IX. NOTES FROM THE BENGAL FISHERIES LABORATORY

No. 4. CESTODE PARASITES OF HILSA, *HILSA ILISHA* (HAM. BUCH.).

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(Plates IV, V.)

CONTENTS.

I. THE ANATOMY AND LIFE-HISTORY OF *RHYNCHOBOTHRIUS ILISHA*, N. SP., FROM THE INTESTINE OF *CARCHARINUS GANGETICUS* (MÜLL. and HENLE).[1]

DURING September and October, 1917 observations were made by us in the Pusser river, district Khulna, on the habits of Hilsa, *Hilsa ilisha* (Ham. Buch.). This anadromous fish ascends the Bengal rivers, during the rains, for the purpose of breeding. Two methods of catching the fish are practised by the Bengal fishermen :—

(1) Small canoes drift down stream, broadside on, trailing behind them a *shangla jal*. This is a small purse-like net which can be manipulated easily by one man. The moment a Hilsa is caught, the mouth of the net is closed, the net is hauled aboard, the fish removed, and the net cast over again. By this method it is very rare for more than one fish to be caught at a time.

(2) A large gill-net, often measuring 300 feet in length, is shot by one, or between two, boats, and allowed to drift downstream for perhaps two miles or so. It is then hauled. The catch varies between two or three fishes and two hundred.

In both cases, the boats return to the starting point, picking their way close to the bank of the river, aided by the wind, which fills a big sail of fantastic shape and colour. In both the above methods of fishing the entry of a fish into the net is most easily detected. Whilst working with the gill-net, we frequently noticed that fish entered the net, but somehow escaped. On hauling the net it was in every case found to be torn. The fishermen assured us that the damage had been

[1] *Carcharius gangeticus* (Müll. and Henle) in Day's Fishes in the "*Fauna of British India.*"

done by a shark, and that sharks frequently attacked and ate Hilsa from the large net. A few days later we were fortunate in catching a shark in one of the small *shangla jals*. It proved to be a specimen of *Carcharinus gangeticus* (Müll. and Henle), which measured a little over 6 feet. The stomach contained a Hilsa, partly digested, and also a portion of the net. On examining, carefully, the partly digested Hilsa, it was found that the flesh of this fish contained numbers of club-shaped Cestode cysts, which, as a result of the partial digestion of the fish, were actively emerging from the flesh into the stomach of the shark. These cysts, which occurred in the muscles, had not been noticed previously. The large intestine of the shark contained numbers of adult Cestodes, but the spiral valve was clean. These parasites were found, ultimately, to be of two species, *viz.*, (1) *Discocephalum pileatum*, Linton. The only species of the genus was recorded by Linton from the spiral valve of the dusky shark *Carcharius obscurus* ? Woods Hole, Mass., July 19th, 1886 ; it has not been recorded since. (2) *Rhynchobothrius ilisha*, n. sp., which forms the subject of this paper. All the cysts seen emerging from the partly digested Hilsa were found to contain larvae of *Rhynchobothrius ilisha*. No cysts were obtained which contained larval forms of *Discocephalum pileatum*, Linton. De, in his report on the "Fisheries of Eastern Bengal and Assam," Shillong, 1910, mentions that sharks and saw-fishes follow the Hilsa up the rivers of Eastern Bengal and Assam. This is certainly true of *Carcharinus gangeticus*.

Systematic position.

Family Tetrarhynchidae.
Sub-tribe Trypanorhyncha, Diesing.
Sub-family Phyllorhynchinae, Van Beneden.
Sub-family I. Dibothriorhynchinae.
Family Dibothriorhynchidae, Diesing.
Genus *Rhynchobothrius*, Rudolphi.
(*Tetrarhynchus* of authors.)

Generic characters :—Body taeniform. Neck tubular. Head continuous with neck, with two opposite bothria, parallel or converging at the apices, lateral or marginal, entire or undivided, or, either bilocular with a longitudinal partition, or bilobed or divided. Proboscides four, terminal, filiform, armed, retractile in the neck, for the most part longer than the head. Genital apertures marginal, female lateral, or male and female marginal approximate.[1]

Rhynchobothrius ilisha, n. sp.

(Plate iv, figs. 1—7.)

Bothria two, lateral, entire, rounded, external face hollowed to form a sucking disc ; widely separated posteriorly, and approximated anteriorly. Neck shorter than the head, flat. Proboscides filiform and armed with four kinds of hooks, arranged in oblique circles, the larger

[1] After Linton (2).

hooks being distributed principally on the outer surface. Anterior segments shallow and numerous. Last segment much longer than head. Total number of segments about 232. Genital apertures irregularly alternate, and situated about the posterior third of the proglottid. Length of worm 11·5 cms. Posterior segments separating in two's and three's.

Habitat.—The large intestine of *Carcharinus gangeticus* (Müll. and Henle). Khulna, district Khulna, Bengal, 21st October 1917 Eleven adult specimens, several young forms just emerged from the cyst, and three cystic forms. No. Z.E.V $\frac{7248}{7}$ in the collection of the Indian Museum.

Observations were made on the adult living worms and also on the free proglottides, in fresh water. Later on, these were preserved in corrosive acetic solution. Specimens were mounted stained whole with borax carmine, and also unstained. Sections were not found necessary as the anatomy could easily be determined from the mounted specimens. The head is large compared with the size of the worm and measures 4·2 mm. in length. The breadth of the anterior extremity is 2·6 mm., and of the posterior extremity 1·4 mm. Length of bothridia 1·8 mm. Length of proboscides 2·1 mm. Length of proboscis sacs 1·6 mm.

The bothridia (B) are paired, approximated anteriorly and widely separated posteriorly (plate iv, fig. 2). They are round in shape, having entire margins, and sucker-like external surfaces. The proboscides (P) are four in number; the armed portion is very short, with an equal length unarmed and very long tubes connecting them to the proboscis sacs (P. S). The hooks (plate iv, fig. 2 *a*—*e*) are of four types arranged in oblique rings, the larger ones being disposed along the outer margins. As usual, the hooks towards the base of the proboscides are much smaller than the rest.

The neck is short, measuring only 2·2 mm. It is flattened and not cylindrical. The anterior proglottides are shallow and numerous. The posterior proglottides are much longer than broad, measuring 5·1 mm. by 1·3 mm. The total number of proglottides is about 232. The male genital organs appear first. The female organs are to be seen only in the last few proglottides. Of the male organs, the testes are first visible about the middle of the worm. The genital aperture is situated about the posterior third of the proglottis, and the male aperture is immediately in front of that of the female.

Male organs (plate iv, fig. 4).—These consist of a large number of testes (T) occupying the greater part of the mature proglottid. They first appear laterally. From each of these is given off a minute tubule; these unite later to form the vas deferens (V D). This is a thick coiled tube originating a little in front of the ovaries and opening directly into the cirrus sac (C). The vesicula seminalis (V S) is a bag-like structure which opens close to the junction of the vas deferens and the cirrus sac. The penis is fairly long and lies coiled up in the spacious cirrus sac. We could not distinguish any armature.

Female organs (plate iv, fig. 4).—The ovaries (Ov) are paired and lie one on each side of the centre line, posteriorly. From each is

given off, anteriorly, a very small oviduct (O.d). The two oviducts unite in the middle-line and receive, at the point of junction, the duct of the shell-gland (S. G). This organ lies between the ovaries, in the centre line. The uterus (Ut) originates, anteriorly, from the point of union of the two oviducts. It runs forward in the middle-line as a blind diverticulum, practically to the anterior termination of the proglottid, narrowing as it goes. The vagina (V) also originates close to the mouth of the uterus and is continued as a narrow coiled tube to near its opening. It then widens to form a barrel-shaped receptaculum seminalis (R.S).

Water-vascular system (plate iv, fig. 3).—This consists of a single pair of wide tubes (W T), situated one on each side, internal to the excretory vessel and nerve. These two tubes communicate with each other by a wide transverse vessel situated at the posterior margin of each segment. In the head, the two tubes break up into a series of fine vessels distributed throughout the substance of the head.

Excretory system (plate iv, fig. 3).—This consists of a pair of very fine tubes (E. D) situated, one on each side, between the water-vascular vessel and the nerve. In the proglottides, they do not unite, but in the head they are united by a single transverse vessel.

Nervous system (plate iv, fig. 3).—In each proglottid this consists of a single fine nerve (N) on each side, external to the water-vascular and excretory duct. No attempt was made to follow the distribution of the nervous system in the head.

The larva.—We have already referred to the fact that numbers of tadpole-like cysts were found in the lateral muscles of the partly digested Hilsa. Previous to this record no cysts had been noticed in the flesh of Hilsa, although some time ago larval forms of *Syndesmobothrium filicolle*, Linton, were recorded by one of us from the mesenteries of this fish (5 & 6). The *Rhynchobothrius* cysts were, as noted, tadpole-shaped (plate iv, fig. 5). They consisted of a club-like head, and a long tail-like structure which was capable of considerable movement, and appeared to us to serve the purpose of mooring the larva in the intestine of the shark, during the digestive processes.

The head, in one specimen, measured 4·8 mm. by 3·6 mm. The tail tapers to a point and measured 51·8 mm. in length. On opening out the " head," the larva (Y) was seen to be a massive structure occupying the greater part of the head and lying in a coiled position (plate iv, fig. 6). The tips of the four proboscides were just everted, and the spines could be clearly seen. Many young worms (plate iv, fig. 7) were also obtained from the lumen of the intestine. These had not had time to attach themselves to the intestine of the host.

Life-history.—The Cestodes usually complete their life-histories in two separate hosts, the larval form occurring in an animal which is devoured wholly, or in part, by the final host of the worm. In a great number of cases the larval forms of adult worms have not been recorded. In fewer instances larval forms have been described, but the adult worm developing therefrom is not known. The circumstances under which we are able to follow the life-history of this worm are undoubtedly unique. In the present instance, the larval form of *Rhyn-*

chobothrius ilisha occurs in the lateral muscles of Hilsa. This fish is eaten by the shark *Carcharinus gangeticus*, and practically all stages between the cystic form and the adult worms are to be found in the intestine of the shark in question.

Three points arise for consideration :—

(1) We have already called attention to the fact that the tail of the tadpole-like cyst is mobile. It appeared to us on examining the living material, *in situ*, that the movements of the tail were directed toward retaining the cyst in the lumen of the shark's intestine, until the larva had had time to emerge and attach itself to the wall of the gut.

(2) We have no information as to the exact manner in which the Hilsa become infected. The eggs of the adult worm are obviously shed into the water. Most probably they are swallowed accidentally by the Hilsa, in which case the larva would be liberated and carried to the muscles, *viâ* the lymph or the blood stream. It is further possible that the larvae hatch out in water, and, attaching themselves to the Hilsa, bore their way to the lateral muscles ; but as we know nothing regarding the structure of the larva, we can only hazard a guess as to the initial mode of infection of the Hilsa.

(3) It will be clear that parasites occurring in the intestines of fish are removed with the entrails of the fish, before the fish is cooked and eaten. But when these parasites occur in the flesh, their removal is impossible.

Rhynchobothrius ilisha, n. sp., is the first example of an Indian Cestode whose life-history has actually been worked out. It is true that in the cosmopolitan forms of tapeworms, such as *Taenia solium*, *Taenia serrata*, etc., the life-history is well known. In India, owing to the occurrence of these species in precisely similar hosts, the same life-history has been inferred ; but so far as we are aware no experimental work of this kind has been attempted.

Shipley and Hornell (4) described two species of tapeworms from *Carcharias gangeticus* (now *Carcharinus gangeticus*) obtained in Dutch Bay, Ceylon (salt water), 3rd January 1905, *viz.*, *Tertrarhynchus perideraeus* and *Tetrarhynchus gangeticus*. Our species is totally dissimilar to the former and differs in the following particulars from *Tetrarhynchus gangeticus* :—

1. Our worms are 17 times longer.
2. A distinct neck is present.
3. The arrangement of the proboscis tubes is quite different.
4. The hooks are different.

As nothing has been stated by the authors regarding the anatomy of their species we have no means of carrying the comparison further. Our species is quite different from other species of this genus.

Four species of Cestoda have now been recorded from this shark, *viz.*, *Tetrarhynchus perideraeus*, *Rhynchobothrius ilisha*, *Tetrarhynchus gangeticus*, and *Discocephalum pileatum*.

Classification.—As a result of some years' observations on the Tetrarhynchidae we are of opinion that this family requires revision, particularly with reference to the anatomy of the reproductive organs. Fortunately, we have a fairly extensive and representative collection

and we are hoping, at no distant date, to be able to determine, in detail, the exact relationships of the various genera included in this family.

The anatomy of the reproductive organs in our species is quite unlike that given by Linton (2) for the various species of Rhynchobothridae recorded by him. On the other hand, it resembles very closely the figure of an immature proglottid of *Tetrarhynchus erinaceus*, Ben., figured by Johnstone (1). It differs only in the absence of vitellaria and a few minor details.

Literature cited—

(1) Johnstone, J.—*Tetrarhynchus erinaceus*, Van Beneden. *Parasitology*, Vol. IV, No. 4, Cambridge, 1912.

(2) Linton, E.—Notes on Entozoa of marine fishes of New England, with descriptions of several new species. *United States Fish Commissioners' Report*, 1887

(3) Regan, C. T.—A revision of the Clupeoid Fishes of the genera *Pomolobus*, *Brevoortia*, and *Dorosoma* and their allies. *Ann. Mag. Nat. Hist.*, Vol. XIX, No. 112, April, 1917

(4) Shipley and Hornell.—Cestode and Nematode parasites from the marine fishes of Ceylon. *Ceylon Pearl Oyster Report*, Vol. V, Royal Society, London, 1906.

(5) Southwell, T.—On some Indian Cestoda. Part I. *Rec. Ind. Mus.*, Vol. IX, Part V, December, 1913.

(6) Southwell, T.—Notes from the Bengal Fisheries Laboratory. Parasites from Fish. *Rec. Ind. Mus.*, Vol. IX, Part V, 1913.

II. A NOTE ON THE CYSTS OF *SYNDESMOBOTHRIUM FILICOLLE*, LINTON, PARASITIC IN THE LATERAL MUSCLES OF HILSA.

Specimens of Hilsa purchased from the Calcutta market during October, 1917 were found, on careful examination, to contain cysts of *Syndesmobothrium filicolle*, Linton, in their flesh (lateral muscles).

Southwell (3) recorded specimens of this cyst from the mesenteries of Hilsa in 1913. This parasite is, of course, distinct from the cysts of *Rhynchobothrius ilisha*, Southwell and Prashad, described in the first part of this paper.

The cysts, when removed from the muscles, showed a considerable amount of movement and remained alive in normal salt solution for a few hours. Both the head and tail of the tadpole-shaped cysts (plate iv, fig. 8) were mobile. The head, in addition, showed contractile movements, owing to which its shape exhibited great variation in form.

The cysts measured about 64 mm. in length, the head being 5·7 mm. long by 3·1 mm. broad, whilst the tail varied in length from 58 mm. to 60 mm. The tail was an elongated tapering structure. The cysts were of a milky-white colour, the head being formed of stout fibrous tissue, whilst the tail portion consists of a thin membrane enclosing an albuminous fluid.

On one of these cysts being dissected out it was seen that the head portion contained a second cyst (Y), almost cylindrical in shape, transparent, and 3 mm. in length.

This second cyst, on being opened, was found to contain the worm (plate iv, fig. 9), which showed four fully developed bothridia and four proboscides, with a neck and an undifferentiated part posteriorly, which terminated in a vesicle.

The parasites were not very numerous in the specimens of Hilsa which we examined.

Literature cited—

(1) Linton, E.—Notes on Entozoa of marine fishes. *Report U. S. Fish Comm. for* 1887. Washington, 1891.

(2) Southwell, T.—*Ceylon Marine Biological Reports*, Part VI. Colombo, 1912.

(3) Southwell, T.—On some Indian Cestoda, Part I. *Rec. Ind. Mus.*, Vol. IX, Part V, 1913.

III. A DESCRIPTION OF A CESTODE PARASITE OF DOUBTFUL SYSTEMATIC POSITION, FROM THE MESENTERY AND LIVER OF HILSA.

I. INTRODUCTION.

In the following paper we propose describing a parasite which, though of small size, appears to be of very great systematic importance, and which further reproduces itself in a manner not before known amongst the Cestoda.

The parasites were found first at Khulna in the mesentery of Hilsa. The mesentery (*m*), binding up the various coils of the intestine, was infected so very heavily as to appear something like a massive liver-like organ in which the various coils of the intestine appeared merely as tubes embedded therein. The infection had further spread to the liver [L (i)] which, in most specimens examined, was also heavily infected, though only in part (plate v, fig. 1).

Since the initial observations were made, the parasites have been found to be widespread. They were found in Hilsa examined by us from Goalundo, Sahebgunj, Kalna, and Calcutta. The infection is of such a heavy nature that, although more than a hundred specimens have been examined, not a single one was found which was not similarly infected. Continuous observations on living and preserved material were made at Khulna and Kalna and in the Fisheries Laboratory in the Indian Museum, over a considerable length of time. It has thus

been possible not only to make exact observations on the parasite, but also to refer to all the literature found necessary. The adult parasites, as found in the mesentery, lie in elongated cysts of a creamy-yellow colour. The cysts measure 2·5 to 3 mm. in length. The younger stages are found scattered in the mesentery, the cyst not having been secreted at this stage.

II. TECHNIQUE.

Living worms are dissected out of the cyst in normal salt solution, under a binocular microscope, and are examined alive on a slide with the highest powers available. They are best preserved for whole mounts in an alcoholic solution of Schaudinn's corrosive acetic solution. The salt solution containing these dissected out worms on the slide is first drained off and a few drops of the fixative added to cover them. After about half an hour the fixative is drained off and the usual method of staining and mounting adopted. We found that Heidenhain's iron haematoxylin gave the best results. Serial sections of the worms were cut with a Minot's rotatory microtome and stained with Heidenhain's iron haematoxylin.

III. THE ANATOMY AND DEVELOPMENT OF THE ADULT WORM.

(1) *The Cyst* (plate v, fig. 2).—The worm occurs, as we have already remarked, in an elongated cyst which varies from 2·5 to 3 mm. in length. Its width is usually ·4 to ·5 mm. The cyst is cylindrical and rounded at both ends. It is made up of strong fibrous tissue. On opening out the cyst it is found to consist of a single adult worm, with a few young worms which have been produced pathenogenetically in a manner to be described later on. The worm is attached to the internal wall of one of the rounded ends of the cyst by four suckers, which occur at the anterior end of the worm. The anterior extremity of the cyst, which is the same as that of the animal, can easily be distinguished under a lens, or the binocular microscope, owing to a reddish-orange pigment shining through the cyst at this end. It may be stated here that the cyst is in no way secreted by the parasite, but is formed by the tissues of the host itself undergoing a change. Besides the worm, the cyst contains a large number of fat globules and fat cells, which appear to serve as food for the parent worm.

(2) *The adult worm* (plate v, fig. 3).—The adult worm is a leaf-like animal resembling a small liver-fluke. It measures 2·4 mm. long and ·38 mm. broad. These measurements refer only to the fully grown animals found in the cyst. It is of a milky-white colour, with two more or less triangular patches of orange-red pigment (P.C.) situated near the anterior end, just posterior to the suckers, one on either side. The worm, on examination under a microscope, is seen to consist of an anterior and a posterior extremity. Anteriorly there is a median rostellum-like structure (R), devoid of any armature. Immediately posterior to it are four typical suckers (plate v, fig. 4), arranged symmetrically round the base of the rostellum. These are circular, having deep concavities, with thick raised, entire, margins. The usual three

kinds of muscles can be distinguished as forming the structures in question. The posterior extremity of the worm is rounded. No opening whatsoever is to be seen at this extremity. The outer cuticle is somewhat thickened.

(3) *Internal structure of the worm.*—On examining the worm with the high power it is seen to consist of a homogeneous substance in which no differentiation into separate organs is to be observed. In fact, the structure is of a most primitive character. All that can be distinguished besides the egg-cells (E) and the coloured corpuscles, in both living and stained specimens and in sections, is a tube, slightly coiled, which runs round the worm, close to, and parallel with, the margin of the leaf-shaped worm. Anteriorly, near the suckers, the two ends curve inwards for a short distance towards the centre of the worm. This is the excretory tube (E.t.), and from it are given off a large number of minute tubules which end in typical flame cells. The flame can, with an oil-immersion lens, be seen moving in these cells, in the living worm. The whole of the homogeneous substance referred to above is filled up with enormous numbers of minute egg-cells. Besides the eggs, *morulae* [(E (i)] and other higher stages in the development of the young were also present in the intima.

The orange-red coloured corpuscles (P. C.) are arranged in two triangular patches, one on each side, immediately behind the suckers. Each of these patches is formed of a large number of nearly rounded corpuscles measuring 23-25 μ in diameter. We are unable to say anything regarding the function of these corpuscles. When the worms die, or are preserved, the pigment disappears.

(4) *Egg-cells.*—The egg-cells (plate v, fig. 5) are elliptical, measuring 17 μ by 12 μ. The structures of the egg-cells is the same as that of a typical ovum with little yolk, and they probably originate in the same way as the parthenogenetic egg-cells in the sporocysts (and other larval stages) of the Trematodes. Some of these egg-cells were seen to be in different stages of development (plate v, fig. 6). They develop in the body of the parent to form young worms identical in structure and appearance with the parent. These will be fully described later on. Under ordinary circumstances the anterior extremity, or rostellum, of the adult worm shows no opening, but, when the development of the parthenogenetic young worms is complete, it is seen that the young worms have gradually worked their way to the anterior extremity of the adult. They now escape through a temporary aperture which is formed in the middle of the rostellum, anteriorly. In plate v, fig. 7 one such young worm is shown in the act of escaping. We were fortunate in being able to observe two such cases, on different occasions, in living animals under microscopic observation. After the parent form has produced numbers of such young, the cyst breaks up and the young escape into the mesentery of the host. The parent form now dies and many empty cysts can always be seen in the mesentery of the host.

(5) *The young worms* (plate v, fig. 8).—These vary in size from ·3 mm. to ·35 mm. in length by ·1 to ·12 mm. in breadth. They, like the adult worm, possess four suckers, a rostellum, imperfectly developed excretory tube, and a few eggs, but are devoid of pigment.

IV SYSTEMATIC POSITION OF THE WORM.

It will be clear from the preceding description that the parasite presents many unique characters. Our first impressions were that the parasite was a Trematode, but subsequent investigation showed that this was not the case. The entire absence of an alimentary canal, and the presence and arrangement of the four suckers, suggested the probability of the parasite being a Cestode, and it was only after careful examination that we concluded, definitely, that the animal belonged to the Cestoda.

Benham (1) defines the characters of the Cestoidea and the Trematoda as follows :—

(1) *Cestoidea.*—Platyhelminths in which an internal parasitic *habit has led to the disappearance of the alimentary canal from every stage in the life-history.*[1] The ciliated covering, as well as definite organs of sense, are likewise absent in the adult. The epidermis, which has sunk into the parenchyma, secretes a thick cuticle as in the Trematoda. In the parenchyma, certain lime-secreting cells are developed in greater or less number. Organs of fixation are developed in a characteristic, but varied form, at one extremity of the worm.

(2) *Trematoda.*—Parasitic Platyhelmia which retain the mouth and alimentary tract of the ancestor, but in which the epidermis not only loses its cilia during embryogeny but is apparently absent in the adult as a distinct continuous cellular layer, having sunk into the mesoblastic tissue after secreting a thick, stratified, chitinous cuticle. Further, in relation to their parasitic habits, suckers are developed at, or near, the posterior end on the ventral surface and also in the region of the mouth.

In considering the classification of the worm just described, three points are to be considered, *viz.* :—

(1) Is the animal a Trematode or a Cestode ?
(2) Is it a larval form or an adult ?
(3) If an adult, then is it a primitive or a degenerate form ?

(1) Is the animal a Trematode or a Cestode ?

The entire absence of all traces of an alimentary tract, the disposition of the suckers, and the absence of ventral posterior suckers are definite Cestode characters which, in our opinion, show that the worm is not a Trematode. The absence of an alimentary canal alone is considered by Luhé, and other leading helminthologists, to be the chief distinguishing character between Cestodes and Trematodes, although in some stages of the life-history of a few Trematodes, owing to degeneration, all traces of an alimentary canal disappear. We were unable to establish, by experiment, the actual presence of calcareous bodies, although under the microscope, typical calcareous bodies appeared to be present. The occurrence of orange-red corpuscles is an incidental character which it shares in common with many adult Tetrarhynchids, but we are not aware of any record of such coloured bodies being found in the Trematodes. Although the parasite seems to us to be undoubtedly a Cestode, we are aware that it differs very widely from

[1] The italics are ours.

any larval or adult Cestode hitherto described. These differences, as we shall see, are so great and so fundamental as to merit very careful consideration before coming to a conclusion.

(2) Is the parasite a larval or an adult form ?

Assuming it to be a larval form the following facts have to be considered :—

(*a*) The parasite exhibits, in common with the larval liver-flukes, the peculiar method of parthenogenetic development, but we know of no case among the Trematodes in which such active larval stages are passed in a vertebrate host. Further, nowhere does this type of parthenogenetic development take place within a cyst. Besides this, as the parasite in question has absolutely no trace of a digestive tract, we have no hesitation in concluding that it is not a Trematode larva.

Turning now to the Cestoda we find that the reproductive process is absolutely unique, whether the parasite be an adult or a larval form. It is unlike any Cestode larva we are acquainted with in being parasitic, absorbing food, reproducing itself, and in the progeny reinfecting the same host. Further, a combination of such adult structural characters as suckers, reproductive organs of whatever kind, and the excretory duct, is not to be seen in any larval Cestode. We are aware of the conditions existing in various species of the genus *Piestocystis* (3). We have seen Villot's account (6) of this form, as well as Hill's description of his species of *Piestocystis hoplocephali* and *Piestocystis lialis* (4). Although our form bears a superficial resemblance to *Piestocystis lialis* with the head evaginated, in having an unarmed rostellum and four suckers, yet our species, though encysted, has the rostellum and suckers always everted as in adult tape-worms ; this is so even in the young individuals of our species. Moreover, the excretory system in *Piestocystis lialis* and other species is open posteriorly, while in the parasite in question it is closed in all stages of its life-history. Also in *Piestocystis lialis* the buds are produced directly by a proliferation of the internal wall of the cyst. This is a typical larval condition, but in this worm which certainly appears to be an adult, the young are developed by a typical method of parthenogenesis (Lipospermia) in the body of the worm and not form the wall of the cyst.

For the above reasons we have to conclude that the parasite is an adult cestode, though the following facts might be urged against this assumption, *viz.*, (*a*) Absence of sexual genital organs, both male and female ; (*b*) the encysted condition of the adult parasite ; but the young parasites, as has been mentioned before, find their way out of the parent cyst, after they have grown to a fair size. They then lie in the mesentery for some time before themselves becoming encysted and repeating the same life-history ; (*c*) the entire absence of the nervous and water-vascular systems. The absence of these characters, however, in no way interferes with the acceptance of the form as a Cestode parasite, which is highly degenerate—a condition which perhaps is to be correlated with a changed life-history, completed in one host only, as appears to be the case with the form in question. This is further borne out by the extensive infection of the host which results in a very large progeny.

(3) If an adult, then is it a primitive or a degenerate form ?

We cannot consider the parasite to be a simple primitive form because of its structure, particularly the structure and disposition of the suckers, the excretory vessel, the specialised cyst, and the parthenogenetic method of reproduction.

Systematic position:—Owing to the degenerate nature, and the peculiar reproductive phase of the parasite in question, there is very great difficulty in assigning it to its true position amongst the Cestoda, but the presence of four unarmed suckers, as well as an unarmed rostellum, would suggest affinities with the Taeneoidea (Cyclophyllidea). For this peculiar worm we propose the name *Ilisha parthenogenetica*, n. g., n. sp.

The generic characters would be as follows :—

Small parasitic leaf-like worms occurring in cylindrical cysts. Anteriorly there is a rostellum and four suckers, which latter are arranged symmetrically round the base of the rostellum. All these are unarmed. Sexual organs and genital pores absent. Parthenogenetic development. The young are quite like the adult and find their way out of the parent, and later on repeat the same life-history.

Of doubtful affinity.

Habitat.—The mesentery and liver of *Hilsa ilisha* (Ham. Buch.) from various places in Bengal ; September and October, 1917.

A very large number of specimens. No. Z.E.V $\frac{7249}{7}$ in the collection of the Indian Museum.

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