ON THE BIONOMICS, DEVELOPMENT AND GROWTH OF A CAUVERY CARP, *LABEO KONTIUS* JERDON*

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CONTENTS.

INTRODUCTION.

Our knowledge of the life-history of Indian food fishes is still very meagre, though valuable contributions have been made by Willey (1910), Raj (1916), Khan (1926, 1943), Job (1938, 1941), Jones (1937), Kulkarni (1943), Bhimachar (1944) and others. Mookerjee and co-workers (1944, 1945, 1946, 1949) have recorded extensive observations on the life-history of the major Indian carps. The position of our knowledge on the breeding and development of Indian freshwater and brackish-water fishes has been reviewed by Jones (1946) in two recent contributions. While complete and connected accounts of the life-history of the major carps of India are still wanting, the contributions of Khan (*loc. cit.*), Mookerjee (1944, 1945) and Nazir Ahamed (1944), among others, give valuable information about the development of these fishes.

The genus *Labeo* includes several of the major carps of Indian waters. The common species of the genus in the river Cauvery in south India are *Labeo kontius*, *L. fimbriatus*, *Labeo* sp. ('Parel'), *L. calbasu* and *L. bata*, mentioned in the order of their abundance. No complete and connected account of the breeding habits and development of any of the above species, excepting *L. calbasu* (Mookerjee, 1946) is yet available. That an intimate knowledge of the life-history of all the major food fishes is essential for any rational development and exploitation of the natural fisheries and their enrichment by cultural operations, is too well known to need any emphasis here.

While working under the Madras Rural Piscicultural Scheme of the Indian Council of Agricultural Research we had opportunities to study the biology of a common Cauvery Carp, *L. kontius*, the breeding habits and development of which were also elucidated by observations during the 1946 and 1948 spawn collection seasons. The information thus gathered is presented in this communication.

* Published with the kind permission of the Director of Fisheries, Madras.
Paper read before the 35th Indian Science Congress, Patna, 1948.

Economic Aspects.

L. kontius is indigenous to the Cauvery system. Locally called "*Karimuli*" at Mettur and "*Kalchel*" at Tanjore, *L. kontius* yields a valuable fishery ranging from 5 per cent. to 50 per cent. of the catches in the various fishing centres along the stretches of the river. It is fairly abundant in localities like Mettur, Bhavani and Tanjore and specimens are available at all seasons of the year, particularly during October to December. In the Tanjore area '*Kalchel*' forms an important item of the tank fisheries, in most cases the fry and fingerlings getting naturally stocked during rainy months when the tanks get connected with the irrigation canals leading from the river. Next to the White Carp, *Cirrhina cirrhosa*, *L. kontius* is generally the dominant species in the large congregations of fish in the supply channels of the Mettur Dam, and also below the Hoggainakkal Falls. Of the several thousands of fish that are annually trapped in the rock pools along the Ellis surplus course of the Mettur Dam, *L. kontius* constitutes about 25 to 40 per cent.

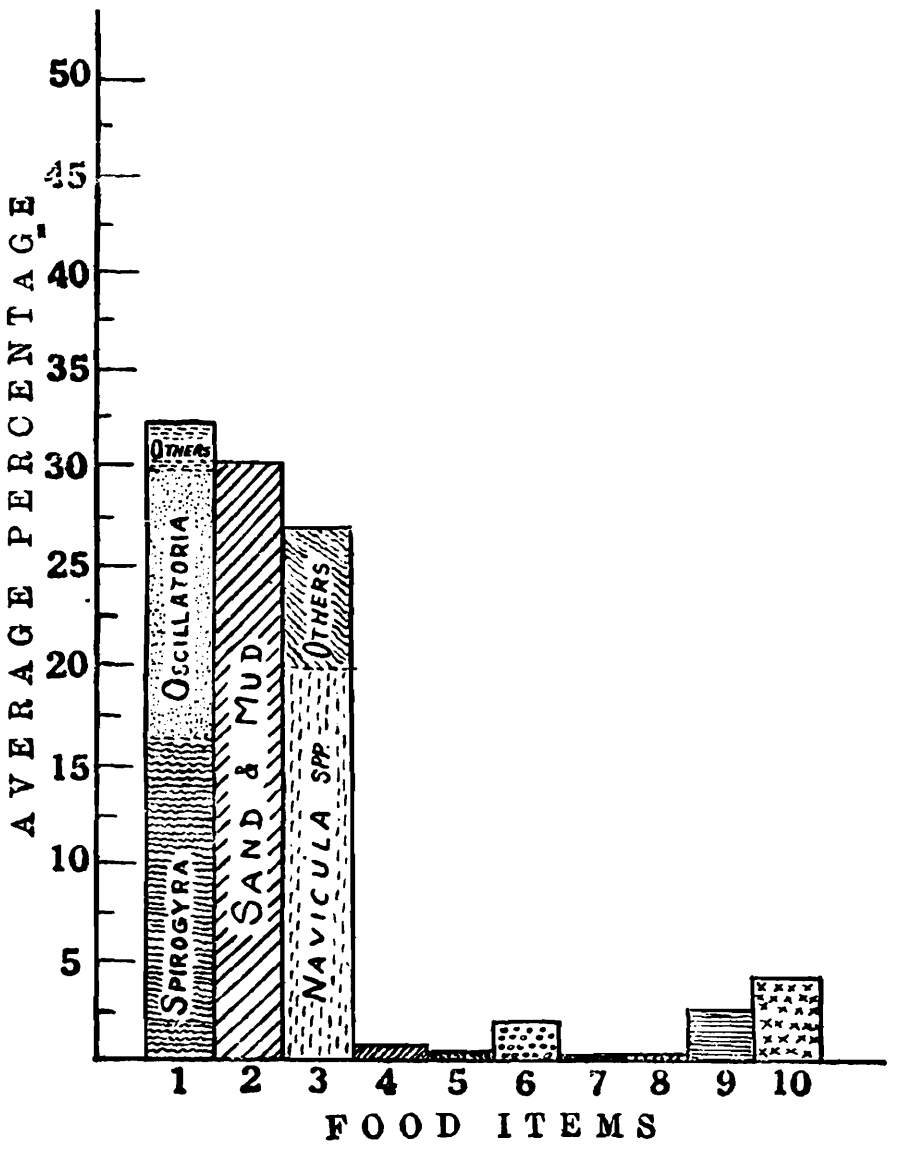
Characteristic Features and Bionomics.

The characteristic dorsal profile distinguishes *L. kontius* from the allied species in the river Cauvery. The snout is very conspicuous and thick; mouth appears to be somewhat sub-terminal and the lower lip is finely fringed at the margin. In the upper reaches of the river Bhavani, in places like Pungar and Satyamangalum *L. kontius* is known as "*Panni-vayi Kendai*", meaning 'Pig-mouthed Carp' It is interesting that the local fishermen have observed the rather remote resemblance of the projecting snout and somewhat sub-terminal mouth of this carp to the facial features of the pig.

The fingerlings of this carp are of a deep slaty colour, particularly towards the dorsal aspect. Fully grown specimens are a little lighter in colour and have the scales along either side spotted with red in the centre. The body is more cylindrical than in *L. fimbriatus*, from which it is easily distinguished by the short dorsal fin, conspicuous snout and the characteristic dorsal profile. It is a very active, hardy fish and in the supply channels of the Mettur Dam specimens could very often be seen jumping up in the air in their attempt to negotiate the cascade-like steps and move upstream. In the natural habitat they are found to withstand wide ranges in the conditions of existence. Fingerlings and adult specimens abound in the black, malodorous water, surcharged with sulphuretted hydrogen, issuing forth from the sluices of the Mettur Dam and also from the tail race of the Mettur Power House during periods of summer stagnation in the reservoir. They were observed to be actively feeding on algal growth and diatoms in the area and were none the worse for the presence of the poisonous gas. While the species thrives well when stocked in ponds, transport of fingerlings has been found to be comparatively difficult. During conditioning and in transit, generally heavy mortality results. While excessive activity of the fingerlings in the limited space of the conditioning box or the tin carrier is bound to result in mechanical injury to several and might lead to their death, systematic study of this aspect is urgently called for.

FOOD AND FEEDING HABITS.

Detailed analyses of the stomach contents of 42 specimens, ranging from 4·4 inches to 19·5 inches in total length, collected from localities like Hoggainakkal, Mettur, Bhavani, Tanjore and the Chetput Fish Farm, were made and the data are represented in Figure I. Like most other species of the genus, *L. kontius* is a predominantly vegetable feeder; the animal part of the food being only about 5 per cent. on the average.



TEXT-FIG. 1.—Food of the Cauvery Carp, *Labeo kontius* (Jerdon). Percentage composition of the important items encountered in the guts of 42 specimens.

1. Filamentous algae and aquatic macrophytes; 2. Sand and mud; 3. Desmids and Diatoms; 4. Dinophyceae; 5. Unicellular green algae; 6. Copepods; 7. Rotifers; 8. Earthworms; 9. Insects; 10. Organic debris.

The following 25 items were encountered in the gut contents :—

Cosmarium, Staurastrum, Navicula, Synedra, Pleurosigma, Pinnularia, Amphora, Gomphonema, Fragillaria, Scenedesmus, Ankistrodesmus; Selenastrum; Euglena, Peridinium, Microcystis, Merismopedia, Oscillatoria, Spirogyra, Leaf bits, insect parts, copepods, rotifers, earthworm remains, organic debris, sand and mud.

Filamentous algae and leaves of aquatic plants together constituted about 32·3 per cent. of the feed. *Spirogyra* was present in 70 per cent. of the specimens examined and ranged from 10 to 80 per cent. of the gut contents; constituting just over half the average total quantity of filamentous algae consumed. *Oscillatoria* was less frequently met with (in 50 per cent. of the specimens examined) and ranged from 3 to 70 per cent. of the feed in the different specimens. Diatoms accounted for over 27 per cent. of the average total feed and of these about 20 per cent. was formed of *Navicula* spp. only. Diatoms were almost invariably met with in the stomach contents and ranged from 10 to 60 per cent. of the latter. Sand and mud particles were encountered in 80 per cent. of the specimens examined and constituted about 30·5 per cent. of the average total feed; while, in individual specimens it ranged from 10 to 80 per cent. Insect parts, earthworm remains, copepods and rotifers which constituted the animal part of the diet, accounted only for 5 per cent. of the average total feed and in 50 per cent. of the specimens examined the stomach contents were of purely vegetable nature.

It is interesting to observe that the majority of the planktonic algae listed above were found in the guts of specimens from lentic water—from the Chetput farm ponds. Sand or mud and organic debris formed only very minor items of the stomach contents in these specimens, in sharp contrast to specimens from riverine habitats.

Post-larval specimens and early fingerlings kept in laboratory aquaria were observed to feed voraciously on zooplankton consisting of rotifers, cladocerans and copepods. Whenever available they were found to gorge the guts with phytoplankton organisms like *Microcystis* also.

Bottom feeding and browsing on stones and other objects in the marginal shallows are clearly indicated from the nature of the stomach contents. While several of the diatoms encountered are planktonic in nature, it is also observed that all of these as very commonly found among growths of filamentous algae. When filamentous algae are consumed in quantities, the epiphytic and embedded diatoms will also be taken in along with them. Several naviculid diatoms are found, as frustules and also in the fresh condition, in the surface layers of the bottom mud, and these are likely to enter the stomach when the fish feeds on insects and worms from these habitats. The presence of quantities of diatoms in the gut in this instance, is therefore not considered as indicating plankton feeding habit to any appreciable extent. The fact that unicellular green algae, including euglenoid flagellates which are truly planktonic, were rarely met with in the stomach contents lends support for the above suggestion.

The observation that planktonic algae were appreciable and that the quantity of sand and mud was limited in the gut contents of specimens from fresh water ponds, would seem to indicate that with the change from the lotic to the lentic environment there has been a slight change in the feeding habits also, probably as an adaptation to the food available in the habitat. This point, however, needs confirmation after systematic investigation, as it is bound to be of practical significance in fish culture.

The proportion of body length (Total length) to the length of gut in *L. kontius* is about 1 : 11. In the closely related *L. fimbriatus*, however, the gut is much longer, the proportion being approximately 1 : 22. The length of gut in *L. calbasu* is more or less the same as in *L. kontius*. The length of gut of an animal is known to depend on the nature of the food it consumes, the length increasing with increasing proportions of vegetable matter in the diet. In *L. kontius* 95 per cent. of the average feed is found to be of vegetable nature and still the entire gut is only about half the length of that in *L. fimbriatus*. It might be of interest to correlate the length of gut and nature of food in the different species of the genus *Labeo*.*

SEXUAL MATURITY AND BREEDING.

Specimens collected from the river Cauvery, below the Mettur Dam, in April, had the gonads in the third stage. Some males were already in milt, oozing on slight pressure. Early in July, the majority of specimens, 12 to 14 inches long, were sexually ripe. While oozing males were very common, females in that stage were not then available. In the Hoggainakkal area also the species was in roe early in July. Lower down at Bhavani, ripe specimens were available in the 4th week of June ; while, in Tanjore, at the Grand Anicut several specimens had the gonads in the 4th stage, early in June. Breeding thus coincides with the monsoon months, June—July. The smallest mature specimen obtained measured 10·6 inches in total length and was a male with the testes in the 4th stage. It is known that in certain carps like *Barbus hexagonolepis* the males mature when they are still of a relatively much smaller size as compared with the size of the mature females (Hora, 1944, Hora and Nair, 1943). In *L. kontius*, however, there does not appear to be any such marked disparity in size between the two sexes.

The fish was breeding in the Cauvery during July—August, 1946 and developing eggs, with advanced embryos inside, were collected in fair numbers at Hoggainakkal. In the river Bhavani the fish spawned during June 1948 and large number of eggs in all stages of development were collected at Satyamangalom and Pungar. The hydrological conditions during collection of spawn were as follows :—

Place.	Date.	Time. Hrs.	Temp. (°C).	Turbidity (Cms.)	pH.	Diss. 02· (cc/L).	Percentage of Saturation.
River Cauvery at Hoggainakkal	27-7-46	9·30	23·6 to 23·5	7·5 to 9·0	7·5 to 7·8	5·225 to 6·094	84·5 to 98·4
River Bhavani at Satyamangalom.	24-6-48	6·20 to 22·00	22·3 to 24·2	5·0	7·5	5·030 to 4·891	77·5 to 82·2
River Bhavani at Pungar	26-6-48	2·30	22·7	6·0	6·6	5·310	84·65
River Moyar at Pungar	25-6-48	22·40	23·2	6·0	6·6	5·030	80·9

* Dr. Hora informs us (in a personal communication, dated 16th January, 1951), "I think food containing more cellulose matter will require a longer intestine for assimilation. This may explain the difference observed between the relative length of the intestines of *L. fimbriatus* and *L. kontius*."

On all the above occasions the river was in spate and there were occasional showers of rain. The flow of water was at the rate of 4 to 7 ft. per second. At Hoggainakkal, the eggs when collected in the morning were fairly well advanced in development, with the embryos actively moving inside. As the day advanced no eggs were caught in the nets. On the other hand at Satyamangalom, eggs in different stages were being caught in appreciable numbers almost throughout the day and night, from 5-30 P.M. to 10 A.M., indicating that spawning was taking place continuously for hours together. Temperature of water ranged from 22·3°C to 24·2°C. The conditions were more or less the same at Pungar and Moyar except that pH. of the water was very low (6·6). The factors influencing spawning of carps in south Indian rivers have been discussed in detail elsewhere (Ganapati and Alikunhi, 1949).

DEVELOPMENT.

Since fertilized eggs were collected from the river in 1946 and 1948, the development could be studied and the details fully checked up. While some late embryonic stages were collected from Hoggainakkal in July, 1946, the account of the embryonic development that follows is mainly based on material collected from the river Bhavani at Satyamangalom in June 1948. The larval and post-larval development were followed in detail from material collected in 1946 and the stages were fully checked with the 1948 material.

Unfertilized Egg.—In the ripe female the ovary is of a dull bluish colour. The ova are fairly large, almost rounded in shape, with a diameter of 1·1 mm. to 1·25 mm. and when teased out have a faint pale bluish tinge. The vitelline membrane closely adheres to the egg surface. The eggs are not sticky in nature.

(*a*) *Embryonic Development.*

Fertilized Egg.—As in other Indian carps, fertilization of the egg is followed by a remarkable swelling of the vitelline membrane, creating the characteristic peri-vitelline space between the latter and the egg proper. In *L. kontius* the fertilized egg when fully swollen is 3 to 3½ times the size of the ripe ovarian egg and generally measures 3·7 mm. to 4·4 mm. in diameter.

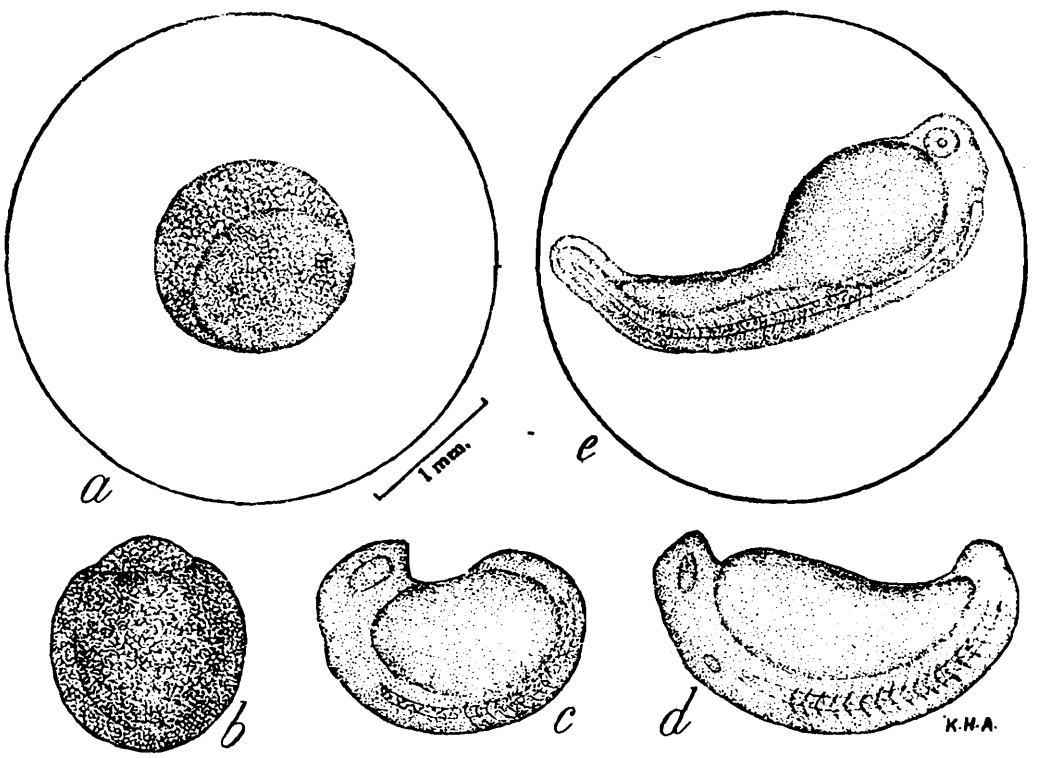
Stage i: *X hours old after fertilization.* (text-fig. 2*a*).—Collected in spawn-catching net from river Bhavani at Satyamangalom, on 24th June 1948, at 17-30 hours. Earliest stage in the collection; two eggs.

Demersal and drifting with the main current, in the river proper, the eggs are perfectly spherical and have the surface remarkably clean without any dirt or debris sticking to it. The diameter of the two eggs is 3·76 mm. and 4·48 mm. respectively. The peri-vitelline space is broad and the egg inside measures 1·28 mm. in diameter. Early cleavage is over and the blastoderm cells have begun spreading over the yolk mass. The yolk is coarsely granular and of a pale transparent blue tinge.

Stage ii : *X*+2½ *hours after fertilization.* (text-fig. 2*b*).—The invasion of yolk by the blastoderm cells is progressing and within an hour after collection, almost three-fourth of the yolk mass is enveloped by the latter. Within 2½ hours, only a small plug-like portion of the yolk remain uncovered. The egg is slightly elongating and measures 1·6 mm. along the long axis.

Stage iii : *X*+3½ *hours after fertilization.*—Formation of the embryo has started as a ridge-like thickening over the yolk mass. Head and tail ends are not yet distinct. 3-4 myotomes have been differentiated.

Stage iv : *X*+5½ *hours after fertilization.* (text-fig. 2*c*).—Several eggs in this stage were simultaneously collected from the river also.



TEXT-FIG. 2.—Developmental stages of *Labeo kontius* (Jerdon). *a*. Fertilized egg, earlist stage collected from river; *b*. Developing egg ; 2½ hours after collection ; *c*. Same 5½ hours after collection ; *d*. Same 11 hours after collection ; *e*. Same 14 hours after collection.

(All figures are of the same magnificatino ; vitelline membrane is not shown in *b*, *c* and *d*.)

The embryo is slightly elongated, with the head and tail ends quite distinct. Optic cup rudiments are visible. 9-11 myotomes have appeared. Yolk mass is oblong. The everage dimensions are as follows :—

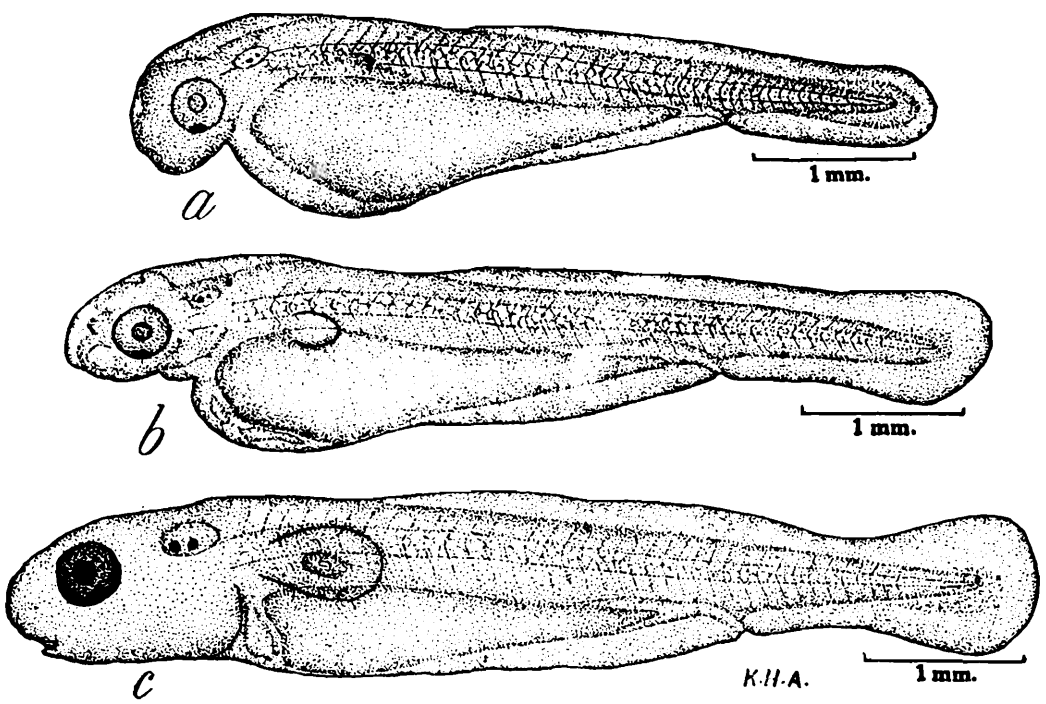
Total length of embryo	1·88 mm.
Max. height of embryo ..	1.16 mm.
Length of yolk mass	1·36 mm.
Height of yolk mass .. .	0·88 mm.

Stage v : *X*+11 *hours after fertilization.* (text-fig. 2*d*).—Embryo is roughly C—shaped ; yolk mass is elongating ; auditory cups are distinct ; head and tail ends are projecting from the yolk mass and 17—19 myotomes have appeared. The embryo is now 2·4 mm. in length.

Stage vi: *X+12½ hours after fertilization.*—The embryo has further elongated and has begun to execute occasional side to side movement of the tail which is well drawn out from the yolk mass. The latter is tapering posteriorly. The number of myotomes has increased to 22.

Stage vii: *X+14 hours after fertilization.* (text-fig. 2*e*).—The embryo now executes active movements within the egg membrane. Two minute concretions have appeared in each of the auditory vesicles which are still far removed from the eyes. Pericardial space has been differentiated between the head and the yolk mass. 26 myotomes have appeared. The tapering hind portion of the yolk mass is slender. The embryonic fin fold is distinct around the tail region. Head portion is still largely adherent to the yolk mass.

Stage viii: *X+15½ hours after fertilization.*—Embryo is now well differentiated and almost ready to hatch. 36 myotomes could be counted. Head is distinct from the yolk mass which is still very conspicuous. No pigment has yet appeared on the body. Heart has begun pulsating feebly. The embryo is making constant, vigorous movements within the egg membrane.



Text-fig. 3.—Developmental stages of *Labeo kontius* (Jerdon).

a. Hatchling, 5·04 mm. long, *b*. Larva, 18 hours after hatching, 5·84 mm. long *c*. Larva, 40 hours after hatching, 6·64 mm. long.

Period of Incubation.—The earliest stage in which the blastoderm cells had begun invasion of the yolk took about 16 hours to hatch in the laboratory. The temperature of water ranged from 22 to 23°C. If the early cleavage and the formation of the blastoderm are assumed to have been completed in about 4 hours after fertilization, the total period of incubation will be about 20 hours. A prolonged period of incubation was, however, noticed in the batch of eggs collected from the Cauvery, at Hoggainakkal, during July—August, 1946. The prevailing temperature of water then was also about 23°C. The eggs when collected were in a fairly advanced stage of differentiation and had the embryos moving

inside, and their age after fertilization was presumed to be about 8—10 hours. These, however, hatched in the laboratory, only 19 hours after collection, indicating a total period of 28—30 hours incubation.

(*b*) *Larval Development.*

The Hatchling. (text-fig. 3*a*).

Total length	5·04 mm.
Maximum height of body ..	1·36 mm.
Length of yolk sac.	2·72 mm.
Maximum height of yolk sac.	0·97 mm.
Height of body at anal level	0·56 mm.

Delicate and almost transparent, the hatchling has a conspicuous yolk mass which is still of a faint bluish tinge when seen against a white background. The head is distinct and projects out from the yolk mass. The eyes are transparent, but each has a small dark spot, ventro-medially. Pectoral rudiments are just indicated as smooth prominences on either side at the level of the thickest portion of yolk sac. The auditory vesicles have migrated closer to the eyes. Of the two concretions in each of the auditory vesicles the anterior one is bigger than the posterior. Mouth is absent. 36 myotomes could be counted. No chromatophores have appeared on the body.

Larva (*Pro-Larva*), *18 hours after Hatching.* (text fig. 3*b*).

Total length	5·84 mm.
Maximum height of body	1·12 mm.
Length of yolk sac.	2·72 mm.
Maximum height of yolk sac.	0·72 mm.
Height of body at anal level	0·68 mm.

Head is conspicuous; mouth and gills are indicated; the eyes are getting pigmented; pectoral rudiments are flat and foliaceous and the yolk is being steadily absorbed. The young larva confines to the bottom of the dish where it often lies quiet, but swims vigorously when disturbed.

Larva (*Pro-Larva*), *24 to 27 hours after Hatching.*

Total length	6·56 mm.
Maximum height of body	1·12 mm.
Length of yolk sac.	2·68 mm.
Maximum height of yolk sac.	0·56 mm.
Height of body at anal level	0·75 mm.

Mouth opening is better indicated and is more forward in position than in the previous stage. The eyes appear dark against a white background. The pectorals are functional. Blood appears reddish. Rudiment of the air bladder is indicated and a few chromatophores are present near the same.

Larva (Pro-Larva), 40 hours after Hatching. (text-fig. 3c).

Total length	6·64 mm.
Maximum height of body	1·24 mm.
Length of yolk sac.	2·44 mm.
Maximum height of yolk sac.	0·64 mm.
Height of body at anal level	0·88 mm.

Eyes have become fully pigmented and dark. Air bladder appears like a small oval bubble. Both the concretions in the auditory vesicle are of equal size. Mouth is well formed and is sub-terminal. The lower jaw is capable of being moved occasionally. Snout is blunt and from the dorsal aspect appears more or less truncated. Pectoral fin is fully functional. The yolk has been considerably absorbed. Chromatophores have appeared all over the body, particularly over the dorsum of head, continued as a mid-dorsal line to the tail, and also along the dorsal aspect of the yolk sac, continued backwards as a median ventral row.

Larva (Pro-Larva), 48 hours after Hatching.—Very similar to the previous stage ; yolk is further reduced ; eyes have become prominent ; air bladder is almost double the size of that in the 40 hours stage ; more chromatophores have appeared on the body. The fry do not lie quiet at the bottom ; but now move about almost constantly, by rapid, active darting movement, characteristic of carp fry.

Larva (Pro-Larva), 84 to 88 hours after Hatching.—

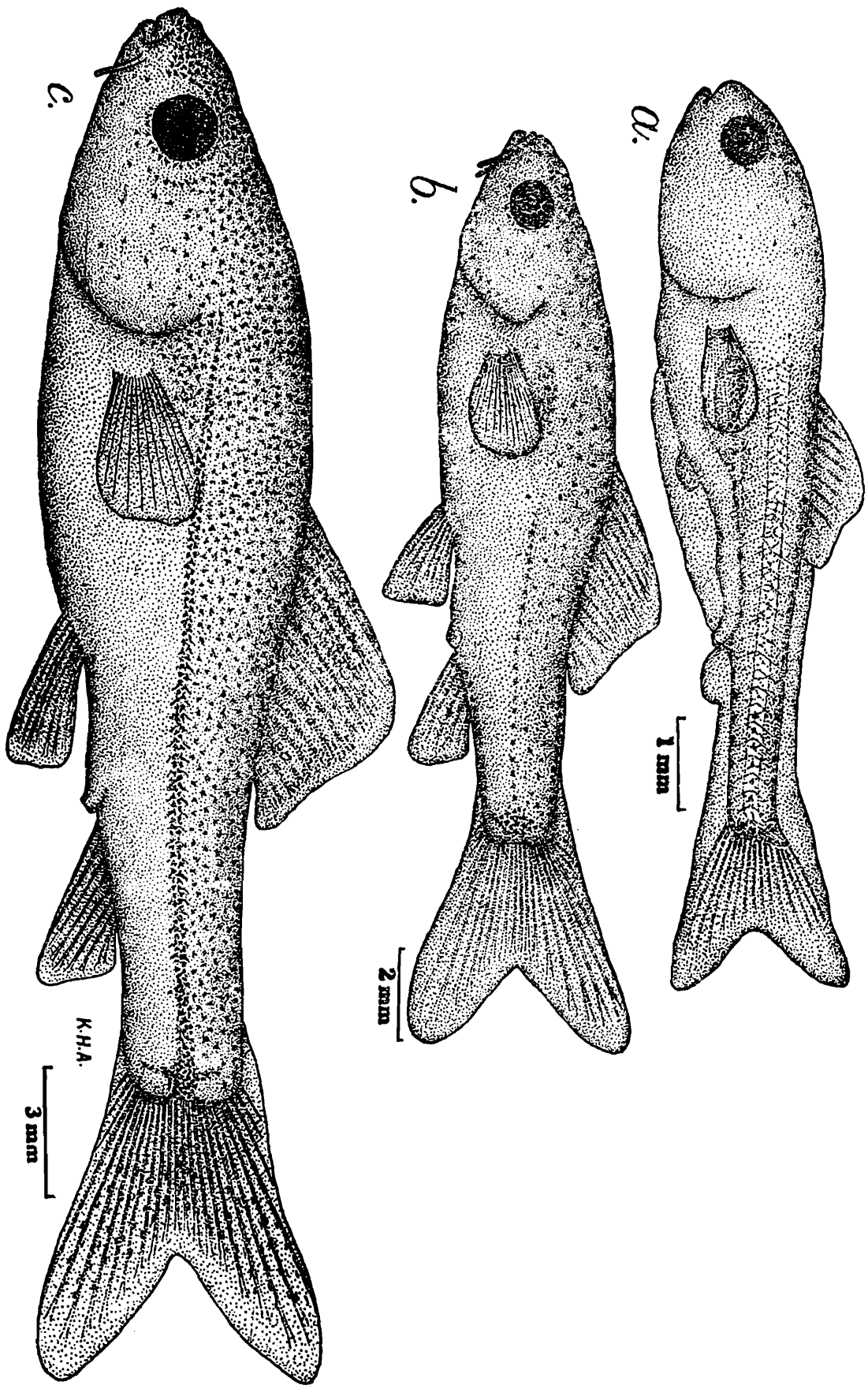
Total length	6·72 mm.
Maximum height of body	1·20 mm.
Length of yolk sac.	1·60 mm.
Height of body at anal level	0·88 mm.

Only a small remnant of the yolk remains to be absorbed. Air bladder, oblong in shape, has become large and conspicuous. Mouth is large, almost terminal and transverse. Chromatophores are numerous and distributed all over the body. An inconspicuous group of chromatophores has appeared on the tail, beneath the tip of the notochord.

Larva (Post-Larva), 5 days after Hatching.

Total length	7·62 mm.
Maximum height of body	1·37 mm.

The embryonic fin fold is continuous ; the dorsal fin rudiment is, however, indicated. Yolk has been fully absorbed and the larva has begun feeding. Tip of the notochord is turned upwards. Rudiments of caudal fin rays are indicated. More chromatophores have appeared particularly on the dorsum of head, on the caudal fin and on either side of the body along the lateral line.



TEXT-FIG. 4—Developmental stages of *Labeo kontius* (Jerdon).

a. Post-Larva, 7 days after hatching, 9·4 mm. long ; *b*. Young fish, 14 days after hatching, 20·0 mm. long ; *c*. Young fish, one month after hatching, 32·0 mm. long.

Larva (Post-Larva), 7 days after Hatching. (text-fig. 4*a*).

Total length	9·4 mm.
Maximum height of body	1·87 mm.

Differentiation of structures has progressed rapidly after the fry began to feed on plankton organisms. While the embryonic fin fold is still continuous, the dorsal fin is clearly indicated and has 7—8 rays. A notch in the dorsal fold indicates the hind margin of the dorsal fin, which is now continued as a narrow strip to the tail. The caudal fin is forked and has 14 rays. Anal fin is also indicated but no rays have appeared and it is continuous with the caudal. Rudiments of the ventral fins are indicated as thickened patches, opposite the dorsal, ventrally. The pre-anal fin fold is broad. More chromatophores have appeared around the tip of caudal peduncle and at the base of the caudal fin, but they have not yet concentrated into any distinct spots.

Larva (Post-Larva), 10 days after Hatching.

Total length	12·00 mm.
Maximum height of body	2·12 mm.

The dorsal fin is fully differentiated and has 3/13 rays. It is completely separate from the caudal fin which now has 17 rays. Fin rays have appeared in the anal fin which is still continuous with the caudal, by a narrow strip of the embryonic fin fold. The ventral rudiment is flat and still undifferentiated. Pre-anal fold is present. Chromatophores are numerous and are large and patch-like on the dorsum of head. At the caudal peduncle they have concentrated into an inconspicuous vertically disposed spot which has its dorsal and ventral edges darker than the middle portion. The row of chromatophores along the lateral line is distinct.

Young Fish, 14 days after Hatching. (text-fig. 4*b*).

Total length	20·00 mm.
Height of body	3·8 mm.

All the fins have been differentiated and have the same number of rays as in the adult. The pre-anal fin fold has disappeared. The mouth has become terminal, with rather thin, though weakly fimbriated lips. A pair of maxillary barbels have appeared. The air bladder is constricted. The caudal spot is rather diffused and is almost the same as in the previous stage. The row of chromatophores along the lateral line is more distinct and appears almost like a band when the specimens are fixed in formalin.

Young Fish, One Month after Hatching. (text-fig. 4*c*).—32 to 36 mm. in total length, the young fish is a miniature adult, except in pigmentation and in the proportions of the snout. A row of scales just above the

lateral line is provided with dark pigment, giving the appearance of a conspicuous dark lateral band extending from the operculum right up to the caudal peduncle where it is confluent with the caudal spot. The caudal spot—a central blotch with streak—like extensions dorsally and ventrally—is rather inconspicuous and finally disappears, along with the lateral band in larger specimens. Pigment is scarse below the lateral line, except near the operculum ; while, all over the body above the lateral line chromatophores are uniformly distributed. By about the 40th day when it attains a length of about 41 to 43 mm., the snout also attains the characteristic shape as in the adult.

DEVELOPMENT COMPARED WITH RELATED SPECIES.

The ovarian and laid eggs being of a bluish tinge, resemble those of *L. calbasu* and *L. gonius*, but are slightly smaller than in the latter species. In *L. fimbriatus* the eggs, though of almost the same bluish tinge, are slightly smaller than those of *L. kontius*. The period of incubation is also longer than in its north Indian congeners. The hatchling is longer than in the allied species and is in more or less the same stage as in *L. fimbriatus*. In the presence of the ventro-median dark spot in the eye, the hatchlings appear to be slightly more advanced than those of *L. calbasu*, *L. gonius* and *L. rohita*.

After absorption of yolk the rate of differentiation of structures depends largely on the availability of food in the environment. Given ample food in the form of live plankton, it is found that the hatchling metamorphoses into a young fish, with all the fins fully differentiated, by the 14th day. The first indication of the dorsal fin rudiment was visible on the 5th day after hatching ; while, in *L. calbasu*, *L. gonius* and *L. rohita* Mookerjee (1945) found similar stage only on the 7th-8th day. If the influence of food is not taken into account, it will be seen that in *L. kontius* the differentiation of structures in the fry takes place at a quicker rate than in the former species.

The conspicuous lateral band in the young fish is characteristic, but the caudal spot is not prominent. In the allied species, *L. fimbriatus*, while the young one has a distinct spot at the caudal peduncle, the lateral pigment band is absent. In the above features *L. kontius* differs from *L. calbasu* and *L. rohita* also.

GROWTH.

(*a*) *In Aquaria and Cisterns.*

The young ones are quite hardy and could be easily transported, even in glass jars, without frequent renewal of water. They could also be fed with crumps of bread, boiled potato, maize, etc. By regular feeding with live plankton collected from ponds it was relatively easy to rear the hatchlings to later stages in aquaria and cement cisterns. The data on early growth gathered by rearing hatchlings from eggs collected at Hoggainakal in July, 1946 are furnished in Table I.

TABLE I.—Data on early growth of *L. kontius* in cement cisterns.

No. of specimens : 35. Size of cistern : 6′ × 3′ × 2·5′.

Date	Age after hatching (Days)	Total length (mm.)			Period elapsed (days)	Growth in length (mm.)			Remarks.
		Max.	Min.	Aver.		Max.	Min.	Aver.	
23-7-46	Hatchling.	..	..	5·04	..		..		
30-7-46	7	9·55	9·25	9·4	7	..	..	4·36	
3-8-46	11	13·5	11·5	12·8	4	3·95	2·25	3·4	
19-8-46	27	27·0	24·0	26·0	16	14·5	13·5	13·2	
26-8-46	34	35·0	31·0	33·6	7	8·0	7·0	7·6	
2-9-46	40	42·0	40·0	41·3	6	9·0	7·0	7·7	
16-9-46	54	52·0	49·0	51·0	14	10·0	9·0	9·7	
27-9-46	65	56·0	54·0	55·0	11	5·0	4·0	4·0	
2-11-46	100	71·0	63·0	66·8	35	15·0	9·0	11·8	Only 9 measured,
21-11-46	119	84·0	66·0	72·7	19	13·0	3·0	5·9	—11—
12-12-46	140	98·0	72·0	80·1	21	14·0	6·0	7·4	—9—
17-1-47	175	106·5	78·0	87·5	35	8·5	6·0	7·4	—6—
1-2-47	190	114·0	81·0	91·6	15	7·5	3·0	4·1	—10—

*Due to incessant rains the nursery got flooded and the majority of fingerlings jumped out and escaped into the adjoining pond during the night.

After 1-2-47 only one specimen survived in the cistern. This was kept under observation for the next 3 months. The growth was very poor and on 23-5-47 it measured only 129 mm. in total length. After the first two months, growth in the cistern has been poor and this is probably accounted for by changes in feeding habits.

(*b*) *In Natural Pond.*

Five of the specimens that escaped into the nursery pond on 12-12-46 were netted out on 9-5-47, when they were 287 days old, and measured 356·6 mm., 344·4 mm., 341·4 mm., 310·9 mm., and 307·8 mm., respectively in total length. All the specimens looked quite healthy and were in excellent condition. They had been in the pond for 147 days during which period the maximum growth in lenght was 258·6 mm. (minimum : 235·8 mm. and average : 152·1 mm.). For the corresponding period growth in the cistern was only 31·0 mm. The limited space, water content and food in the cistern, no doubt, account for the poor growth.

In the natural habitat specimens over 12 inches in length have been found to be sexually mature. In the fresh water pond a maximum length of 11·7″ was attained in the course of 287 days, of which the first 140 days were spent in the cistern. Larger size would, undoubtedly have been attained if the young fish were released into the pond earlier. From the above observations it is apparent that *L. kontius* attains maturity size late in the first year of its life. It is, however, possible that growth in the natural fluviatile environment might not be as quick as that in the pond where food is generally plentiful.

ACKNOWLEDGMENTS.

The observations recorded in this paper were made during investigations under the Madras Rural Piscicultural Scheme, sponsored jointly by the Indian Council of Agricultural Research and the Government of Madras. Our grateful thanks are due to Dr. S. L. Hora for kindly going through the manuscript and offering valuable suggestions.

SUMMARY.

1. *Labeo kontius*, a major carp, indigenous to the Cauvery to river system, in South India, yields a valuable fishery, accounting for 5 to 50 per cent. of the catches in the different fishing centres along the river.

2. Attaining a maximum length of 20 to 24″, it becomes sexually mature when it is about 12 to 14″ long. It breeds during the monsoon months, June to August.

3. It has been found to breed almost at all hours of the day and night, in waters with pH. ranging from 6·6 to 7·1 and temperature from 22·3 to 24·2 C.

4. Laid eggs in large numbers were collected from Cauvery at Hoggaidakkal and the Bhavani at Satyamangalom, and the embryonic, larval and post-larval development were studied and described in detail.

5. The food and feeding habits of the fry, fingerlings and adults have been described.

6. Data on the early growth of the specimens is cement cisterns are furnished. In the natural pond growth is quick and the maturity size is attained late in the first year of life.

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