LARVAL DEVELOPMENT OF *GARRA CEYLONENSIS CEYLONENSIS* (BLEEKER).

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In a previous paper (Jones, 1938*a*) the external features in the embryonic development of *Garra ceylonensis ceylonensis* (Bleeker) were given, and the present paper deals with the post-embryonic development of this form till the attainment of adult features. A week after the specimens hatched out, they were brought down from Demodera (Ceylon) to Colombo, and from there to Tambaram, Madras. It is of interest to note that the larvae stood the journey well and readily adapted themselves to a very hot climate from a comparatively mild one, and to Tambaram water which is well known for the high percentage of dissolved calcium salts.

Newly hatched larva.—It is 5 mm. in length and usually remains attached to algae by the lower side of the mouth, though how this is done is not understood, as no adhesive organ of any kind was noticed. Due to the presence of functional pectoral fins the larva has greater control over its movements than other newly hatched Cyprinids. When disturbed it darts off at great speed, but hangs on to the algae after some time (for further details see Jones, 1938*a*).

Second day.—The mouth opening is larger, yolk is reduced to half and the notochord at the caudal end is bent slightly upwards (Text-fig. 1*a*). A rudiment of the air-bladder is visible. The larva has a golden yellow colour under the microscope and actively swims about in water.

Third day.—The eyes begin to shine, the air-bladder shows a distinct bubble of air, gall bladder becomes visible, small papillary projections appear on the sides of the head, chromatophores increase on the dorsal side and the animal moves about very actively.

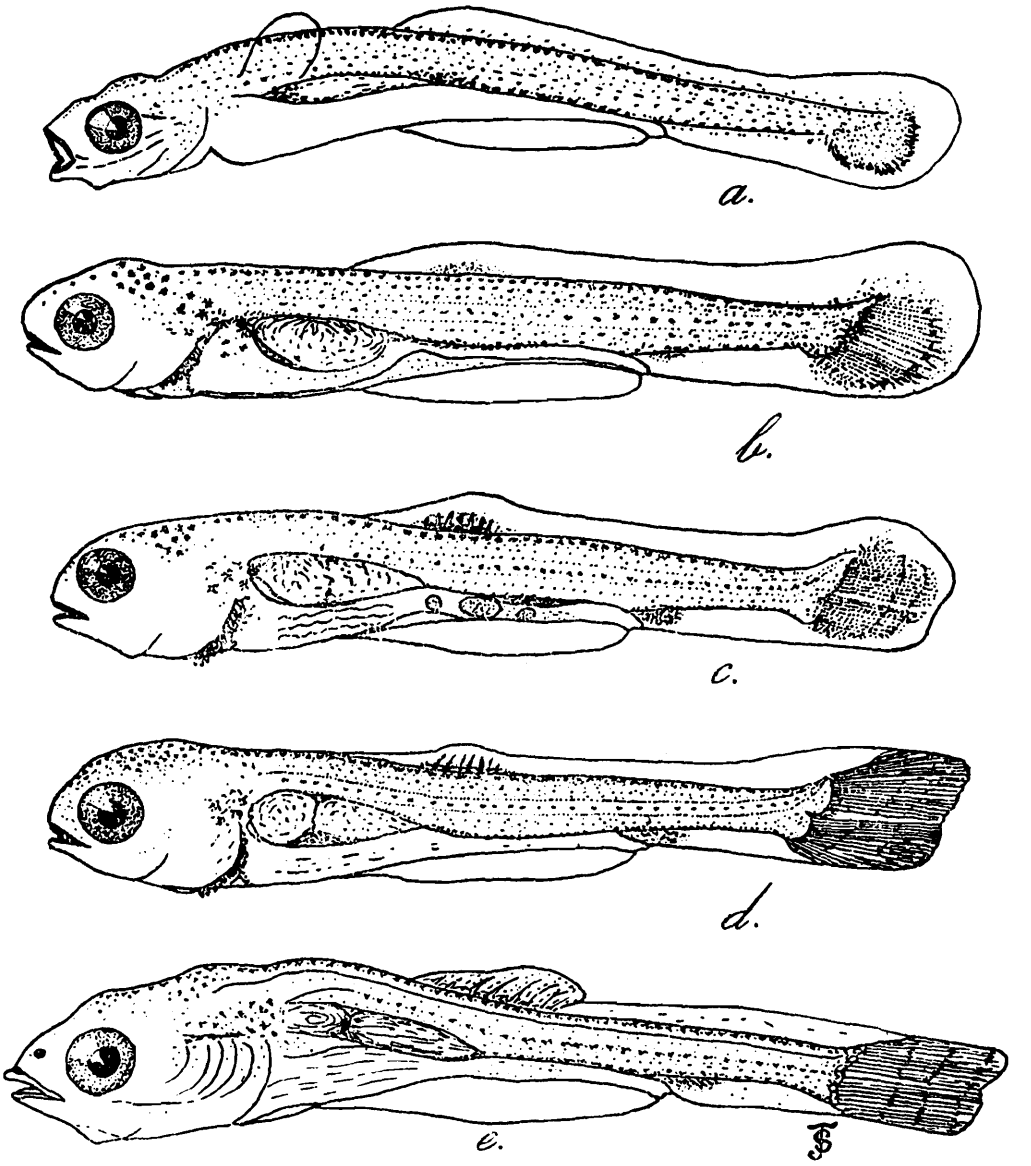
Fifth day. (Text-fig. 1*b*).—The mouth has well developed lips. All the yolk is absorbed, and the liver and the gut as a straight tube can be distinguished. External gills, which are mere filamentous elongations of the internal gill lamellae, are very well developed. The notochord at the posterior end is turned distinctly upwards and the caudal fin has rudimentary fin-rays. Chromatophores appear on the fins and the median fin-fold is broader at the position of the future dorsal fin. The papillary outgrowths on the head increase in number.

Seventh day. (Text-fig. 1*c*).—The chromatophores become more dense. About 18 fin-rays are formed in the caudal fin which develops a notch in the middle transforming it into the homocercal type, and rudiments of the dorsal fin-rays are developed. The animal feeds on algae.

Eighth day.—The air-bladder, which was simple at first, becomes constricted in the middle.

Ninth day. (Text-fig. 1*d*).—The constriction in the air-bladder becomes deeper showing two distinct regions, a rounded anterior and a conical posterior region.

Fourteenth day.—The caudal fin has a fringed edge, and is well supplied with blood vessels. Minute wart-like projections, perhaps the rudiments of rostral tubercles, are found on the snout.



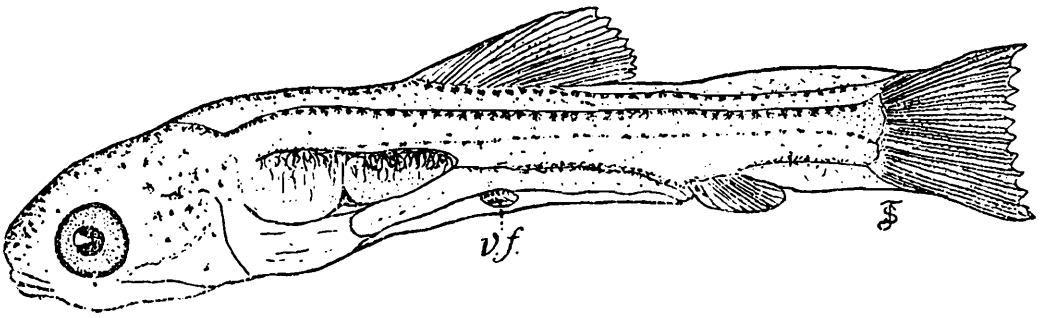
Text-fig. 1.—Larval stages of *Garra ceylonensis ceylonensis* (Bleeker).

a. Second day: ×20; *b*. Fifth day: × 20; *c*. Seventh day: × 20; *d*. Ninth day: × 20; *e*. Twentieth day: × 14.

Twentieth day. (Text-fig. 1*e*).—Length 7·5 mm. There are seven or eight fin-rays in the dorsal fin and the caudal fin is almost homocercal, but the dorsal half is a little larger. The position of the anal fin is marked by a broader portion in the marginal fin behind the anus. The number of chromatophores have considerably increased in the body, and the animal appears light grey to the naked eye. The mouth is inferior in position. The animals display cannibalistic tendencies, the larger and stronger ones attacking and devouring the smaller and the weaker.

One month old. (Text-fig. 2).—Length 8·8 mm. The anal fin with distinct fin-rays is developed, though the fin-fold connecting it to the

caudal still persists, and the ventrals are seen as small buds in front of the anus. The gut develops a loop in the middle, and the barbels



TEXT-FIG. 2.—One month old larval stage of *Garra ceylonensis ceylonensis* (Bleeker) : × *ca* 11.

become visible. The young fish devour everything from bread and rice to frog meat and mussel flesh, and browse on the algal growth on the sides of the aquarium.

One and a half months old.—The young fish is 13·3 mm. long and has attained most of the external characters of the adult except the ventral sucker which is only rudimentary. The mouth is antero-ventral in position. There is only a single surviving specimen which grows stout with the ventral side getting flattened.

When the fish is about 2 months old the mouth becomes ventral in position and the sucker is developed. It is omnivorous in its diet, greatly relishing chopped meat and flesh. Since the development of the sucker the animal continually feeds on the algae growing on the sides of the aquarium.

The author's idea of working out the development of the ventral sucker had to be given up owing to the lack of specimens belonging to the later stages. About 40 living specimens were brought from Ceylon, and of these only two survived after a month and a half. One of them grew to a length of one and a half inches when three months old. In November 1937, the author had to leave Tambaram for Trivandrum and the specimen was also taken there where it was living till the end of February 1938, when it died in the absence of the author from the place. After it was brought to Trivandrum it could not be properly attended to and it did not grow to any appreciable extent. It was a chubby little fish resembling very much its congener, *Garra ceylonensis phillipsi* Deraniyagala.

The influence of the environment on eggs is well illustrated in *Garra*, which in the course of evolution has developed a comparatively large-sized egg resulting in the precocious development of the early larva. A comparison with the eggs and early larvae of other Cyprinids, whose development is known, is of interest (Khan, 1926, and Jones, 1938). Recently the author has been able to work out the development of two other South Indian Cyprinids [1] which provides additional evidence concerning the highly evolved nature of the egg and early larva of *Garra*.

The young *Garra* that was being reared used to come near the surface,

[1] The results have not yet been published.

especially in the evenings, and produce bubbles of air which accumulated as patches of sticky foam near the sides of the aquarium. Fraser (1937, p. 705) has recorded this habit in a number of Cyprinid fishes of Deolali, Nasik. As Hora says in a footnote (Fraser, *op. cit.*), the sticky nature of the bubbles may be caused by the slime taken up by the air as it passes over the gills.

About *Garra mullya* which was able to live for a short period of four days only in the aquarium, showing all the time respiratory difficulties due to lack of oxygen, Fraser (*op. cit.*, p. 691) says. " They periodically and frequently rose to the surface and by muscular action alone maintained themselves perpendicularly suspended, but not by their lips, for 30 to 35 seconds. While thus engaged, they create a froth of bubbles " Mr. S. J. Silas of Demodera (Ceylon) had a small fish-pond and I was able to notice adult specimens of *Garra* showing a similar behaviour whenever they were introduced into it. None of the specimens survived for more than a couple of days except a juvenile specimen about 4 inches long that lived for some months.

During a visit to the Peerumedu Hills in Travancore in February 1938, the author caught a young *Garra* from one of the hill streams there at a height of about 3,500 ft. This was brought to Trivandrum where it lived in a small glass vessel for $4\frac{1}{2}$ months. This had the habit of making bubbles of froth regularly in the evenings.

The few experiments that I performed to test the adhesive capacity of the mental disc of an adult *Garra* were too crude and unsatisfactory to be relied on. The young specimen that the author was rearing did not at any stage exhibit any tendency to use the ventral disc as an adhesive organ. Whenever an artificial current was produced, it either swiftly darted against it or was helplessly carried along with it.

The condition was different in the case of the young *Garra* from Travancore. Whenever an artificial current was produced, it fixed itself to the bottom by the paired fins, especially the pectorals, and lowered its head bringing the ventral side into close contact with the bottom preventing the flow of water through the underside of the head. The animal remained in this position at one place for only a moment. It quickly darted forwards and effected fresh attachments. In still water it was noticed on a few occasions attempting to stick to the sides of the aquarium ; but it was never found capable of effecting a permanent grip.

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