

SCIENTIFIC RESULTS OF THE YALE NORTH INDIA EXPEDITION.

Biological Report No. 20.*

HELMINTH PARASITES OF FISHES FROM NORTH INDIA, WITH SPECIAL REFERENCE TO ACANTHOCEPHALANS.

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INTRODUCTION.

This report on the Helminth parasites of fishes collected by the Yale North India Expedition (1932) deals with Acanthocephala and Cestoda only. Towards the end of 1935, my colleague, Mr. Dev Dev Mukherji, handed over to me the material under report which he found during his investigations on the intestinal contents of the fishes collected by the expedition. Dr. S. L. Hora also very kindly handed to me a couple of specimens of the loach *Nemachilus hutchinsoni* Hora, with cestodes in the body cavity. Additional material, in ten tubes, was received from Dr. G. E. Hutchinson from America in March, 1936.

Earlier work on Acanthocephala was very unsatisfactory, and up to 1892 nearly all species of these worms were assigned to the genus *Echinorhynchus*. The detailed systematic work of Lühe (1911), Van Cleave's reports on worms from Japan, America and India, Fukui's (1929) work on Acanthocephala found in Japan, Yamaguti's report on the Helminth Fauna of Japan (1935) and the latest published monograph on Acanthocephala by Meyer (1933) have placed the systematics of these worms on a sound foundation.

* Mr. G. Hutchinson, who was one of the members of the Yale North India Expedition, has informed me that on financial grounds it would not be possible to publish any further reports on the material collected by the Expedition in the "Memoirs of the Connecticut Academy of Arts and Sciences"—Yale North India Expedition Series. The present paper and others on material worked out by the Zoological Survey of India will, therefore, be published in the "Records of the Indian Museum".—Ed.

The collection under report, although small, is of considerable interest, as the genera *Acanthocephalus* and *Neoechinorhynchus* had not hitherto been recorded from India.

The genus *Eosentis* was established by Van Cleave (1928) for a new worm *E. rigidus* from *Schizothorax zarudnyi* from Seistan. His description of the genus and species was based on a female specimen that was sent to him from the collections of the Indian Museum, Calcutta, where also the holotype is deposited. The main feature of the genus is the difference in the number of sub-cuticular nuclei, but unfortunately the author does not mention their number, or any other generic differences. In the holotype I find that there are 9 sub-cuticular nuclei in the mid-dorsal and 1 in the mid-ventral line. On the basis of these I describe below two new species of this genus, *Eosentis devdevi* and *Eosentis yalei*. I may also mention that from a specimen of *Schizothorax zarudnyi*, from the same collection from Seistan as the one examined by Van Cleave, I dissected out of the intestine 35 specimens of *Eosentis rigidus*, both males and females; a detailed report on these specimens will be published later. From a preliminary study of these worms I find that the number of sub-cuticular nuclei varies slightly; the number of sub-cuticular nuclei in the generic diagnosis should, therefore, read 8-9 in the mid-dorsal line and 1-2 in the mid-ventral line.

The old species *Neoechinorhynchus rutili* (Müller), has been recorded from various fish hosts, but only once from a species of the genus *Nemachilus*, *N. barbatula* (Linn.), which is an extra-Indian species. *Neoechinorhynchus rutili* from *Nemachilus stoliczkae* and *N. vittatus* is recorded in this paper for the first time from India.

The additional material sent by Dr. Hutchinson mainly consisted of larval forms of *Ligula intestinalis*. Only in two tubes I found *Acanthocephala*. In one host, *Nemachilus vittatus*, the parasite was *Neoechinorhynchus rutili* from the Wular Lake, Kashmir. The worm in the second tube, from the fish *Diptychus maculatus* from Leh, represents a new species of *Neoechinorhynchus*. This represents an interesting new species of the genus, as it shows a marked difference in the measurements of the two sexes and also in the peculiar narrowing of the body in the male.

Ligula intestinalis, the only Cestode in this collection, has been recorded in larval form by various authors from India. Southwell (1913, 1915) recorded it from *Labeo calbasu*, *Labeo rohita*, *Danio aequipinnatus*, and *Nemachilus rupicola*. This larval form is now recorded from *Schizopygopsis* sp., *Schizothorax* sp., and *Nemachilus hutchinsoni* Hora. As Southwell (1930) remarked, it is curious that only the larval form of this worm has so far been found in India.

I am indebted to Dr. S. L. Hora and the authorities of the Yale North India Expedition, and specially to Dr. G. E. Hutchinson, for giving me the opportunity of studying this interesting collection of Helminth parasites. I am also indebted to Dr. Bains Prashad, Director, Zoological Survey of India, for his kind help in the preparation of this report. My thanks are also due to my colleague, Mr. D. D. Mukerji, for very kindly sorting out the parasites, on which the major portion of this report is based. Mr. B. Bagchi has very kindly executed the illustrations under my supervision.

SYSTEMATIC ACCOUNT.

ACANTHOCEPHALA.

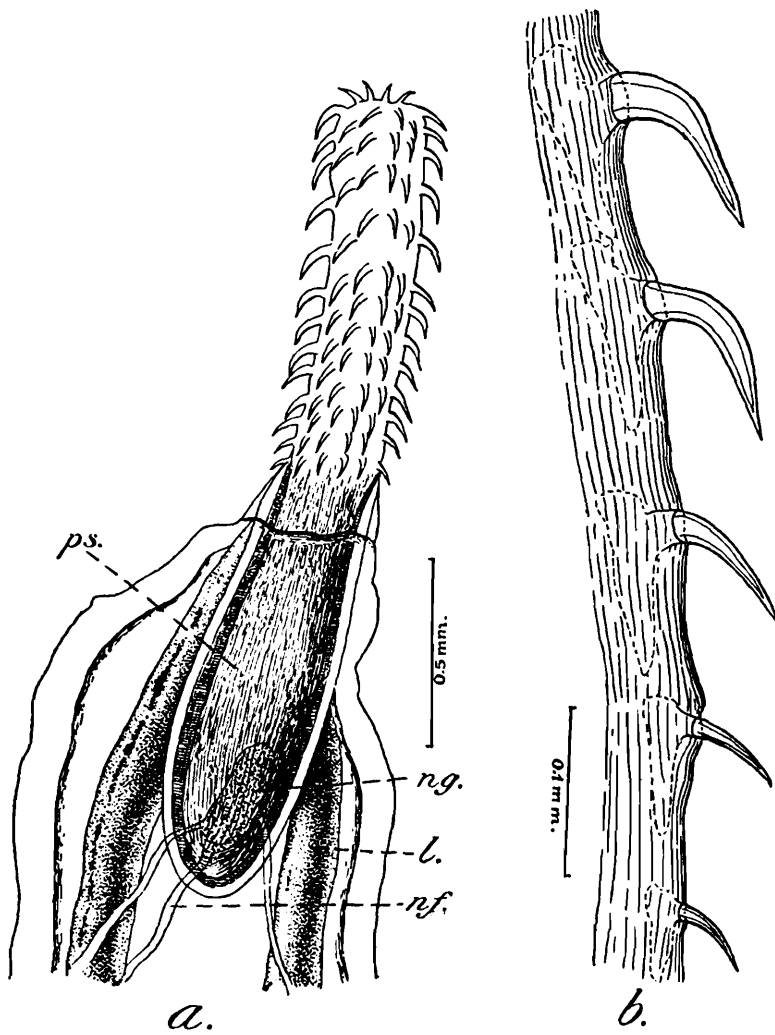
Family *ECHINORHYNCHIDAE* (Cobbold, 1879) Hamann 1892
(emend.).

Acanthocephalus Koelreuther 1771, Lühe 1911 (emend.).

Acanthocephalus kashmirensis, sp. nov.

Of this new species I have examined 19 specimens dissected from three specimens of *Schizopygopsis stoliczkae*. The worms were all dark-brown in colour and very stiff. All these were kept in a mixture of glycerine and alcohol, and, after softening, 17 of them were stained and mounted permanently in Canada Balsam.

They showed marked sexual dimorphism, the males being comparatively small and more slender than the females. The body cavity of almost all the females was congested with egg-balls and ova in various stages of development; they were easily identified from the males by their longer and stouter bodies. The males measured 1.75—8.60 mm. \times 0.44—0.99 mm., and the females 3.48—14.60 mm. \times 0.57—1.00 mm.



TEXT-FIG. 1.—*Acanthocephalus kashmirensis*, sp. nov. (a) Anterior region; (b) Proboscis hooks highly magnified.

l., lemnisci; *nf.*, nerve fibres; *ng.*, central nerve gland; *ps.*, proboscis sheath.

The body is long, cylindrical and tapering near the posterior end. At the anterior end there is a proboscis with a short neck. The body is devoid of spines.

The proboscis (Fig. 1, *a*) is long and cylindrical and is continued into a short, bare neck. There are 13-18 rows of 6-8 hooks each radially and symmetrically arranged. The hooks of the anterior rows are much stouter and longer than those at the posterior rows, in the so-called basal region. The anterior ones are 0.110 mm. in length and 0.030 mm. in diameter near the base, the basal ones are 0.075 mm. in length and 0.019 mm. in diameter near the base. All the hooks have got broad and pyriform basal plates which are embedded in the wall of the proboscis (Fig. 1, *b*).

The proboscis sheath is a thick, double-layered, muscular sac which hangs from the base of the proboscis. The proboscis can be drawn into this sac by the action of the strong bands of muscles. There are two sets of muscular bands known as the retractor and protractor muscles, which form the motor system for the retraction and protrusion of the proboscis. In some cases the retraction was so great at the time of the death of the worms that even with strong pressure between two slides it was not possible to evert the proboscis for examination.

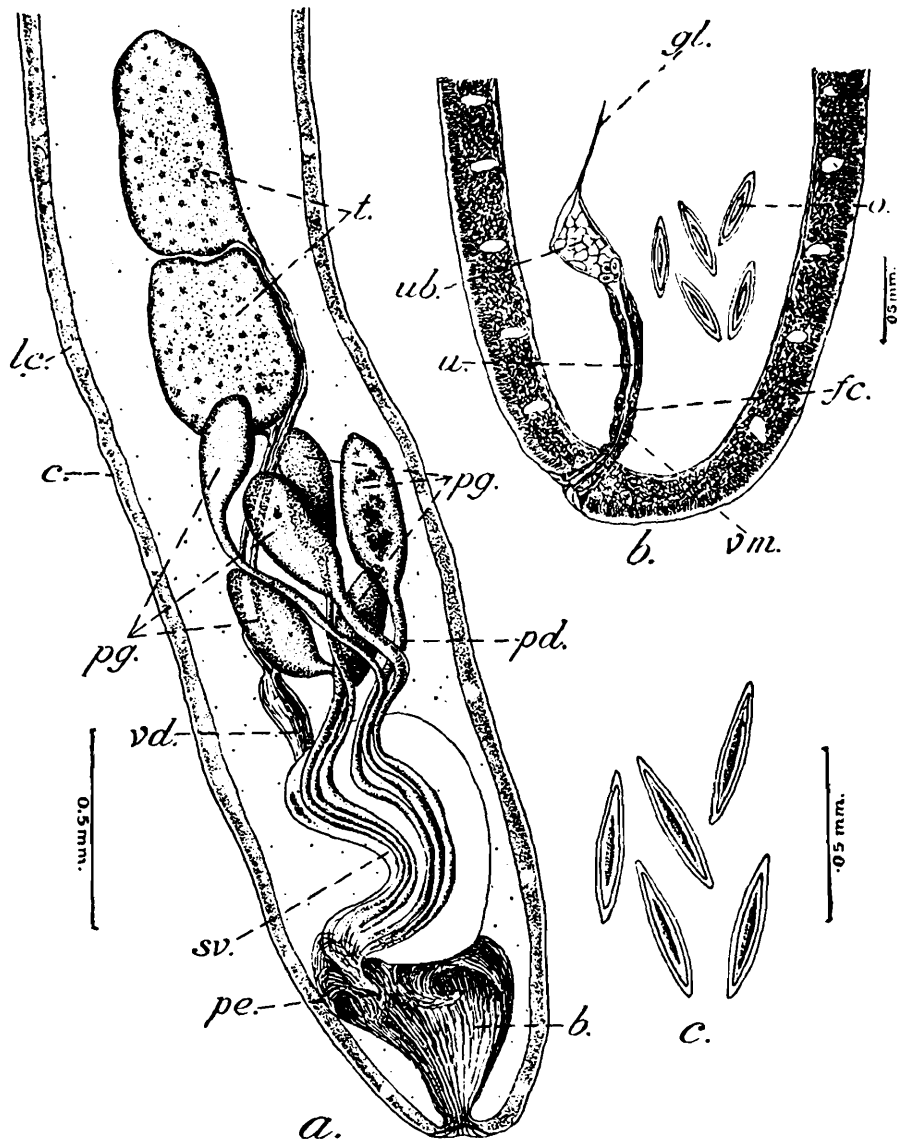
The central nervous system consists of a single ganglion embedded in the wall of the proboscis sheath near its posterior end. A few nerve branches issue out from the ganglion and supply the body wall.

The two folds of lemnisci, which hang on either side of the proboscis sheath, are equal to, or a little longer than, the sheath. There are a few nuclei embedded in them. These lemnisci are continuations of the hypodermis and of some of the muscle fibres of the body wall. The comparative length of the lemnisci and the proboscis sheath are sometimes helpful in systematic classification, and great stress is laid by some authors on this point (Southwell and Macfie, 1925). But sometimes great difficulties are encountered on account of the heavy contraction at the time of fixing the specimens, the different ages of the worms also rendering it difficult to differentiate by these measurements.

The body wall is composed of a thick layer of cuticle forming the outermost wall followed by a thick layer of subjacent hypodermis in which there are canals and canaliculi forming a network of canals of the lacunar system (Verma and Datta, 1929). Below the hypodermis there are the circular and longitudinal muscle fibres.

The male genitalia (Fig. 2, *a*) consist of a pair of ovoid testes, two vasa efferentia, a vas deferens, a seminal vesicle, six club-shaped prostatic glands, a penis and a funnel-shaped bursa. The testes, which are nearly equal in size, lie closely apposed, one behind the other. Ducts from these, the vasa efferentia, lead for a short distance along the side of the first couple of prostatic glands and then join with each other to form the vas deferens. A pear-shaped seminal vesicle lies close to the group of the prostatic glands with its opening near the base of the muscular penis. The six prostatic glands are club-shaped and are situated, apparently in pairs, close to one another. It seems as if they set themselves in two groups of three each, and the prostatic ducts from these lead to and ultimately open into the penis. These ducts also appear to run in two distinct sets before joining each other to open at the base of the penis. It appears, therefore, that all these tubes from the vas deferens, seminal vesicle, and prostatic glands open jointly at the base of the penis. The penis is a muscular cone-like organ, which hangs at the top of the retracted

bursa. The bursa is everted out as a funnel-shaped organ at the time of mating.



TEXT-FIG. 2.—*Acanthocephalus kashmirensis*, sp. nov. (a) Posterior region showing the male genitalia; (b) Posterior region showing the female genitalia; (c) Ova highly magnified.

b., bursa; c., cuticle; fc., flask-shaped cells in the uterine wall; gl., genital ligament; lc., lacunar canals; o., ova; pd., prostatic duct; pe., penis; pg., prostatic glands; sv., seminal vesicle; t., testes; u., uterus; ub., uterine bell; vm., vaginal muscles.

The female genitalia (Fig. 2, b) consist of a long funnel-shaped bell, the uterine bell. This bell is kept in position by a ligament, the genital ligament, which at the anterior end is attached to the base of the proboscis sheath. There are a few cells, the guard cells, at the base of the uterine bell which serve to sort out the mature ova and allow them to pass into the uterus while the immature ova are all returned to the body cavity. The uterus is a thick-walled, flabby tube which can expand at the time of breeding when masses of ripe eggs pass into it from the uterine bell. At the posterior end of the uterine wall there are a couple of club-shaped cells, the flask cells. The uterus leads into a short and thick-walled vagina which opens externally through the vulva. The opening of the vagina is controlled by two bands of strong muscles which serve to allow the ova to pass out in a single file. The vulva which forms the external opening of the genitalia is situated at the postero-ventral side.

Measurements.—Males 1.75–8.60 mm. \times 0.44–0.99 mm. ; females 3.48–14.60 mm. \times 0.57–1.00 mm. ; the proboscis 1.50 \times 0.51 mm. ; proboscis sheath 1.69 \times 0.44 mm. ; lemnisci 1.276 \times 0.220 mm. ; anterior testis 1.188 \times 0.506 mm. ; posterior testis 1.122 \times 0.440 mm. ; prostatic gland 0.550 mm. in length ; seminal vesicle 1.188 \times 0.484 mm. ; bursa 0.594 \times 0.396 mm. ; ova 0.060 \times 0.010 mm. The hooks of the anterior region are 0.110 mm. in length and of the basal region are 0.075 mm. in length.

TABLE I.—Characters of some closely related species of *Acanthocephalus*.*

Species.	Dimensions.	Proboscis.	Proboscis-sheath.	Hooks.	Prostatic glands.
1. <i>A. anguillae</i> (Müller, 1780).	♂ 5.7 \times 0.8-1.1 ♀ 12.20 \times 2.0	1.0 \times 0.65	1.7 \times 1.3	10 rows of 6-7	6 in pairs.
2. <i>A. paroni</i> (Fr. Condo-relli, 1897).	♂ 5.6 \times 0.6	0.5 \times 0.23	..	10 rows of 8	6
3. <i>A. lucii</i> (Müller) Lühe, 1911.	♂ 4.5 \times 1.0-1.4 ♀ 8-17	0.5-0.7 \times 0.25-0.30	1.5	12-16 rows of 7-9	..
4. <i>A. gracilacanthus</i> Meyer, 1933.	♀ 9.5 \times 1.0	1.4 \times 0.4	1.7	12 rows of 8-9	..
5. <i>A. gotoi</i> Van Cleave, 1925.	♂ 5.0 ♀ 7.2	0.6 \times 0.2	..	15-17 rows	..
6. <i>A. acerbus</i> Van Cleave, 1931.	♀ 5.1-8.8 \times 0.94-1.25	0.48-0.85 \times 0.19-0.25	..	12 rows of 6-8	6 in 3 pairs.
7. <i>A. echigoensis</i> Fugita, 1920.	♂ 2.2-4.0 \times 0.5 ♀ 5.0-12.0 \times 0.6-1.0	0.6 \times 0.15-0.20	..	10-13 rows of 6-10	6 in 3 pairs.
8. <i>A. kashmirensis</i> , sp. nov.	♂ 1.75-8.60 \times 0.44-0.99 ♀ 3.48-14.60 \times 0.57-1.00	1.5 \times 0.51	1.69 \times 0.44	13-18 rows of 6-8	6 in 2 groups.

* All measurements are in millimetres.

In referring the specimens to the genus *Acanthocephalus* I have relied on (i) the shape and size of the male and female, (ii) the position of the central nervous system in the proboscis sheath, (iii) the absence of spines in the short neck and on the body, (iv) the size of the lemnisci, which are equal or a little larger than the proboscis sheath, and (v) the shape and number of prostatic glands.

From the comparative table given above it is evident that *Acanthocephalus kashmirensis* differs considerably from the allied species. The rows of hooks and the number in each row on the proboscis are very marked. The males are generally smaller than the females, and the position of the central nervous system is near the posterior end of the proboscis sheath. The prostatic glands are six in number and are club-shaped. The lemnisci are nearly equal or slightly longer than the proboscis sheath.

Type specimens are deposited in the collections of the Indian Museum, Calcutta.

Host.—*Schizopygopsis stoliczkae* Stiedachner.

Location.—Intestine.

Locality.—Sta. L. 37 (Indian Tibet, Ladak), large rapid stream between Tangste and Mugleb. Altitude, ca. 13,700 ft.

Family *NEOECHINORHYNCHIDAE* Van Cleave, 1919.

Neoechinorhynchus Hamann 1892.

Neoechinorhynchus rutili (Müller).

1776. *Echinorhynchus rutili*, Müller, *Zool. Dan.* II, p. 61.

1800. *Echinorhynchus clavaiceps*, Zeder, *Nachr. Eingeweidewurm*, p. 130.

1803. *Echinorhynchus tuberosus*, Zeder, *Anleit. Eingeweidewurm*, p. 163.

Neoechinorhynchus rutili is a very common Acanthocephalan parasite found in fishes, and recorded from time to time by various authors but not from India.

I have examined two lots, one containing six specimens from a loach, *Nemachilus stoliczkae* and another containing three specimens from *Nemachilus vittatus*. They were all very brittle and shrunken. Considerable difficulty was, therefore, experienced in taking their measurements and in making permanent mounts. Fortunately the specimens were not so dark and their internal anatomy could be easily studied.

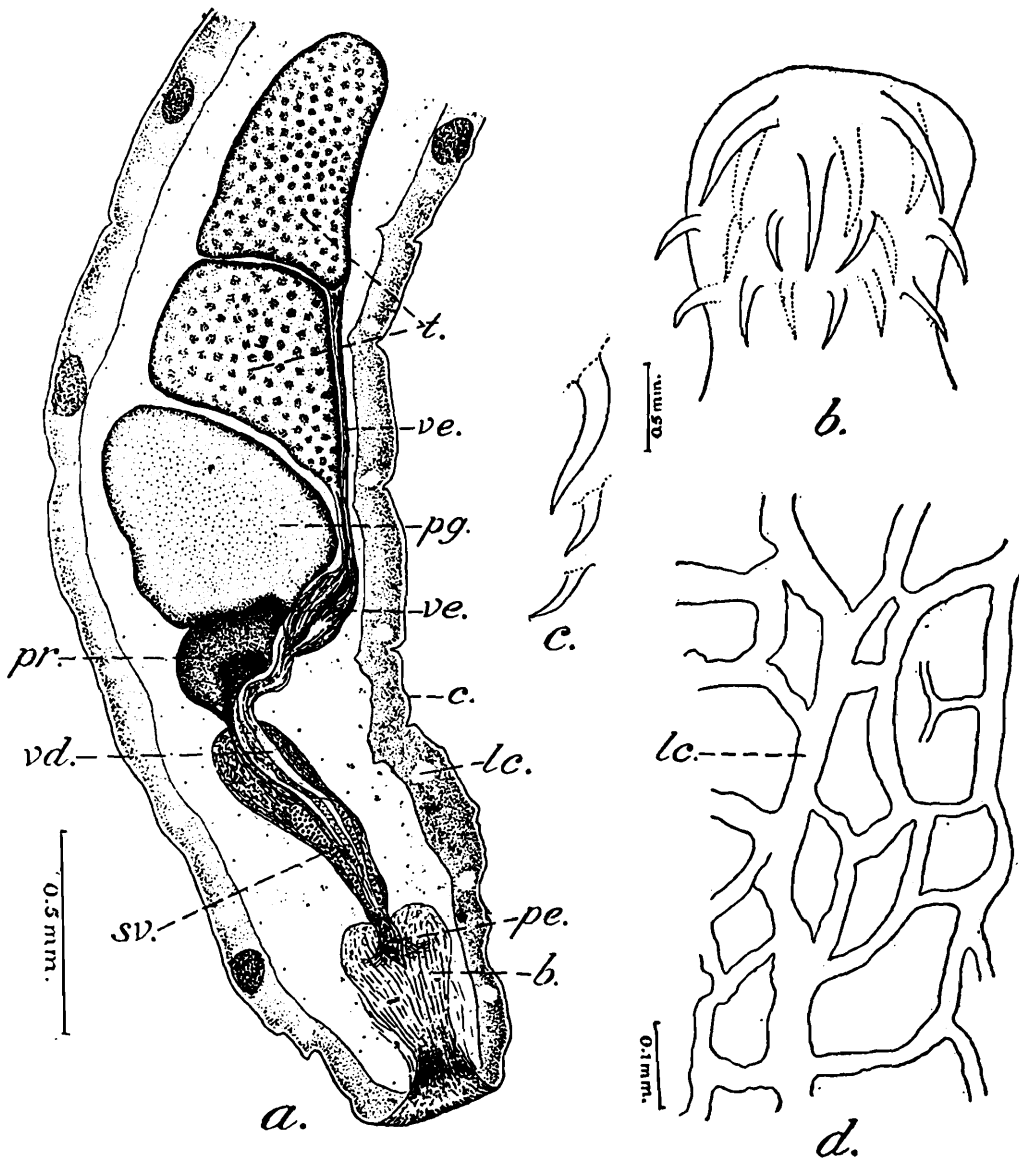
The body is fusiform and devoid of spines. Owing to its shrunken state deep furrows are visible on the body. The proboscis (Fig. 3, *b*) is globular with three circles of six hooks each. The hooks (Fig. 3, *c*) of the terminal circle are much longer and stouter than the succeeding two circles, as is generally found in this genus. The proboscis sheath is a single-walled muscular sac hanging from the base of the proboscis. The central nervous system consists of a single ganglion situated in the wall of the proboscis sheath near its posterior end, and a few nerve fibres emerge from this to supply the body wall.

A pair of muscular folds, the lemnisci, hang on the sides of the proboscis sheath. They are very long and sometimes reach up to the region of the testes. It has been definitely observed that one of them is always a little longer than the other. Nuclei are present in both the lemnisci, two in one and one in the other.

The body wall consists of a thick layer of cuticle as the outermost covering below which there is a broad layer of submucosa intermixed with bands of fibrous tissue. In the submucosa are seen numerous canals and canaliculi which form a regular network of canals of the lacunar system (Fig. 3, *d*). The very prominent transverse canals give the body wall the appearance of an internal annulation, although the depressions on the external body wall are not very deep; in fact there is no segmentation or annulation of the body wall. Below the submucosa there are a few layers of circular muscle fibres while the longitudinal muscles form the innermost layer. In the body wall there are some cuticular nuclei, five on the mid-dorsal line and one on the mid-ventral.

The male genitalia (Fig. 3, *a*) consist of a pair of ovoid testes, a pair of vasa efferentia, a vas deferens, a syncitial prostatic gland, a prostatic reservoir, a seminal vesicle, a muscular penis and a funnel-shaped bursa. The oval testes are situated near the middle of the body, lying closely one behind the other. A short tube from each testis, the vas efferens, runs for a short distance, and then swells a little, before joining with each other to form the vas deferens. This characteristic is generally observed

in *Neoechinorhynchus*. The vas deferens, which is a short muscular tube, runs for a short distance alongside the seminal vesicle and then



TEXT-FIG. 3.—*Neoechinorhynchus rutili* (Müller). (a) Showing male genitalia; (b) Proboscis showing arrangement of hooks; (c) Hooks of the terminal, middle and basal circles showing their comparative sizes; (d) A portion of the lacunar canals showing the arrangement in the body wall.

b., bursa; c., cuticle; lc., lacunar canals; pe., penis; pg., prostatic gland; pr., prostatic reservoir; sv., seminal vesicle; t., testes; vd., vas deferens; ve., vas efferens.

opens at the base of the penis. The prostatic gland is a single syncytial mass, the anterior end of which touches the posterior testes. The gland evacuates its contents into a reservoir, the prostatic reservoir, which leads to the prostatic duct. The duct is a thin long tube which opens posteriorly near the base of the penis. A thin walled sac, the seminal vesicle, also opens posteriorly near the base of the penis. So it is evident that the vas deferens, the seminal vesicle and the prostatic duct all empty their contents jointly into the penis. The penis is a short muscular cone-like organ, which hangs near the top of the eversible bursa. The bursa is a bell-shaped, muscular organ, which is capable of being everted at the time of copulation.

The female genitalia consist of the uterine bell, the uterus, the vagina and the vulva. The long, thin-walled and funnel-like uterine bell is attached at one end to the ligamentous tissue of the genital ligament,

and is kept in position in the lumen of the body by the ligament being attached to the base of the proboscis sheath. At the posterior end of the uterine bell there are a few cells, the guard cells, which serve the function of separating the mature from the immature ova. The uterus is a thick-walled flabby tube with two flask-shaped cells embedded in its wall near the posterior end just before it opens into the short muscular vagina. The vagina is a thick muscular tube with two strong bands of muscles at each end; these bands allow the ova to pass out in single file. The vulva is the external outlet of the female genitalia and is situated at the postero-ventral end.

Measurements.—Male 3.0–4.20 mm. \times 0.50–0.80 mm., female 7.50–8.80 mm. \times 0.60–1.50 mm.; proboscis 0.132 \times 0.143 mm.; proboscis hooks terminal 0.080 mm., middle 0.040 mm., basal 0.037 mm.; proboscis sheath 0.242 \times 0.176 mm.; lemnisci longer 1.584 \times 0.088 mm., shorter 1.276 \times 0.088 mm.; testis anterior 1.100 \times 0.550 mm., testis posterior 0.770 \times 0.374 mm.; prostatic gland 0.814 \times 0.330 mm.; prostatic reservoir 0.286 \times 0.198 mm.; prostatic duct 0.660 \times 0.440 mm.; bursa 0.374 \times 0.176 mm.; ova 0.050 \times 0.013 mm.

From Table II (*vide* page 221) showing differences between closely allied species of *Neoechinorhynchus* it is evident that my specimens agree in all essentials with the description of *Neoechinorhynchus rutili* (Müller).

Hosts.—*Nemachilus stoliczkae* Steindachner, and *Nemachilus vittatus* (Heckel).

Location.—Intestine.

Locality.—Indian Tibet (Ladak), Sta. L. 64; altitude 16,082 ft., and Wular Lake, Kashmir, Sta. K. 43; altitude 5,160 ft.

***Neoechinorhynchus hutchinsoni*, sp. nov.**

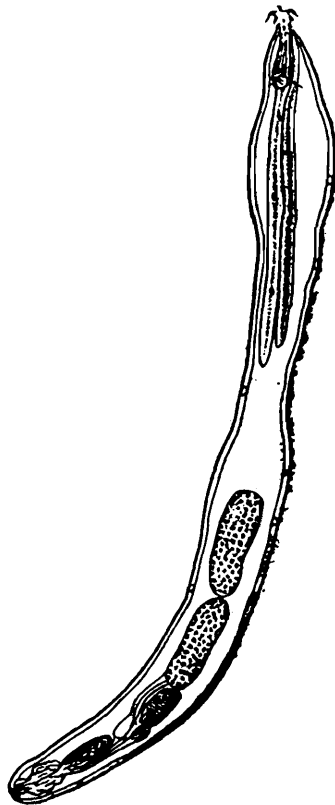
Of this species I have examined four specimens, 3 males and 1 female, from a specimen of the fish, *Diptychus maculatus*. The single female was received in three pieces, but from the shape of the broken ends it is clear that these belong to one specimen; the dimensions of the female are of the broken pieces.

In the species under description sexual diamorphism is well marked. The males are much smaller and more slender than the female. The body is cylindrical in shape with tapering ends. In the males there is a peculiar depression of the body about its middle. This peculiar narrowing of the girth of the body just above the region of the testes is constant in all the three males specimens in the collection, and I consider it to be a characteristic feature of the new species.

The proboscis is oval, but its breadth is greater than the length. Hooks on the proboscis are in three rows of six each. The hooks of the terminal row are much stouter and longer than that of the middle and basal rows.

The number of sub-cuticular nuclei on the mid-dorsal line of the body wall is five, and on the mid-ventral line two, which conforms to the number generally found in the genus.

The proboscis sheath is a single-walled muscular sac hanging from the base of the proboscis. The central nervous system consists of a single ganglion, which is situated in the posterior portion of the wall of the proboscis sheath, and sends out a few nerve retinaculi to the body wall.



TEXT-FIG. 4.—*Neoechinorhynchus hutchinsoni*, sp. nov., male specimen showing the peculiar depression of the body-wall.

The two lemnisci, one of them a little longer than the other, arise from the base of the proboscis, one on either side of the proboscis sheath, and are filamentous. In this case they do not reach the testicular region but end near the depression of the body-wall.

The male genitalia consist of a pair of elliptical testes, two vasa efferentia, a vas deferens, a single syncytial prostatic gland, a seminal vesicle, a penis and a bursa. The vasa efferentia from both the testes swell a little before they join, with each other to form the vas deferens. The elliptical testes lie closely apposed one behind the other. The prostatic mass lies close behind the posterior testis. The prostatic reservoir is spherical and gives out the prostatic duct which ends at the base of the muscular cone-like penis. The vas deferens opens in the seminal vesicle just before its opening into the penis. The penis hangs at the top of the inverted bell-shaped bursa, which is capable of being everted at the time of mating.

The female genitalia were not clearly seen in the single damaged specimen.

Measurements.—Males 7.8–8.2 mm. \times 0.8–1.0 mm., female 18.9 \times 1.30 mm.; proboscis 0.077–1.00 mm. \times 0.099–0.110 mm.; proboscis sheath 0.264 \times 0.099 mm.; lemnisci longer 2.728 \times 0.176 mm., shorter 2.508 \times 0.176 mm.; anterior testis 1.188 \times 0.484 mm., posterior testis 1.122 \times 0.484 mm.; prostatic mass 0.902 \times 0.352 mm.; seminal vesicle 0.484 mm.; bursa 0.682 mm.; ova 0.154 \times 0.055 mm.; proboscis hooks terminal 0.050 mm., middle 0.037 mm., basal 0.035 mm.

TABLE II.—Characters of some closely related species of *Neoechinorhynchus*.*

Species.	Dimensions.	Proboscis.	Proboscis hooks.	Number of Subcuticular nuclei.
1. <i>N. agilis</i> (Rudolphi, 1819).	♀ 45 × 0.5-1.0	Length greater than breadth.	3 rows of 6 i. 0.09-0.12 ii. 0.041-0.053 iii. 0.03-0.07	Dorsal—4. Ventral—2.
2. <i>N. australis</i> Van Cleave, 1931.	♂ 3.6-7.0 ♀ 4.0-18.0 × 0.35	0.15-0.18 × 0.12- 0.15	3 rows of 6	..
3. <i>N. cylindratus</i> (Van Cleave, 1913).	♂ 4.5-8.5 × 0.5- 0.7	0.172 × 0.150	i. 0.079-0.097 ii. 0.037 iii. 0.021-0.025	..
4. <i>N. tenellus</i> (Van Cleave, 1913).	♂ 2.0-8.0 ♀ 3.5-13.0 × 0.6	0.15-0.135	i. 0.09-0.11 ii. 0.038 iii. 0.027	..
5. <i>N. crassus</i> Van Cleave, 1922.	♂ 4.0-7.0 ♀ 6.0-9.0	0.27-0.325 × 0.24-0.27	i. 0.094-0.1 ii. 0.071-0.083 iii. 0.047-0.071	..
6. <i>N. magnus</i> Southwell & Macfie, 1915.	♀ 90.0 × 1.5	..	3 rows of 6. i. 0.06-0.071 ii. 0.03-0.037 iii. 0.018	..
7. <i>N. variabilis</i> (Diesing, 1856).	♂ 9.0-25.0 ♀ 9.0-50.0	..	2 rows.	..
8. <i>N. zacconis</i> Yamaguti, 1933.	1.43 × 0.37	..	6 oblique rows of 3. i. 24μ ii. 18μ iii. 12μ	..
9. <i>N. octonucleatus</i> Tubangui, 1933.	♀ 9.09 × 1.09	..	3 rows of 6. i. 88-91μ ii. ? iii. 35μ	..
10. <i>N. rutili</i> (Müller, 1780).	♂ 2.0-6.0 × 0.4- 1.0 ♀ 5.0-10.0	0.038 × 0.019- 0.021
11. <i>N. hutchinsoni</i> sp. nov.	♂ 7.8-8.2 × 0.8- 1.0 ♀ 18.9 × 1.30	0.077-0.100 × 0.099-0.110 Breadth greater than length.	3 rows of 6. i. 0.050 ii. 0.037 iii. 0.035	Dorsal—5. Ventral—2.

* All measurements are in millimetres except where otherwise indicated.

In referring the specimens to the genus *Neoechinorhynchus* I have relied on the characters of (i) the number and rows of proboscis hooks and their relative sizes, (ii) the shape and size of the proboscis, (iii) absence of spines on the body, (iv) the position of the central nervous system in the proboscis sheath, (v) the size of the lemnisci, (vi) the genitalia and the syncytial prostatic gland, and (vii) the number of the giant sub-cuticular nuclei.

From the above table and measurements it is evident that the new species *Neoechinorhynchus hutchinsoni* differs from the closely related species in the peculiar narrowing of the body in the males, in the dimensions of the males and females, in the shape and size of the testes and the prostatic mass, in the size of the terminal hooks as compared to the middle and basal rows; in that the lemnisci, though filamentous, are not long enough to reach to the testes.

The Type specimens are deposited in the collections of the Indian Museum.

Host.—*Diptychus maculatus* (Steindachner).

Location.—Intestine.

Locality.—Leh ; altitude 11,500 ft.

I have great pleasure in naming the species after Dr. G. E. Hutchinson.

Eosentis Van Cleave (1928).

Generic diagnosis.—Agrees with the diagnosis of the family *Neoechinorhynchidae*, except in the presence of 8-9 sub-cuticular nuclei in the mid-dorsal and 1-2 in the mid-ventral line. Body fusiform and tapering towards the posterior extremity, devoid of spines. Proboscis short and globular with three circles of six hooks each. Proboscis sheath a single-layered, thick, muscular sac. Three nuclei in each of the large lemnisci. Prostatic gland a single syncytial mass. Parasitic in the adult stage in the digestive tract of fishes.

Eosentis devdevi, sp. nov.

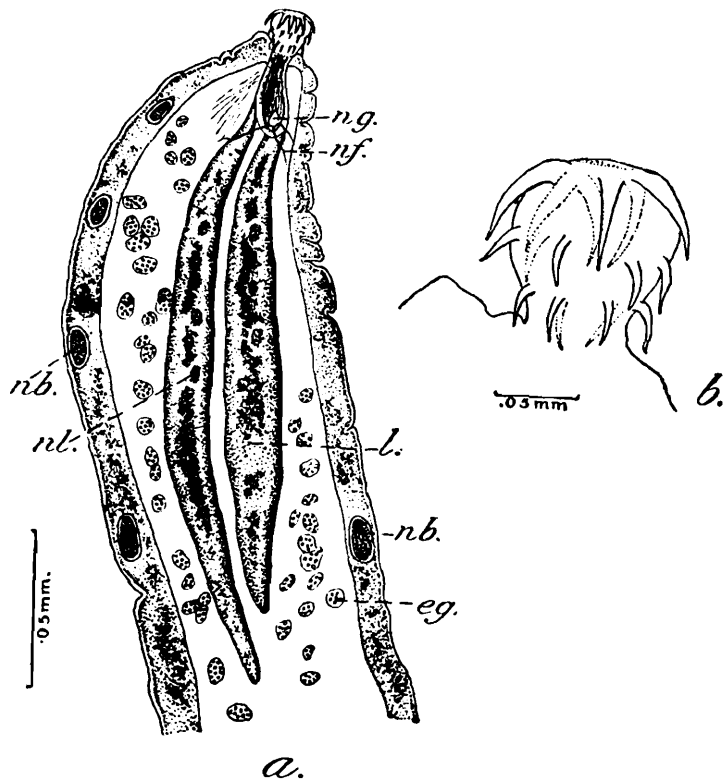
The genus *Eosentis* established by Van Cleave in 1928 is of interest as it is based on the study of one female specimen only. The genus is based mainly on the relatively large number of sub-cuticular nuclei, but the author does not mention the exact number that is generally found, although they are visible in the holotype of *Eosentis rigidus* deposited in the collections of the Indian Museum. The number of nuclei in the mid-dorsal line is 9 and in the mid-ventral line 1. This number, with slight modifications, seems to be constant in all the species belonging to this genus and distinguishes them from the species of the genus *Neoechinorhynchus*, in which there are 4-5 nuclei in the mid-dorsal and 1-2 in the mid-ventral line.

The new species is fusiform in shape and tapers moderately towards the posterior end. The external body wall is slightly furrowed giving it an annulated appearance. This condition is not a permanent feature of the species as in whole mounts the ridges disappear, and the transverse canals of the lacunar system become prominent in the body wall. The body is devoid of spines.

The proboscis (Fig. 5, *b*) is short and globular with three circles of six hooks each. The hooks of the terminal circle are much longer and stouter than those of the other two circles. The proboscis is, in most cases, found tucked in in the short, thin, proboscis sheath, provided with a single-layered muscular wall. The retraction and protrusion of the proboscis is controlled by sets of strong bands of retractor and protractor muscles.

The two lemnisci are long filamentous structures which hang on either side of the proboscis sheath. There are three nuclei in each of these lemnisci as compared to *Neoechinorhynchus*, where we find two in one and one in the other.

The central nervous system consists of a single nerve ganglion situated near the base of the proboscis sheath. It gives out a few fine nerve branches which emerge through the wall of the proboscis sheath and supply the body wall. (Fig. 5, a.)



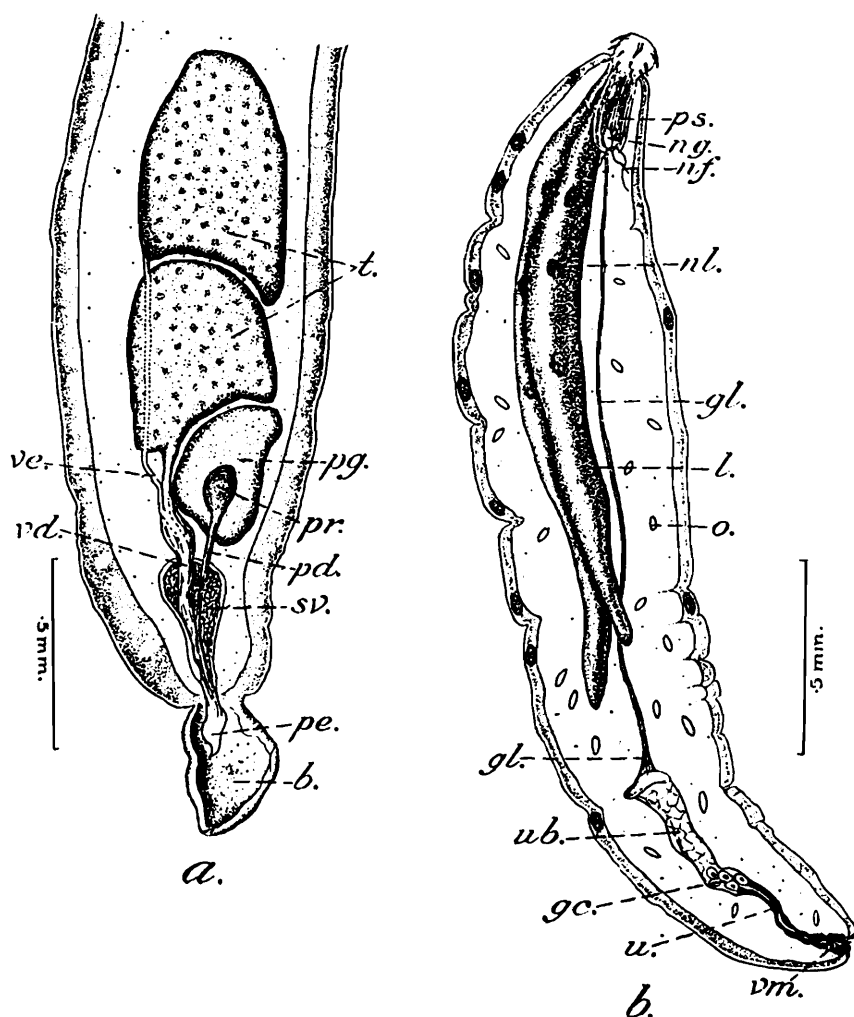
TEXT-FIG. 5.—*Eosentis devdevi*, sp. nov. (a) Anterior region; (b) Proboscis highly magnified showing arrangement of hooks.

eg., egg balls; l., lemnisci; nb., subcuticular nuclei; nf., nerve fibres; ng., central nerve gland; nl., nuclei of the lemnisci.

The male genitalia consist of two ovoid testes, almost equal in size, lying closely one behind the other. Each of the testes gives out a vas efferens, which runs by the side of the prostatic gland and meets the other to form the thick vas deferens, which opens with the opening of the seminal vesicle, at the base of the penis. The prostatic gland is a single syncytial mass which opens into a thick prostatic reservoir. The prostatic fluid is taken by the prostatic duct which ends at the base of the penis. The seminal vesicle is a thick-walled sac, which opens near the base of the penis to deliver the genital contents stored in it. The penis is a short, thick, muscular cone-like structure which hangs at the top of the funnel-shaped inverted bursa. The bursa can be everted (Fig. 6, a.) out of the body with slight pressure or at the time of mating.

The female genitalia consist of the funnel-shaped uterine bell kept in position by the genital ligament attached at the anterior end to the base of the proboscis sheath. The guard cells, which are rather large in size, lie at the base of the bell. The uterus is flabby and short; there are two flask-shaped cells situated near the posterior end of the uterine wall where it opens into the vagina. The vagina is a short, thick-walled muscular tube and is guarded by two bands of strong muscles, which control the exit of the ova in a single file through the vulva; the external opening of the genitalia is situated at the postero-ventral end.

Measurements.—Males 2.290–3.300 mm. \times 0.730–1.080 mm.; females 2.970–7.590 mm. \times 0.616–1.276 mm.; proboscis 0.132 \times 0.099 mm.; pro-



TEXT-FIG. 6.—*Eosentis devdevi*, sp. nov. (a) Posterior region showing the male genitalia; (b) Young specimen showing fully developed female genitalia.

b., bursa; *gc.*, guard cells; *gl.*, genital ligament; *l.*, lemnisci; *nf.*, nerve fibres; *ng.*, central nerve gland; *nl.*, nuclei of the lemnisci; *o.*, ova; *pd.*, prostatic duct; *pe.*, penis; *pg.*, prostatic gland; *pr.*, prostatic reservoir; *ps.*, proboscis sheath; *sv.*, seminal vesicle; *t.*, testes; *u.*, uterus; *ub.*, uterine bell; *vd.*, vas deferens; *ve.*, vas efferens; *vm.*, vaginal muscles.

proboscis sheath 0.264 \times 0.132 mm.; longer lemnisci 1.870 \times 0.132 mm., shorter 1.782 \times 0.132 mm.; anterior testis 0.704 \times 0.440 mm., posterior testis 0.616 \times 0.440 mm.; prostatic gland 0.440 \times 0.308 mm.; seminal vesicle 0.374 \times 0.198 mm. at the broadest end; uterine bell 0.415 \times 0.070 mm.; uterus 0.250 \times 0.035 mm.; vagina 0.050 \times 0.040 mm.; ova 0.020 \times 0.005 mm.; proboscis hooks terminal 0.090 mm., middle 0.045 mm., basal 0.040 mm.

Eosentis devdevi differs from *Eosentis rigidus* in the length and shape of the body, in the exact number of sub-cuticular nuclei in the body wall, and in the presence of a heavy network of lacunar canals.

All type specimens are deposited in the collections of the Indian Museum, Calcutta.

Host.—*Schizothorax planifrons* Heckel.

Location.—Intestine.

Locality.—Kashmir valley; canal to Dal Lake, Srinagar (Sta. K. 6); Dal Lake, Srinagar (Sta. K. 11); altitude *ca.* 5,200 ft.; channels to Mansbal Lake, Srinagar (Sta. K. 48), altitude 5,196 ft.

I have great pleasure in associating this species with the name of my colleague, Mr. Dev Dev Mukerji.

***Eosentis yalei*, sp. nov.**

The four specimens which I refer to this new species, were in a poor condition, and great difficulties were experienced in taking their measurements and making permanent stained preparations. They were deep brown in colour and very tender. There was only one male specimen in the collection, and the remaining three were gravid females. The main anatomy tallies with the description of *Eosentis devdevi*, except in measurements and in the number of sub-cuticular nuclei in the mid-dorsal and mid-ventral line of the body wall.

Measurements.—Male 5.390×0.880 mm.; females $5.00-8.00$ mm. \times $0.990-1.100$ mm.; proboscis 0.132×0.110 mm.; proboscis sheath 0.242×0.132 mm.; longer lemnisci 2.090×0.242 mm., shorter 1.870×0.242 mm.; anterior testis 1.144×0.616 mm., posterior testis 1.100×0.528 mm.; prostatic gland 0.396×0.242 mm.; seminal vesicle 0.286×0.196 mm. at the broadest end; uterine bell 0.308×0.132 mm.; uterus 0.484×0.055 mm.; vagina 0.110×0.088 mm.; ova 0.028×0.008 mm.; proboscis hooks terminal 0.080 mm.; middle 0.040 mm.; basal 0.040 mm.

TABLE III.—Comparative table of the species of the genus *Eosentis*.*

Species.	Dimensions.	Proboscis.	Proboscis hooks.	Number of sub-cuticular nuclei.
1. <i>Eosentis rigidus</i> Van Cleave, 1928.	♀ 9.0×0.87	0.192×0.153	i. 70μ ii. 47μ iii. 41μ	8-9 & 1-2.
2. <i>Eosentis devdevi</i> , sp. nov.	♂ $2.29-3.30 \times 0.73-1.08$ ♀ $2.970-7.590 \times 0.616-1.276$	0.132×0.099	i. 0.090 ii. 0.045 iii. 0.040	9 & 2.
3. <i>Eosentis yalei</i> , sp. nov.	♂ 5.390×0.880 ♀ $5.00-8.00 \times 0.990-1.110$	0.132×0.110	i. 0.080 ii. 0.040 iii. 0.040	8 & 1.

* All measurements are in millimetres except where otherwise indicated.

From the above table it is evident that the two new species, *Eosentis devdevi* and *Eosentis yalei*, differ from each other as also from *Eosentis rigidus*, mainly in the dimensions of the body in both the sexes, and in the number of cuticular nuclei. The proboscis in both the new species is smaller than in *E. rigidus*.

All type specimens of *E. yalei* are deposited in the collections of the Indian Museum, Calcutta.

Host.—*Schizothorax esocinus* Heckel.

Location.—Intestine.

Locality.—Kashmir valley, Srinagar (Sta. K. 7), altitude ca. 5,200 ft.; Jhelum river (Sta. K. 14), altitude ca. 5,200 ft.; channel to Mansbal Lake, Srinagar (Sta. K. 48), altitude 5,196 ft.

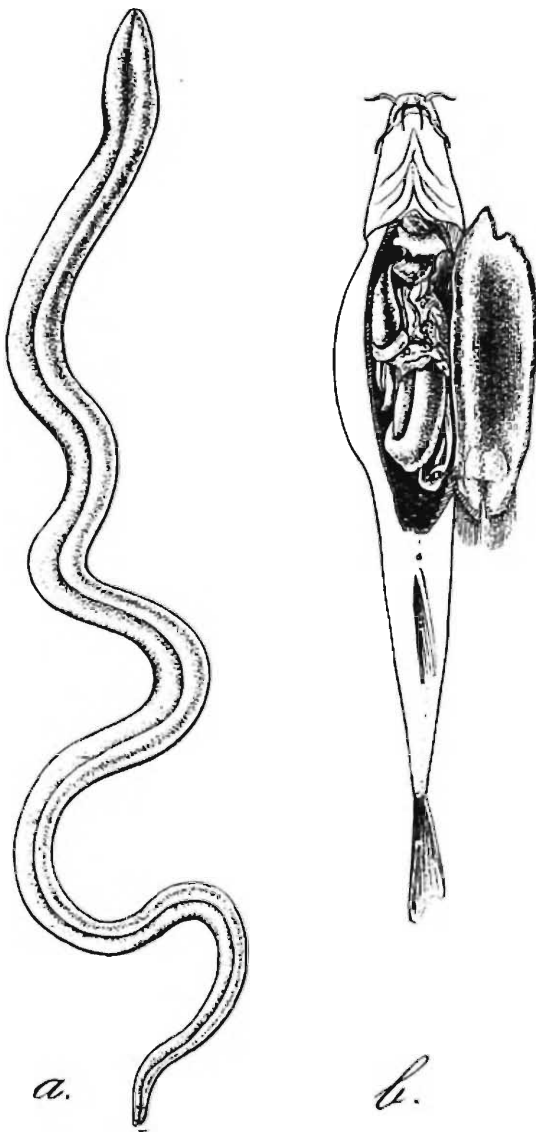
I have great pleasure in associating this species with the name of the Expedition which collected the material under report.

CESTODA.

Subfamily *LIGULINAE* Monticelli & Crety.**Ligula** Bloch 1782.**Ligula intestinalis** (Linnaeus, 1758).1930. *Ligula intestinalis*, Southwell, *Fauna Brit. Ind.*, *Cestodes* I, p. 63.

The collection of Cestoda received from Dr. G. E. Hutchinson in several tubes, and the collection in a single tube from Dr. S. L. Hora consisted of larvae of *Ligula intestinalis* (*vide infra* p. 227), in various stages of development.

Ligula intestinalis in the larval form is found very commonly in fishes all over the world. In the present collection, all the parasites are from hosts in which they have not been recorded so far.



TEXT-FIG. 7.—*Ligula intestinalis* (Linnaeus), (larval form). (a) Entire specimen from the body cavity of *Nemachilus hutchinsoni*; (b) Showing the position of the parasite within the body cavity of the host, *Nemachilus hutchinsoni*.

The parasites are light cream in colour except in some cases where they had been kept in preservatives for a long time when they appear somewhat brownish. They are lanceolate in form with blunt tapering ends. The maximum breadth is at a point just about one third the

distance of the total length from the anterior extremity. There is no sign of bothridea or external segmentation. They vary in length sometimes attaining a length of about a metre, the breadth also varies from 5 mm. to 15 mm. Throughout the entire length of the worm a channel-like depression is seen in the middle of the body. Slightly irregular notches are seen about the margins of the body. The smallest specimen in the collection is 4 mm. \times 0.98 mm. from Tube No. 476-A.

Material examined.

- Tube No. 209.* Host—?. Locality—Tso Nyak; altitude ca. 14,100 ft.; 7 specimens. Dimensions 16.0–55.0 mm. \times 2.5–6.8 mm.
- Tube No. 474.* Host—*Schizopygopsis* sp. Locality—L. 74. Pangur Tso, altitude ca. 14,203 ft. 1 specimen. Dimensions 168.0 mm. \times 8.0 mm.
- Tube No. 474.* Host—*Nemachilus* sp. Locality—L. 74. Pangur Tso, altitude ca. 14,203 ft. 2 specimens. Dimensions 41.5–48.0 mm. \times 4.5–7.0 mm.
- Tube No. 476 (A).* Host—?. Locality—L. 74. Pangur Tso, stream west end; altitude ca. 14,203 ft. 5 specimens. Dimensions 4.0–72.0 mm. \times 0.98–6.00 mm.
- Tube No. 522.* Host—Smaller fish No. F. 151. Locality—L. 74, Pangur Tso altitude ca. 14,203 ft. 2 specimens. Dimensions 52.0–54.0 mm. \times 2.2–5.0 mm.
- Tube No. 713.* Host—*Schizothorax* sp. Locality—K. 6 J-N. Ganjibal, Dal Lake, Srinagar; altitude ca. 5,200 ft. 1 specimen. Dimensions 24.0 mm. \times 2.5 mm.
- Tube No. 723.* Host—*Chush* Locality—K. 12-A. Below bridge canal, Srinagar; 2 specimens. Dimensions 39.8–41.5 mm. \times 2.1–2.2 mm.
- Tube No. ?.* Host—*Nemachilus* sp. Locality—L. 74, Pangur Tso; altitude ca. 14,203 ft. 1 specimen. Dimensions 27.0 mm. \times 2.0 mm.
- Tube No. ?.* (From Dr. S. L. Hora). Host—*Nemachilus hutchinsoni* Hora Locality—L. 40. Pool isolated from river near Pangur Tso; altitude ca. 14,164 ft. 1 specimen. Dimensions 152.0 mm. \times 7.5 mm.

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