

ON THE EGGS AND LARVAL STAGES OF THE MALABAR SOLE  
*CYNOGLOSSUS SEMIFASCIATUS* DAY

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Our knowledge of the early development of flat-fishes from India is based chiefly on the work of Gopinath (1946), Jones and Menon (1951), Nair, (1952 a; 1952 b), Bapat (1955), Seshappa and Bhimachar (1955), Kuthalingam (1957), Vijayaraghavan (1957) Jones and Pantulu (1958) and Balakrishnan (1961; 1963). The present communication deals with the eggs and early larval stages of *Cynoglossus semifasciatus*, commercially the most valuable flat-fish from Indian waters.

*C. semifasciatus* is popularly known as the Malabar sole because of its abundance in the Malabar area of the south-west coast of India. Although it is known to occur along both the east and west coasts, it supports a fishery of a high magnitude only along the Malabar and south-Kanara zones (George, 1958). Seshappa and Bhimachar (1951; 1954; 1955) have studied various aspects of the biology and fishery of this species. These authors (Seshappa and Bhimachar, 1955) have observed that "spawning commences in the species in October and continues up to May..... Eggs and larvae have also been found in the plankton during some of these months". They (1955) have described a few post-larval stages and metamorphosis of the fish from the symmetrical condition to the asymmetrical stage as in the adults. Balakrishnan (1961) has given an account of many stages in its larval history, most of them belonging to the post-larval phase. Apart from these, nothing substantial is known so far of the eggs and early larvae.

PROCEDURE

A search for the eggs of *C. semifasciatus* in the plankton collected off Cannanore (an important Malabar sole fishing locality in the northern sector of Malabar) was attempted, as partly and fully spent females (as well as males) appeared in the catches made by indigenous crafts and mechanised vessels operating off Cannanore during November 1964. The plankton was sampled by a 3/4 metre net of fine organdie cloth towed for about 15 minutes between 07.30 and 08.00 hours in the 6 fathom area. Twenty seven eggs identified as of this species were isolated on 20-11-1964 and reared in the laboratory for the stages in the larval history.

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Rearing was successful for about five days after hatching. Attempts were made to feed the larvae with copepods, nauplius larvae and/or diatoms, but were not successful. Growth after the two-day-old larval stage was negligible and a gradual decrease in size was apparent in the subsequent days, probably due to lack of food. The progressive features of the different stages continued to unfold, aiding comparison with similar and a little advanced stages described by previous authors and confirmation of the identity.

The eggs and larvae were studied for their characteristics in the living condition in a cavity slide and sketched either alive or immediately on fixation in 2% formalin. Length of the larvae when alive as well as in formalin are given for the sake of comparison.

#### *Planktonic egg*

The free eggs are pelagic, spherical, transparent and have an average diameter of 0.65 mm. in the living condition. The yolk is spherical, colourless, neither vacuolated nor segmented. It contains 25 to 30 oil globules in the diameter range of 0.038 to 0.076 mm. The perivitelline space is narrow. At 08.45 hrs. on 20-11-1964 all the eggs were in an early stage of development (Fig. 1), the germinal disc spreading over half of the yolk-mass. Development appears to be rapid, as at 11.00 hrs. the same day the embryo was formed (Fig. 2) and optic vesicles were indicated.

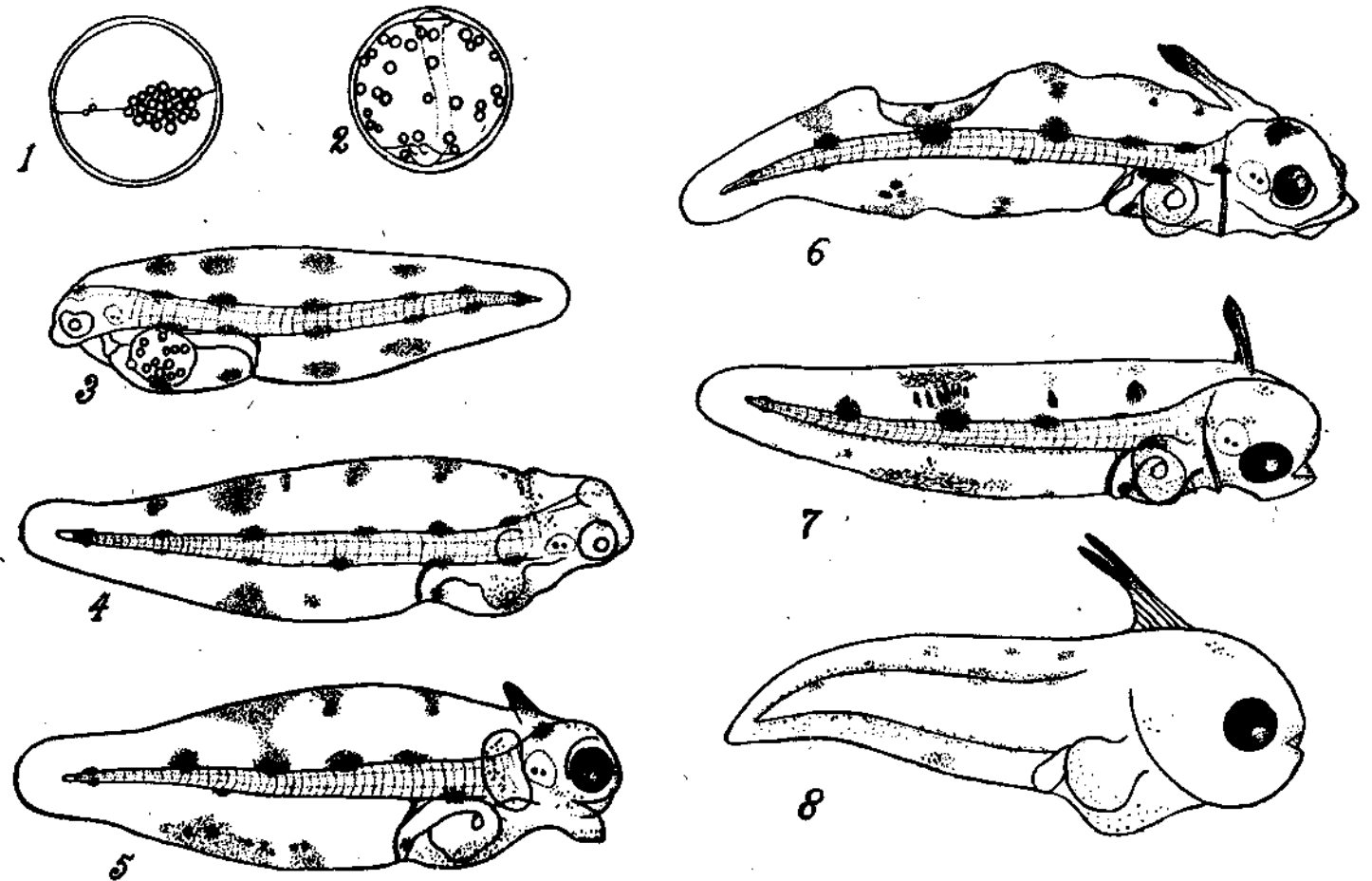
#### EARLY LARVAE

On the following morning (21-11-1964) at 08.00 hrs. all the eggs were found hatched out, obviously during the preceding night. The larvae survived till the morning of 26-11-64 and six stages in the early larval development were obtained.

#### *Stage I (Fig. 3)*

(Pro-larva at 08.00 hrs. on 21-11-1964)

This is the earliest larval stage observed, probably only a few hours after hatching. It measures 2.23 mm. when alive and 2.08 mm. in formalin. The larva is broader in the region between the auditory vesicles and posterior 1/3rd of the post-anal region. The larval fin-fold is prominent and continuous, commencing dorsally from the supra-orbital region and ending below the region of the eye ventrally. The caudal region tapers gradually and ends in a somewhat rounded tail-fin. The body of the larva (excluding the fin-fold) is broader anteriorly and tapers gradually in the hinder region, ending in a somewhat pointed tail. The eyes have an almost triangular shape with an upper depression and are unpigmented. The mouth is not yet formed; the alimentary canal is rather straight anteriorly and makes a downward bent for the anus which is situated below the 13th myotome. The yolk-mass is prominent and the oil



Eggs and larval stages of *Cynoglossus semifasciatus*. Fig. 1 and 2, eggs in two stages of development, at 0845 hrs and 1100 hrs respectively on 20-11-64; Fig. 3, 4 and 5 prolarva at 0800 hrs on 21-11-64, one day old larva at 0830 hrs on 22-11-64, and two days old larva at 0900 hrs on 23-11-64 respectively. Fig. 6, 7 and 8 postlarvae three days old at 0900 hrs on 24-11-64, four days old at 0900 hrs on 25-11-64, and five days old larvae at 0815 hrs on 26-11-64 respectively.

globules are distinct. The heart is recognisable in front of the yolk and is made up of an anterior tubular region and a posterior bulbus region. The auditory vesicles are oval in shape and have distinct otoliths. There are 13 pre-anal and about 37 post-anal myotomes, the exact number of the latter is difficult to be ascertained because their boundaries become indistinguishable near the tip of the tail. The pigmentation of the larva is characteristic and consists of six discontinuous bands of greenish-yellow chromatophores disposed transversely. Intermingled among them are a few minute blackish pigments. The anterior first four bands are made up of four patches each, while the posterior two are composed of only two patches. The upper and the lower patches of the anterior four bands ornament the fin-fold along its dorsal and ventral aspects while their intermediate patches along with the posterior two bands ornament the dorsal and ventral bases of the fin-fold. A few black pigment spots are present above the eyes.

The pro-larvae in this stage are active and swim from place to place by the undulation of the body and lashing of the tail. Occasionally, however, they become passive and float on the water surface.

#### *Stage II (Fig. 4).*

(One-day old larva at 08.30 hrs. on 22-11-64)

This stage is 2.426 mm. when alive (2.25 mm. in formalin). The larva has become a little broader in the middle than in the previous stage and the caudal region has become elongated. The eyes have become somewhat circular but remain unpigmented, the auditory vesicles somewhat triangular and the gut has assumed a more marked bent. The pectoral fin has developed in the form of a circular bud. Black pigment spots have appeared on the head, snout and along the dorsal aspect of the eyes. The future tentacle, representing the first dorsal ray, is indicated as a swelling of the fin-fold above the hind region of the head. The yolk and the oil globules are under progressive absorption. The number and disposition of the myotomes in this stage as well as the subsequent ones remain the same as in the previous stage.

#### *Stage III (Fig. 5)*

(Two-days old larva at 09.00 hrs. on 23-11-64)

The two-days old larva measures 3.06 mm. when alive (2.69 mm. in formalin). It has become much broader in the middle region than in the previous stages and is characterised by the disappearance of the yolk, formation of the mouth with a prominent lower jaw and pigmentation of the eye; all marking the early post-larval condition. The tentacle appears as a conical bud with black pigmentation at its tip followed by a trace of greenish-yellow

below it. A prominent stellate chromatophore has appeared on the supra-occipital region. The eyes have a brownish-silvery lustre in the living condition. The auditory vesicles have become larger. The pectoral fin has become broader and contains a few black chromatophores. The alimentary canal has become coiled. It contains a few minute black pigment spots along the ventral aspect.

The larvae in this stage as well as the next two were observed to move frequently to the bottom of the aquarium, which they were seen to peck uninterruptedly. When disturbed they moved away but to return shortly to resume pecking. It is probable that with the utilisation of the yolk and formation of the mouth they were in search of food at the bottom. Copepods, nauplius larvae and diatoms, individually and in combination supplied to them as well as to the subsequent stages, were not fed upon by the larvae as observed from their indifference to these organisms and from the always-empty stomachs of the larvae.

#### *Stage IV (Fig. 6)*

(Three-days old larva at 09.00 hrs. on 24-11-64)

No increase in length has been observed in this stage over the previous. The larva has become a little narrower, particularly in the middle region, than the two-days old larva. The tentacle has grown considerably longer. The pectoral fin has assumed a somewhat fan shape. The significant change observed is the formation of the opercular cleft as a transverse streak. The pigmentation has assumed a highly branching and stellate character in this stage. Five chromatophores are present along the dorsal side of the body, one behind the auditory region, a few along the dorsal aspect of the fin-fold in its anterior half, one on the upper side of the intestinal coil, one in front of the anus, another far behind it and a few mid-way between the anus and the caudal end.

The larvae in this stage suffered large-scale mortality; of the 21 larvae left over in the aquarium on the evening of 24-11-64, as many as 18 were in varying conditions of emaciation, death and disintegration on the following morning. Only three larvae survived to attain the succeeding stage.

#### *Stage V (Fig. 7)*

(Four-days old larva at 09.00 hrs. on 25-11-64)

The larva at this stage has become shorter, measuring 2.76 mm. when alive (2.48 mm. in formalin), and narrow. The mouth has become slit-like and the antero-dorsal aspect of the head has assumed a somewhat rounded profile. The second dorsal ray is indicated behind the tentacle-like first. A slender conical bud-like structure, probably representing the rudimentary pelvic

fin is observed in the ventral region of the viscera. Some of the black chromatophores in the middle of the dorsal fin-fold have become downwardly branching and the greenish-yellow chromatophores of the fin-fold have assumed an anastomosing character.

*Stage VI (Fig. 8)*

(Five-days old larva at 08.15 hrs. on 26-11-64)

The larva has decreased to a size of 1.96 mm. when alive (1.59 mm. in formalin). The head region has become proportionately larger and the post-anal region gradually tapers to the caudal end. The body proper has become wider. The branching and anastomosing pattern of pigmentation has become modified into one of unbranching nature. Black pigments have appeared on the visceral mass, snout and lower jaw. At the bases of the dorsal and ventral fin-folds longitudinal pigment rows have appeared. Three more dorsal rays, shorter, have appeared behind the first two which are of equal length in this stage. The visceral region has become bulged out, though not markedly. The conical bud-like structure is not recognisable in this stage, probably shrunken accompanying the overall shrinkage.

#### DISCUSSION

The identification of the eggs and larvae described in this paper as of *Cynoglossus semifasciatus* is based, apart from the circumstantial evidence of the coincident occurrence of the eggs in the plankton and spawners in the local catches during the month of November 1964—Seshappa and Bhimachar (1955) have observed that the period of intensive spawning for the Malabar sole extends from October/November to December/January—upon the direct evidence furnished by the affinities the stage VI larva bears for the 2.8 mm. post-larval stage described by Seshappa and Bhimachar (1955). It may be noted in this connection that the stage VI larva is in an earlier stage of developmental sequence than the 2.8 mm. larva observed by them. However, the visceral sac in the 2.8 mm. stage is larger in size than in the stage VI larva and the anterior margin of the head is rather flat. The former feature is due to good feeding of the larva which was collected by the authors from the plankton, while the stage VI larva reared in the laboratory has not taken food and has undergone reduction in size. The somewhat flat anterior margin of the head in the 2.8 mm. larva observed by Seshappa and Bhimachar (1955) is an advanced character over stage VI larva and denotes the beginning in the formation of the rostral bulge that becomes prominent in the later stages (Seshappa and Bhimachar, 1955). Obviously these features such as reduction in size, less prominent visceral mass and an earlier stage in the developmental sequence observed in the stage VI larva, do not stand in the way of linking it with the 2.8 mm. stage described by them.

Balakrishnan (1961) has given an account of many stages mostly in the post-larval development of *C. semifasciatus*. Of these the 2.0 mm. larva given by him appears to be a pro-larva and may be compared to stages I and/or II in the present paper and the 2.3 mm. larva may be compared to stage V. These bear many fundamental affinities for one another such as the size, identical features of development etc., but differ in the nature of pigmentation. It may be noted in this connection that many other stages described by Balakrishnan (1961) such as the 4.5 mm., 7.2 mm. and 11.0 mm. larvae do not agree in the pattern of their pigmentation to similar stages earlier observed by Seshappa and Bhimachar (1955). For instance the 4.5 mm. larva described by Balakrishnan (1961; Fig. 4 pl. I) appears to have independent stellate chromatophores on the dorsal aspect of the body and a row of chromatophores along the margin of the pectoral fin, while in the 4.5 mm. stage described by Seshappa and Bhimachar (1955; Fig. 13) the pigmentation along the dorsal aspect of the body is in the form of about six longitudinal streaks and in the pectoral fin there is no localisation of pigmentation. It is quite probable that this difference is only a variation, as in the other characters these have many similarities. Incidentally it may be mentioned here that the general pattern of pigmentation of the stage VI larva conforms to the condition observed by Seshappa and Bhimachar (1955) in the 2.8 mm. larva.

Seshappa and Bhimachar (1955) have given the figures (Fig. 11 a) of what they suspected to be the free eggs of *C. semifasciatus*. The diameter of these eggs tallies with that of the present eggs. The number and size of the oil globules in the eggs are not given by them but from the figures it appears that they are less in number (12 or 13) and larger in size (average diameter calculated is about 0.05 mm.) than in the present case. It may be stated in this context that the number and size of the oil globules in the eggs in which the perivitelline space is narrow (unlike the true sardine eggs) is subject to variation. For instance in the eggs of *Setipinna*, *Coilia* etc. (Delsman, 1932 a; 1932 b) the number and size of the oil globules vary; in the case of *Kowala coval* (Nair, 1951) in which the usual number of oil globules in the eggs is six to eight, it ranges from three to twenty seven with varying diameters. Even in the eggs of true sardines having a single oil globule such as *Sardinella longiceps* where the perivitelline space is considerably wide, the number and size of the oil globule varies from one to three and 0.10 to 0.18 mm. in diameter respectively (Devanesan, 1943). This is probably due to variation in the environmental conditions such as increase of temperature that causes division of the oil globules altering their number and size. It thus appears not improbable that the difference in the number and size of the oil globules in the eggs figured by Seshappa and Bhimachar (1955) is only a variation and the eggs doubtfully assigned by them to *C. semifasciatus* actually belong to the species. These authors appear to have been in possession of data on the ripe ovarian eggs that would have aided in identifying the free eggs in their

early stages of development, but adequate information on the ripe eggs is not given by them.

Information relating to the eggs and early larvae of flat-fishes from Indian waters is scanty and doubtful. John (1951) described the eggs and early larvae of what he believed *Solea* sp. from the Madras plankton. These were later assigned to *Cynoglossus* (Nair, 1952 a; Balakrishnan, 1963). From the same locality Nair (1952 a) and Vijayaraghavan (1957) described certain unidentified eggs and early larvae of *Cynoglossus* spp., while Kuthalingam (1957) described the early development of *Cynoglossus lingua*. Bapat (1955) gave a brief note of the eggs and early larvae of *Cynoglossus* sp. from Mandapam area. The present eggs and larvae bear resemblance to those of *Cynoglossus* I described by Nair (1952 a) in their size, number of oil globules etc. but differ from them in larval pigmentation. The eggs of *Cynoglossus* II observed by Nair (1952 a), *Cynoglossus* sp. noted by Bapat (1955), *Cynoglossus* A and B given by Vijayaraghavan (1957) and *C. lingua* described by Kuthalingam (1957) have overlapping ranges of diameter but differ from one another among other features, in details of larval pigmentation. It appears quite probable that all these belong to related species, if not closely allied ones.

#### ACKNOWLEDGEMENTS

My deep gratitude is due to Dr. S. Jones, Director, C.M.F.R. Institute, for critically going through the manuscript, offering very valuable suggestions, kindly bringing to my attention recent literature on the subject and for making available to be from his personal library some of the relevant references. I am grateful to Mr. K. N. R. Kartha for the help given in rearing the eggs and larvae.

#### SUMMARY

The eggs of *C. semifasciatus* are pelagic, spherical and transparent with an average diameter of 0.65 mm. The yolk is clear and unsegmented with a narrow perivitelline space and contains 25 to 30 oil globules in the diameter range of 0.038 to 0.076 mm. The early larvae are characterised by the presence of six discontinuous bands of greenish-yellow pigments intermingled with black chromatophores which undergo branching as development proceeds. The mouth is formed in the 2-days old larva; the tentacle-like first dorsal ray is indicated in the 1-day old stage and the first two rays become prominent in the 5-days old larva. The affinities the larvae show for similar stages described by previous workers are discussed.

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