J. Mar. biol. Ass. India, 1967, 9 (1) : 70-76

EGGS AND DEVELOPMENTAL STAGES OF *TYLOSURUS CROCODILUS* (LESUEUR)

By V. B. MASUREKAR

Department of Zoology, Institute of Science, Bombay

Tylosurus crocodilus (Lesueur) is one of the three species of garfishes which occur in Bombay waters, the other two being *T. strongylurus* (v. Hass.) and *T. leiurus* (Blkr.). Large-sized specimens of *T. crocodilus* ranging from 75 to 100 cm. in total length are found in the inshore catches during September, October and November. A fairly good number of specimens of this fish were examined in October 1955, as it was presumed that the huge masses of large eggs, which are often washed ashore at Choupatty and Backbay-Apollo Bunder, during this period, probably belonged to this fish. Further experimental work confirmed this presumption. Most of the specimens examined during this period were mature.

The mature fish have cylindrical ovaries, asymmetrical in length. One of the specimens examined had a total length of 95 cm. and its ovaries weighed as much as 1352 gm. The ovaries were full of large mature ova interspersed with some immature ova which normally occur in any ovary in any stage. The ovaries were in a condition preceding spawning.

The mature eggs are very large, ranging from 4.0 to 4.1 mm. in diameter. The yolk is vacuolated, transparent, with minute scattered oil globules. The egg membrane is very tough and bears a number of long, fine, transparent thread-like filaments. These filaments are entangled with those of the others, thus forming large bunches of eggs which are laid amongst the seaweeds. Such egg masses (Fig. 1) are often washed ashore during October and early part of November.

A large egg mass containing thousands of eggs was collected on October 8, 1955, (and again in 1961 for confirmation of the previous results) at the Backbay shore near Apollo Bunder. Except for the fact that these eggs were fertilized, they entirely resembled the mature ovarian eggs. Subsequently the hatched larvae and their further development as studied in the laboratory aquarium confirmed the earlier presumption that the eggs were probably those of *Tylosurus crocodilus*.

The eggs of *Tylosurus* species in general appear to be large. Those of *T. strongylurus* as described by Job and Jones (1938), have a diameter of 2.5 mm. The American silver-gar (*T. longirostris*) has eggs with a diameter of 3.5 mm. with numerous long filaments arising from the surface of the egg membrane (Ryder,* 1852), whereas the diameter of the eggs of the European gar (*Rhamphistoma belone*) is 3-3.5 mm. (Ehrenbaum,* 1904). Delsman (1924) has recorded that in *Tylosurus melanotus* (Blkr.), the eggs have a diameter of about 4.0 mm. In the species under study, *Tylosurus crocodilus*, the egg diameters in the egg masses collected at the Backbay had a range of 4.0 to 4.1 mm., the same as seen in the ovarian eggs of the fish.

* Indirectly referred through the paper of Delsman (1924).

Eggs with such large diameter generally take a long time for development. The egg masses were collected on October 8 at 6 p.m. and it was not until October 14 at about 11 a.m. that the first batch of larvae came out, the remaining eggs hatching on the next two days i.e. October 15 and 16. The condition of embryos within the eggs suggested that spawning had probably taken place at least 2-3 days prior to the time of collection. It can therefore be presumed that it takes about 8-10 days for the eggs to hatch.

FIG. 1

FIG. 1. A portion of the egg mass of *Tylosurus crocodilus*.

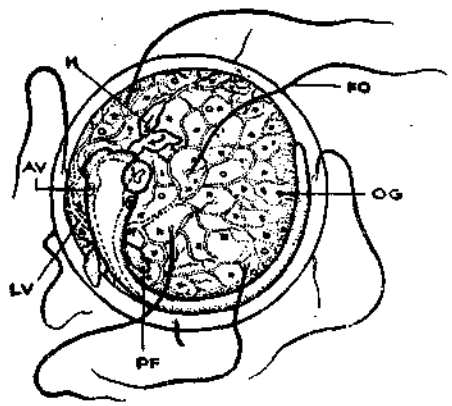

FIG 2

FIG. 2. A free sketch of the egg of *Tylosurus crocodilus* 18 hours after collection. AV-Auditory Veside; FO-Filamentous outgrowth; H-Heart; LV-Lateral vessel; OG-Oil globule; PF-Pectoral fin.

The *egg* is spherical. Fig. 2 is a sketch of an egg 18 hours after collection. The yolk mass is transparent, spherical and almost completely occupying the interior of the egg membrane. The embryo encircles the yolk for more than half its circumference. Stellate black chromatophores are uniformly distributed over the yolk surface. The heart is distinctly seen in front of and below the embryonic head. Two lateral vessels have appeared by the side of the fairly well developed pectorals. A median ventral blood vessel running through the body of the embryo and coming out posteriorly is also seen but not shown in the text-figure. The course of blood circulation is shown by arrows. The heart beats range from 114-116 per minute. The circulation of the blood over the yolk-sac is very prominent. Blood corpuscles could be distinctly seen through the thin blood vessels.

The pectorals are conspicuous but without any rays at this stage and are constantly seen moving outward, inside the egg membrane. The formation of dorsal and ventral finfolds can be just noticed. Auditory vesicles have made their appearance. The optic cups, each with a prominent lens, are also well developed. Minute oil droplets as seen in the ovarian eggs are present in the yolk. The mouth is indicated by a slit-like opening at the anterior end of the embryo.

The *embryo* (*42 hours after collection*, i.e. on 10-10-55) is slightly elongated. There is a slight reduction in the size of the yolk-sac. Dorsal and ventral fin-folds become distinct and the operculum can be distinguished. Eyes are as yet without pigment and the mouth becomes distinct.

11-10-55. 66 *hours after collection* the embryo is seen constantly moving inside the egg membrane with its posterior region becoming somewhat free from the yolk-sac. Pectorals become very active as can be seen by their constant movement. In most of the eggs the minute oil droplets accumulate to form a big oil globule. The eye lenses become prominent, black pigment develops around the lenses and the eyes protrude out. Opercular movements could be distinctly seen. The lower jaw becomes visible and shows slight movement.

The same day, 72 *hours after collection*, calcareous concretions appear in the auditory capsules. By this time the posterior half of the body is free from the yolk-sac. In almost all cases, the pectorals, especially the left one, show brisk movements. The embryo as a whole shows jerky movements inside the egg. The head is quite broad and large. The yolk-sac gets somewhat shrunken in size. Formation of the air-bladder could just be noticed.

12-10-55. 96 *hours after collection*, the lower jaw of the embryo shows constant up and down movement. Yolk-sac gets more depressed and shrunken, and the embryo now considerably elongated, completely encircles the yolk mass, the tail approaching the head. The eyes are much more blackened and the whole body of the embryo is strewn with yellowish brown and black pigment spots. About 8-10 rays are visible in the caudal fin. The gape of the mouth extends below and opposite the front edge of the eye. The bubble-like distinct, shining air-bladder can be seen arising from the dorsal side of the gut over the posterior border of the yolk-sac. The brain and the nerve cord also can be clearly observed at this stage.

13-10-55. 120 *hours after collection*, the yolk-sac is seen to be still more reduced. Rays have started appearing in the median dorsal and ventral-fin-folds. The movement of the jaws, pectorals and the operculum becomes more frequent and vigorous. The embryo appears dark as the whole body is now covered with small black stellate chromatophores. The pigment has also spread on the dorsal one-third of the yolk-sac in addition to its original black chromatophores. Numerous brownish or reddish brown spots are also seen in between the black stellate chromatophores. The head is still free of pigmentation.

14-10-55. Hatching of the eggs started taking place after about 136 hours. Some of the eggs hatched out at about 11 a.m. on October 14, and the majority of the remaining eggs during the subsequent 2-3 days, hour after hour in good numbers. The egg membrane gets ruptured at one end and the head of the embryo comes out first. In this condition it remains almost motionless for about a quarter of an hour or less, except for the constant movement of the jaws and the operculum. If the egg is forcibly broken prior to hatching, the empty egg membrane remains tough and chitin-like ; but when the egg is hatched in the normal course, the egg membrane becomes invariably soft and flaccid. After some time, the embryo (hereafter termed *larva*) starts moving the head sideways, periodically. The eyes also show constant movement. After a few minutes the pectorals come out and by constant lateral and forwardly directed movements the larva succeeds in getting its yolk-sac partly out of the slit in the egg membrane and comes out of the egg membrane by a jerky movement. Periodically the larva moves on the substratum by lateral flickering of the tail, trailing the yolk-sac on the bottom. After a time, by using the pectorals and the caudal fin the larva gradually rises up and starts swimming.

The length of the larva immediately after hatching ranges normally between 10.7 to 11.0 mm. but in a few cases the newly hatched larvae measured as much as 12.0 mm. in total length.

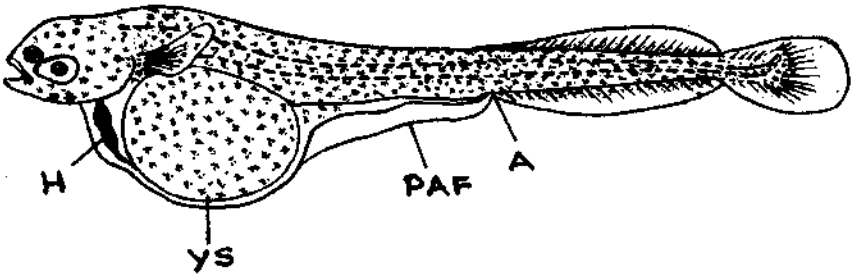

FIG. 3

FIG. 3. Newly hatched larva of *T. crocodilus*.

A-Anus; H-Heart; PAF-Pre-anal fin fold; YS-Yolk-sac.

Newly hatched larva (Fig. 3). Length 10.9 mm. The whole body appears grey because of the uniformly strewn brownish black pigments mixed with orange spots. Some imperfect rays are seen in the pectorals. About 15 caudal rays could be distinctly seen in the caudal fin which is more or less rounded. The rays, however, do not extend right up to the posterior margin. The median dorsal fin-fold extends slightly beyond the level of the anus and about 20 imperfectly formed dorsal rays can be distinguished. The anal fin-fold also shows about 19 imperfect rays. The pre-anal fin-fold extends forward from the anus to the yolk-sac. Basally the median fins appear greyish because of the uniformly scattered black pigments. The dorsal and the caudal are tinged with orange colour. The stellate black chromatophores on the yolk-sac are persistent. The lower jaw is longer than the upper which is slanting downward.

Larva 24 hours after hatching. Length 12.9 mm. The yolk-sac is more or less completely absorbed. Nostrils are distinct. The portion from the tip of the snout to the region of the pectorals turns greenish yellow. All the fins except the pelvics have now a full complement of rays, namely 23 in the dorsal, 21 in the anal, 17 in the caudal, and 13 in the fan-shaped pectorals. The dorsal and dorso-lateral sides behind the pectorals are uniformly grey with small stellate black chromatophores but those along the ventral and ventro-lateral sides become large and more conspicuous. The region of the dorsal side of the head behind the eyes is crowded with black stellate chromatophores.

Larva 36 hours after hatching. The whole body now appears greenish yellow or brown. The black stellate chromatophores covering the body are still mixed with the orange spots which are more on the head. The dorsal fin is now wholly pigmented with black chromatophores. The yolk-sac is completely absorbed by this time and that part of the abdomen where the yolk-sac has been absorbed appears less pigmented. The pelvic buds become distinct. No spiny frills on the head region, as described by Job and Jones (1938) for *T. strongylurus*, are seen in any of these stages. The pre-anal fin-fold is reduced in size.

Post-larva 44 hours old. The jaws are slightly elongated and very minute but distinct teeth are seen developed in them. Pelvics are still in bud condition.

Post-larva 100 *hours old.* (Figs. 4 & 5). Length 15.2 mm. The body now appears much elongated and cylindrical, with yellowish green colour mixed with black stellate chromatophores mentioned above. The chromatophores at the base of the pectorals become more conspicuous. Three to four large chromatophores

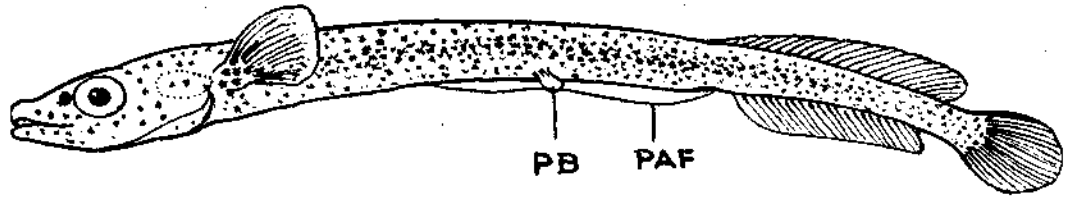

FIG. 4

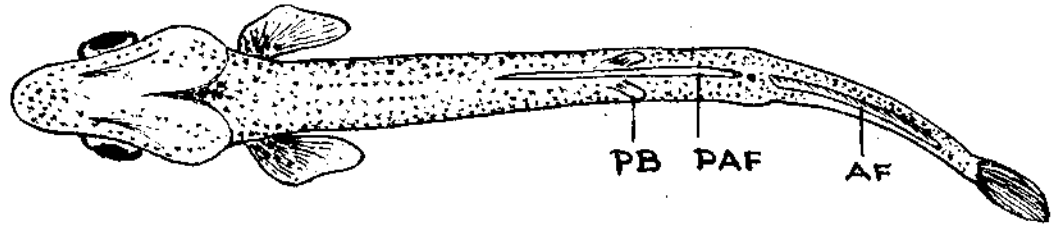

FIG. 5

FIG. 4. 100 hrs. old post-larva of *T. crocodilus.* (side view)
FIG. 5. 100 hrs. old post-larva of *T. crocodilus.* (ventral view)
AF-Anal fin ; PB-Pelvic buds ; PAF-Pre-anal fin-fold.

appear in a row along the isthmus. The pelvics are small and colourless. Along the lateral sides, the pigment is heavily concentrated. The caudal fin is still rounded.

Post-larva six days old. (Fig. 6). Length 19.3 mm. The black chromatophores along the body lose their intense black colour, become faint and appear brownish except ventro-laterally where the pigments are still pitch black. The inter-spinous membrane of both the dorsal and anal fins is deeply pigmented. The caudal fin is deeply pigmented only at the base, the rest of the fin being colourless. The pelvics and distal parts of the pectorals are colourless. Teeth become conspicuous. Eighty-four vertebrae can be counted in the alizarin preparations, the same number as recorded by Delsman (1924) for *T. choram* (now *T. crocodilus*), as against 83 vertebrae recorded by him for *T. melanotus.* The other two species, *T. leiurus* and *T. strongylurus*, occurring in Bombay waters, have 88 and 63 vertebrae respectively. Moreover, like the typical garfish the post-larvae often remain motionless at the surface of water.

Post-larva seven and a half days old. (Fig. 7). Length 21 mm. Rays appear in the pelvics. The number of fin rays in all the fins is now complete. The black stellate chromatophores become still more faint and brownish. Along the ventral and ventro-lateral sides they are still darker. The pre-anal fin-fold in front of the pelvics disappears and the rest is much reduced. The caudal fin loses its rounded

appearance and becomes truncated. There are 11 pointed teeth on each side in the upper jaw and 9 on each side in the lower jaw. The latter are more strong than the former. The post-larva now more or less remains at the surface and parallel to it and but for the as yet unforked caudal fin, gives the typical appearance of the garfish.

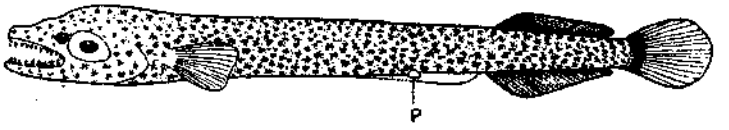

FIG 6

FIG. 7

FIG. 6. 6 day old post-larva of *Tylosurus crocodilus*. P-Pelvic fin.
FIG. 7. 7½ day old post-larva of *T. crocodilus*.

Beyond this stage the post-larvae could not be reared in the aquarium and thus the further elongation of the jaws and the forking of the caudal fin could not be observed. In the course of this developmental study some factors influencing their growth were noted. The optimum pH favourable to the development of the larvae ranged between 7.9 to 8.1 and a high mortality occurred at pH 7.5. The optimum temperature is about 28-29°C.

SUMMARY

Large bunches of eggs often washed ashore along the coast of Bombay in October-November were collected and the eggs reared in the laboratory. The study of eggs and subsequent developmental stages conclusively proved that the eggs belonged to *Tylosurus crocodilus* (Lesueur). The larvae could be reared in the aquarium only for a period of about eight days.

ACKNOWLEDGEMENTS

Thanks are due to the Director, Institute of Science, Bombay, for the help and encouragement given during the course of this work. Thanks are also due to Shri R. D. Shirgaonkar, for help rendered in making the illustrations.

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