : 2 in the former and of 1 : 1 in the latter. This was found by me to be substantially correct, but there was a considerable degree of variation in the two measurements, which made this character unreliable. The total length of the gubernaculum was found, however, to be a more reliable guide, because in *O. longicaudum* it varied between 0·104—0·120 mm. with an average of 0·114 mm., and in *O. dentatum* it varied between 0·116—0·136 mm. with an average of 0·129 mm., there thus being very little overlapping in the two species.

I have measured twenty females of *O. longicaudum* and forty females of *O. dentatum*. The worms of the first species varied between 8·33—10·36 mm. in length, and among them three worms, containing eggs, were found which measured 9·06—9·74 and 10·36 mm. in length. The forty specimens of *O. dentatum* varied between 9·69—14·48 mm. in length, six of these worms were below 9·89 mm. in length and did not contain eggs, but the one next in size, which was 10 mm. in length, contained eggs as did the remaining thirty-three worms which were longer than this. Apparently female *O. dentatum* reach maturity when about 10 mm. in length and this is a fairly well defined point, but in the case of *O. longicaudum* such a clear demarcation between immature and mature females does not seem to exist, for between the two mature worms, which were 9·06 and 9·74 mm. in length, there were four specimens intermediate in size which did not contain eggs, and also between the worms which were 9·74 and 10·36 mm. in length there were four specimens with no eggs in the uterus.

The distance from vulva to anus, and from the anus to the tip of the tail is greater in *O. longicaudum* than it is in *O. dentatum*. Goodey, who only had a few immature *O. longicaudum* to examine, gives the distance from vulva to anus as 0·46—0·40 mm., and the distance from anus to tip of tail as 0·38—0·46 mm., whereas the same author gives the corresponding dimensions of *O. dentatum* as 0·35 and 0·36—0·38 mm. respectively. With a larger number of worms, some of which were mature, I have found the distance from vulva to anus to be 0·41—0·52 mm., and from anus to tip of tail to be 0·36—0·37 mm. in *O. longicaudum*, and the corresponding measurements in *O. dentatum* were 0·28—0·39 mm. and 0·25—0·43 mm. respectively. If these two measurements are added together and the distance from the vulva to the tip of the tail is thus given, the difference is even more striking, for a shorter distance from vulva to anus is often compensated for by a longer tail and *vice versâ*, it is thus found that in *O. longicaudum* the distance from the vulva to the tip of the tail is 0·812—0·990 mm., and in *O. dentatum* it is 0·534—0·792 mm., so that it appears that this measurement in *O. longicaudum* is always greater than 0·800 mm. and in *O. dentatum* it is always less than 0·800 mm.

The eggs of *O. longicaudum* removed from the uterus of a single female were 0·048—0·052 by 0·028—0·031 mm., and those of *O. dentatum* measured at the same time were found to be 0·070—0·074 by 0·040 mm.

TABLE 3.

Comparison between my and Goodey's measurements for the two species O. dentatum and O. longicaudum.

	O. dentatum Goodey (1924)	My *O. dentatum*	*O. longicaudum* Goodey (1925)	My *O. longicaudum*
Length—				
Male	8—10	8·38—10	8—10	6·56—8·85
Female	11—14	9·69—14·48	..	8·33—10·36
Diameter of buccal capsule	..	0·036—0·042	..	Ant. 0·04—0·044 Post. 0·056—0·064
Spicules, length . .	1·15—1·3	1·15—1·32	0·9—0·95	0·78—0·88
Gubernaculum, length .	0·14	0·116—0·136	..	0·104—0·120
Vulva to anus	0·36—0·38	0·28—0·39	0·46—0·46	0·41—0·52
Anus to tip of tail . .	about 0·35	0·25—0·43	0·36—0·38	0·36—0·47
Vulva to tip of tail . .	..	0·53—0·79	..	0·81—0·99
Eggs	0·07—0·074 × 0·04—0·042	0·07—0·074 × 0·04	..	0·048—0·052 × 0·028—0·031

Comparison between Goodey's measurements and those taken by me and given in the above table clearly shows that although Goodey was only dealing with immature material the dimensions he gives are essentially correct. *O. longicaudum* has only been recorded once before in a pig in New Guinea, and on this occasion it was mixed with *O. dentatum*. As it has now been found in Inda, also in company with *O. dentatum*, it seems probable that more careful examination of collections of *O. dentatum* in other parts of the world will reveal the presence of *O. longicaudum* among them.

Oesophagostomum conicum, n. sp.

This worm was found in nine out of forty-nine pigs but it was never present in large numbers as only seven males and seventy females were found altogether. It was present in the caecum and large intestine.

The external appearance of the anterior end is quite distinctive as the worm is relatively broad in proportion to its length ; it tapers towards the anterior end from about the level of the cervical papillae, and there is no distinct mouth collar (figs. 14 and 15). There are three papillae on each side of the mouth, but the sub-dorsal and sub-ventral papillae are only very slightly more prominent than the lateral papillae. The ventral cervical groove is deep and the anterior cuticular lip of the groove overhangs it (fig. 15). It is situated relatively far forward, being well

in front of the narrowest part of the oesophagus. The cervical papillae are slightly asymmetrical and are situated opposite where the oesophagus commences its posterior bulbar enlargement (fig. 14).

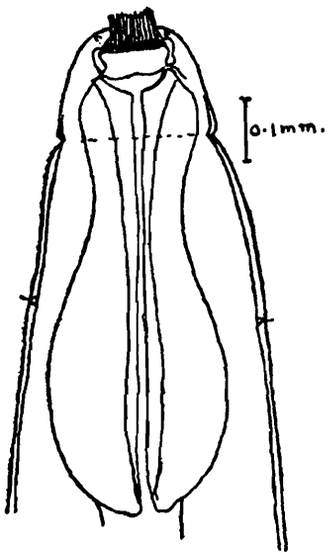

FIG. 14.—*Oesophagostomum conicum*, n. sp. Anterior end, dorso-ventral view.

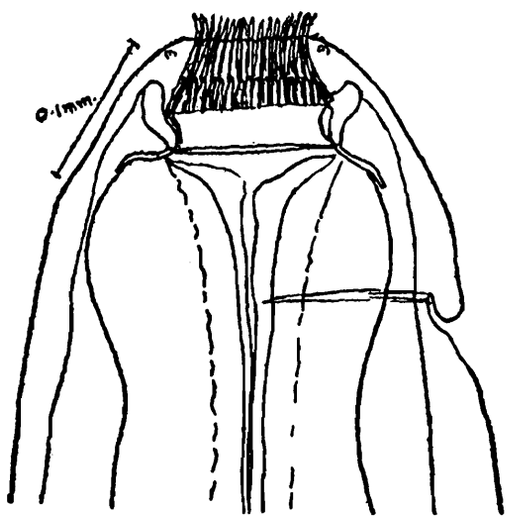

FIG. 15.—*Oesophagostomum conicum*, n. sp. Anterior end, lateral view.

The buccal capsule is relatively broad and massive compared with most other members of the genus. It is circular in outline (fig. 16) and in optical section it is comma-shaped with the broad end anterior (fig. 15). There is a distinct groove encircling its innner surface slightly anterior to the middle, from which both leaf crowns appear to arise. The leaf crowns each consist of thirty elements. The anterior end of the oesophagus is surmounted by a thin plate of chitin, which in optical section appears as a tail-like extension of the comma-shaped capsule

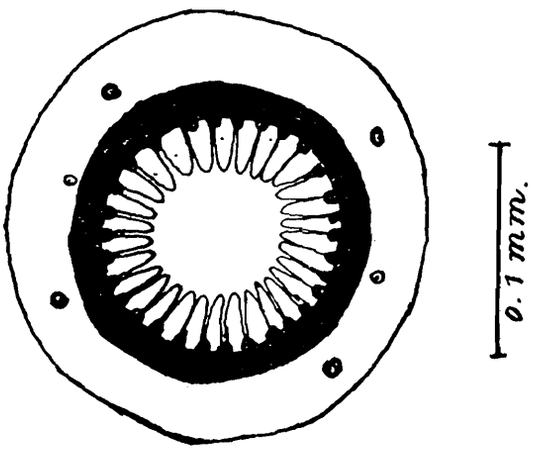

FIG. 16.—*Oesophagostomum conicum*, n. sp. Buccal cavity, end on view.

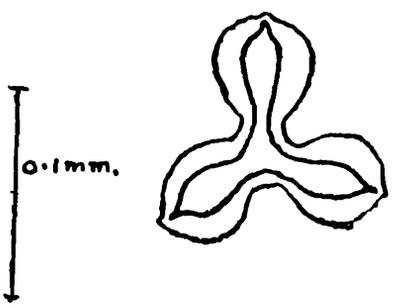

FIG. 17.—*Oesophagostomum conicum*, n. sp. Anterior end of oesophagus, end on view.

(fig. 15). The oesophagus is relatively broad with a distinct oesophageal funnel. The inner surface of the oesophagus has a chitinous lining

throughout its length, and in the region of the funnel there are three chitinous ridges projecting into its lumen (fig. 17).

Male.—The bursa conforms to the type for the genus, but the tips of the ventral rays project slightly beyond its edge and the dorsal ray shows a considerable degree of individual variation (figs. 18 and 19). The edge

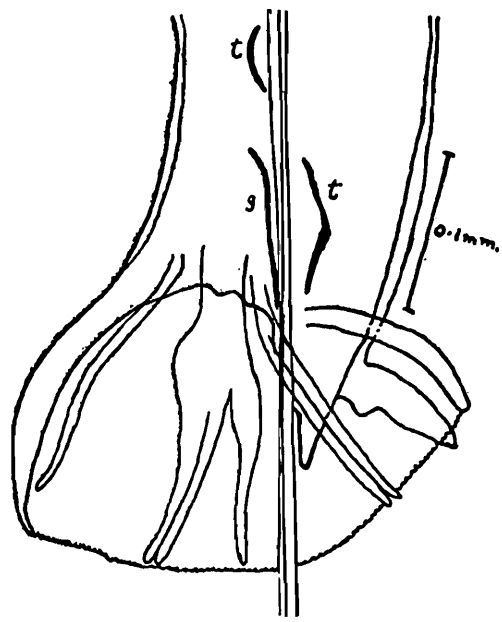

Fig. 18.—*Oesophagostomum conicum*, n. sp. Tail of male, lateral view.

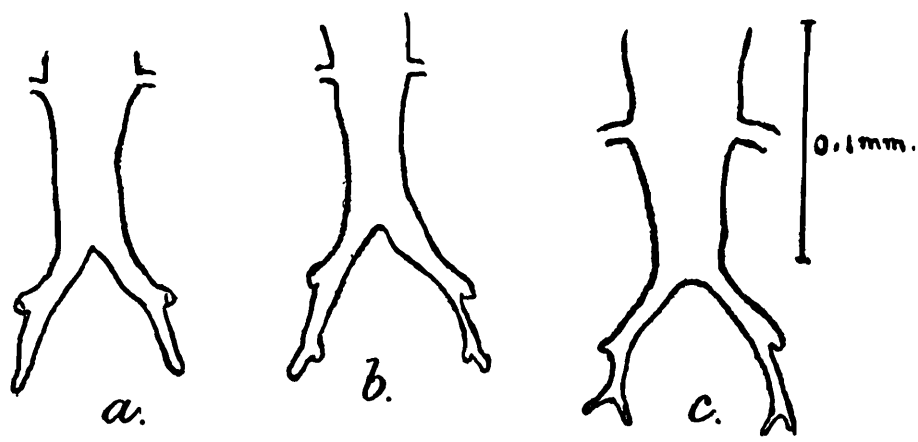

Fig. 19.—*Oesophagostomum conicum*, n. sp. Dorsal ray, showing variation in branching of tips.

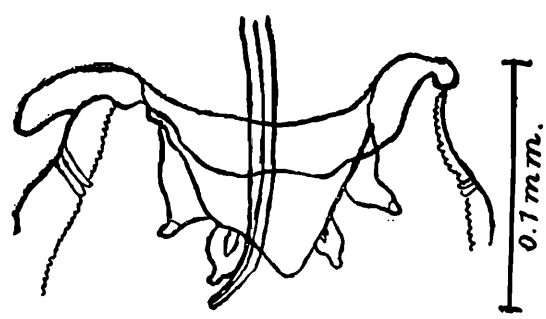

Fig. 20.—*Oesophagostomum conicum*, n. sp. Genital cone, male.

of the bursa is finely serrated, each serration corresponding with a striation on the bursa. The ventral genital cone consist of a central triangular lobe with two long fleshy papillae on each side of it (fig. 20). The

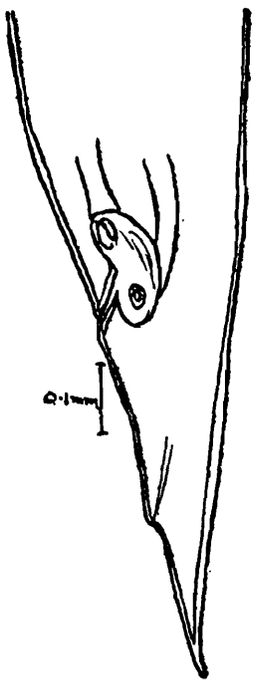

FIG. 21.—*Oesophagostomum conicum*, n. sp. Tail of female, lateral view.

gubernaculum and spicules are of the usual type, and the telamon is well developed, the parts of it which are easily made out being a curved piece on the dorsal side of the spicules anterior to the gubernaculum, and an angular chitinous plate opposite the gubernaculum on the ventral side of the spicules (fig. 18).

Female.—The posterior end of the female is straight and tapering, similar to that of *O. dentatum*, except that the distances between the vulva and anus, and anus and tip of tail are different in this species. There is a short vagina running inwards and forwards to end in a kidney-shaped ovejector, very similar to that of *O. dentatum* (fig. 21).

Type specimens of *O. conicum*, n. sp. are in the Indian Museum, Calcutta.

Oesophagostomum suis, n. sp.

This species was by far the commonest of all the Oesophagostomes present in the pigs examined, as it was found in forty-three out of forty-

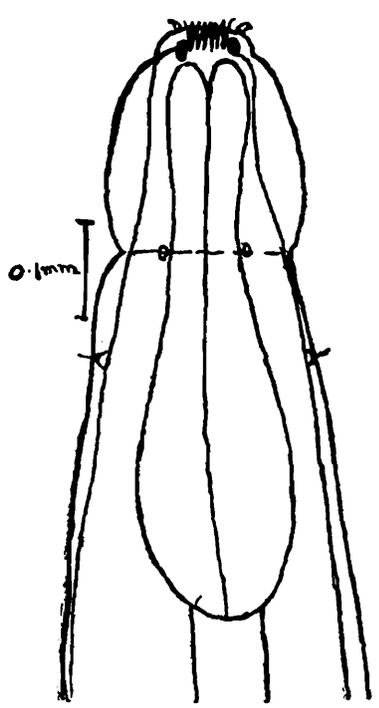

FIG. 22.—*Oesophagostomum suis*, n. sp. Anterior end, dorso-ventral view.

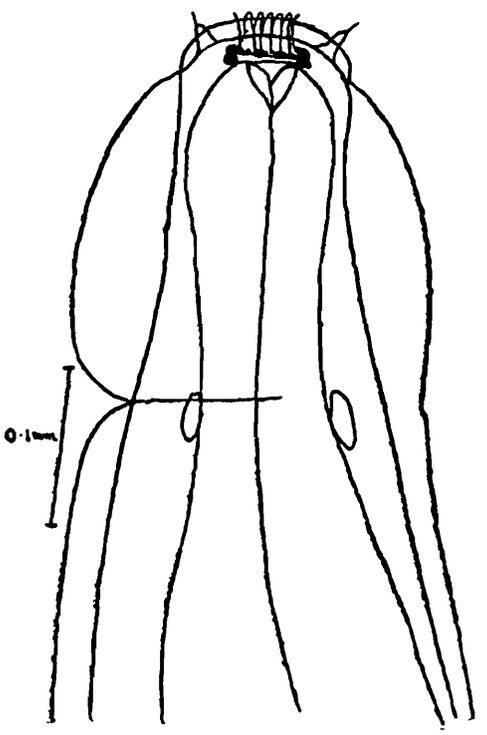

FIG. 23.—*Oesophagostomum suis*, n. sp. Anterior end, lateral view.

nine animals. It was in the usual site for this genus, *viz.* the caecum and large intestine, and many hundreds of specimens were recovered.

In external appearance the anterior end of the worm is very like that of *O. dentatum* (figs. 22 and 23). The cephalic papillae on each

side of the mouth are similar to those of *O. dentatum*. The nerve ring and excretory pore are opposite the cervical groove, and the cervical papillae are symmetrically placed, slightly more anteriorly than they are in *O. dentatum*, in relation to the posterior oesophageal bulb and the cervical groove (fig. 22). The buccal capsule and its appendages are quite characteristic and distinct from those of *O. dentatum*.

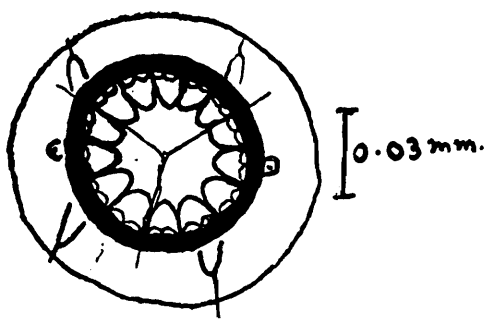

FIG. 24.—*Oesophagostomum suis*, n. sp. Buccal cavity, end on view.

In optical section the capsule presents a slightly irregular outline due to two grooves which encircle it, one on the inner surface and one on the outer surface about its centre. The two leaf crowns arise from the internal surface of the capsule at the level of the groove, the elements of the external numbering fourteen and of the internal twenty-eight (fig. 24). The oesophagus is of the typical shape for the genus and it is slightly expanded anteriorly. There is a definite oesophageal funnel at the anterior end, which is lined with chitinous material (fig. 23).

Male.—The male characters are typical of the genus and, therefore, call for little special description. The spicules and gubernaculum are of the usual type, and the telamon does not seem to be very well-developed, as all that could be seen of this structure was a faintly chitinized bar in the ventral wall of the spicule canal opposite the gubernaculum (fig. 25).

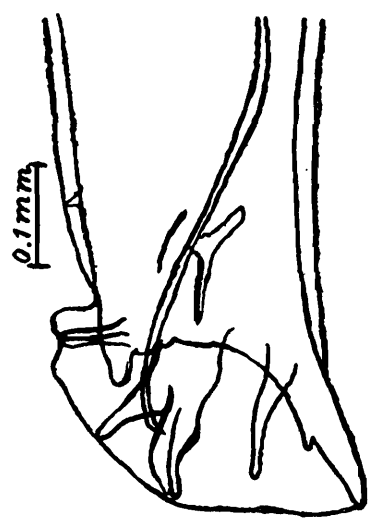

FIG. 25.—*Oesophagostomum suis*, n. sp. Tail of male, lateral view.

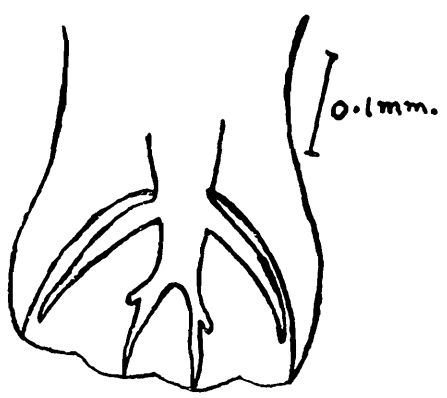

FIG. 26.—*Oesophagostomum suis*, n. sp. Dorsal ray.

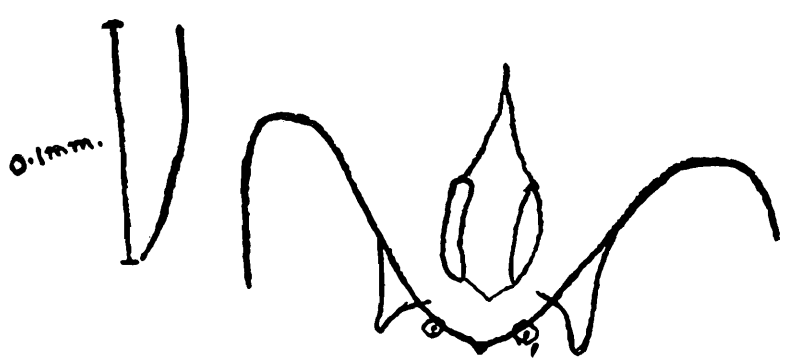

FIG. 27.—*Oesophagostomum suis*, n. sp. Genital cone, male.

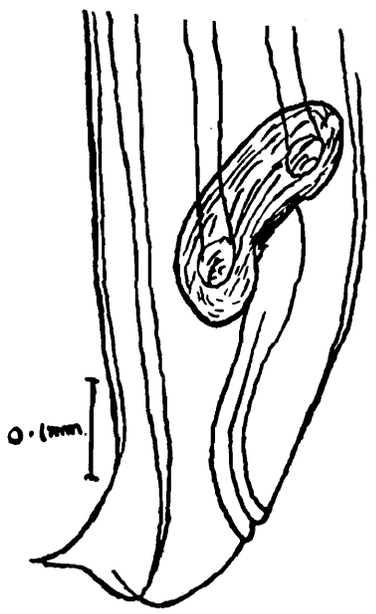

FIG. 28.—*Oesophagostomum suis*, n. sp. Tail of female, lateral view.

The ventral genital cone consists of a central broadly rounded body ending in a fine tip, and on each side there is a large conical fleshy papilla and a small rounded papilla more centrally placed (fig. 27).

Female.—The tail of the female is very characteristic as the ventral surface begins to curve dorsally immediately behind the vulva, so that the anus is only very slightly posterior to but a considerable distance dorsal to this opening. The dorsal curve continues behind the anus and the tail ends in a sharp point which is directed dorsally (fig. 28). The vagina is relatively long and it runs forwards to end in a typically kidney-shaped ovejector which receives the two uterine tubes.

Type specimens of *Oesophagostomum suis* have been placed in the Indian Museum, Calcutta.

TABLE 4.

Dimensions of the two new species O. suis and O. conicum.

	O. suis.		*O. conicum.*	
	Male	Female	Male	Female
Length	6·87—8·75	8·85—11·4	6·87—7·91	8·2—9·1
Diameter	0·297	0·375—0·475	0·317—0·336	0·455—0·495
Cervical groove from ant. end	0·237	0·218—0·237	0·158—0·164	0·158—0·178
Cervic. papillae from ant. end	0·360	0·328—0·376	..	0·460—0·480
Diameter of buccal capsule	0·04—0·044	..	0·080	0·082
Depth of buccal capsule	0·016	0·016	0·040	0·040
Oesophagus, length	..	0·436—0·495	..	0·673—0·713
Gubernaculum length	0·122	..	..	..
Spicules, length	1·3	..	0·832	..
Vulva to anus	..	0·614—0·792	..	0·317—0·356
Anus to tip of tail	..	0·356—0·515	..	0·237—0·257
Vagina, length	..	0·218—0·257	..	0·060—0·064
Eggs	..	0·056—0·060 × 0·028—0·033	..	0·060—0·032

Bourgelatia diducta Railliet, Henry and Bauche, 1919.

This worm was very common, being present in large numbers in forty-two out of forty-nine pigs and a total number of many hundreds of specimens were recovered.

Examination of the ample material demonstrate that the original description is somewhat inadequate, so a redescription is given below.

There are three papillae on each side of the mouth, the lateral pair being larger than the four sub-ventral papillae. The buccal capsule is large and is composed of two separate rings of chitin. In optical section the posterior ring of the capsule appears large and thick and there is a notch on its antero-internal surface into which the smaller anterior ring

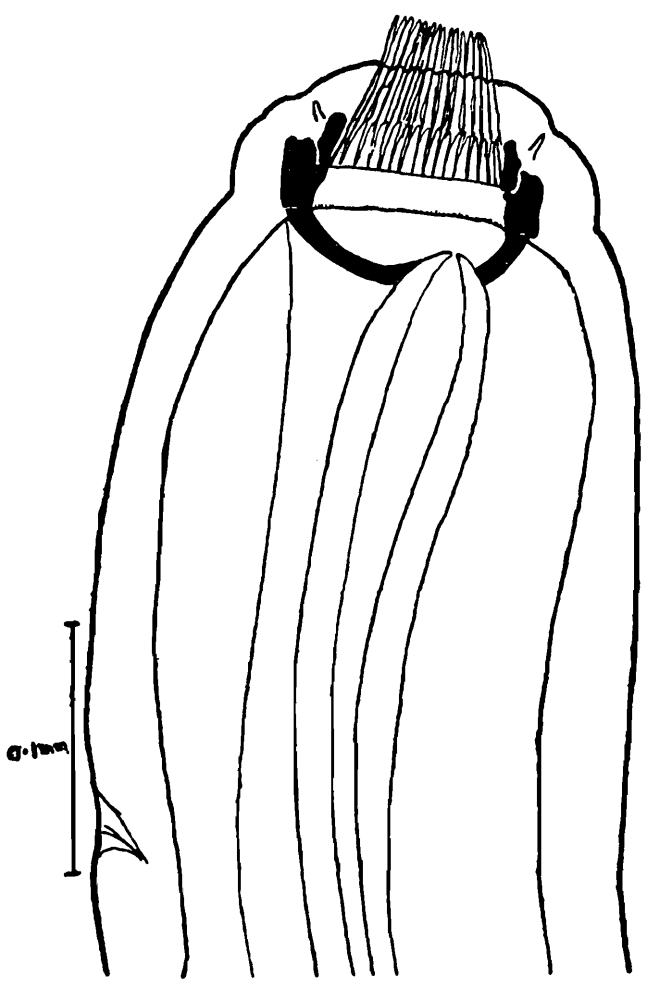

FIG. 29.—*Bourgelatia diducta.* Anterior end, lateral view.

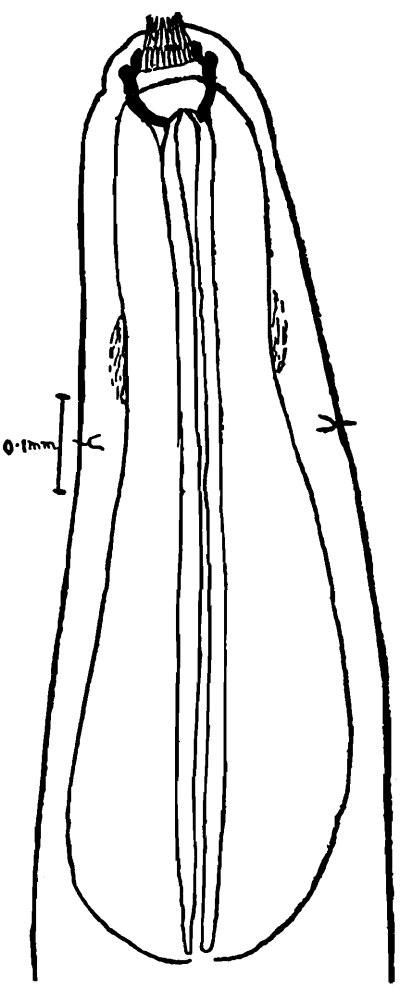

FIG. 30.—*Bourgelatia diducta.* Anterior end, dorso-ventral view.

fits (fig. 29). There are two leaf crowns which appear to arise from the projecting edge of the notch on the posterior ring of the capsule (fig. 29). There are twenty-one elements in the external leaf crown and at its origin from the capsule the internal leaf crown consists of the same number of elements, but the tips of the internal crown are bifid. This character can only be appreciated if an anterior view of the mouth is obtained (fig. 31). Seen from this aspect it is noted that the buccal capsule is more or less divided into twenty-one portions corresponding with the origins of the external leaf crown. These portions are marked by a groove on the external surface from which a faint line runs centrally

through the thickness of the capsule wall. Each element of the internal leaf crown appears to arise from two almond-shaped pieces of chitin, which lie partly embedded in the wall of the buccal capsule and partly projecting from its inner surface (fig. 31).

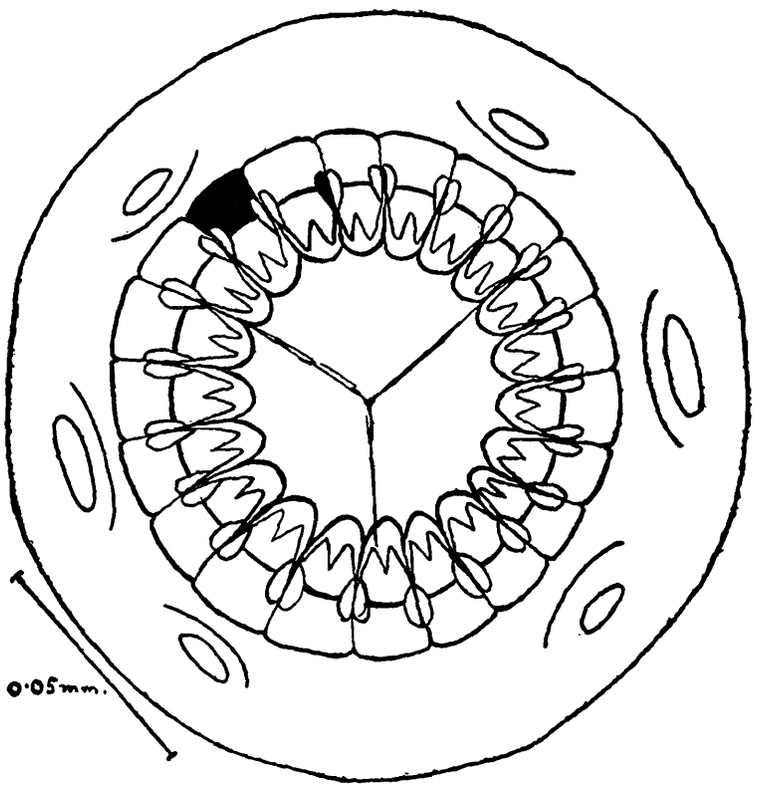

FIG. 31.—*Bourgelatia diducta.* Buccal cavity, end on view. A single section of the internal and external portions of the capsule is darkened.

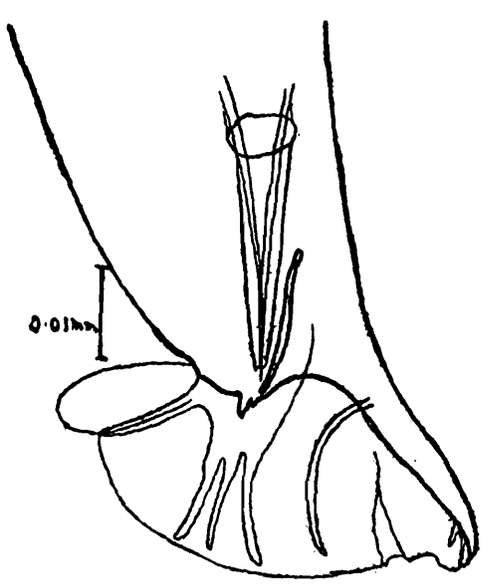

FIG. 32.—*Bourgelatia diducta.* Tail of male, lateral view.

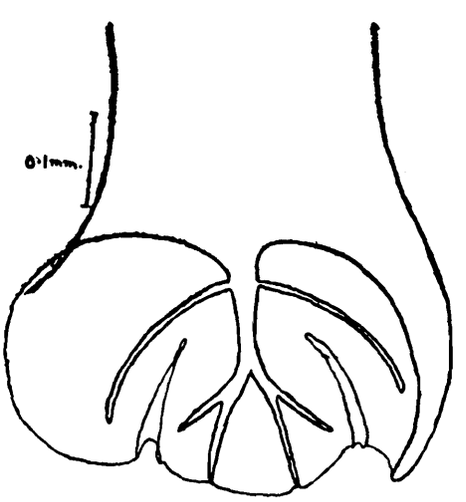

FIG. 33.—*Bourgelatia diducta.* Dorsal ray.

The oesophagus is lined for its whole length by a thick chitinous layer. Anteriorly this oesophageal lining projects in the form of a cone into the extremely broad oesophageal funnel (figs. 30 and 31). The opening of the oesophagus into the funnel is much nearer the dorsal than the ventral surface (fig. 29).

Male.—The tail of the male is surrounded by a bursa the rays of which present the same formula as in the genus *Oesophagostomum* (figs. 32 and 33). The bursa itself, however, has special characters. Where the tips of the ventral rays reach the edge of the bursa there is a deep notch which divides off a small ventral lobe on each side, and there are two deep folds in the bursal membrane between the dorsal ray and the externo-dorsal rays on each side, which differentiate a dorsal lobe from the lateral lobes (figs. 32 and 33).

FIG. 34.—*Bourgelatia diducta.* Genital cone, male.

The ventral genital cone consists of a long central pointed structure with a large papilla on each side of its base (fig. 34). The spicules appear

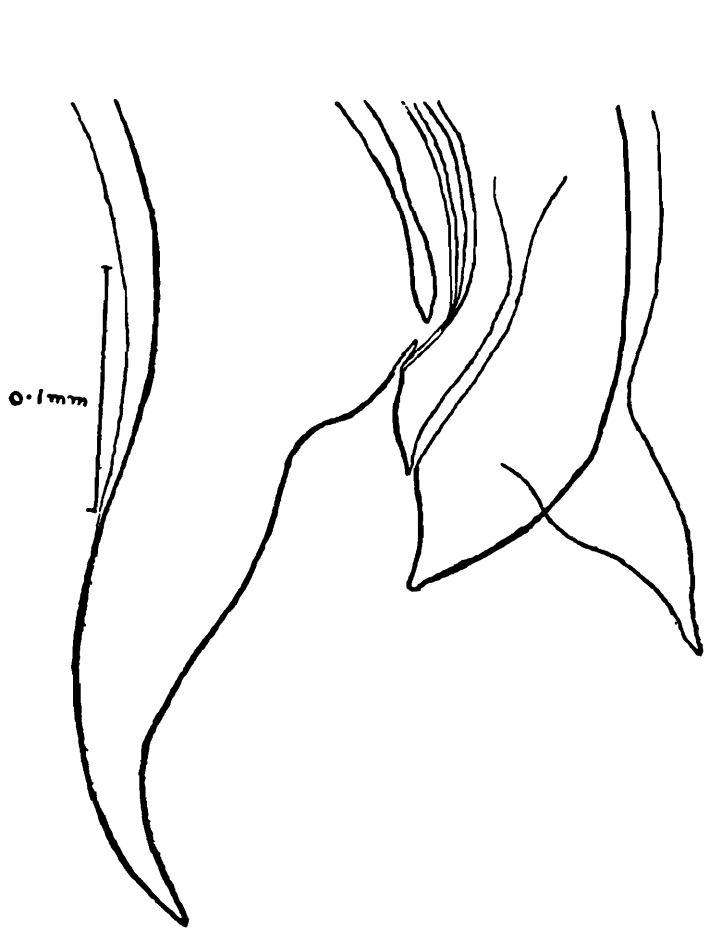

FIG. 35.—*Bourgelatia diducta.* Tail of male, lateral view, showing separate openings of spicular canal and anus.

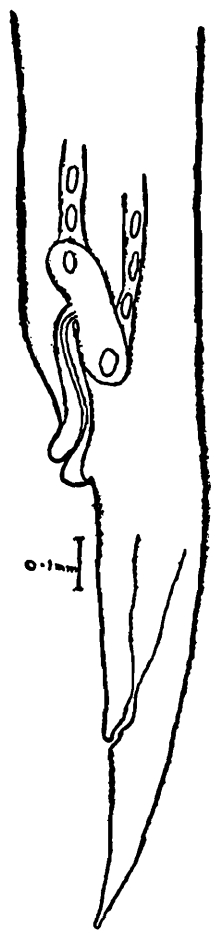

FIG. 36.—*Bourgelatia diducta.* Tail of female.

to emerge through a separate canal dorsal to the intestinal opening (fig. 35).

The spicules are equal, straight and alate. In the original description the gubernaculum is said to be inconspicuous, and in the drawing it is shown as an indefinite, more or less ring-shaped structure, which is situated rather farther forward than is usually the case with this organ. In the present material, many specimens of which were examined, the ring-like structure appears to be the oblique anterior opening of a chitinous funnel-shaped canal surrounding the spicules, and which is probably an exceptionally well-developed telamon. The gubernaculum is a definite structure similar in shape and in position to this organ in the genus *Oesophagostomum* (fig. 32).

Female.—The posterior end of the female is straight and it ends in a sharp point, and the vulva, which has prominent lips, opens a short distance anterior to the anus. A fairly long vagina runs anteriorly to end in a kidney-shaped ovejector similar to that seen in Oesophagostomes (fig. 36).

TABLE 5.

Principal measurements of B. didacta.

	Male.	Female.
Length	8·85—10·67	10·0—12·24
Buccal capsule, diameter	0·068—0·070	0·068—0·072
depth	0·036—0·040	0·036—0·040
Oesophagus, length	0·851—0·951	0·931—0·107
Cervic. papillae from ant. end	0·396—0·415	0·436—0·475
Ex. pore from ant. end	0·268—0·320	0·308—0·344
Spicules, length	1·12—1·24	....
Gubernaculum, length	0·148—0·160	....
Telamon, length	0·240—0·260	....
Vagina, length	....	0·204—0·260
Vulva to anus	....	0·535—0·554
Anus to tip of tail	....	0·297—0·376
Ovejector, length	....	0·232—0·272
Eggs	....	0·058—0·060 × 0·036—0·038

This worm was originally recorded from a pig in Annam by Railliet, Henry and Bauche (1919), and until the present occasion the only other record of its occurrence is by Smit and Notosoediro (1927) in pigs in

Java. The finding of this worm in three Eastern countries, and its great frequency in Indian pigs indicates that in the East at all events it is probably a much commoner parasite than the few records of its occurrence would lead one to suppose.

The Genus *Globocephalus* Molin, 1861.

This genus was reviewed by Cameron (1924), and his conclusions were that *G. urosubulatus* (Alessandrini, 1909) was a species which exhibited a wide range of variation in the size of the sub-ventral teeth, and that *G. connorfilii* Lane, 1922 was a synonym of this species. He also considered it possible that *G. samoensis* (Lane, 1922) may be the same species as *G. longemucronatus* Molin, 1861, because Molin may have missed the teeth owing to his specimens having their mouth cavities filled with debris, but that this point needs further investigation before it can be established as a fact.

Another new species of *Globocephalus* was described under the name *Characostomum amucronatum* by Smit and Notosoediro (1927) from pigs in Java ; the name of this species was changed to *G. amucronatus* by Smit and Ihle (1928). The originals of these two papers have not been available to me but according to Baylis (1929) the distinguishing characters between *G. urosubulatus* and *G. amucronatus* are as follows :—

G. urosubulatus.—Length, male 4·4—5·5 mm. ; female 5—7·5 mm. Sub-ventral teeth usually small, simple. Length of spicules 0·54—0·59 mm. Length of tail in female 0·18—0·23 mm.

G. amucronatus.—Length of male about 5 mm. ; female 6—7 mm. Subventral teeth variable in size, triangular. Length of spicules about 0·7 mm. Length of tail in female 0·132—0·166 mm.

In the course of the present work I have examined the mouth capsules of over two thousand specimens, and have taken measurements of seventy worms, and I have come to the conclusion that there are two different types of mouth capsule, and two different types of teeth, and that the same type of teeth is always associated with the same type of capsule, although both types of teeth show a considerable variation in size.

In the first type, in which the capsule is more or less globular, the teeth are triangular and they arise from the posterior part of the ventral wall of the capsule, the posterior border of the tooth running to the extreme posterior edge of the capsule where it joins the oesophagus (fig. 37, *a* and *b*). The second type of capsule is narrower and is consequently more cylindrical or funnel-shaped and the teeth arise somewhat further forward on the ventral wall of the capsule ; they are more in the nature of longitudinal ridges with a curved outline, and the posterior border always fuses with the capsule wall some distance anterior to its junction with the oesophagus (fig. 37, *c* and *d*). The teeth of both types are variable in size and also in formation, in some cases they appear to be homogeneous chitinous structures, but in others the tip of the tooth is formed by a colourless point of chitin, between which and the tooth proper there is a clear line of demarcation. In some of the specimens, with the narrower capsule and more anterior teeth, they are represented by faint longitudinal ridges not surmounted by a point, and in extreme cases even these faint ridges are absent.

In the subsequent discussion continued reference will have to be made to the above two types of mouth capsule and teeth, so it is proposed to refer to the type with a globular capsule and basal triangular teeth as " Type A ", and the type with a narrower capsule and more anterior teeth as " Type B ".

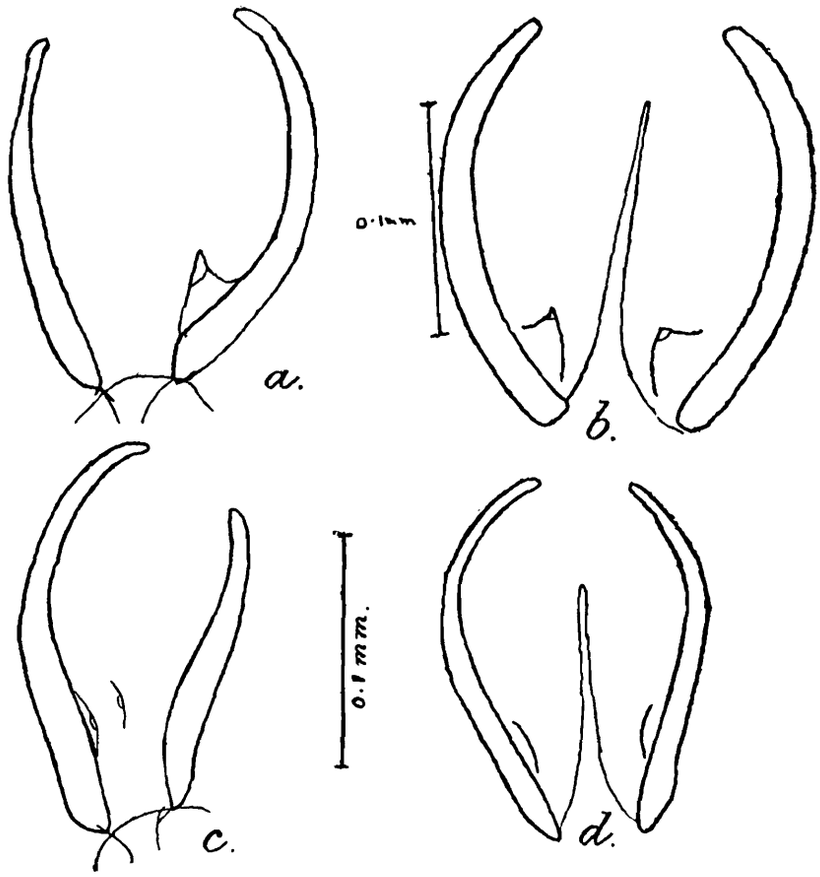

FIG. 37.—(*a*) *Globocephalus urosubulatus.* Buccal capsule, lateral view.
(*b*) *Globocephalus urosubulatus.* Buccal capsule, dorso-ventral view.
(*c*) *Globocephalus connorfilii.* Buccal capsule, lateral view.
(*d*) *Globocephalus connorfilii.* Buccal capsule, dorso-ventral view.

Turning to other points of difference between Types A and B it is found that Type A is generally stouter than Type B although there is slight overlapping in extreme cases. In measurements of the capsule, the depth and maximum diameter of Type A are generally greater than in Type B, although reference to the table below indicates that there is considerable overlapping in these dimensions between the two types. But an important and reliable point is that the maximum diameter of Type A capsules is situated about the middle of the capsule on account of its rather globular shape, whereas the maximum diameter of the Type B capsules is much nearer the anterior end on account of its somewhat funnel-shaped contour. The length of the spicules in Type A is invariably greater than in Type B, but differences in the length of the female tail in the two types was not found a reliable character.

Although the differences between these two types of worm are slight they appear to be constant, and consequently it is considered that Smit and Notosoediro (1927) are correct in dividing into two species the worms that have hitherto been regarded as variants of *G. urosubulatus ;* but

it is unfortunate that they have chosen as the type of their new species *G. amucronatus*, worms, which from their description more nearly correspond with figures 3, 4 and 5 by Alessandrini (1909), and figures 1 and 2 by Cameron (1924) of the same species. It is true that the length of the spicules, *viz.* 590μ given by Alessandrini, and 0·55 mm. given by Cameron agree with the length of the spicules in my Type B worm, which seems to be the same as *G. urosubulatus* by Baylis (1929), whereas the length of the spicules, *viz.* 0·7 mm. by Smit and Notosoediro (1927) nearly agrees with the length of the spicules in my Type A, which appears to be *G. amucronatus* following the description of Baylis (1929) after Smit and Notosoediro. It should be borne in mind, however, that neither Alessandrini nor Cameron recognised two species of worm, so it is possible that they gave the length of the spicules from one type and drawings of the mouth capsule of the other type.

As there seems to be such general agreement among previous workers regarding the shape of the buccal capsule and teeth of *G. urosubulatus vide* the drawings of Alessandrini (1909), Cameron (1924), and v. Linstow (1897), it would seem preferable to consider *G. amucronatus* (Smit and Notosoediro, 1927) as a synonym of *G. urosubulatus*, and to take *G. urosubulatus* of Baylis (1929) after Smit and Notosoediro as another species.

Lane (1922, 1923) described a new species *G connorfilii*, and among the distinguishing characters he gave were the facts that the buccal capsule was longer than broad, and that the teeth were rudimentary. Cameron (1924) did not consider these differences reliable so he made *G. connorfilii* a synonym of *G. urosubulatus*. The above examination of a large number of worms has established the fact that Lane's points are valid, and that in the males with the type of buccal capsule described by him the spicules are always shorter than they are in the type with the broader capsule. Reference to figures 50 and 51 by Lane (1923) makes it clear that he was dealing with my Type B. It is true that the length of the spicules, *viz.* 0·275 mm. given by Lane (1922) is considerably less than that found by me in my series, but this difference serves to emphasise rather than to invalidate the difference between Lane's species and *G. urosubulatus*. It is therefore considered justifiable to re-erect *G. connorfilii* Lane, 1922 as a valid species.

Tubangui (1925) described some worms from pigs in the Philippine Islands, with a cylindrical buccal capsule and no sign of teeth, and, regarding the absence of teeth as of more importance than differences in the shape of the buccal capsule, he tentatively referred his worms to *G. longemucronatus* Molin, 1861, but he suggested the possibility that his material may represent a new species. Reference to figures 2*a* and 2*b* by Tubangui make it clear that he was dealing with my Type B for my examination of a large amount of material has shown that extreme examples exist in which no ridges or teeth are visible, and from these forms all degrees of variation exist up to worms with definite ridges surmounted by a chitinous point forming a tooth, and this gradual variation in prominence of the teeth makes it impossible to separate them into different species. Therefore it is considered that *G. longemucronatus* Molin, of Tubangui, 1925, is an extreme example of *G. connorfilii* (Lane,

1922) in which no teeth are visible. Figures 21 A and B by Yorke and Maplestone (1926) purporting to be *G. longemucronatus* are also obviously those of my Type B or *G. connorfilii*.

TABLE 6.

Measurements of G. urosubulatus and G. connorfilii from the present material.

	G. urosubulatus (my Type "A")		*G. connorfilii* (my Type "B")	
	Male	Female	Male	Female
Length . .	3·99—4·69	4·74—6·87	4·01—4·99	4·1—6·52
Diameter, max.	0·297—0·376	0·336—0·475	0·237—0·336	0·297—0·455
Internal diameter of capsule	0·084—0·108	0·096—0·140	0·068—0·092	0·084—0·108
Depth of capsule .	0·140—0·168	0·152—0·200	0·120—0·168	0·152—0·212
Anus to tip of tail . .	..	0·120—0·196	..	0·128—0·212
Spicules, length . . .	0·852—0·931	..	0·455—0·594	..

Globocephalus samoensis (Lane, 1922).

This worm was present in small numbers in five pigs. It is quite a definite species and is easily separated from the other two by its markedly globular buccal capsule even if the teeth are obscured by dèbris. Over fifty specimens were obtained and in the majority of cases the large bicuspid teeth are clearly visible, but in a few instances the buccal cavity was filled with dèbris, and in a few others there was some degree of distortion of the capsule, which rendered the teeth invisible or difficult to see, but as the teeth were clearly visible in all the clean and undamaged specimens, which represented the great majority, there was no reason to suppose that the teeth were absent in the few dirty or distorted examples. Cameron (1924) suggested the possibility that *G. samoensis* is the same as *G. longemucronatus* and that Molin failed to see the teeth owing to the presence of dèbris in the mouth cavity. The present observation lends support to Cameron's view, but it is not considered that enough material has yet been examined to definitely establish the fact that worms with this type of buccal capsule do not exist without teeth.

The tail of the female in *G. samoensis* ends in a bluntly rounded extremity which is surmounted by a fine hair-like process, whereas the tails of *G. connorfilii* and *G. urosubulatus* taper evenly from just behind the anus to the fine tip of the tail.

The following table shows that my measurements and those of Lane (1922) for this species are in close agreement.

TABLE 7.

Comparison of my measurements with those by Lane of G. samoensis.

	G. samoensis.	
	Lane.	My measurements.
Length, male	4·5—5·5	4·17—5·72
Length, female	5·25—5·6	5·31—6·72
Tail, female	0·07—0·1	0·084—0·124
Spicules, length	0·38—0·41	0·376—0·495

The length of Molin's material, *viz.* 7—8 mm. is greater than the maximum of the above measurements but the difference is not sufficiently marked to exclude the possibility of their unity as a species.

Cameron (1924) pointed out that the question of generic and specific names in this genus were considerably involved, and it is clear from consideration of the subsequent publications regarding the species of the genus *Globocephalus* that the matter has been still further complicated. The following summary is suggested as the most reasonable solution, in the light of existing knowledge.

Type species.—G. longemucronatus Molin, 1861. Length of male 7 mm.; female 8 mm. Buccal capsule definitely globular, teeth absent. Female tail ends in a mucronate tip.

Other species.—G. samoensis (Lane, 1922).

Synonyms.—Crassisoma samoense Lane, 1922. *Raillietostrongylus samoensis* (Lane, 1922) Lane, 1923.

Length, male 4·2—5·7 mm.; female 5·25—6·72 mm. Buccal capsule definitely globular, with large bicuspid sub-ventral teeth. Length of spicules 0·038—0·49 mm. Length of female tail 0·07—0·12 mm., ending in a mucronate tip. (May be identical with *G. longemucronatus.*)

G. urosubulatus (Alessandrini, 1909).

Synonyms.—Crassisoma urosubulatus Alessandrini, 1909. *Characostomum amucronatum* Smit and Notosoediro, 1926. *Globocephalus amucronatus* Smit and Ihle, 1928.

Length, male 3·99—5 mm.; female 4·74—7 mm. Buccal capsule more or less globular, with triangular sub-ventral teeth of variable size arising from base of capsule. Length of spicules 0·7—0·93 mm. Length of female tail 0·120—0·196 mm., ending in a tapering point.

G. connorfilii Lane, 1922.

Synonyms.—G. urosubulatus of Baylis, 1929. *G. longemucronatus* of Tubangui, 1925.

Length, male 4·01—5·5 mm.; female, 4·1—7·5 mm. Buccal capsule narrow, cylindrical or slightly funnel-shaped, with or without sub-ventral ridges which may or may not be surmounted by chitinous tips. Length of spicules 0·45—0·59 mm. Length of female tail 0·13—0·23 mm., ending in a tapering point.

REFERENCES.

Alessandrini, G. (1909). Raro Parassita dell' intestino del Maiale. *Arch. de Parasitol.*, Vol. XIII, p. 458.

Baylis, H. A. (1929). A Manual of Helminthology, Medical and Veterinary. Bailliere Tindall and Cox., London.

Baylis, H. A. and Lane, Clayton. (1920). A Revision of the Nematode family Gnathostomidae. *Proc. Zool. Soc. London,* 1920, p. 245.

Cameron, T. W. M. (1924). On the Nematode Genus *Globocephalus* Molin, 1861. *Journ. of Helminthol.*, Vol. II, p. 65.

Canavan, W. P. N. (1929). Nematode Parasites of Vertebrates in the Philadelphia Zoological Gardens and Vicinity. I. *Parasitol.*, Vol. XXI, p. 63.

Chandler, A. C. (1925). A Contribution to the Life History of a Gnathostome. *Parasitol.*, Vol. XVII, p. 237.

Goodey, T. (1924). The Anatomy of *Oesophagostomum dentatum* (Rud.). A Nematode Parasite of the Pig with Observations on the Structure and Biology of the Free-living Larvae. *Journ. of Helminthol.*, Vol. II, p. 1.

Goodey, T. (1925). *Oesophagostomum longicaudum* n. sp. from the Pig in New Guinea. *Ibid.*, Vol. III, p. 45.

Heydon, G. M. (1929). Creeping Eruption or Larva Migrans in North Queensland and a note on the worm *Gnathostoma spinigerum* (Owen). *Med. Journ. Aust.*, Vol. I, 16th Year, p. 583.

Khalil, M. (1927). *Cruzia mexicana* n. sp. parasite d'un Lezard Mexican (1). *Ann. de Parasitol. Hum. et Comp.*, Vol. V, p. 41.

Lane, Clayton. (1922). A preliminary note on two Strongylata from Swine. *Ann. Mag. Nat. Hist.*, Series 9, Vol. IX, p. 683.

Lane, Clayton. (1923). Some Strongylata. *Parasitol.*, Vol. XV, p. 348.

v. Linstow, O. (1897). Uber Molin's Genus *Globocephalus*. *Zool. Anzeiger*, Vol. XX, p. 184.

Molin, R. (1861). Il sott' Ordine degli Acrofalli. *Mem. dell' I. R. Inst. Veneto di Sc.*, Vol. IX, p. 427.

Smit, H. J. and Ihle, J. E. W. (1928). *Globocephalus amucronatus* (Smit & Notosoediro). *Centralb. Bakt. Jena,* Series 2, Vol. LXXV, p. 1.

Smit, H. J. and Notosoediro. (1927). Twee wormen van het Varken. *Ned.-Ind. Blad. Diergeneesk.*, Vol. XXXIX, p. 47. (Review in *Cent. f. Bakt. Referate.*, Vol. XCI, p. 361).

Tubangui, M. A. (1925). Metazoan Parasites of Philippine Domestic Animals. *Philip. Journ. Sci.*, Vol. XXVIII, p. 11.

Yorke, W. and Maplestone, P. A. (1926). Nematode Parasites of Vertebrates. J. and A. Churchill, London.