ON SOME EARLY STAGES IN THE DEVELOPMENT OF THE SO-CALLED INDIAN SHAD, *HILSA ILISHA* (HAMILTON).

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(Plate V.)

CONTENTS.

INTRODUCTION.

Over a quarter of a century ago attempts were made both in Bengal and Madras to propagate *Hilsa* artificially on the lines followed for Shad in America. Artificial fertilisation of the eggs was carried out successfully in both places ; but whereas in Bengal the eggs could not be reared into larvae on account of the large quantities of the mud held in suspension in the river water and fungus attacks (Southwell and Prashad, 1918, p. 6), in Madras eggs were hatched out successfully (Sundara Raj, 1917, p. clxxxiv), and the present position in Madras is summed up as " the collection and hatching of *Hilsa* eggs continues as a routine at Madras (*sic*)" (Devanesen, 1939, p. 126). No detailed description of the eggs and early development of *Hilsa* has so far been published by the Madras Fishery Department, probably on account of the fact that the rearing of the delicate fry to the fingerling size in fresh waters has not so far been attempted. In his preliminary note on the spawning grounds and bionomics of *Hilsa*, Hora (1938) explained the circumstances under which young of *Hilsa* were found in great abundance in the settling tanks and filterbeds of the Calcutta water-works at Pulta. He also referred to the probable rate of growth of *Hilsa* as judged from measurements of 900 specimens collected from the isolated pucca settling tank No. 4 on the 21st November, 1937 Dr. Hora, with a view to elucidating the breeding season of this fish, and other fishes in the river Hooghly, had monthly collections made from this settling tank. After each collection the tank was dewatered almost completely and it can, therefore, be inferred that young fish only one month old or younger were collected each month. Such collections of young forms were made over a

period of one year. In the material thus obtained young *Hilsa* of different sizes were found in great abundance, especially from March to November, and these form the subject matter of the present article. The specimens described below were, however, obtained in November 1938.

Lebour (1921, p. 428) found that in distinguishing fish larvae the number of vertebrae provides a very good and reliable character. Accordingly the young of *Hilsa* were cleared in caustic potash and stained with Alizarin, which enabled the number of vertebrae to be counted without any difficulty. In specimens treated with caustic potash, however, the counting of myotomes, was not possible. In the adult examples of *Hilsa* the usual number of vertebrae was found to be 46, very rarely 45 ; the first vertebra being the one immediately behind the head, and the last vertebra being the one with a modified neural arch behind which there is a urostyle. With the help of this character the youngest specimens that could definitely be assigned to *Hilsa* were 14 mm. in total length, a size which probably represents a few days' growth after hatching. At this stage the young are quite different from the adult fish and it is only after several marked changes that the adult form is assumed. Another point to which attention may be directed here is the fact that all specimens of the same size are not necessarily at the same stage of development, for, smaller specimens were sometimes found to have scutes, etc., better developed than somewhat larger examples. As in the earlier stages marked differences of structures are noticeable within very narrow limits of size, I have in the following account described a few stages with 1 mm. differences in their lengths.

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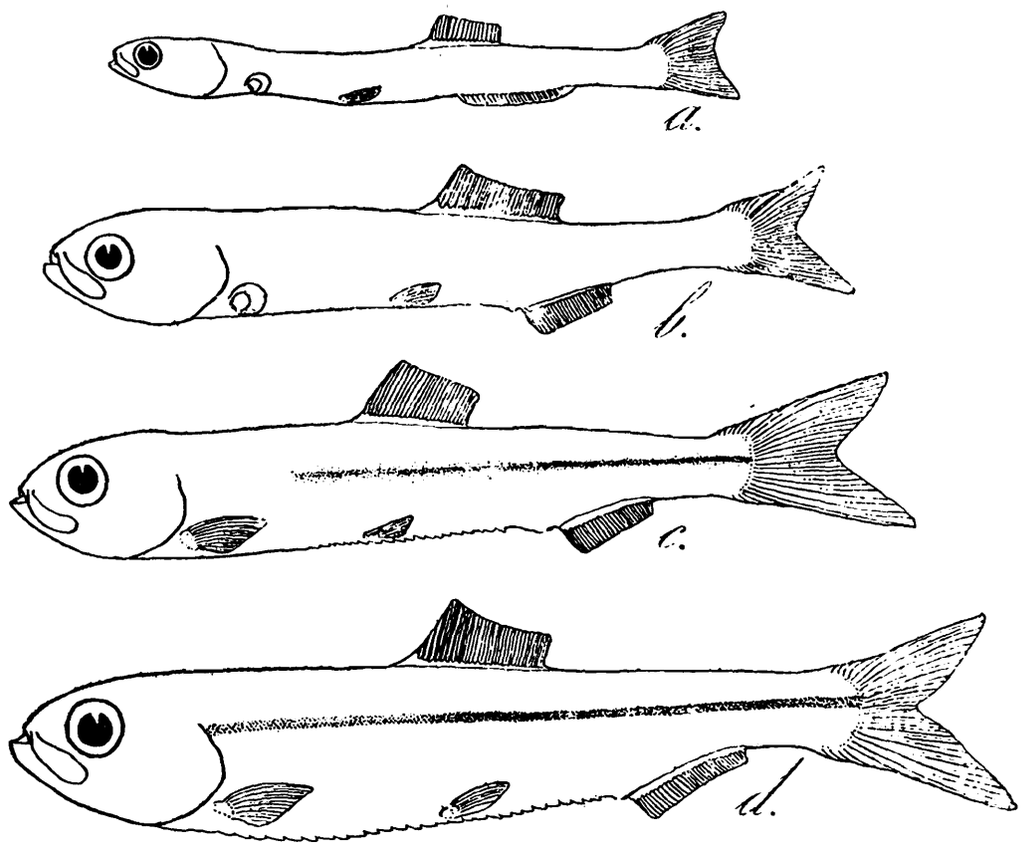
DESCRIPTION OF MATERIAL.

The body of a 14 mm. larva (text-fig. 1*a*) is slender, long and narrow ; its caudal end being almost as broad as the anterior region. It is devoid of any colour, though it is not quite transparent. The dorsal contour of the head is more convex and the eyes, which are big and bulging, are black with a silver lining around them. The mouth is large and the lower jaw is slightly longer than the upper. The maxilla is prominent even at this stage. The continuous larval skin fold has practically disappeared and all the fins, except the pectorals, are more or less provided with delicate supporting fin rays ; the rudiments of the pectorals can be seen just behind the gill openings with a few wavy slender ray-like supports which are not quite well developed at this stage. The rays of the caudal fin, however, are more developed and are distinctly segmented. The dorsal fin at this stage is situated far behind, but is in advance of the anal. The pelvic fins are anterior to the dorsal. The gills are formed, and so are the gill covers. The alimentary canal is a simple structure ; after some distance from the mouth it bends towards the left, and is continued anteriorly when it turns to the right and runs backwards as a straight tube to the anus.

In a larva of 15 mm. in total length, the head and the eyes are considerably more pronounced. The body is colourless except for a few



TEXT-FIG. 1.—Young *Hilsa* from 14 mm. to 22 mm. in total length. × 4½.
a. 14 mm.; *b*. 18 mm.; *c*. 20 mm.; *d*. 22 mm.

chromatophores at the bases of the anal and the caudal fins. There is also another set of chromatophores inside the body which begin behind the pectoral fins and are spread along the alimentary canal. The dorsal fin is placed slightly forward, so that, it commences just above the point where the pelvics terminate. The last ray of the dorsal fin, as in the case of Pilchard, Sprat, etc. (Lebour, 1921, p. 432), is double and without a proximal radial to support it. The pectoral fins are not fully formed, but they are represented by thick folds. In the anal fin, as in the dorsal, the last ray is double and is also without a proximal radial. The caudal peduncle is relatively longer and the caudal fin is the most developed among fins; its early development may be accounted for by the fact that it is the main organ for locomotion. The 19 principal rays of the adult caudal fin are already fully formed at this early stage and can be clearly seen in Alizarin preparations. The operculum is very thin and transparent. The air bladder is small and cylindrical; its posterior end reaches a point about midway between the pelvics and the anus. The intestine is very prominent and its characteristic convoluted inner walls could be seen through the body wall. The food of the larvae at this stage probably consists of minute organisms, such as diatoms, etc.

The general shape of the body of a specimen of 16 mm. in total length is similar to that of a larva of the 15 mm. size. The pectoral fins are more developed and there are slender rays to support them. The

posterior end of the alimentary canal can well be seen with its convoluted inner walls from the pelvics backward. The anus lies immediately below the point where the dorsal fin ends. The food of the larvae at this stage includes Ostracods, which were found in the alimentary canal of some individuals. The ventral margin of the body is not yet Clupeid in structure and form, but is rounded without any indication of scutes. In specimens of 17 mm. in total length, the pectoral fins have become bigger and the rays stronger. There are no scutes even at this stage. Ostracods and Copepods were found in the alimentary canals of some individuals.

In specimens of 18 mm. total length the body is still narrow (text-fig. 1*b*), the anal fin commences behind the middle of the dorsal fin which has shifted forwards, and contains a few more rays. The intestine is still visible through the body wall. The abdomen is not yet keeled and the scutes are generally absent, though a few projections may be noticed in front of the pelvic fins. In a few specimens of this size, however, four fine points of the scutes were seen in front of the pelvic fins. In Alizarin preparations, however, the bony parts of the developing scutes can be seen very clearly (text-fig. 2*a*). Among the contents of the alimentary canal a few bits of mica were seen. Presumably these had been accidentally ingested along with small planktonic organisms.

The general shape of the body in a specimen of 19 mm. in total length begins to take the Clupeid form. The longitudinal black stripes on the two sides of the body, which are fairly prominent in young *Hilsa*, make their appearance at this stage, but are restricted to the portions between the pelvic fins and the base of the caudal fin. There are a few chromatophores at the bases of the caudal and anal fins, and on the ventral side of the stomach also. The dorsal fin has shifted still further forwards and now lies exactly above the origin of the pelvic fins. The posterior end of the dorsal fin is considerably in advance of the anal fin. The abdomen along the mid-ventral line in its central part is more or less keel-shaped and bears 12 scutes in various stages of development; of these seven are in front of and five behind the pelvic fins (text-fig. 2*b*). The remainder of the abdominal margin is still smooth and does not exhibit any projections. The air bladder is still in the form of a cylindrical tube.

In specimens of 20 mm. in total length (text-fig. 1*c*) the dorsal fin has shifted still further forwards, so that it now lies slightly in advance of the origin of the pelvics. The anal fin is by now far behind the posterior end of the dorsal. There are a number of chromatophores on the caudal fin as well as at the base of the anal fin. The longitudinal black stripe on the body is longer and occupies about $\frac{3}{4}$th the length of the body. The air bladder at this stage is divided into two parts, a short and barrel-shaped anterior chamber which is connected by a short narrow neck with a posterior elongated tubular part. The abdomen is keel-shaped, and, generally speaking, about twenty scutes can be made out (text-fig. 2*c* and 2*d*).

In specimens of 21 mm. in total length, the longitudinal black stripes on the sides of the body are complete, and can be seen extending from the end of the operculum right up to the base of the caudal fin. The

posterior half of each stripe is broader and more prominent. The larvae seem to feed voraciously at this stage, for as many as 90 Copepods could be seen in the alimentary canal of one of the specimens examined. At this stage there are about 25 scutes on the abdomen. The chromatophores can be seen along the course of the alimentary canal and at the bases of the anal and caudal fins.

The black stripes are more prominent in specimens of 22 mm. in total length (text-fig. 1*d*). The shape of the body now almost approaches that of the adult form and the scutes have increased in number to 30, including the first six which are not fully developed. The 31st scute, which lies in front of the anus, is not yet developed. Copepods seem to be the main food of the larva, though an occasional Chironomid larva could also be seen in the alimentary canal.

A specimen of 27 mm. in total length shows most of the features characteristic of the adult fish. The shape of the body, the number of rays in the various fins are all identical with those of the adult, but the number of scutes is still thirty. The young at this stage are voracious feeders and, though delicate, are agile and quick in their movements.

GENERAL OBSERVATIONS.

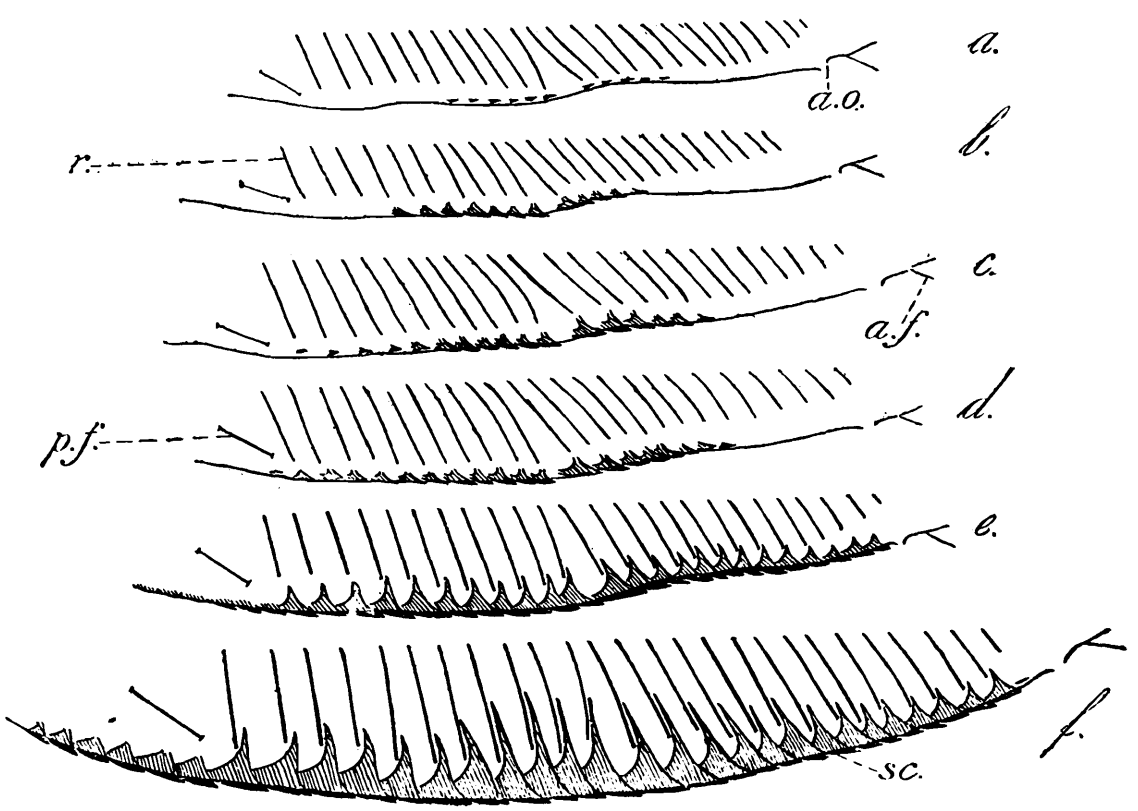
In the larval forms described above attention may specially be invited to the forward migration of the dorsal fin and anus, the development of the scutes, and to the relative proportions of the various parts of the body.

Forward movement of dorsal fin.—The dorsal fin shifts about 8 vertebrae in its migration forwards during the growth of the young from 16 mm. to 23 mm. in length. In a specimen of 16 mm., it commences above the 16th vertebra and ends above the 28th. Along with the growth of the larva, the dorsal fin travels gradually forwards and in a specimen of 23 mm. it commences above the 8th and ends above the 21st vertebra ; this is its permanent position in the adult fish. As in the case of the Pilchard and others (Lebour, 1921), the first two rays of both the dorsal and anal fins are supported by the first radial while the last one though double is counted as one. These last double rays of both the fins do not possess a proximal radial till the specimens attain a size of about 35 mm. in total length ; their proximals, however, are considerably smaller than those of the other rays.

Change in position of anus.—During the growth of *Hilsa* the anus begins to migrate forwards (Pl. V), as is already known in the case of Pilchard, Sprat and Herring (Lebour, 1921). This forward movement of the anus in relation to the vertebrae is clearly visible in Alizarin preparations. The figure in plate V is a diagrammatic representation of the forward movements of the dorsal fin and the anus in relation to the vertebrae of young *Hilsa* of various sizes. The anus moves over about 4 vertebrae (from 34th to 30th) during the growth of the fish from 16 mm. to 23 mm. size. Fage (1920) and Lebour (1921, p. 429) attribute this migration to unequal growth of the posterior part of the body. In the adult of *Hilsa*,

however, it is situated below the 34th vertebra which shows that at a later stage a backward shifting of the anus takes place. This backward shifting starts in specimens of about 24 mm. size and is very slow, for, the anus reaches its permanent position, *i.e.*, below the 34th vertebra, at a stage when the specimen is about 144 mm. in total length. This cannot be satisfactorily explained on an assumption of an unequal growth in the anterior region of the fish since there is no backward shifting in the position of the dorsal fin. On the other hand, it appears possible that the anus is mechanically shifted backwards by the growth of the abdominal scutes. These scutes grow posteriorly, in virtue of their position and attachment, and since they are partly within the body wall they tend to shift the muscles behind them along with their growth. The contour of the ventral side of the fish becomes more and more convex as the fish grows. This fact along with the very slow progress of the backward shifting of the anus seem to support this view. Along with the anus, the anal fin also is shifted backwards.

Development of scutes.—In an adult specimen there are 17 scutes in front of and 14 scutes behind the pelvic fins. All the scutes excepting the first six, which are in front of the first rib, are supported by ribs. Very rarely an additional scute appears in between the regular ones,



TEXT-FIG. 2.—Development of scutes in young *Hilsa* from 18 mm. to 31 mm. in total length. × 6.

a. 18 mm.; *b.* 19 mm.; *c.* and *d.* 20 mm.; *e.* 23 mm.; *f.* 31 mm.
a. f. anal fin; *a. o.* anal opening; *p. f.* pectoral fin; *r.* rib; *sc.* scutes.

and, in such cases it is not supported by a rib. Such an odd scute may generally be found between the regular 17th and 18th. The scutes originate in the form of short longitudinal pieces (text-fig. 2*a*) which appear in the position of the future scutes. These in course of time

develop into two roughly triangular plates laterally (text-fig. 2*b*) which send up an arm each at the dorsal angle to be supported by the corresponding rib. A representative series of the different stages of development is shown in figure 2. For studying the formation of the scutes, Alizarin stained specimens were used, and the figures reproduced here were made from such specimens with the help of a camera lucida.

A specimen up to 17 mm. in total length does not show any sign of the abdominal scutes and the ribs do not join ventrally. That is to say, the ribs of the stained specimens take the colour only as far as shown in the figures. In an 18 mm. specimen a few short longitudinal streaks, just in front of and behind the pelvics can be seen. The first scutes to form as such are the three or four immediately in front of the pelvics. Then three or four appear immediately behind the pelvics. In this way the scutes begin to appear, a few in front alternated by a few behind the pelvics until 30 of them are formed when the specimen is about 23 mm. in total length. The last scute, which is the one nearest the anus, is not developed till sometime afterwards. The last scute makes its appearance as a short longitudinal piece, devoid of any arms, in a specimen of 31 mm. in total length. This scute also sends up two lateral arms to meet the corresponding ribs and is well supported by the same when the specimen is about 33 mm. in total length.

Relative proportions of different parts.—The forward shifting of the dorsal fin referred to above is also clear from the table of measurements and proportions given below. In a specimen of 15 mm. in length the distance between the tip of the snout and the commencement of the dorsal fin is contained about 1·9 times and the distance between the dorsal and caudal fins is contained about 4·7 times in the total length. With the forward movement of the fin during growth the former distance is gradually reduced, so that in a specimen of 24 mm. in length it is contained about 2·6 times in the total length, while the latter distance is gradually increased so that in specimen of 24 mm. in length it is contained about 3·1 times in the total length.

It has been indicated above that the body is very narrow in the early stages ; this is borne out by the fact that the depth of body in a specimen of 15 mm. is contained about 7·9 times in the total length while the same proportion is reduced to about 5·3 in a specimen 24 mm. in length. It is of interest to record that whereas the depth of the body goes on increasing gradually the height of the caudal peduncle proportionately remains almost the same. The tables of measurements show that both the caudal fin and the head increase in size during the growth of the fish.

In the following table **A**. denotes the length of base of the anal fin ; **AC**., the distance between tip of snout and anus ; **C**., the length of caudal ; **CP**., the least height of the caudal peduncle ; **D**., the length of base of dorsal ; **DB**., the depth of body ; **DC**., the distance between dorsal and caudal ; **H**., the length of head ; **SA**., the distance between the tip of snout and anus ; **SD**., the distance between the tip of snout and the commencement of dorsal ; **T**., the total length of the fish.

Table of measurements and relative proportions.

T.	C.	$\frac{T}{C.}$	DB.	$\frac{T}{DB.}$	H.	$\frac{T}{H.}$	CP.	$\frac{T}{CP.}$	D.	$\frac{T}{D.}$	A.	$\frac{T}{A.}$	SD.	$\frac{T}{SD.}$	DC.	$\frac{T}{DC.}$	AC.	$\frac{T}{AC}$	SA.	$\frac{T}{SA.}$
mm.	mm.		mm.		mm.		mm.		mm.		mm.		mm.		mm.		mm.		mm.	
15	1·8	8·33	1·9	7·89	2·9	5·17	1·5	10·00	1·9	7·89	2·1	7·14	8·0	1·88	3·2	4·69	1·3	11·54	9·8	1·53
15	1·9	7·89	1·9	7·89	2·8	5·36	1·6	9·38	2·0	7·50	2·1	7·14	7·9	1·89	3·2	4·69	1·3	11·54	9·8	1·53
16	2·0	8·00	2·3	6·96	3·0	5·33	1·5	10·80	2·1	7·62	2·1	7·62	8·2	1·95	3·5	4·57	1·8	8·89	10·1	1·58
16	2·0	8·00	2·6	6·15	3·1	5·16	1·4	11·43	2·4	6·66	2·1	7·62	8·1	1·98	3·5	4·57	1·8	8·89	10·3	1·55
16	2·1	7·62	2·1	7·62	2·9	5·52	1·5	10·89	2·5	6·40	2·0	8·00	8·3	1·93	3·5	4·57	1·4	11·43	10·5	1·52
16	2·0	8·00	2·0	8·00	3·1	5·16	1·6	10·00	2·3	6·96	2·3	6·96	8·3	1·93	3·6	4·44	1·2	13·33	10·5	1·52
17	2·1	8·09	2·3	7·39	3·3	5·15	1·8	9·44	2·3	7·39	2·2	7·73	8·0	2·13	4·5	3·78	1·5	11·33	11·2	1·52
17	2·2	7·73	2·2	7·73	3·2	5·31	1·6	10·63	2·5	6·80	2·2	7·73	8·5	2·00	4·3	3·95	1·4	12·14	11·0	1·55
17	2·1	8·09	2·2	7·73	3·2	5·31	1·4	12·20	2·4	7·08	2·2	7·73	8·4	2·02	4·3	3·95	1·5	11·83	11·2	1·52
17	2·2	7·73	2·3	7·39	3·2	5·31	1·4	12·20	2·4	7·08	2·3	7·39	8·3	2·05	4·7	3·62	1·5	11·83	11·0	1·55
18	2·0	9·00	2·0	9·00	4·0	4·50	1·6	11·25	2·7	6·66	2·3	7·83	8·0	2·25	5·5	3·27	2·0	9·00	11·7	1·54
18	2·1	8·57	2·2	8·18	3·6	5·00	1·4	12·86	2·7	6·66	2·3	7·83	7·8	2·31	5·4	3·33	1·8	10·00	11·9	1·51
18	2·0	9·00	2·7	6·66	3·9	4·62	1·5	12·00	2·8	6·43	2·5	7·20	8·2	2·95	6·0	3·00	2·0	9·00	12·1	1·49
18	2·0	9·00	2·7	6·66	4·0	4·50	1·6	11·25	2·7	6·66	2·4	7·50	7·7	2·34	5·8	3·10	1·9	9·48	12·0	1·50
19	2·5	7·60	3·0	6·33	4·0	4·75	1·5	12·67	2·9	6·55	2·5	7·60	8·1	2·35	5·6	3·39	1·5	12·67	12·5	1·52
19	2·5	7·60	2·9	6·55	3·9	4·87	1·5	12·67	2·9	6·55	2·6	7·31	8·0	2·38	5·9	3·22	1·4	13·57	12·6	1·51

19	2·4	7·92	2·9	6·55	3·8	5·00	1·4	13·57	2·9	6·55	2·6	7·31	8·1	2·35	5·7	3·33	1·6	11·88	12·4	1·53
19	2·5	7·60	2·6	7·31	3·8	5·00	1·5	12·67	2·8	6·78	2·6	7·31	8·0	2·38	6·0	3·17	1·6	11·88	12·3	1·54
20	2·8	7·14	3·0	6 67	4·0	5·00	1·6	12·50	3·0	6·67	2·8	7·14	8·2	2·32	6·5	2·92	2·0	10·00	12·4	1·61
20	2·2	9·09	3·2	6·25	4·5	4·44	1·3	15·38	3·0	6·67	2·8	7·14	8·6	2·33	5·9	3·38	1·8	11·11	13·2	1·52
20	2·5	8·00	3·1	6·45	4·7	4·25	1·4	14·29	3·0	6·67	2·6	7·69	8·9	2·25	5·7	3·51	1·8	11·11	13·1	1·53
20	2·5	8·00	3·5	5·72	4·1	4·87	1·6	12·50	2·9	6·89	2·8	7·14	8·5	2·35	6·2	3·23	1·5	13·33	13·2	1·52
21	3·0	7·00	3·9	5·38	4·6	4·56	1·3	16·15	3·1	6·78	2·5	8·40	8·5	2·47	6·6	3·18	1·9	11·05	13·6	1·54
21	2·9	7·24	3·9	5·38	4·8	4·38	1·6	13·13	3·0	7·00	2·6	8·08	8·4	2·50	6·8	3·09	1·9	11·05	13·6	1·54
21	3·0	7·00	3·8	5·53	4·7	4·47	1·5	14·00	3·0	7·00	2·7	7·78	8·8	2·39	6·8	3·09	1·9	11·05	13·5	1·56
21	3·0	7·00	3·8	5·53	4·8	4·38	1·4	15·00	3·0	7·00	2·6	8·08	8·7	2·41	6·7	3·13	1·9	11·05	13·5	1·56
22	2·8	7·86	4·2	5·24	4·8	4·58	1·9	11·58	3·1	7·09	3·0	7·33	8·8	2·50	7·6	2·89	1·9	11·58	14·2	1·55
22	2·8	7·86	4·5	4·89	4·9	4·49	2·0	11·00	3·1	7·09	3·1	7·09	8·7	2·52	7·5	2·93	1·8	12·22	14·2	1·55
22	2·9	7·58	4·5	4·89	4·7	4·68	1·8	12·22	3·1	7·09	3·0	7·33	9·3	2·37	5·7	3·86	1·8	12·22	14·3	1·54
22	2·8	7·86	4·5	4·89	4·8	4·58	1·9	11·58	3·0	7·33	3·0	7·33	8·9	2·47	7·6	2·89	1·9	11·58	14·3	1·54
23	3·6	6·39	4·3	5·35	4·8	4·79	2·1	10·95	3·3	6·97	3·2	7·19	9·0	2·56	7·5	3·07	1·4	16·43	14·4	1·59
23	3·7	6·22	4·2	5·48	4·8	4·79	2·1	10·95	3·3	6·97	3·2	7·19	9·1	2·53	7·8	2·95	1·5	15·33	14·6	1·58
23	3·7	6·22	4·2	5·48	4·8	4·79	2·0	11·50	3·3	6·97	3·1	7·42	9·2	2·50	7·8	2·95	1·5	15·33	14·7	1·58
23	3·7	6·22	4·2	5·48	4·9	4·69	2·1	10·95	3·4	6·76	3·1	7·42	9·1	2·53	7·7	2·99	1·5	15·33	14·7	1·58
24	3·8	6·32	4·3	5·58	5·1	4·71	2·2	10·91	4·0	6·00	3·6	6·67	8·6	2·79	7·9	3·04	1·5	16·00	15·1	1·59
24	3·8	6·32	4·6	5·22	5·1	4·71	2·2	10·91	3·9	6·15	3·5	6·86	9·2	2·61	7·8	3·08	1·8	13·33	15·2	1·58
24	3·7	6·49	4·9	4·89	5·2	4·62	2·2	10·91	3·3	7·27	3·1	7·74	9·5	2·53	7·8	3·08	1·9	12·63	15·3	1·57
24	3·8	6·32	4·5	5·33	5·1	4·71	2·2	10·91	3·5	6·86	3·5	6·86	9·2	2·61	7·9	3·04	1·7	14·12	15·0	1·60

Summary.

The material of young *Hilsa* described in this article was obtained from the Pulta Water-works, Calcutta, and in determining the very young forms reliance was placed on the number of vertebrae which is believed to be a constant character. For the counts of vertebrae specimens were cleared in caustic potash and stained with Alizarin. Fourteen young stages of 14 mm. to 27 mm. in total length are described in detail and attention is directed to the changes in the relative proportions of the different parts of the fish during growth.

List of References.

Devanesen, D. W., 1939.—Research Work on the *Hilsa*. *Curr. Sci.* VIII, p. 126.

Fage, L., 1920[1].—Engraulidae, Clupidae. *Rept. Danish. Oceanogr. Exped., 1908-1910, to the Mediterranean and the adjacent seas,* II, *Biol.*, A. 9.

Hora, S. L., 1938.—A Preliminary Note on the Spawning Grounds and Bionomics of the So-called Indian Shad, *Hilsa ilisha* (Ham.) in the River Ganges. *Rec. Ind. Mus.* XL, pp. 147-158.

Lebour, M. V., 1921.—The Larval and Post-larval Stages of the Pilchard, Sprat and Herring from Plymouth District. *Journ. Mar. Biol. Assn.*, (N. S.) XII, pp. 427-457.

Southwell, T. and Prashad, B., 1918.—On *Hilsa* Investigations in Bengal, and Bihar and Orissa. *Bull. Dept. Fish. Bengal, Bihar and Orissa*, No. 11, p. 6.

Sundara Raj, B., 1917.—On the Habits of the *Hilsa* (*Clupea ilisha*) and Their Artificial Propagation in the Coleroon. *Proc. 4th Ind. Sci. Cong.*, p. clxxxiv.

[1] Not consulted by the author.