THE SPAWNING HABITS AND EARLY STAGES IN THE DEVELOPMENT OF THE CARP, *LABEO GONIUS* (HAMILTON), WITH HINTS FOR DISTINGUISHING EGGS, EMBRYOS AND LARVAE OF *LABEO GONIUS, CIRRHINA MRIGALA* AND *WALLAGONIA ATTU.*

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CONTENTS.

INTRODUCTION.

In an earlier article (Nazir Ahmad, 1944), the breeding and development of the so-called Freshwater Shark, *Wallagonia attu* (Bloch and Schneider), were described and a detailed account of its spawning grounds in the shallow water of the Budha Nala, Ludhiana, was given. In 1932, along with *Wallagonia*, several other fish of economic importance were also found sporting and breeding in the same waters, so an attempt was made in the following year to collect early stages of some carp of commercial value. The collections and observations recorded here on *Labeo gonius* (Hamilton) were made in July, 1933, at a time when the life-history of not a single species of the principal Indian food fishes was known. I regret that in spite of my best efforts, other preoccupations did not permit me to complete the work earlier.

According to relative economic importance Labeos as a group rank first among carps, but as food the usefulness of *Labeo gonius* is rather disputed. Hamilton (1822) and Day (1869) are of the opinion that it is not regarded as good food, while Hamid Khan (1934), and Prashad and Mukerji (1929) consider it a valuable food fish. *Labeo gonius* has a great resemblance with the popular Rohu fish (*Labeo rohita*) and is generally sold under that name to the public.

Day (1877) recorded the maximum length of the fish as 5 feet but specimens measuring more than 2 feet are seldom seen in the market. The fish inhabits ponds and streams alike and has been recorded from India and Burma. Day (1877) states that the fish is extensively used for stocking ponds; it is, however, not favoured for stocking in the Punjab and Dr. Hora informs me that in Southern and Eastern Bengal it is not used for cultural purposes.

SPAWNING HABITS.

In July, 1933, about one hundred early stages of *Labeo gonius* (Hamilton) were collected after the artificial fertilization of its eggs. The collection dealt with here includes eggs in various stages of development and embryonic, larval and post-larval stages.

The spawning of *Labeo gonius* (Hamilton) was observed on the 20th July, 1933, at Budha Nala, Ludhiana. The water of the Nala was comparatively clear the day before spawning, but at the time of spawning it was found to be very muddy and its level had risen considerably, showing thereby that it had rained somewhere in the upper part of the Nala. The flood water covered the low, grassy banks of the Nala up to about six inches. From the small rise in water level it was obvious that it was not sufficient to induce the bigger species of fish to spawn. It was at 7-10 A.M. that *Barbus* (*Puntius*) *sarana* (Hamilton) and *Labeo gonius* (Hamilton) began to congregate on the shallow banks. It is noteworthy that whereas very few specimens could be seen in the Nala before the flood, now the place was teeming with hundreds of them. All of them were very active and made considerable noise by their splashing movements. They had become so fearless that even an intruder could interfere but little with their activities. A large number of the spawning fish were netted in a few minutes time but only two males and two females were selected for stripping purposes. The ratio of males and females was about equal in the catch. The ripe eggs and spermatozoa were squeezed out by a gentle pressure on the abdomen. Both ova and spermatozoa were mixed in a clean dish and allowed to stand for five minutes and then were transferred to hatching trays. The trays were moored in the Nala where a continuous current of water passed over them.

The temperature of the air at the time of spawning was 80°F. and that of water was 78°F. By 10-15 A.M. the clouds had disappeared, and the temperature of the water rose to 87°F. by 12 noon.

Previous Work.

Hamid Khan (1934), while commenting upon the habits and habitats of food fishes of the Punjab, observed that *Labeo gonius* (Hamilton) 'breeds during July and August, and is a prolific breeder. The egg measures 1·5 mm., is non-floating and swells to three times its size as soon as it sinks. It hatches out within 24 hours in a temperature ranging from 78°F. to 82°F.' Previously the same author (1924) described a few isolated developmental stages of the fish. He stated that the colour of the egg is bluish, after a week the fry is 7 mm. in length, mouth opens for respiration 24 hours after hatching and the gut is completely formed after 72 hours. The following year (1925) the same author described some more stages of the fish and also gave two figures, one of twelve hours stage and the other of a newly hatched larva.

Structure of the ripe unfertilized egg.

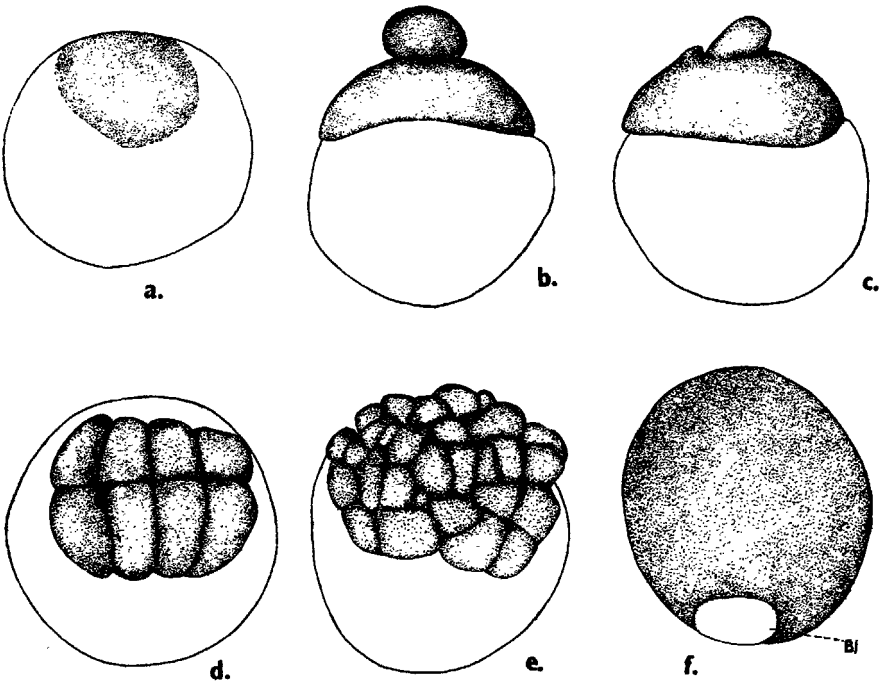
Eggs of *Labeo gonius* are mostly perfect spheres but some are oval in outline with the longer axis in the dorso-ventral direction. Diameter of an egg measures from 1·0 to 1·3 mm. The egg is closely covered by a single, thin, translucent vitelline membrane, which is quite smooth and possesses no striations of any kind. Like the eggs of so many other freshwater fishes, these eggs are demersal and are devoid of oil-globules. There does not appear to be any germinal-disc at this stage.

Structure of the fertilized egg.

In the fertilized egg germinal-disc (Text-fig. 1*a*) appears within ten minutes of fertilization as a convex whitish cap lying on the top of the big yolk-sac. Yolk-sac is made up of yellow granules, which in the healthy eggs shine with glassy transparency while in the unhealthy and dying eggs they are quite opaque. As soon as the fertilized egg is transferred to water, the membrane begins to swell. The sample taken ten minutes after fertilization shows a small perivitelline space [1] filled with a clear fluid but in an egg only

[1] Various theories have been propounded to explain the origin of the perivitelline space. Ransom (1867) states that the space is formed by the enlargement of the yolk-sac or capsule, while Gerbe (1875) believes that it is produced as the result of the contraction of the yolk. Keber (1854) surmises that a part of the contents of the egg flows out, resulting in the decrease of the size of the egg proper. Kupffer (1878) cites the example of *Clupea*, in which, according to him, the yolk contracts and the

four minutes older a full-sized space is present; thus the size of the egg increases to about four times.



TEXT-FIG. 1. Early stages in the development of *Labeo gonius* (Hamilton). ×30.
In all cases egg-membranes have been removed.

a. Freshly fertilized egg; *b*. Egg with one cell; *c*. Egg with two cells; *d*. Egg with eight cells; *e*. Egg showing cap of cells at apical pole; *f*. Blastoderm investing most of the yolk-sac; *Bl* = Blastopore.

SEGMENTATION.

Segmentation is meroblastic and is confined to the germinal-disc only. Yolk-sac, on the other hand, remains unaffected by the cleavage.

Stage 1.—Fourteen minutes after fertilization (Text-fig. 1*b*). A projection is given off from the germinal-disc. This projection is usually rounded at its free end. The remaining part of the disc shows no change and closely lies on the top of the yolk-sac, as before.

Stage 2.—Twenty-six minutes after fertilization (Text-fig. 1*c*). One more outgrowth is given off from the disc, forming two cells usually of unequal size. In other words, unlike *Wallagonia attu* (Nazir Ahmad, 1944) here only an outgrowth is given off from the disc and the latter as a whole does not segment.

Stage 3.—Forty minutes after fertilization. A cell or two are added to the already existing. The arrangement of the blastomeres is quite irregular and the cells are unequal in size.

Stage 4.—An hour and ten minutes after fertilization (Text-fig. 1*d*). Whereas in early stages the blastomeres show irregular arrangement, in the present case they are arranged in two rows of four cells each, forming a whitish rectangle.

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capsule also enlarges. On the other hand, Lereboullet (1873), like the present author, arrives to the conclusion that the increase in size is due to absorption of water and not by the contraction of yolk.

There is such a marked increase in the eggs of these fishes, that it cannot be explained by the theory of the contraction of the vitellus. The explanation of Keber also does not explain this phenomenon for in most of the eggs studied by the present author, there did not appear to be a trace of any solid mass in the fluid filling the perivitelline space.

Stage 5.—An hour and forty minutes after fertilization (Text-fig. 1*e*). The blastomeres again show irregular arrangement. An egg with sixteen cells regularly arranged has not been observed. There are, however, present eggs with 12, 18, 20 and more blastomeres.

Stage 6.—Two hours and ten minutes after fertilization. Blastomeres show active division and have become considerably smaller; they cover about one-half of the yolk-sac.

Stage 7.—Two hours and forty minutes after fertilization. The blastoderm layer covers three-fourths of the yolk-sac, leaving one-fourth of the sac uncovered. The free edge of the sheet formed by these cells is quite prominent and thick.

Stage 8.—Five hours and ten minutes after fertilization (Text-fig. 1*f*). Only a small ventral part of the yolk-sac remains uncovered. The free edge of the yolk-sac bulges out through the so-called blastopore.

Embryonic development.

Stage 9.—Five hours and forty minutes after fertilization (Text-fig. 2*a*). Rudiment of the embryo is seen here. There is only a slight trace of blastopore. Embryo is present as a white thickening round the circumference of the yolk-sac. The future anterior end is narrow while the posterior end is wide and lies towards the ventral side of the yolk-sac. There is no trace of optic vesicle or of otocyst.

Stage 10.—Six hours and forty minutes after fertilization (Text-fig. 2*b*). Anterior end of the embryo becomes enlarged and shows marked changes. A pair of optic invaginations are present. Otocyst has not yet made its appearance. Yolk-sac has slightly elongated in the antero-posterior direction. Embryo is closely attached to the yolk-sac except its anterior end, which is free and projects beyond the sac.

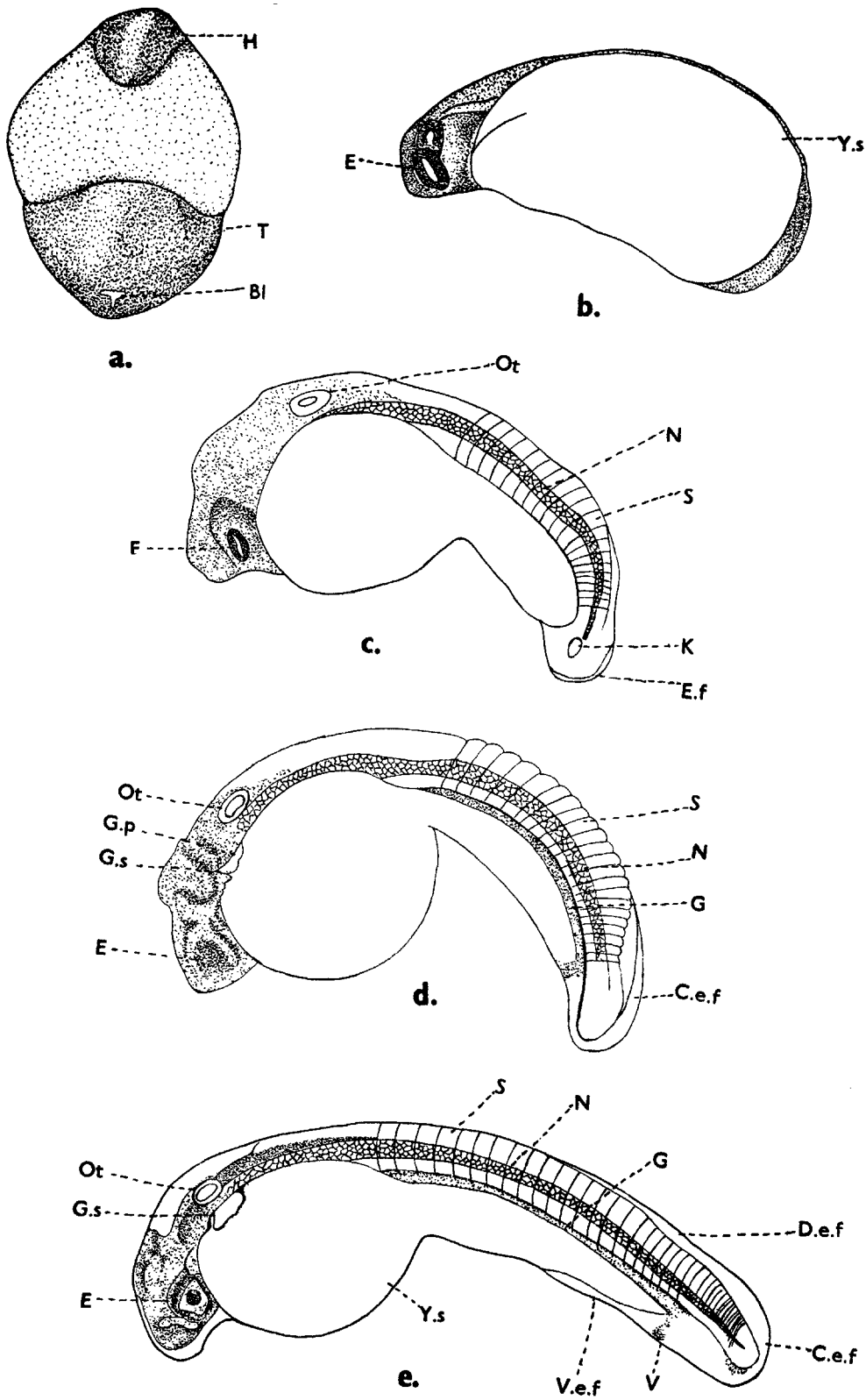
Stage 11.—Seven hours and forty minutes after fertilization. Kupffer's vesicle has made its appearance; it is oval in outline and lies in the caudal region of the embryo, touching the yolk-sac. Yolk-sac shows broader oval anterior part and narrow elongated posterior part. Notochord as well as mesodermal somites are seen in the middle region and behind it, but in the end of the caudal region, these are undifferentiated. A darkly stained plate of tissue represents the rudiment of the otocyst.

Stage 12.—Eight hours and forty minutes after fertilization (Text-fig. 2*c*). Two portions of the yolk-sac are clearly marked out. Otocyst shows a narrow lumen and thick wall. Kupffer's vesicle does not touch the yolk-sac and has shifted backwards. Notochordal cells are clearly distinguishable up to the end of the yolk-sac. Tail region is also free from the yolk-sac. Dorsal surface of the head region of the embryo shows depressions. A very narrow transparent fold of integument surrounds the end of the body.

Stage 13.—Nine hours and forty minutes after fertilization (Text-fig. 2*d*). Embryo is still curved; its tail end elongates a good deal. Wall of the otocyst has become thinner while the lumen has become wider. Kupffer's vesicle is absent. Anterior part of the nervous tube has become complicated and shows thickenings. A sheet of tissue is present below each otocyst; this possesses the rudiment of one gill-slit. Running between the notochord and the yolk-sac there is a band of yellow matter ending on the ventral side, behind the yolk-sac; it represents rudiment of the digestive tract. Fin-fold is present as a transparent fold of integument encircling the tail and running anteriorly, both on the dorsal and the ventral sides; it is quite broad at the posterior end but very narrow towards the anterior sides.

Stage 14.—Eleven hours and forty minutes after fertilization (Text-fig. 2*e*). Third and fourth ventricles of the brain are visible. The rounded lens is clearly seen. Rudiment of vent is seen just behind the yolk-sac. Fin-fold, which is better developed than in the preceding stage, can be divided into dorsal fin-fold, ventral fin-fold and caudal fin-fold.

Stage 15.—Twelve hours and ten minutes after fertilization. Embryo has elongated and has become more straightened. Lens is rounded but it does not completely fill the



TEXT-FIG. 2. Embryonic development of *Labeo gonius* (Hamilton). × 37·5.
In all cases egg-membranes have been removed.

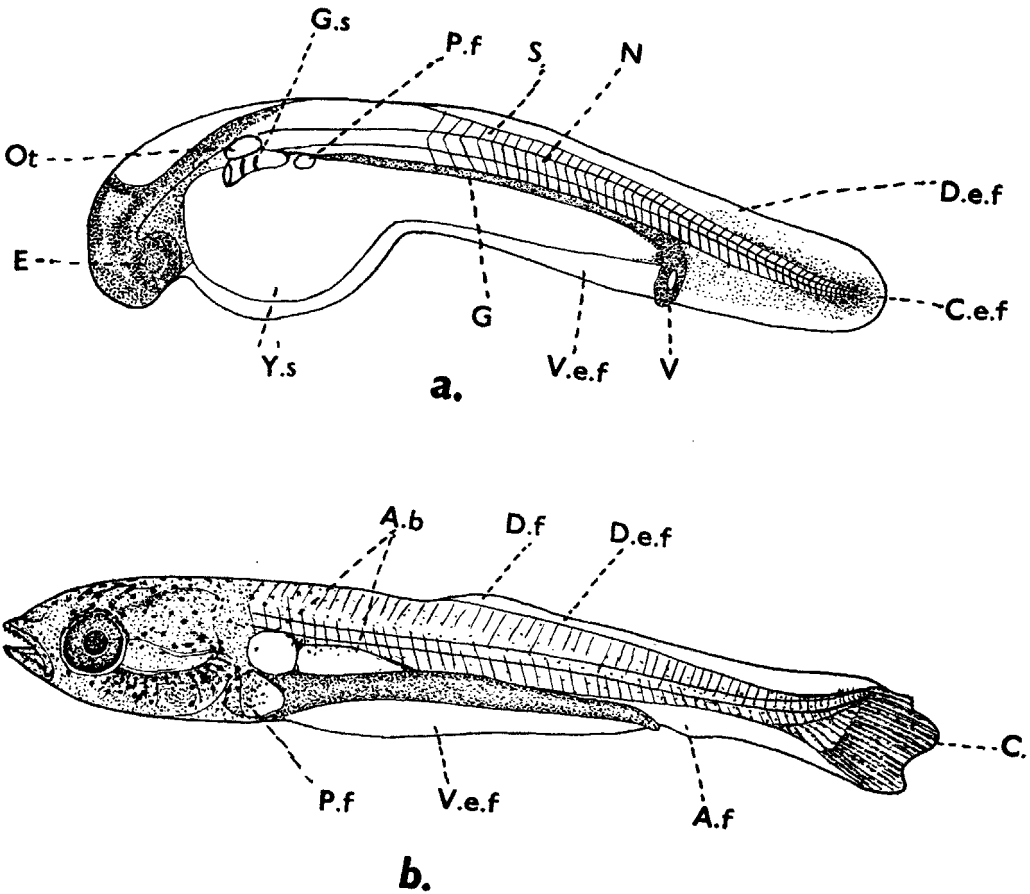
a. Egg, showing rudimentary embryo; *b*. Embryo, 6¾ hours old; *c*. Embryo, 8¾ hours old; *d*. Embryo, 9¾ hours old; *e*. Embryo, 11¾ hours old; *Bl* = Blastopore; *C.e.f* = Caudal fin-fold; *D.e.f* = Dorsal fin-fold; *E* = Eye; *E.f* = Embryonic fin-fold; *G* = Gut; *G.p* = Gill-plate; *G.s* = Gill-slit; *H* = Head end; *K* = Kupffer's vesicle; *N* = Notochord; *Ot* = Otocyst; *S* = Somite; *T* = Tail end; *V* = Vent; *V.e.f* = Ventral fin-fold; *Y.s* = Yolk-sac.

optic cup. Posterior part of the yolk-sac becomes narrower and more elongated. Segmentation of mesoderm is seen in the posterior region of the embryo as well. Fin-folds become broader but as yet there are no fin-rays; caudal fin-fold is rounded at the free end. Notochordal cells are bigger than in early stages. Digestive tract, especially its posterior end, becomes more prominent. The rudimentary vent is situated in the posterior one-fourth of the embryo. There is no sign of pectoral fin. The rudiments of first pair of gill-slits have become more clear.

Stage 16.—Fourteen hours and forty minutes after fertilization. The first indication of rudiments of pectoral fins are seen in this stage; these appear as white specks immediately behind the gill-plates, one on either side of notochord.

Larval development.

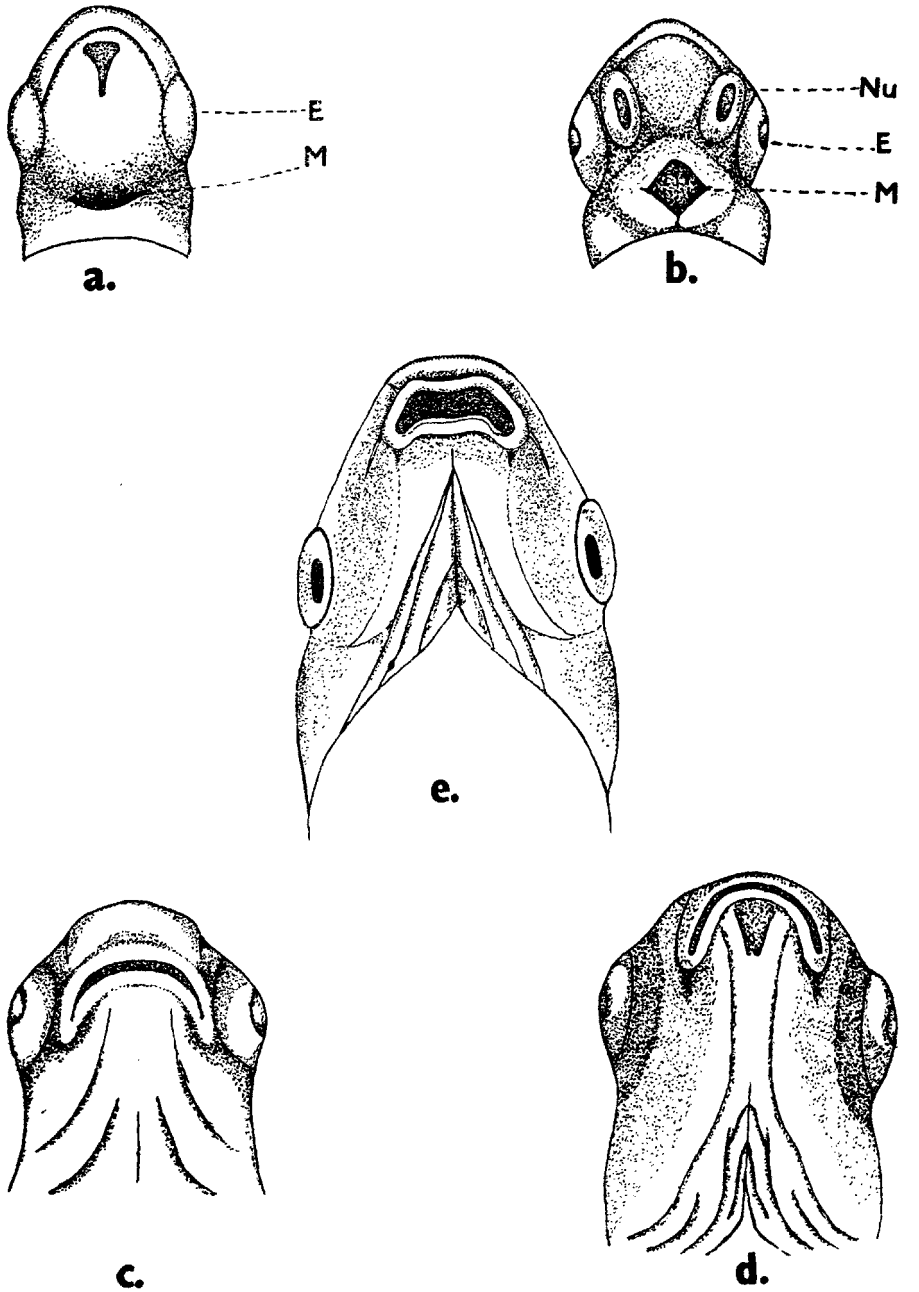
Stage 17.—Sixteen hours and ten minutes after fertilization (Text-fig. 3*a*). The larva ruptures the vitelline membrane and becomes free swimming but yet it depends for its



Text-fig. 3. Larval development of *Labeo gonius* (Hamilton).

a. Newly hatched larva × 30; *b*. 162 hours old larva × 18; *A.b* = Air bladder; *A.f* = Rudimentary anal fin; *C.e.f* = Caudal fin-fold; *C.f* = Caudal fin; *D.e.f* = Dorsal fin-fold; *D.f* = Rudimentary dorsal fin; *E* = Eye; *G* = Gut; *G.s* = Gill-slit; *N* = Notochord; *Ot* = Otocyst; *P.f* = Pectoral fin; *S* = Somite; *V* = Vent; *V.e.f* = Ventral fin-fold; *Y.s* = Yolk-sac.

food supply on the attached yolk-sac. It measures from 3·3 to 3·8 mm. in length. The greatest depth of body is almost equal to the tail region and the pre-yolk region is less than half of the former; head region is deflected. Mouth is present in the oral pit state.



TEXT-FIG 4. Ascent of mouth and nostrils, as seen in ventral views of head.

a. Larva, 5 hours old × 50; *b*. Larva, 8 hours old × 50; *c*. Larva, 21 hours old × 50; *d*. Larva, 162 hours old × 50; *e*. Fry, 5 weeks old × 18; *E* = Eye; *M* = Mouth; *Nu* = Nostril.

Nervous system, notochord and digestive tract are fully differentiated. Notochord gradually becomes narrower at its posterior end. Dorsal and ventral fin-folds extend further forward both on the dorsal and ventral sides and they also become wider. Posteriorly the end of the yolk-sac possesses very small yolk-granules. Pigment granules are noticeable in the tail region, surrounding the notochord and nerve cord. The white specks representing pectoral fins become more dense. The gill-slits become deeper and more prominent. Eye possesses free circular orbital margin. Nostrils have not made their appearance yet. Heart is seen below the head and anterior to the yolk-sac. Otocysts are in the form of deep pits, each with a single external opening.

The first batch of eggs hatched at fifteen hours and forty minutes after fertilization, while the last batch came out of the vitelline membrane an hour and a half later.

Stage 18.—An hour after hatching. Pectoral fins are better developed. Gill-slits are wider than in the preceding stage and behind the first pair of gill-slits, grooves representing rudiments of the remaining gill-slits are present. Eye is without pigments.

Stage 19.—Five hours after hatching. Anterior gill-slits become much wider and triangular in outline while grooves of the following two gill-slits become deeper but as yet they do not show internal openings. Pectoral fins are better developed and their free edges bulge out. Mouth (Text-fig. 4*a*) is quite prominent, with a clear posterior margin and comparatively indistinct anterior boundary. The yolk-sac, especially its narrow part, seems to be surrounded by smaller granules, which merge into the granules of vent posteriorly. In the vent there has appeared a narrow lumen.

Stage 20.—Eight hours after hatching. The rudimentary gill-slits decrease in size antero-posteriorly. With the first two interbranchial septa, on each side, there are attached muscular lobules, which in due course would form the branchial lamellae. The lobules attached with the first interbranchial septum are better developed. From the hyoid arch the rudiment of operculum grows backwards as a muscular flap. Mouth (Text-fig. 4*b*) is very prominent and its anterior and posterior margins become distinct; it is now quadrangular in outline. Nostrils are present on the ventral side of the head anterior to the mouth. Pectoral fins become enlarged and are rounded at their free edges. Lumen in the vent has become longer and wider. In the caudal portion of the fin-fold, the granules seem to have been arranged end to end, forming long striations running from the central region to the periphery of the fin.

Stage 21.—Thirteen hours after hatching. Nostrils are more prominent and wider than in the preceding stage. Pectoral fins are better developed. To all the interbranchial septa rudimentary gill-lamellae are attached. Gape of mouth is slightly narrower than in the preceding stage. Heart is better developed. Numerous redimentary fin-rays have made their appearance in the caudal fin-fold.

Stage 22.—Twenty-one hours after hatching. Pectoral fins are more elongated and stand out almost at right angle to the body; they have developed thick muscular base. Otocysts are quite prominent. Caudal fin has begun to be differentiated from the dorsal and the ventral fin-folds. Due to straightening out of the head region of the larva, the mouth has shifted towards anterior side and has become crescentic in outline. Nostrils have come to lie anteriorly instead of ventrally (Text-fig. 4*c*). Operculum extends backwards and covers the anteriormost branchial arches but still the rudimentary gill-lamellae of the remaining arches project out from the wide gill-openings. Between the gill-slits of the two sides is the isthmus. Posterior end of the notochord has bent upwards. The rudimentary vent has slightly shifted forwards.

Stage 23.—Twenty-four hours after hatching. Air-bladder appears as a clear area behind the pectoral fins and dorsal to the anterior globular region of the yolk-sac. There is no sign of barbels yet. Operculum has extended further backwards. The branchial lamellae are thinner than in the earlier stages. Gill-rakers have made their appearance as small bud-like outgrowths. Somites are present from behind the pectoral fins to the posterior end of the body. External opening of the otocyst has diminished in size and has become semi-lunar instead of oval.

Stage 24.—Forty-one hours after hatching. Larvae measure from 5·2 to 6·0 mm. in length. Operculum shows spine-like radiating structures, which project beyond its

free margin. Anterior part of the gut, below the air-bladder, has become wider. The yolk-sac has become very much reduced. Nostrils are quite prominent.

Stage 25.—Forty-five hours after hatching. Chromatophores are sparcely distributed on the dorsal and lateral sides of the body and head. Air-bladder has become slightly longer. The gut has acquired a narrow lumen, which possesses numerous black food particles. Basal plate is distinguishable in the skull. Eyes have developed pigments.

Stage 26.—Sixty-seven hours after hatching. Yolk-sac has been absorbed. The gut is almost full of black food particles, but as yet it does not seem to be opening to the exterior. Except the anteriormost enlarged region, the gut possesses a uniform thickness. The terminal part of the notochord has bent upwards more than in the earlier stages. Caudal fin-rays are quite prominent.

Stage 27.—One hundred and twenty-six hours after hatching. Air-bladder is almond-shaped; it has become broader and longer. Below the air-bladder has appeared the rudiment of liver. Caudal fin-rays have become prominent. End of the notochord supports the upper part of the caudal fin. Base of the pectoral fin has become more muscular and stronger. External opening of the otocyst is not seen.

Stage 28.—One hundred and sixty-two hours after hatching (Text-fig. 3*b*). Anterior part of the dorsal fin-fold has become elevated to develop into dorsal fin. The ventral fin-fold, just behind the anal region, becomes slightly deeper to form rudiment of future anal fin. Neither the dorsal nor the anal fin possesses any trace of fin-rays at this stage. Caudal fin is divided into a large upper and a small lower lobe; it possesses all the nineteen fin-rays. Pelvic fin has not yet made its appearance. Pectoral fin like the dorsal and the anal, is devoid of fin-rays. Gut is quite straight. Larva measures about 7 mm. in length. Big chromatophores are present on the head and smaller ones on the body and tail. Air-bladder shows division into an anterior and a posterior lobe. Mouth has shifted to anterior side (Text-fig. 4*d*); its lower lip is distinctly fringed. Nostrils have come to lie at the antero-superior angle of the orbits, as in the adult.

Stage 29.—One hundred and ninety-eight hours after hatching. Pelvic fins arise as small white buds behind the pectoral fins, one on either side of the ventral fin-fold. Anal fin has become deeper and is without fin-rays. Dorsal fin is distinct and possesses fin-rays. Pectoral fins are well-developed and are functional. Anterior part of gut shows convolutions. Lobes of caudal fin have become deeper but still they are unequal. Dorsal and ventral fin-folds are still present.

The growth of the larva is evidenced by the increase in thickness and depth, the length remaining about the same as before. The middle region of larva has become arched.

Stage 30.—Two hundred and thirty-six hours after hatching. Anal fin has become more prominent and possesses fin-rays; still it is continuous with the caudal fin-fold posteriorly. The ventral fin-fold, in front of the anal-opening, is still quite prominent. Lobes of the caudal fins are deeper than in the preceding stage.

Stage 31.—Three weeks old larva. The larva measures from 13·1 to 14·3 mm. in length. Maxillary barbels are well-developed while the rostral ones are insignificant. All the fins possess distinct and well-developed fin-rays. Pectoral fin possesses thick muscular base. Caudal fin is deeply forked and its two lobes are similar. Dorsal fin-fold has disappeared. A part of ventral fin-fold is still perceptible before and behind the vent; it is more prominent before than behind the vent. Interorbital space possesses big chromatophores. The chromatophores also occur behind and before the eyes in smaller numbers, more on the dorsal than on the lateral sides; these are altogether missing on the lower side of the body. Snout possesses pores. Lips are fringed. The notochord is broken up into vertebral elements. Anterior part of the digestive tract is greatly coiled. The larva shows the diagnostic characters of the adult except the presence of narrow ventral fin-fold and the absence of scales.

Stage 32.—Five weeks old fry. The ventral fin-fold disappears and the scales make their appearance. Mouth assumes the adult position (Text-fig. 4*e*). It is now a young adult.

Hints for distinguishing eggs, embryos and larvae of *Labeo gonius*, *Cirrhina mrigala* and *Wallagonia attu*.

'Adequate measures for conservation of our fishery resources and the production of the maximum quantity of food with the minimum of expenditure through proper propagation methods require as their basis a reasonably complete knowledge of the life-histories and habits of the fishes. The first step in this direction is the determination of the character of the eggs and young, so that they may be recognized at any stage of development.' The views of Kunts and Radcliffe (1918) referred to here suggest the usefulness of comparison between early stages of different species of fish. Taking this into consideration the stages of *Labeo gonius* have been compared with those of two other food fishes, *viz.*, *Cirrhina mrigala* and *Wallagonia attu*, which were found breeding together under more or less

Table showing the distinguishing characters of the eggs, embryos and larvae of Labeo gonius, Cirrhina mrigala *and* Wallagonia attu.

	Labeo gonius (Hamilton).	*Cirrhina mrigala* (Hamilton).	*Wallagonia attu* (Bl. & Schn.).
Breeding season.	July (Monsoon).	July (Monsoon).	July (Monsoon).
Egg-membranes.	Single.	Single.	Double.
Diameter of freshly fertilized egg.	1·0 to 1·3 mm.	1·5 mm.	1·2 to 1·5 mm.
Size of egg after swelling.	About four times.	From three to four times.	About double.
Segmentation.	Irregular; blastomeres are regularly arranged only in egg with 8 cells.	Regular; in eggs up to 16 cells, the blastomeres are arranged regularly.	Regular, as in *Cirrhina mrigala*.
Appearance of embryonic rudiment.	5⅔ hours after fertilization.	7 hours after fertilization.	8 hours after fertilization.
Appearance of eye rudiment.	6⅔ hours after fertilization.	10 hours after fertilization.	9½ hours after fertilization.
Appearance of gill rudiment.	6½ hours before hatching. All of them are present at 8 hours after hatching.	7 hours after hatching.	3½ hours before hatching.
Appearance of Pectoral fin-buds.	1½ hours before hatching.	11 hours after hatching.	Present in newly hatched larva.
Period of incubation.	15⅔ to 17⅛ hours.	16 to 19 hours.	14 to 20 hours.
Length of newly hatched larva.	3·3 to 3·8 mm.	3·8 to 4·0 mm.	3·2 to 3·8 mm.
Characteristic of newly hatched larva.	Eyes, otocysts, embryonic fin-fold, rudiments of pectoral fins, rudimentary gill-slits, etc. present.	Eyes, otocysts, embryonic fin-fold present; pectoral fins and gill-slits absent.	Eyes, otocysts, embryonic fin-fold, rudimentary barbels, rudiments of pectoral fins and rudimentary gill-slits present.
Appearance of dorsal fin rudiment.	162 hours after hatching.	About 168 hours after hatching (7 days).	....
Appearance of anal fin rudiment.	162 hours after hatching.	About 288 hours after hatching (12 days).	....
Appearance of pelvic fin rudiment.	198 hours after hatching.	About 288 hours after hatching (12 days).	....
Appearance of barbels.	During post-larval development.	As in *L. gonius*.	During post-embryonic development.
Fry.	Head compressed; thin barbels; mouth toothless; body with scales; lips fringed, both continuous at angle of mouth; no symphysial knob on lower jaw.	Head compressed; thin barbels; mouth toothless; body with scales; upper lip entire, not continuous with lower lip; a symphysial knob on lower jaw.	Head depressed; snout spatulate; barbels well developed; mouth with teeth; body scaleless.

similar conditions. From what follows it becomes abundantly clear that not only the fishes belonging to two different families differ in their early life-histories but even the members of the same family can be distinguished from one another in early stages of development.

Both, *Labeo gonius* (Hamilton) and *Cirrhina mrigala* (Hamilton) breed during monsoon and possess eggs of almost the same size and shape. In the *Labeo*, however, the early segmentation divisions are irregular, while in the *Cirrhina*, these are quite regular and resemble the corresponding stages of *Wallagonia attu* (Bl. and Schn.). The time of appearance of embryonic rudiments, length of newly hatched larvae and incubation period also slightly differ in the two carps. The structures of the larvae of the two are also not exactly the same. In the *Labeo* the newly hatched larva possesses rudiments of pectoral fins and rudimentary gill-slits while both these structures are missing in that of *Cirrhina* at this stage. In the former dorsal and anal fin rudiments appear simultaneously while the pelvic fins appear much later but in the latter the dorsal fins appear much earlier while the anal and the pelvic fins appear simultaneously. About three weeks old larvae possess most of the characters of the adult and offer no difficulty in identification.

The catfish, *Wallagonia attu* (Bl. and Schn.), is so different from the above carps, that it can easily be distinguished from them at almost all stages. Unlike the carps, its eggs are enshrouded in two membranes and its yolk-sac remains spherical throughout. Moreover the barbels of the catfish appear as very thick lobules in the post-embryonic period while in the carps these are very thin and appear very late during larval development. The fry of *Wallagonia* possesses broad and depressed head, characteristic mouth, well-developed barbels, very long anal and rounded unequal lobes of caudal, while in the above carps the head is compressed, barbels are short and thin, anal fin is short, and the caudal fin possesses sharp and equal lobes.

SUMMARY.

An account of the study of thirty-two selected stages out of about one hundred developmental stages of *Labeo gonius* (Hamilton), from egg to fry, is given. The stages were obtained as a result of stripping the spawning fish and artificially fertilizing the eggs.

Ripe unfertilized egg measures from 1·0 to 1·3 mm. in diameter; is enclosed in a single membrane and possesses no germinal-disc. Fertilized eggs swell to about four times their original size after they are immersed in water.

Segmentation is irregular and the blastoderm covers almost the whole of yolk-sac in $5\frac{2}{3}$ hours and at the same time rudiment of embryo makes its appearance. After an hour the yolk-sac prolongs posteriorly. Newly hatched larva possesses nervous system, notochord, yolk-sac, oral pit, rudiment of digestive tract, embryonic fin-fold, pectoral fin-buds, rudimentary gill-slits, otocysts and heart; it takes $15\frac{2}{3}$ to $17\frac{1}{6}$ hours to hatch.

Rudiment of the eye appears at $6\frac{2}{3}$ hours after fertilization. Lens separates from epidermis when the embryo is $11\frac{2}{3}$ hours old.

Otocyst appears as simple ovoid sac in $8\frac{2}{3}$ hours old embryo; it later on becomes deeper and opens to the exterior by a single aperture.

Gill-plates appear as white mass of tissue, one on either side, behind the eyes, when the embryo is $9\frac{2}{3}$ hours old; each possesses a rudimentary gill-slit. Operculum arises from the hyoid arch 8 hours after hatching. Gill-rakers appear and the operculum cove s the branchial arches at 24 hours after hatching.

Pectoral fins appear as white specks posterior to the gill-plates at $1\frac{1}{2}$ hours before hatching; these develop and become functional by 198 hours after hatching but the fin-rays are seen in the fry 3 weeks old.

Rudiment of dorsal and anal fins are marked out from the embryonic fin-fold by the time the larva is 162 hours old, while the pelvic fin appears about 36 hours afterwards. The anal fin possesses fin-rays at 236 hours after hatching, while the dorsal fins become provided with rays 38 hours earlier. Rudiment of caudal fin-rays appear at 8 hours after hatching and these are distinctly seen 118 hours after. Posterior part of the notochord definitely bends upwards 21 hours after hatching and fully formed homocercal tail is formed by 236 hours after hatching.

Rudimentary gut appears at $9\frac{2}{3}$ hours after fertilization. Mouth appears in the form of oral pit in the larva at the time of hatching; it becomes deeper 5 hours later, becomes quadrangular and wide 3 hours after, shifts upwards and becomes adult-like by the time the larva is 162 hours old. Air-bladder appears at 24 hours after hatching. Yolk-sac becomes absorbed when the larva is 67 hours old. Nostrils appear on the ventral side of the head at 8 hours after hatching, shift to anterior end 13 hours later and assume the adult position, when the larva is 162 hours old.

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