ON THE SPAWNING HABITS AND EARLY DEVELOPMENT OF THE COPPER MAHSEER,[1] *BARBUS* (*LISSOCHILUS*) *HEXAGONOLEPIS* McCLELLAND.[2]

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Contents.

Introduction.

Like other Mahseers, the Copper Mahseer, *Barbus* (*Lissochilus*) *hexagonolepis* McClelland is a popular game fish and according to Shaw and Shebbeare (1938, p. 38) weight for weight, there is nothing to choose between this and the deep-bodied Mahseer, *Barbus* (*Tor*) *tor* (Hamilton). The Copper Mahseer, during breeding season is known to go to the higher reaches for spawning purposes but the recent researches (Hora and Ahmad, 1946) have shown that this species can be made to breed in tanks also and can also be stripped. Like Trout, the Copper Mahseer can be stripped and like Mirror Carp it can be induced to breed in tanks. If the fish is not stripped in time, it deposits its ova in suitable place in the tank. Theoretically, once a tank is properly stocked with this fish and suitable conditions for its breeding provided, one needs only to thin out his stock from time to time.

Although the fish is well known for its sporting qualities, nothing is known about its development. Recent articles of Hora and Nair (1943), Hora (1944), Langdale Smith (1944) and Hora and Ahmad (1946) have, however, thrown some light on its breeding habits.

In the present article a short account of the early development of the fish, based on the study of material obtained as the result of artificial fecundation, is given.

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[1] Though popularly known as a variety of Mahseer by anglers, it is not a true Mahseer as its labial groove is interrupted in the middle. It is a fish of the Barbel type.

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MATERIAL.

The material for the present study was obtained as the result of artificial fertilization, except the larva described as stage No. 15, which was collected from the terraced pond at Kalimpong. The first 12 stages described in this paper were collected from Runglee Rungliot in 1945, while the stages Nos. 13–15, were obtained from Kalimpong in 1946.

In 1945, the fertilized ova (Hora and Ahmad, p. 6) were transferred to hatching trays, which were kept in a shallow pool with a gentle, continuous flow of water. At Kalimpong two types of hatching trays were used, *i.e.*, (i) ordinary trays, with fine wire-gauze as their bottom, and (ii) trays with wooden bottom instead of wire-gauze. The first category of trays were internally lined with mosquito curtain so that the ova by coming into direct contact with the wire-gauze may not get injured and also that silt may not get into trays and produce unhygienic conditions. In the trays with wooden bottom pebbles of various sizes were spread in order to provide, as far as possible, natural environment for the development of ova and larvae. Both types of trays were in turn placed in a big wooden trough and a continuous current of water was set in it. Near the entrance of the trough a break plate was fixed so as to break the force of the current as soon as it entered the trough. The trough was water-tight so that some water always remained in it and at no stage was there any chance of its drying up. At the bottom of the trough near its outlet an opening was provided for cleaning the trough; this opening could be controlled and regulated by a wooden plug.

SPAWNING SEASON.

The factors favouring spawning have already been enumerated in an earlier article (Hora and Ahmad, p. 5). It was observed (*loc. cit.*, p. 7) that its breeding season had been recorded to be May-June by some and August-September by others. But the recent observations made at Kalimpong reveal that the breeding season of the fish extends from April with interruptions to October.

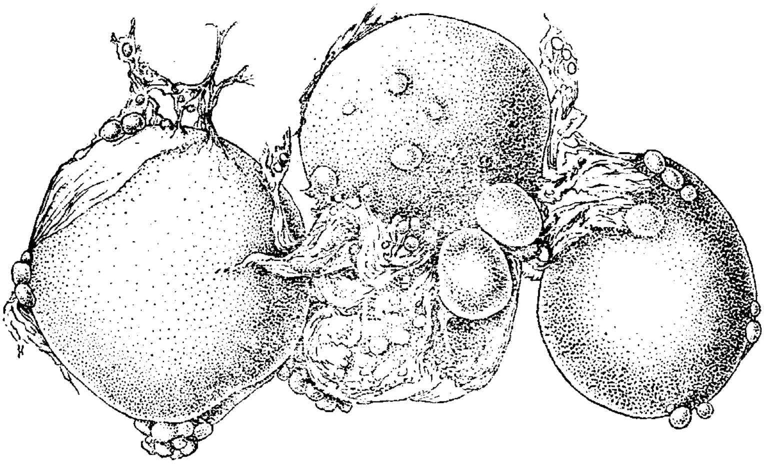
The tank at Kalimpong is situated at an altitude of about 3,500 feet. The first sign of sexual excitement of the fish in this tank was noticed on the 28th of April 1946 and the fish were caught and stripped on the 30th April. The maximum atmospheric temperature on the 30th April was 81°F. and the minimum was 66°F. while that of water ranged from 77°F. to 67°F. during that day. There was no rain on the 28th and the 29th April while local observatory recorded 0·53″ rainfall on the 30th April. After the 30th April the fish did not show any sign of sexual activity for about four months but it was renewed again in September and that month was found to be the peak period in the spawning of *Katli* at Kalimpong as shown in the table below:—

Date of Stripping.	Time of Stripping.	Number of males with size.	Number of females with size.	Temperature of water on the day.		Atmospheric temperature on the day.		Rain-fall.
				8 a.m.	5 p.m.	Max.	Min.	
8-9-1946	3-40 p.m.	Two; 10″ and 12″	One; 20″	75°F.	80°F.	81°F.	71·5°F.	Nil.
20-9-1946	8 a.m. 1 p.m.	One; 7″ Two; 12″ and 15″	One; 12″ Two; 20″ and 21″	73·5°F.	75·8°F.	80°F.	72°F.	Nil.
24-9-1946	12-30 noon.	One; 12″	One; 16″	71°F.	75°F.	78°F.	70°F.	0·40
14-10-1946	8 a.m.	Two; 8″ and 10″	One; 17″	70·5°F.	72·5°F.	77·5°F.	66·5°F.	Nil.

On the other hand, at Runglee Rungliot, as has been stated in the previous article (Hora and Ahmad, p. 6), the fish were stripped on the 8th, 9th and 24th August and 1st and 10th of September. It follows from the observations recorded during the last two years that although the peak period in the spawning of this fish is August and September, it begins to shed ova from the month of April. Further observations at different altitudes will show whether the breeding season extends right from April to October or during some of the months there is no sexual activity.

Ovaries and ovarian ova.

During the breeding season ovaries contain innumerable ova in various stages of development. A *Katli* caught on the 11th August, 1945, from the terraced ponds at Runglee Rangliot (Dist. Darjeeling), measured $21\frac{1}{4}''$ in length, weighed $3\frac{1}{2}$ lbs. and possessed ovaries, each measuring 4·5 inches in length and weighing 4 tolas (approximately 1·7 oz.). Another *Katli* secured from the same pond and on the same day, had ovaries weighing $2\frac{3}{4}$ tolas (approximately 1 oz.) and 4 inches in length.



Text-fig. 1.—Ovarian ova. $\times 16\frac{2}{3}$.

The ova obtained from these ovaries were of various sizes (Text-fig. 1) suggesting that all the ova in an ovary do not become ripe just at the same time.

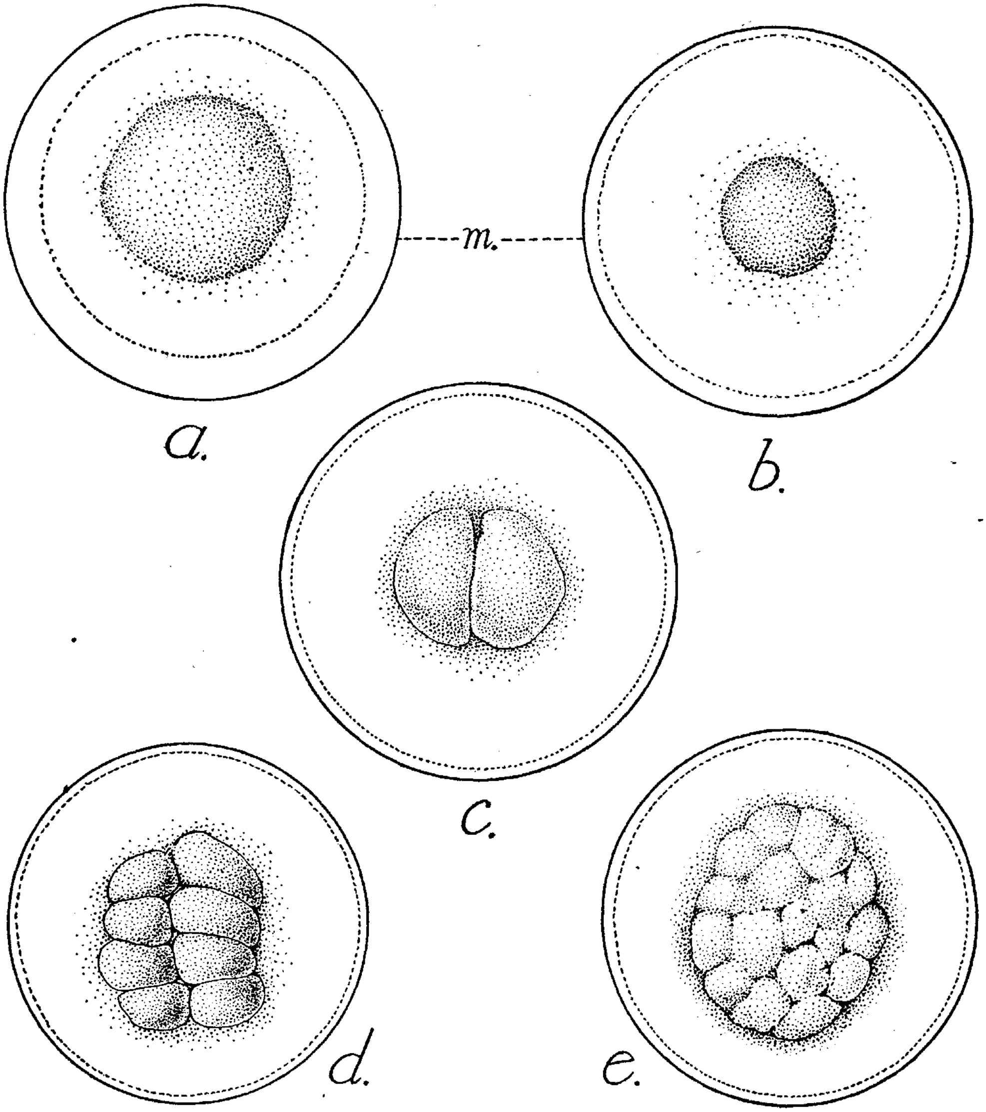
Ripe unfertilized ovum.

At the time of shedding, the ova are almost translucent and yellowish in colour. These are spherical in outline and measure from 2·3 to 2·5 mm. in diameter. They are demersal and settle down at the bottom, when shed in comparatively still water. The yolk is devoid of oil-globules and the ovum is closely surrounded by a single thick egg-membrane.

Embryonic development.

Stage 1.—Fifteen minutes after fertilization. The ovum collected fifteen minutes after fertilization shows a thin blastodisc at the animal pole (Text-fig. 2*a*). The periphery of the disc is thinner than the central portion and from its study it appears that cytoplasm in the yolk has concentrated to form this mass. It is spherical in form and measures 1·2 mm. in diameter in the specimen under report. The egg-membrane is separate from the egg proper and the small perivitelline space is full of imbibed water.

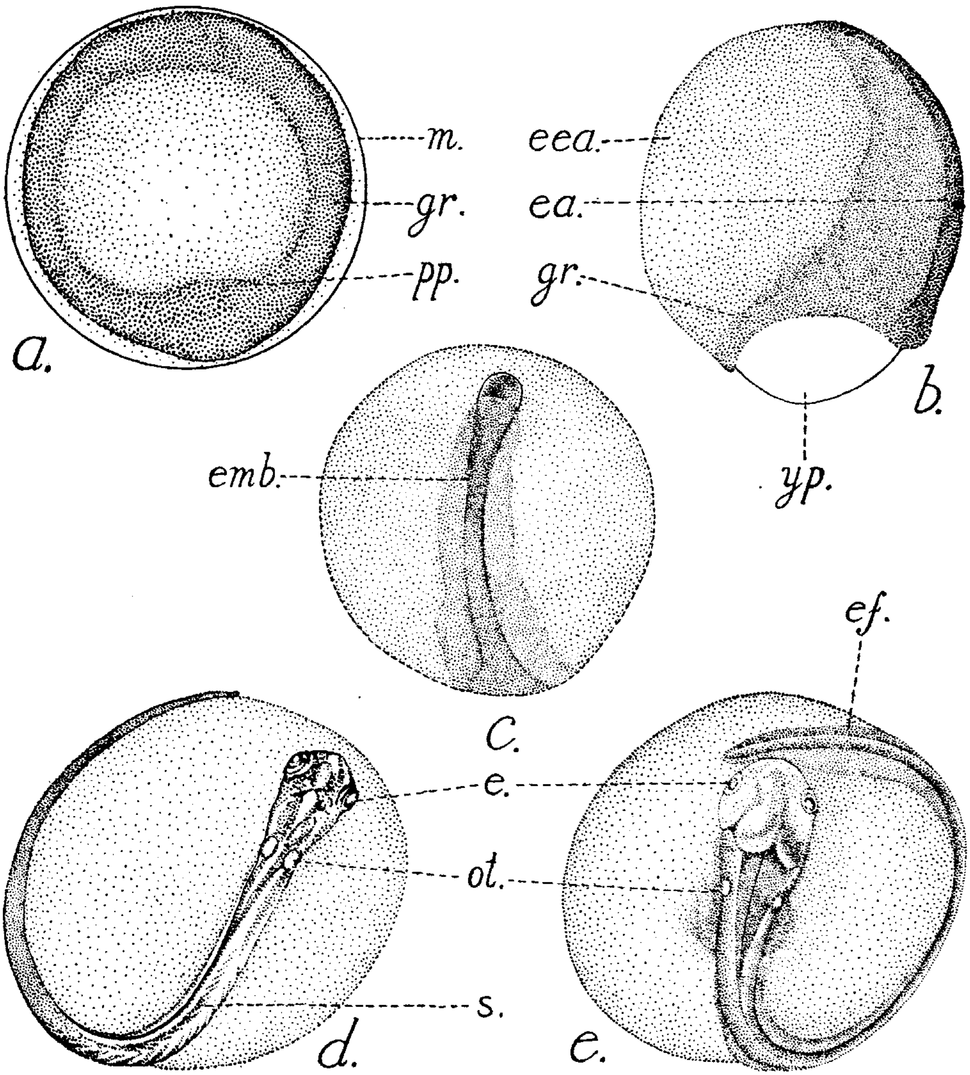
Stage 2.—Two hours and fifteen minutes after fertilization (Text-fig. 2*b*). The blastodisc is more condensed and prominent. It is shorter in diameter than in the earlier stage.



TEXT-FIG. 2.—Early embryonic development of *Barbus* (*Lissochilus*) *hexagonolepis* McClelland. ×20.
(*a*) Egg fifteen minutes after fertilization.
(*b*) Egg with fully formed blastodisc.
(*c*) Egg with two blastomeres.
(*d*) Egg with eight blastomeres.
(*e*) Egg with seventeen blastomeres.
m.—Egg-membrane.

Stage 3.—Three and a half hours after fertilization (Text-fig. 2*c*). The germinal disc has divided into almost equal halves. Each blastomere has rounded outer and straight inner margins. The cleavage of the blastodisc appears to have been almost complete. The free edges of the blastomeres are quite prominent. At the bases of the blastomeres, there is a layer of thin protoplasm.

Stage 4.—Five and a half hours after fertilization (Text-fig. 2*d*). The blastoderm consists of 8 blastomeres. From the study of a number of ova of this stage, it appears that before the blastoderm divides into 4 cells, third set of furrows makes its appearance with the result that the ovum comes to consist of 8 blastomeres.



TEXT-FIG. 3.—Embryo formation in *Barbus* (*Lissochilus*) *hexagonolepis* McClelland. ×20.

(*a*) Egg showing formation of germ-ring.
(*b*) Egg showing differentiation of embryonic shield.
(*c*) Further stage in the formation of embryo.
(*d*) Embryo showing otocysts, eyes, somites, etc.
(*e*) Embryo 62½ hours before hatching.

e.—Eye; *ea.*—Embryonic area; *eea.*—Extra-embryonic area; *ef.*—Embryonic fin-fold; *emb.*—Embryo; *gr.*—Germ-ring; *m.*—Egg-membrane; *ot.*—Otocyst; *pp.*—Posterior pole of blastoderm; *s.*—Somites; *yp.*—Yolk-plug.

The protoplasm surrounding the cells is reduced and the cells stand out more prominently than in the last stage. The blastomeres are much smaller than those in *Stage* 3. In some cases, it is noticed that 4 blastomeres resulting from the division of one of the blastomeres of the two-celled stage, remain quite separate from those of the other.

Stage 5.—Seven hours after fertilization (Text-fig. 2*e*). There is no regular arrangement of blastomeres. Eggs with 12, 17 and 18 blastomeres are fairly common although a few possess 16 blastomeres also. There is not much trace of the protoplasm surrounding the blastomeres.

Stage 6.—Twenty-five and a half hours after fertilization. The blastomeres have divided and subdivided forming a mass of smaller cells, which have covered a greater part of the yolk than in earlier stages.

Stage 7.—Forty-two and a half hours after fertilization (Text-fig. 3*a*). The blastoderm has covered almost half of the yolk. The free margin of the blastoderm has become thickened to form a band-like thickening, the germ-ring (*gr.*). At one point the germ-ring is thickened and broader, this represents the posterior pole (*pp.*) of the blastoderm.

Stage 8.—Forty-eight hours after fertilization (Text-fig. 3*b*). The blastoderm cells have covered more of the yolk than in earlier stages. At this stage only about one-fifth of the yolk remains exposed. The embryonic shield is well developed; it is triangular in outline and is distinguishable into two parts, (1) a thickened ridge running antero-posteriorly, representing the axis (*ea.*) of the embryo, and (2) a thin sheet of protoplasm representing extra embryonic area (*eea.*).

Stage 9.—Fifty-seven and a half hours after fertilization (Text-fig. 3*c*). The blastoderm has completely grown round the yolk mass and the blastopore is closed. The embryonic axis is more developed and it extends about two-thirds along the circumference of the yolk. The region of the closed blastopore has thick mass of tissue while anteriorly the embryonic area becomes narrow and ends bluntly.

Stage 10.—Eighty-one and a half hours after fertilization (Text-fig. 3*d*). The embryo is well defined and is closely attached to the yolk. The rudiment of eye (*e.*) is present but so far there is no pigment in it. Otocysts (*ot.*) are present. Somites (*s.*) are distinguishable in the middle of body.

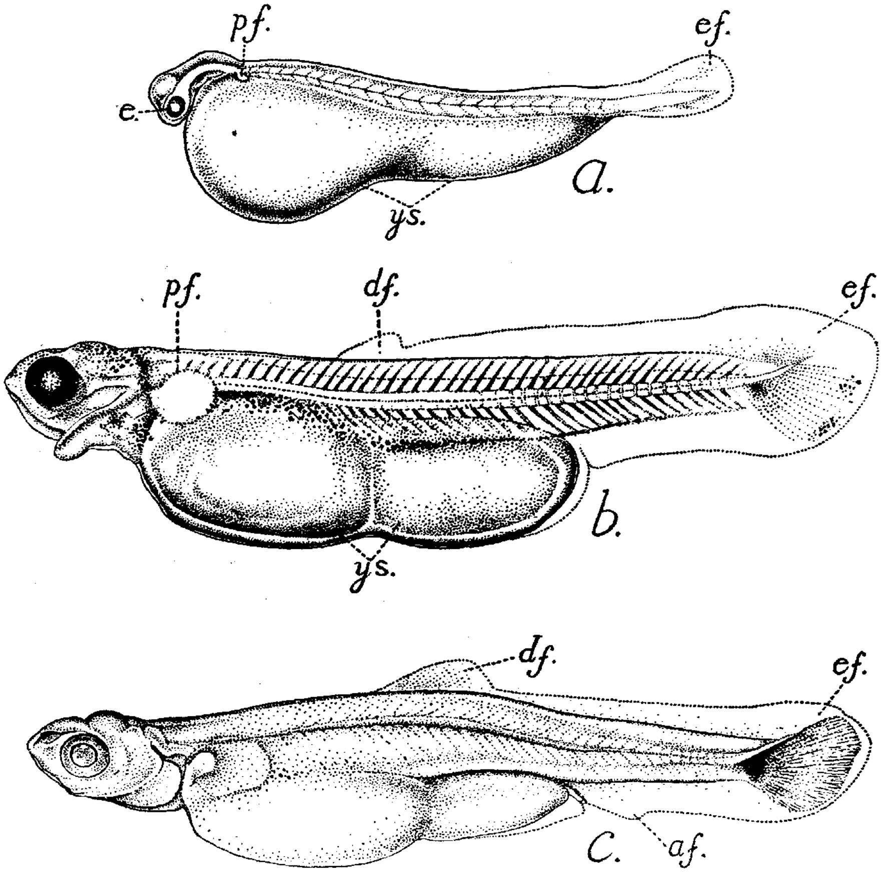
Stage 11.—Ninety hours after fertilization. The embryo is slightly more elongated than in the last stage. Head cavities are quite prominent. The embryonic fin-fold is present in the form of a narrow fold surrounding the tail and extending forward both along the dorsal and the ventral sides of the body.

Stage 12.—One hundred and twenty hours after fertilization (Text-fig. 3*e*). The lens of the eye can be seen. The head cavities are not so prominent as in the last stage. The fin-fold is more developed. Behind each otocyst, there is seen a rudiment of a gill-slit. Pectoral fin appears as a small bud behind each gill-slit.

Larval development.

Stage 13.—Newly hatched larva. Six days after fertilization (Text-fig. 4*a*). The newly hatched out larva is almost colourless. It possesses deflected head, ventral mouth, elongated yolk-sac, bud-like pectoral fins (*pf.*), otocysts and rudimentary gill-slits. It measures about 6·2 mm. in length. The first batch of larvae hatched out at 103½ hours and the last one at 190 hours after fertilization of ova.

Stage 14.—Six days old larva (Text-fig. 4*b*). The larva has grown in length to 9·3 mm. The continuous fin-fold (*cf.*) is quite wide and is much more developed than in the early stage. The anterior-most part of the fin-fold on the dorsal side has become enlarged to form the rudiment of the dorsal fin (*df.*). The posterior end of the notochord has bent upwards. In the caudal region, rudimentary rays have made their appearance in the fin-fold. The eyes have developed pigment. Pigment is also distributed on the head and along the body, more so immediately below the notochord than above it.



TEXT-FIG. 4.—Larval development of *Barbus* (*Lissochilus*) *hexagonolepis* McClelland.

(*a*) Newly hatched out larva. $\times 12\frac{1}{2}$.
(*b*) Six days old larva. $\times 12\frac{1}{2}$.
(*c*) About one month old larva. $\times 9\frac{1}{2}$.

af.—Anal fin-fold; *df.*—Dorsal fin rudiment; *e.*—Eye; *ef.*—Embryonic fin-fold; *pf.*—Pectoral fin; *ys.*—Yolk-sac.

Stage 15.—Larva measures 1 $\frac{1}{5}$ cms. in length (Text-fig. 4*c*). The eyes and gills are well developed, dorsal fin (*df.*) is more prominent, yolk-sac is reduced and the anal fin (*af.*) has made its appearance.

The above specimen was collected last year from a tank at Kalimpong and according to the statement of the owner of the tank, it is about a month old. Since there is no definite evidence to prove the statement, nothing much can be said on this point.

SUMMARY.

Barbus (*Lissochilus*) *hexagonolepis* McClelland can be stripped like Trout and by providing suitable conditions can be induced to breed in tanks like Mirror Carp.

The fish breeds from April to October but the peak period reaches in August and September.

Sometimes ripe females yielded relatively few ova at a time by stripping although innumerable ova in various stages of development were found in the ovaries. It follows that all the ova in an ovary do not become mature at the same time.

Ova are typical like those of other carps. Blastodisc appears 15 minutes after fertilization, 2-celled stage is formed 3½ hours after, 8-celled stage 2 hours later and the cells become an irregular mass 7 hours after fertilization. Germ-ring makes its appearance when the ovum is about 42½ hours old. At this stage the blastoderm has invested about half of the yolk. Forty-eight hours after fertilization, only ⅕ of the yolk remains exposed and the embryonic shield is well developed and is distinguishable into an embryonic and an extra-embryonic area.

The embryo becomes well-defined when it attains an age of 81½ hours. At this stage the rudiment of eyes, otocysts and somites are clearly visible. Embryonic fin-fold appears about 90 hours after fertilization and lens of eye as well as rudiment of gill-slits appear 30 hours later.

Incubation period was found to vary from 103½ to 190 hours in different cases. Newly hatched out larva is almost colourless, possesses deflected head, elongated yolk-sac, bud-like pectoral fins, gill-slits and otocysts.

The anteriormost part of the fin-fold becomes enlarged to form the rudiment of the dorsal fin, posterior part of the notochord bends upwards, rudimentary rays make their appearance and eyes develop pigment when the larva becomes 6 days old.

In about a month old larva, eyes, gills, dorsal fin and rudimentary anal fin are clearly seen.

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