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THE EMBRYONIC AND EARLY LARVAL DEVELOPMENT OF THE LONG-FINNED HERRING, *OPISTHOPTERUS TARDOORE* (CÜVIER)*

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Opisthopterus tardoore, the so-called long-finned herring, is one of the commercially valuable clupeiform fishes occurring in the Indian coastal waters. It is common in the trawl catches off Karwar, Mangalore, Cannanore and Ernakulam along the west coast and off Tuticorin in the east coast. Information hitherto available on the early life-history of this species is limited to the description of a juvenile stage from Madras coast by John (1951). Hence the present paper on its embryonic development and early larval stages may be of interest.

PROCEDURE

The eggs identified as of *O. tardoore* were isolated from the plankton samples of the 6-fathom area (surface hauls) off Cannanore, south-west coast of India, collected by means of a ¾ metre net of fine organdie cloth towed for about 15 minutes between 07.30 and 08.00 hours in the course of January to April, 1964. The search for the eggs was made because mature, spawning and partly spent *O. tardoore*, having the size-range of 120 to 180 mm. total length with the dominant mode at 165 mm. occurred in large numbers in the catches by the Indo-Norwegian Project trawlers operating off Cannanore. Comparison of the ripe ovarian eggs with the planktonic eggs in their early developmental stages and verification of the myotome number of the larvae with the adult vertebral number confirmed the identification.

Batches of eggs were reared in the laboratory in large glass-containers with filtered sea water. On the fourth morning most of the larvae have become shrivelled up and died, while the one or two semi-alive were inactive and emaciated. Most of the embryonic stages figured were on living material. The larvae were sketched immediately on fixation in 2% formalin.

RIPE OVARIAN EGG

The ripe ovarian eggs of *O. tardoore* (Fig. 1) are spherical and colourless with diameter ranging from 0.68 to 0.84 mm. The yolk is transparent, highly vacuolated and leaves a narrow perivitelline space. Oil globule is absent.

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PLANKTONIC EGG

The free eggs of *O. tardoore* are pelagic, transparent, spherical, devoid of oil globule and range in diameter between 0.78 and 0.95 mm. The yolk is transparent and highly vacuolated. The perivitelline space is narrow in living eggs (Figs. 2, 3, 4 and 7), while in eggs preserved in formalin the yolk shrinks, leaving a large perivitelline space (Figs. 5, 6 and 8). The eggs were observed to undergo a gradual increase in their size accompanied by progressive development of the embryo.

EMBRYONIC DEVELOPMENT

The planktonic eggs when brought to the laboratory were in various stages of development. Based on the important developmental features of the embryo, four phases were recognised.

I. *Egg prior to cleavage :* This is an early stage (Fig. 2), the one soon after fertilisation, in which the cytoplasm has seggregated to one pole of the yolk but cleavage has not yet commenced.

II. *Formation of the eye :* In the next stage (Fig. 3) available in the collections the embryo is indicated. The anterior end of the embryo is somewhat oval in shape, marking the head region. The formation of the optic vesicles is indicated by grooves on either side of the head. In this stage the boundaries of about eight myotomes can be recognised. In the following stage (Fig. 4) the optic vesicles are fully evaginated. The embryo is under progressive development and about 14 myotomes are formed. The development of the optic cups accommodating the lens is completed in the next stage (Fig. 5).

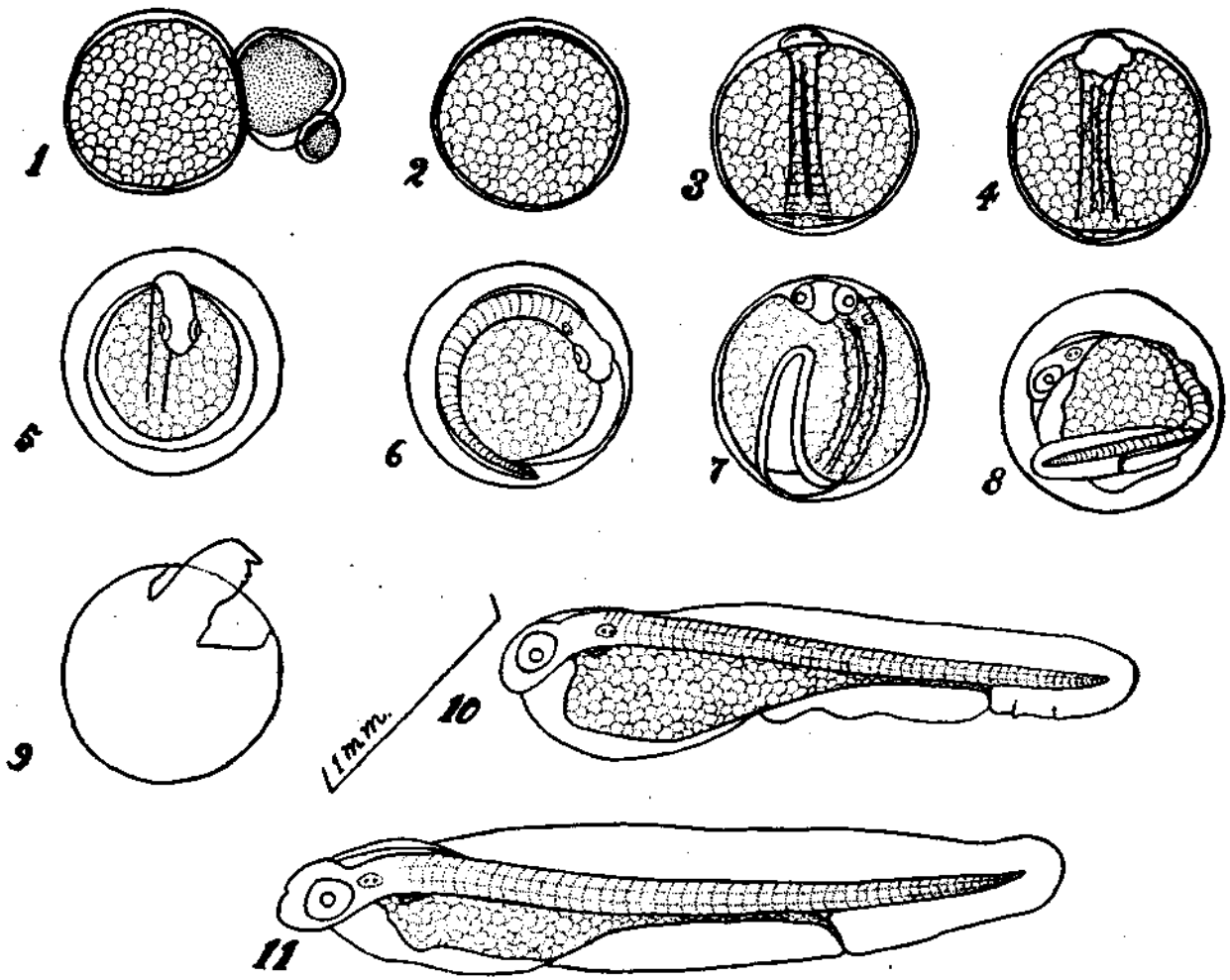
III. *Formation of the tail :* The tail in its earliest stage of development present in the collections appears as an elongated bud-like structure (Fig. 6) with rudiments of the larval fin-fold along its dorsal and ventral aspects. The auditory capsules are also visible. In the succeeding stage (Fig. 7) the larval fin-fold bordering the tail has become wider. The tail is free from yolk and the embryonic as well as vitelline regions are devoid of pigmentation. The heart is functional in the living condition.

IV. *Fully-formed embryo :* The embryonic development is completed in this stage (Fig. 8). The alimentary canal and the proctodaeum are clearly seen. In the living condition the embryo does lateral as well as longitudinal jerking movements of its body.

HATCHING

At the time the collections were brought to the laboratory, at about 09.00 hrs., most of the eggs were in stages of tail-formation ; the others were in eye-formation stages and rarely in pre-cleavage as well as fully-formed conditions. Except for a single egg that hatched on the afternoon of the day of collection (12.45 hrs. on 20-3-1964), all the eggs were found hatched on the following morning.

The jerking and lateral movements observed in the fully-developed embryo, were, at the time of hatching, repeated more frequently, accompanied by stretching



FIGURES 1-11 : Ripe egg, embryonic stages and early larvae of *Opisthopterus tardoore*. FIG. 1 : ripe ovarian-egg ; fig. 2 : egg before cleavage ; figs. 3-5 stages in eye-formation ; figs. 6-7 : stages in tail-formation ; fig. 8 : fully-developed embryo ; fig. 9 : egg capsule after hatching ; figs. 10-11 : early larvae ; fig. 10 : newly-hatched larva ; fig. 11 : 3.32 mm. stage.

of the trunk, elongation of the yolk-sac into a pear-shaped structure and lashing of the head against the egg-capsule. Repetition of these movements, results in the abrupt rupture of the capsule near the head region and the embryo struggles to emerge out of the capsule which is finally ridden of it (Fig. 9) by the movements of the body and lashing of the tail. About 15 seconds last between the breakage of the capsule and the emergence of the embryo as the newly-hatched larva.

EARLY LARVAL STAGES

Newly-hatched larva : The newly-hatched larva (Fig. 10) measures 2.63 mm., is transparent and unpigmented. It is broader in its anterior half and is of almost uniform height in its posterior half which ends in a somewhat rounded tail-fin. In the post-orbital region, dorsally, a constriction is present. The larval fin-fold is entire and continuous. It commences, dorsally, about anterior ¼th of the larva and ends, ventrally, well in front of the middle of the body on the posterior aspect of the yolk-sac. The yolk-sac occupies more than half the length of the larva, is pyriform in shape and tapers gradually to the hinder region. The maximum height of the larva is measured in the middle of the yolk-sac. The alimentary canal, in continuation of the yolk-sac, is rather straight and ends in a bent-up proctodaeum situated below the 38th myotome. The post-anal number of myotomes is difficult to be ascertained, as they become indistinguishable in the tail-end of the larva. There are 38 pre-anal and about 16 post-anal myotomes. The total myotome number in the newly-hatched larva is higher than in the advanced larval stages and the vertebral count of the adult, namely 50. The auditory capsules are somewhat oval in shape and contain dot-like otoliths. The larva swims actively, occasionally becomes passive and floats on the water surface.

3.32 *mm. larva :* From the developmental stage of the eggs left over in the aquarium on the evening of 20-3-1964, which were found hatched out on the following morning (at 10.00 hrs.) it appears that hatching took place by about mid-night or afterwards. It may be tentatively stated that the larva in this stage is about 10 hrs. old.

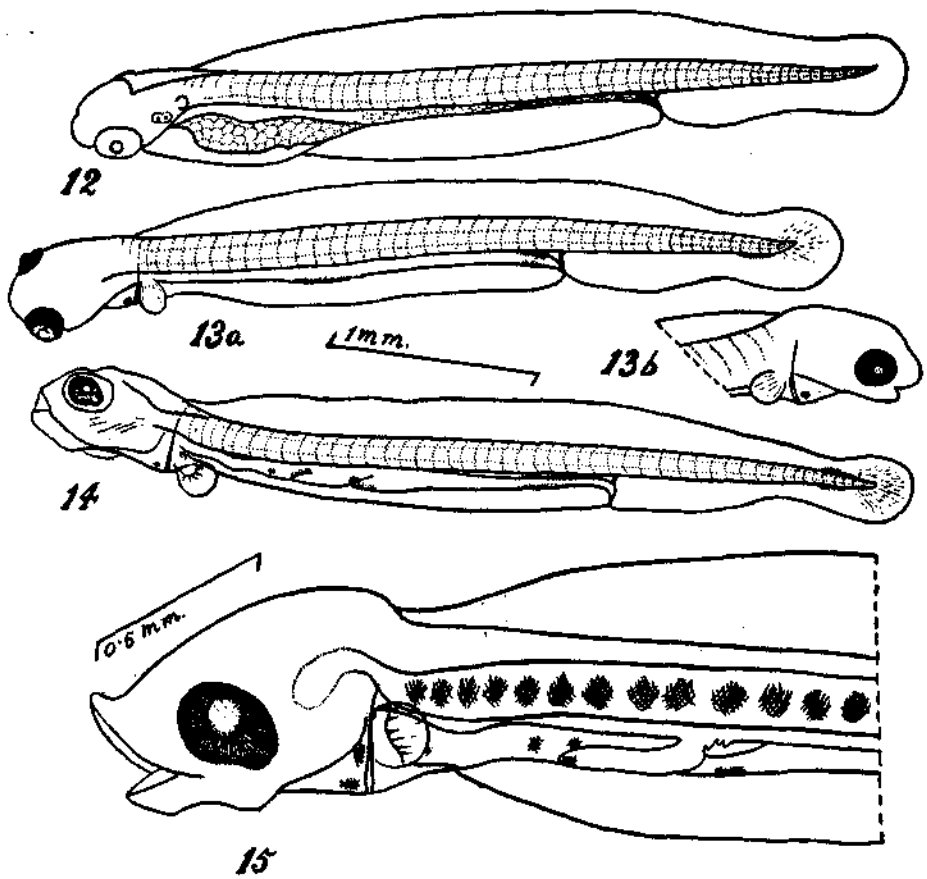
The anus in the 3.32 mm. larva (Fig. 11) has shifted forwards and opens below the 33rd myotome. The fin-fold has become broader and the yolk-sac has become narrower than in the previous stage. The larva has become elongated and somewhat fusiform, with the maximum height of the larva not confined to the middle of the yolk-sac, but extending from there till about the middle of the larva. The larva in this stage now and then resorts to moving with the head directed downwards and occasionally approaches the bottom of the container.

3.68 *mm. larva :* This stage is about 16 hrs. old (Fig. 12). The main changes noted are the shifting of the anus to the 32nd myotome and the indication of the pectoral fin as a bud-like structure. The yolk has largely been absorbed and the caudal region is somewhat constricted.

3.76 *mm. larva :* This is about 32 hrs. old (Figs. 13 a and b). The significant changes noted are the formation of the mouth, disappearance of the yolk and pigmentation of the eyes ; all marking that the larva has entered the post-larval phase of its development. The mouth is crescentic in shape and somewhat inferior in position. The alimentary canal has become wider. The eyes are deeply pigmented black and in the living condition have a silvery brownish-green lustre on the surface.

The pectoral fin has become a circular flap-like structure with faint striations marking the future rays. Caudal region also shows the beginnings of rays. The vent has moved still forward, thus reducing the number of pre-anal myotomes to 30. Twenty post-anal myotomes are clearly discernible in this stage. The total myotome number of the larva corresponds to the vertebral number of the adult. It may be noted in this connection that the number of pre-anal and post-anal vertebrae in the adult (17 and 33 respectively) is different from the disposition of myotomes in the larvae. The gill opening is formed as a transverse slit on either side of the hind end of the branchial region.

For the first time in the development, it is in the present stage that pigmentation has appeared. It is in the form of a chromatophore in front of the opercular cleft latero-ventrally ; a few along the ventral aspect of the mid-gut ; a trace of pigmentation along the dorsal and ventral aspects of the hind-gut and a trace along the



FIGURES 12-15 : Further stages in the larval development of *O. tardoore*. Fig. 12 : 3.68 mm. stage ; fig. 13 : 3.76 mm. stage., *a* entire larva, *b* showing the head region ; fig. 14 : 4.04 mm. stage ; fig. 15 : the head region of the larva on the fourth morning after the day of hatching.

ventral aspect of the tail. The larva in this stage appears to prefer bottom habit and can be seen pecking there frequently.

4.04 *mm. larva :* In this stage the larva is about 56 hrs. old (Fig. 14). The jaws are prominent, the branchial arches are indicated, the alimentary canal is under differentiation into various regions and the pectoral rays have become prominent, although their precise number is not yet discernible. The caudal fin has become increasingly constricted from the rest of the body. The pigmentation has increased with the appearance of a few chromatophores above the pectoral base and a few on the dorsal aspect of the tail. The number and disposition of the myotomes in this stage remain the same as in the previous.

The larvae in this stage resort to the bottom more often, accompanied by pecking there. When disturbed they move away from the bottom, but to return there shortly and to resume pecking. It is likely that with the utilisation of the yolk and formation of the mouth the larvae are in search of food. Except for a single case on 7-4-1964, all the larvae left-over in the aquarium on the evening of the third day after hatching, were shrivelled up, bent in the region of the anus and are dead on the fourth morning. It is quite probable that the heavy mortality is due to starvation.

The single larva surviving on the morning of 7-4-1964 is about 80 hrs. old (Fig. 15). It is emaciated in appearance with a shrunken body and measures only 3.68 mm., showing a reduction of 0.36 mm. from the previous stage. The chief changes noted are the slight tilting up of the upper jaw and the appearance of an additional chromatophore laterally in front of the opercular cleft. This stage probably marks the beginning of the critical phase when the post-larva gradually changes over to the early juvenile condition.

REMARKS

The eggs of *Opisthopterus tardoore* can be differentiated from those of *Sardinella=Clupea* spp. (Delsman, 1926 *a* ; 1933 *b* ; Devanesan, 1943 ; John, 1951 ; Nair, 1959), chiefly by the absence of a wide perivitelline space, apart from the other general characters of sardine eggs such as the presence of an oil globule and embryonic pigmentation. The eggs of *Dussumieria* spp. contain an oil globule (Delsman, 1925 ; Devanesan and Chacko, 1944 ; Kuthalingam, 1961) ; while those of *Kowala coval=Clupeoides lile* (Delsman, 1933 *a* ; Devanesan and John, 1941 ; Nair, 1951) and *Anodontostoma chacunda=Dorosoma chacunda* (Delsman, 1926 *b* ; 1933 *a* ; Bapat, 1955) contain many oil globules. The eggs of *Anchoviella=Stolephorus* spp. (Delsman, 1931 ; Nair, 1952) have an elongated structure and most of them contain an oil globule. The eggs of *O. tardoore* differ from those of *Setipinna* spp. and *Coilia* spp. (Delsman, 1932 ; Jones and Menon, 1952) in the absence of oil globule and in the smaller size of the egg. The eggs of *Setipinna* and *Coilia* contain many oil globules, one or more of which are larger than the rest.

In the absence of oil globule and in size the eggs of *O. tardoore* bear resemblance to those of *Thrissocles=Engraulis* spp. (Delsman, 1929 ; John, 1951 ; Nair, 1952 ; Bapat, 1955). But the perivitelline space in the eggs of *O. tardoore* is relatively narrower than in those of *Thrissocles* spp. ; besides, the newly hatched larva of *O. tardoore* has about 54 myotomes of which 38 are pre-anal ; while those of *Thrissocles* spp. have not more than 45 to 48 myotomes of which not more than 32 are pre-anal, corresponding to the smaller number of vertebrae in the adult which ranges from 41 in species like *Thrissocles dussumieri* to 45 in species like *T. mystax* and *T. setirostris* (Delsman, 1929).

Summary

The planktonic eggs of *O. tardoore* have a diameter of 0.78-0.95 mm.; are pelagic, transparent devoid of oil globule and have vacuolated yolk. The newly hatched larva is unpigmented, measures 2.63 mm. and has about 54 myotomes, of which 38 are pre-anal. The pro-larval period lasts till about the 3.68 mm. stage. The early post-larval condition marked by the disappearance of the yolk, formation of the mouth and pigmentation of the eyes and body is accomplished in the 3.76 mm. larva, which has 30 pre-anal and 20 post-anal myotomes; the total myotome number corresponding to the adult vertebral number. The 4.04 mm. larva has well-developed jaws and shows increase in pigmentation. After this stage heavy mortality was observed of the larvae reared in the laboratory, probably due to lack of food. The eggs and larvae are compared and contrasted with those of allied fishes occurring in Indian coastal waters.

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