

**OBSERVATIONS ON THE LIFE HISTORY AND FEEDING HABITS
OF THE INDIAN SARDINE, *SARDINELLA LONGICEPS*
(CUV. & VAL.) ¹⁾**

by

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Since the Sardine is a fish of considerable commercial importance it has been the subject of a great many investigations, and its biology has been studied in nearly all the countries in which it occurs. Though the clupeids enjoy a world-wide distribution in the tropical and sub-tropical waters, it is well known that the true sardine belonging to the genus *Sardina* are confined only to higher latitudes. In the tropics the place of true sardines is taken up by ten species of *Sardinella*. These species which contribute to the bulk of Sardine fisheries of warmer waters are *Sardinella longiceps*, *S. dayi*, *S. lile*, *S. sirm*, *S. sindensis*, *S. fimbriata*, *S. gibbosa*, *S. melanura*, *S. clupeoides* and *S. albella*. Practically nothing is known about the life history of these important groups of fishes of the Indian waters.

The present account is a part of the results of the investigation carried out by the author at the Madras University, Marine Biological Research Laboratory on fish eggs and larvae occurring in the Madras Plankton during the year 1953-1958.

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Eggs.

About 208 eggs of *S. longiceps* were collected on January 10th 1956 at about 8 A.M. and brought to the laboratory about 12 P.M. As shown in fig. 1 the eggs were perfectly spherical transparent and had an average diameter of 1.7 mm. The clear space between the egg and the egg membrane, the yolk being segmented with a single oil globule were character-

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istic of clupeids. The tail and the whole embryo were attached to the yolk mass. The outline of the embryo was clear, but the myotomes could not be made out. Fig. 2 represents the eggs as they appeared at 3 P.M. The eggs were more or less rounded and when viewed from above the outline of the head could be seen protruding beyond the eggs. The embryo had grown larger almost completely encircling the yolk mass. Kuffer's vesicle was located adjacent to the caudal mass. According to SUMMER (1900) Kuffer's vesicle is a post-anal gut. Fig. 3 shows the eggs as they appeared at 6:30 P.M. The embryo was fully developed and the yolk had shrunk to an inconspicuous size. Myotomes were distinct. Movements due to muscular contraction took place at intervals and became more frequent and marked. The embryo made frequent wriggling movements and in a few minutes the egg membrane nearest to the head burst, and the larvae emerged out of the egg membrane at about 7 P.M.

Larvae just hatched (fig. 4)

All the 208 larvae hatched out were nearly 2.1 mm long and floated with the yolk upwards. The mouth was not formed and the eyes were unpigmented, but an auditory vesicle was present. The long narrow alimentary canal terminated in the anus opening under the 38th myotome and only five post-anal myotomes were distinct. The fins were present as fin-folds. There was no indication of the formation of the pectoral fin.

Larvae 12 hours after hatching (fig. 5)

At about 7 A.M. the next morning, except two all the rest survived. The length of the larvae had increased to 2.3 mm and the tip of the head projected out from the yolk mass. The yolk was much reduced and the alimentary canal was clear, but there was no indication of the mouth. Nine post-anal myotomes were counted at this stage. The pectoral fins appeared as transparent fin-folds behind the auditory vesicle and a few black pigment spots were noticed in the lateral region of the myotomes.

Larvae 24 hours after hatching (fig. 6)

Four larvae were found dead. The rest had not grown in length but exhibited a slight circular depression-like mouth. The yolk sac had shrunk in size still further. The pectoral fins were clearly visible and had no rays. The black pigment spots along the lateral region of the body became lost and a number of very reduced black spots were found along the lateral side of the myotomes. Groups of black spots appeared on the head.

Larvae 3rd day after hatching (fig. 7)

At 8 o'clock on the morning of the third day all the 202 larvae were alive and had grown to a length of 3.8 mm. The yolk sac had shrunk to such a small size that the pro-larvae were able to swim about carrying the yolk downwards. The eyes had become black, the auditory vesicle had enlarged and four gills had become visible. The mouth was formed but did not open into the alimentary canal. About 4 P.M. on the same day the yolk was absorbed completely and the pro-larvae became post-larvae. The larvae did not feed and the food items counted and introduced into the container remained undiminished, though the larvae were actively swimming about here and there.

The newly formed post-larvae (fig. 8)

The newly metamorphosed post-larvae had an average length of 4.0 mm and a very marked pigmentation. The black pigment spots scattered on the lateral margin of the myotome, now disappeared giving place to patches of black chromatophores arranged along the dorsal and ventral margins of the myotome and in the middle of the body. The larvae had thirty-eight pre-anal and fourteen post-anal myotomes including the unsegmented caudal portion. The rudimentary pectoral fin could be clearly made out as a circular structure and the heart as a pulsating organ. The larvae continued to swim actively, but did not take any food.

Larvae 4th day after hatching (fig. 9)

Fifty-two larvae were found dead overnight while the rest were active. There was no change in length. The alimentary canal was distinct and opened by the well-formed mouth. The black chromatophores arranged in definite rows along the dorsal and ventral margins and on the sides of the body in the previous larvae had become fewer in number, and were scattered. The eyes acquired a metallic shine and the iris was black.

To ascertain the diet of these post-larvae, the following experiments were conducted. Definite numbers of five different kinds of planktonic organisms such as copepod nauplii, larval bivalves, cirripede larvae, polychaete larvae, and diatoms were supplied to the larvae in five different containers. Three hours later it was found that the food most consumed was diatoms. When algae were supplied along with zooplankton, it was found that the algae was most consumed. A further experiment was conducted by introducing a known volume of fresh plankton in a glass container along with twenty post-larvae. After the experiment the larvae were killed

and the stomachs teased out. It was found that 80% of food items consisted of diatoms and algae and the remaining 20% consisted of other food items such as copepod nauplii and copepods, cirripede larvae and polychaete larvae. The diatoms were identified as *Pleurosigma* sp., *Asterionella* sp., *Biddulphia* sp., *Diploneis* sp., *Cymbella* sp., *Coscinodiscus* sp., *Thalassionea* sp., *Thalassiothrix* sp., and *Nitzschia* sp.. Species of *Oscillatoria* and *Enteromorpha* were the only green algae that could be identified. BAPAT and BAL (1950) reported that the larvae of *Sardinella* sp. of the Bombay coast take foraminifera, but experiments showed that larvae of *S. longiceps* of Madras did not care for it. When fresh fish and dried fish soaked in water were served chopped up, the larvae declined them but fed avidly on diatoms and algae which were supplied later. After some hours one larva was observed to be inactive and died shortly after. When examined it was found that death was due to over feeding.

No further change was observed in the post-larvae till another six days both in feeding and in structure.

Larvae 11th day after hatching (fig. 10)

There had been no casualties during the preceding six days and the larvae had grown to a length of 9.9 mm. There was no change in pigmentation. Feeding experiments showed that there was no change in diet though the quantity of food consumed was greater probably due to the larger size of the larvae.

No change in larvae was noticed for another four days.

Larvae 16th day after hatching (fig. 11)

The post-larvae attained a length of 11.3 mm. The general shape and appearance more or less resembled the juvenile, but was extremely soft and transparent. Fin-rays appeared at two different regions of the body. The black chromatophores in the caudal region had migrated from the region of the myotome and were scattered on the caudal fin-folds where the fin-rays had begun to develop. There was no change in diet.

Larvae 30th day after hatching (fig. 12)

The larvae were now 18.7 mm long. Though the pre-anal myotomes continued to be the same each myotome had extended dorso-ventrally increasing the height of the body. Characteristics of this final post-larval stage are: — the body becoming thick and less transparent, the appearance of the first fin-rays in the median fin, the formation of the folds in the

alimentary canal, the mouth becoming sub-terminal, and the development of the gills. The lower jaw was prominent and both the jaws were still toothless. Incipient elements of the operculum had developed. The tip of the tail was slightly curved upwards and fin-rays of the caudal fin appeared slightly harder than the tissues around. Eyes had become black with black iris and numerous black spots of pigment cells were scattered all over the body but crowded on the tip of the tail. In virtue of all these features, the larvae resembled the juveniles though it was only nine days later that they reached a length of 22.9 mm and actually became juveniles. There was no change in diet.

Larvae 40th day after hatching (fig. 13)

During the preceding twenty-nine days, sixty-three larvae had died and the remaining sixty-six juveniles were reared in the laboratory for another twelve days. All the important taxonomic features were in evidence and the fish could be identified as *Sardinella longiceps* (D. 16. P. 17. V. 9. A. 16. C. 17. L. 1. 46). Scales were distinctly arranged. The lower jaw was slightly longer. Gill rakers were very numerous and were more than two hundred in numbers. The caudal was deeply forked. The juvenile was bluish along the back with golden reflection. The abdomen was silvery. There was a large greenish-gold spot on the upper margin of the opercle.

The juveniles measured 28.7 mm in length and were supplied with fresh concentrated unsorted plankton. Three hours after the experiment random samples were killed and their stomach contents were analysed. The stomach contained 48.5% copepods, 12.5% fish remains, 10% molluscan remains, 21% amphipods, and 8% noctiluca. The copepods were identified as *Corycaeus* sp., *Paracalanus* sp., *Pontellopsis herdmani*, *Eucalanus* sp., *Oithona rigida*, *Oithona robusta*, *Oithona spinulosa*, *Euterpina acutifrons*, *Acartia erythraea*, *Acrocalanus longicornis*, *Eucalanus attenuatus*, *Pseudodiaptomus* sp., and *Temora* sp.. When twenty juveniles starved overnight were supplied with diatoms and algae and their stomachs examined three hours later, the stomachs were found empty suggesting that the fish had definitely abandoned feeding on plants.

Feeding habits of adults

189 adult fishes ranging from 60.5 mm to 120.5 mm in length were collected during the months of February and March from the sea shore and their stomach contents were analysed. The diet of fish was dominated by crustaceans of rather smaller size. Excepting in the case of two individuals whose stomachs contained partly digested teleostean fish, the diet of

Sardinella longiceps was devoid of piscine items. Entomostraca such as copepods belonging to species of *Oithona*, *Acartia*, and *Eucalanus*, ostracods and larval cirripede as well as malacostraca like *Lucifer* and larval penaeids, palaemonids and anomurans constituted the contents of the stomach. Larval bivalves, polychaete larvae and Sergestids as well as a few diatoms and algae were also found.

Food and feeding habits of post-larvae collected from the fishermen's nets

129 post-larvae were collected in the month of February 1956. Of these eighteen were 19.5 mm, twenty-two were 28.9 mm, and the rest were intermediate between the two. Examination of the stomach contents of these fishes revealed that their stomachs consisted of diatoms and algae forming the major item of food, while copepods, adults and nauplii, molluscan and polychaete larvae and amphipods formed minor items of diet. GARSTANG (1900), FORD (1933) and LEBOUR (1922) reported that many of the post-larvae of clupeids of temperate regions have been observed to feed on a mixed meal of vegetable and animal matter in an equal amount. The present study also revealed that the post-larvae of *S. longiceps* feed more on vegetable matter than on animal diet.

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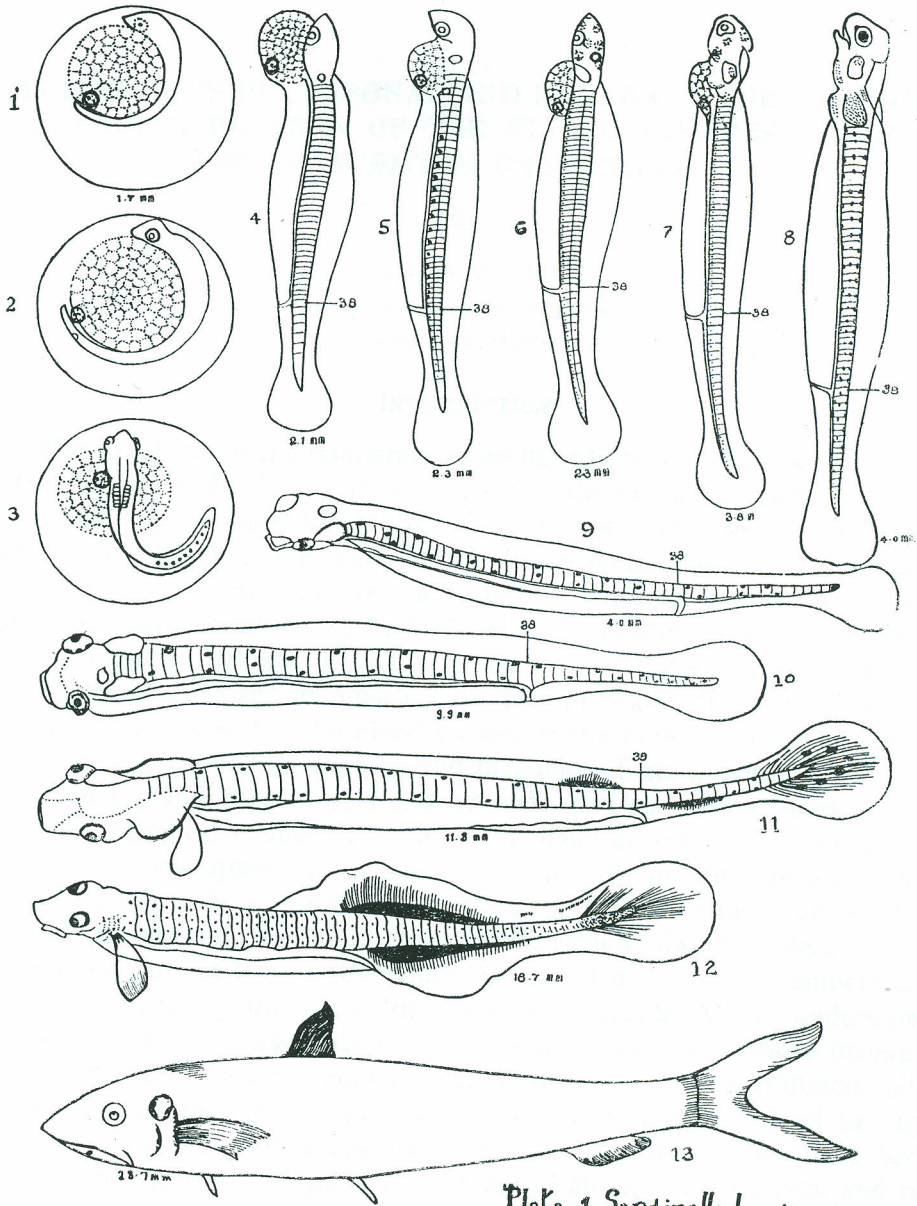


Plate 1 *Sardinella longiceps*.

Sardinella longiceps (CUV. & VAL.) — Fig. 1-3, eggs; fig. 4-7, pro larvae; fig. 8-12 post larvae; fig. 13 juvenile.