

ON THE LIFE-HISTORY AND BIONOMICS  
OF THE CARP MINNOW, *CHELA*  
*PHULO* (HAMILTON)\*

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INTRODUCTION

THE genus *Chela* is widely distributed throughout India and as many as 10 species have been recorded from Indian waters by Day (1889) and a few more by subsequent workers. Of these *C. gora* and *C. untrahi* attain a length of 8 or 9 inches. The smaller species generally occur in large numbers, and yield valuable minor fisheries in certain areas. Most of them take baits and are therefore popular with anglers. In spite of their relative abundance in almost all inland waters, our knowledge of their bionomics and life-history is still very meagre. A very brief account of the food, feeding habits and development of *C. argentea* by Chacko *et al.* (1946), and a similar account of *C. untrahi* by Chacko (1951) appear to be the main contributions on these aspects at present. So far as we are aware, only passing references are made in other contributions on the bionomics of this genus.

*Chela phulo* is one of the smaller species of the genus and its distribution according to Day (*op. cit.*) is from Assam, through eastern and central India, to the Thungabhadra and Kistna basins. It is commonly found in ponds at Cuttack. This and other carp minnows generally abound in carp nurseries and stocking ponds. During an investigation of the causes of heavy mortality of carp fry in nursery ponds at Cuttack, attempts were made to elucidate the role of these 'weed' fishes in the economy of pond life. In the present paper the observations made on the breeding, fecundity, development, food and feeding habits of *C. phulo*, are detailed.

The fertilised eggs collected from the pond were identified as those of *C. phulo* by extensive comparison of the range and average size of the ovarian eggs of all the species of *Chela* commonly occurring in the locality, *viz.*, *C. phulo*, *C. bacaila* and *C. gora*. Besides, at the time of collection of the eggs, *C. phulo* predominated in the pond to the almost complete exclusion of other species of the genus. As the very few specimens of *C. bacaila*

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present in the pond were then immature, they could not have been breeding when *C. phulo* was spawning. The characters of the advanced post-larvæ rule out the possibility of any doubt in their identity.

#### MATURITY AND BREEDING

Though reported to grow over 5 inches in length (Day, *op. cit.*) specimens longer than 3½ inches are rarely met with. The largest of over 600 specimens examined was only 85 mm. long. Sexual maturity is attained at a relatively small size; the smallest mature specimen, male or female, obtained being 54 mm. long.

Gonads were immature from October to January. By the middle of February some of the larger specimens (73 to 77 mm.) had the gonads in the IV-stage. By the end of March most of the males (54 to 67 mm.) had the testes in the V-stage. Females also then had the ovaries in the IV-V stage. Towards the last week of April some of the larger specimens (62 to 67 mm.) of either sex were found already spent. The majority of specimens were, however, fully ripe; while some small individuals, 48 to 50 mm. long had the gonads in the III stage (developing). Mature specimens were available till the middle of September. Though the breeding season thus extends from February to September, intensive breeding takes place only during April-May.

*C. phulo* breeds in stagnant ponds at Cuttack during the last week of May, when laid eggs were observed in the shallow margin of a small nursery pond, 50' × 50'. The water was only 2½' deep, and light greenish in colour, with a sparse bloom of algæ as the rains had not started. Spawning appears to take place usually in the morning (7-50 hours) as the fertilized eggs in their initial stages of cleavage collected on the 26th and 27th May, 1951 and on subsequent days indicate. The water was only a few inches (4 to 8") deep at the marginal shallows where the eggs were found.

#### SEXUAL DIMORPHISM

Fresh mature specimens of both the sexes in the breeding season could be easily distinguished by the colour of the body and the fins as follows:

Distinguishing characters	Male	Female
(a) Ventral fins .. ..	Yellow	Whitish
(b) Anal fins .. ..	Yellow	Whitish
(c) Colour of body above lateral line	with distinct dirty yellow tinge	Dull; no yellow tinge
(d) Dorsal aspect of body ..	with a narrow dark streak medially	Entire dorsal aspect dark in colour.

There is no marked difference in size between the sexes. The largest male specimen in the present collection measured only 74 mm. long; while the few larger specimens obtained were all females, indicating that the females probably attain a slightly larger size than the males.

## FECUNDITY

The fecundity of the species was studied by noting the total volume of the ovaries and then counting the number of ova in a sample piece of the ovary, the sample generally representing  $\frac{1}{2}$  to  $\frac{3}{4}$  of the total volume. The data gathered are summarised in Table I.

TABLE I

*Data on the length, weight, maturity and fecundity of  
Chela phulo Hamilton*

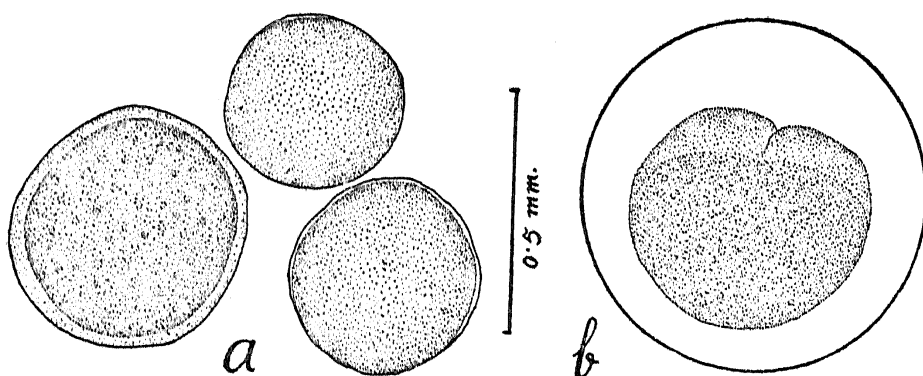
No. of fishes studied	Total length (mm.)		Aver. wt. (g.)	Stage of maturity	Vol. of ovaries (c.c.)		Total No. of ova		Aver. dia. of ovum (mm.)
	Range	Aver.			Range	Aver.	Range	Aver.	
4	57.0-59.0	58.25	..	V	0.12-0.20	0.15	1276-2512	1750	..
3	60.0-61.0	60.33	..	IV-V	0.10-0.20	0.16	1125-1660	1480	0.42
7	60.0-62.0	61.0	1.8	V	0.15-0.20	0.185	1296-2576	1912	0.465
6	63.0-66.0	63.7	1.92	V	0.13-0.20	0.157	1188-2092	1539	0.478
3	67.0-68.0	67.33	2.36	V	0.18-0.20	0.193	1679-2508	2026	0.483
3	73.0-77.0	75.0	3.35	IV-V	0.20-0.30	0.233	2092-2540	2309	0.446

It is seen from the table that generally fecundity increases with the size of the fish. Though the maximum number of eggs encountered in a single fish (62 mm. long and 1.9 gms. weight) is only 2576, when the size and weight of the fish are taken into consideration the fecundity is found to be exceedingly high. For instance, a specimen of the major carp *Cirrhina mrigala* weighing  $3\frac{1}{4}$  lb. is reported to have as many as 2,16,000 eggs in the ovaries (Khan, 1947). On this basis, *i.e.*, when the weight of the fish and the number of eggs produced are compared, the fecundity of *Chela phulo* (weighing only about 3 gms. and producing over 2,000 eggs) is 4-6 times as high as that of *Cirrhina mrigala*. Though the ovarian egg shows a gradual increase in size with the size of the fish (Table I) the somewhat arbitrary estimation of the stage of maturity of the ovaries might well have contributed to render this increase quite distinct.

### DEVELOPMENT

The fertilised eggs collected from the pond were reared in the laboratory through the embryonic and larval stages, noting the details of development. Simultaneously the post-larval stages were also procured from the pond. These are described below.

*Ovarian egg* (Fig. 1 *a*).—The ripe ovary is pale or light grey in colour with the ova of different sizes. The fully ripe unfertilised ovum is nearly spherical, with a diameter of 0.41 mm. to 0.48 mm. The invisible vitelline membrane of the fresh egg becomes clear when properly dehydrated and cleared in clove oil.



TEXT-FIG. 1. Development of *Chela phulo* Ham.

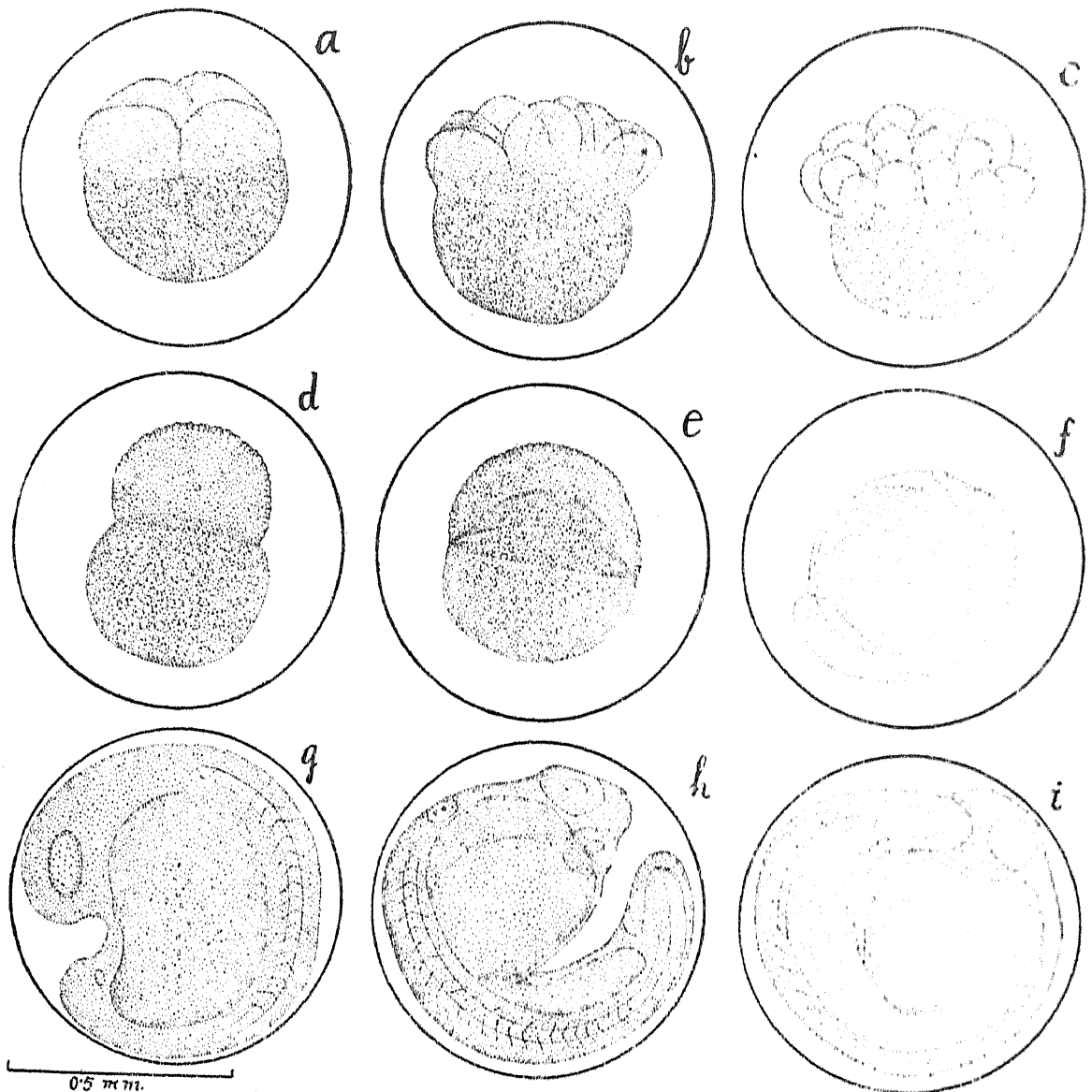
(*a*) Ovarian eggs, cleared in clove oil; (*b*) Fertilized egg undergoing first cleavage.

### *Embryonic development*

*Cleavage* (Figs. 1 *b*; 2, *a-e*).—The small, demersal, somewhat sticky fertilised eggs settle at the bottom where particles of sand and debris stick to the egg membrane, but fall off when the egg is fixed in 5% formalin, leaving the egg membrane clear. After extrusion from the fish the egg swells rendering the vitelline membrane conspicuous with a fairly large perivitelline space between it and the egg (Fig. 1 *b*). The egg is now 0.675 mm. to 0.727 mm. in outer diameter, and 0.476 to 0.485 mm. in inner diameter which is slightly larger than the ovarian egg.

In the earliest embryonic stage collected from the pond which is not more than half an hour after fertilisation, the first cleavage has just commenced, and the blastodisc appears as a narrow, refractile area spread over one end of the yolk mass. The almost transparent egg contains coarsely granulated yolk. The first division divides the blastodisc into two large blastomeres. Five minutes later the second division takes place, followed by the 8-celled stage in another 7 minutes (Fig. 2 *a, b*). The fourth cleavage is effected

8 minutes later (Fig. 2 *c*), with the 32-cell stage following in the next 12 minutes. The morula stage is reached 1 hour after commencement of cleavage (Fig. 2 *d*).



TEXT-FIG. 2. Embryonic development of *Chela phulo* Ham.

(*a*) Fertilized egg, 4-celled stage; (*b*) Fertilized egg, 8-celled stage; (*c*) Fertilized egg, 16-celled stage; (*d*) Fertilized egg, morula stage; (*e*) Fertilized egg, blastoderm cells spreading over yolk; (*f*) Fertilized egg, yolk invasion completed; embryonic rudiment laid; (*g*) Embryo, early C-shape; (*h*) Advanced embryo, about 8 hours after first cleavage; (*i*) Embryo ready for hatching; about 11 hours after first cleavage.

(All sketches by camera lucida, from fresh and freshly preserved material.)

*Differentiation of the Embryo*

*2 hours after first cleavage* (Fig. 2 e).—The crown of minute cells in the morula soon begins to spread over the yolk mass, about a third of which is covered within an hour after the morula stage.

*4 hours after first cleavage* (Fig. 2 f).—The blastoderm cells engulf the whole of the yolk mass; the embryonic rudiment is quite distinct though the head and tail portions are hardly distinguishable from one another.

*5 hours after first cleavage*.—The embryo is somewhat C-shaped, with the head, optic cups and the tail portions quite distinct, and 9 myotomes differentiated. The yolk is still a round mass.

*6½ hours after first cleavage* (Fig. 2 g).—Distinctly C-shaped, the embryo now fills the entire perivitelline space. The yolk mass has become oblong, about 0.48 mm. long. The number of myotomes has increased to 14 or 15. The optic cups are better differentiated and at the base of the projecting tail rudiment the Kupfer's vesicle has appeared as a small clear oval or oblong area.

*7 hours after first cleavage*.—The embryo shows occasional faint, twitching movements. The yolk mass has also assumed the characteristic shape, tapering towards the tail which is further elongated. The head is also more prominent. 20 myotomes have appeared.

*7¼ hours after first cleavage*.—The auditory cups have appeared. Both the head and the tail regions of the embryo are now moved frequently. The embryonic fin fold has also appeared around the tail. The posterior portion of the yolk is much drawn out and slender, though somewhat blunt.

*8 hours after first cleavage* (Fig. 2 h).—Two minute concretions appear in each of the auditory vesicles. More myotomes have appeared. The position of the anus is indicated very far backward, near the tail. Lens has appeared in the eye. The embryo is now able to change its position by frequent movement within the egg membrane.

*8 hours, 40 minutes after first cleavage*.—The heart begins to pulsate faintly. The embryo is very much elongated and is almost completely doubled up within the egg membrane.

*11 hours after first cleavage*.—The embryo is fully differentiated and almost ready for hatching, executing vigorous movements within the egg membrane.

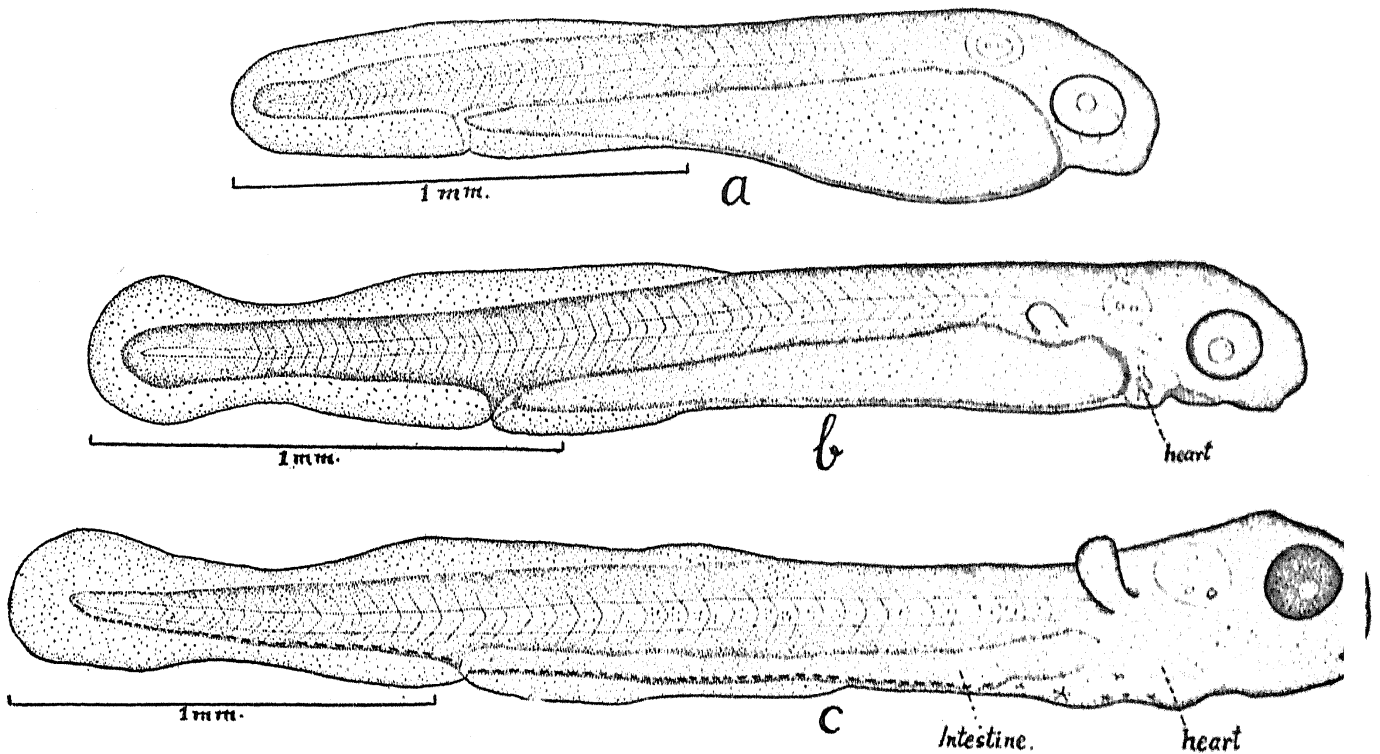
Within a few minutes all the eggs hatched out, almost simultaneously.

The cleavage and the entire embryonic development are completed in about 11 hours after the first division. The period of incubation, therefore, does not exceed 12 hours. The range of temperature of water in which the eggs were developing was 29.3 to 33.3° C.

### Larval Development

#### Hatchling (Fig. 3 a)

Total length	..	..	..	— 2.025 mm.
Post-anal length of body	..	..	..	— 0.540 mm.
Length of yolk-sac	..	..	..	— 1.290 mm.
Maximum height of body	..	..	..	— 0.390 mm.
Maximum height of yolk-sac	..	..	..	— 0.285 mm.
Height of body at anal level	..	..	..	— 0.255 mm.



TEXT-FIG. 3. Larval development of *Chela phulo* Ham.

(a) Hatchling, 2.025 mm. long; (b) Larva, 12 hours after hatching, 2.565 mm. long; (c) Larva, 48 hours after hatching, 3.165 mm. long.

(Camera lucida sketches from freshly preserved material.)

The hatchling is very small and is almost transparent. The eyes are non-pigmented except for a faint dark tinge at the anterior margin of each. The heart, situated antero-dorsally to the yolk-sac, pulsates fairly rapidly. The auditory vesicles are more or less rounded. The concretions inside the

auditory vesicle are of almost equal size. Rudiment of the air bladder has appeared; while, the pectoral fin buds are absent. The yolk-sac is conspicuous. The embryonic fin fold is broad around the tail. Dorsally it extends forwards to a point almost midway between the tip of snout and the tip of tail. The narrow ventral fin fold in front of the anus extends anteriorly a little beyond the level of the dorsal fin fold. As the anus is situated far back the post-anal length of body is only just over  $\frac{1}{4}$  the total length. 25 of the 42 myotomes are pre-anal in position.

*Larva, 3½ hours after hatching.—*

Total length	.. ..	..	2.415 mm.
Length of post-anal region of body	.. ..	..	0.675 mm.
Maximum height of body	.. ..	..	0.375 mm.
Height of body at anal level	.. ..	..	0.285 mm.
Length of yolk-sac	.. ..	..	1.470 mm.
Maximum height of yolk-sac	.. ..	..	0.255 mm.

The yolk-sac has become a little drawn out and appears much thinner. The pigment at the anterior margin of the eye is now distinct, with a small dark spot ventro-medially in each eye. The larva lies quiet at the bottom of the dish.

*Larva, 12 hours after hatching (Fig. 3 b)*

Total length	.. ..	..	2.565 mm.
Length of post-anal region of body	.. ..	..	0.835 mm.
Maximum height of body	.. ..	..	0.345 mm.
Height of body at anal level	.. ..	..	0.292 mm.
Length of yolk-sac	.. ..	..	1.275 mm.
Maximum height of yolk sac	.. ..	..	0.150 mm.

The eyes are pigmented, with their anterior portion darkest in colour, though the lenses still remain unpigmented. The buccal invagination has appeared. Rudiment of the air bladder is quite distinct. Auditory vesicles are not fully rounded in shape and the concretions inside are equal in size. Absorption of yolk is rapid and the yolk-sac now looks very thin and narrow. 26 of the 41-42 myotomes seen are pre-anal in position. The tip of the notochord is straight.

The larva generally lies quiet at the bottom of the dish but occasionally swims about.

*Larva, 24 hours after hatching.—*

Total length	.. ..	..	2.955 mm.
Length of post-anal region of body	.. ..	..	—1.005 mm.



The larva is extremely frail and slender. The mouth is now well formed though the lower jaw cannot yet be moved. The eyes have become dark. The pectoral rudiments have grown into larger flap-like functional structures enabling the larva to freely swim about in water. The yolk is almost completely absorbed except for a slender anterior portion. Along the mid-ventral line of the body the chromatophores are somewhat diffuse.

*Larva, 36 hours after hatching.*—Yolk is completely absorbed and the mouth has become fully terminal in position. The chromatophores have become slightly more distinct.

*Larva, 48 hours after hatching*

Total length	.. .. .	3.135–3.165 mm.
Length of post-anal region of body	.. .. .	1.005–1.065 mm.

The chromatophores along the ventral aspect form a continuous row from the pectoral region upto the notochordal tip. 36–38 of the 72 chromatophores are preanal in position. The larva is so slender and transparent that it is very difficult to find it even in a small beaker of water. It swims near the surface of water in a characteristic manner. The pectoral fins have further grown. The mouth is fully functional, though the gut was empty. In the auditory vesicle the posterior concretion has become distinctly bigger than the anterior. The embryonic fin fold is continuous and the tip of the notochord is not yet perceptibly upturned.

*Larva, 72 hours after hatching.*—There has been no appreciable growth or differentiation of structures after the 48-hour stage and the larvæ are not active. However, at the hind portion of the head 8–9 chromatophores have appeared on either side which merge with the ventral row of chromatophores. Mouth is larger than in the 48-hour stage.

Heavy mortality of larvæ started after the 48-hour stage. As there was no yolk at this stage the larva, under natural conditions, would have begun feeding. The excessive mortality in the laboratory might be due to lack of suitable food.

*Post-larva, 4.815 mm. long (Fig. 4 a).*—(Collected from Killa nursery pond No. 29, Cuttack, on 2–6–1951).

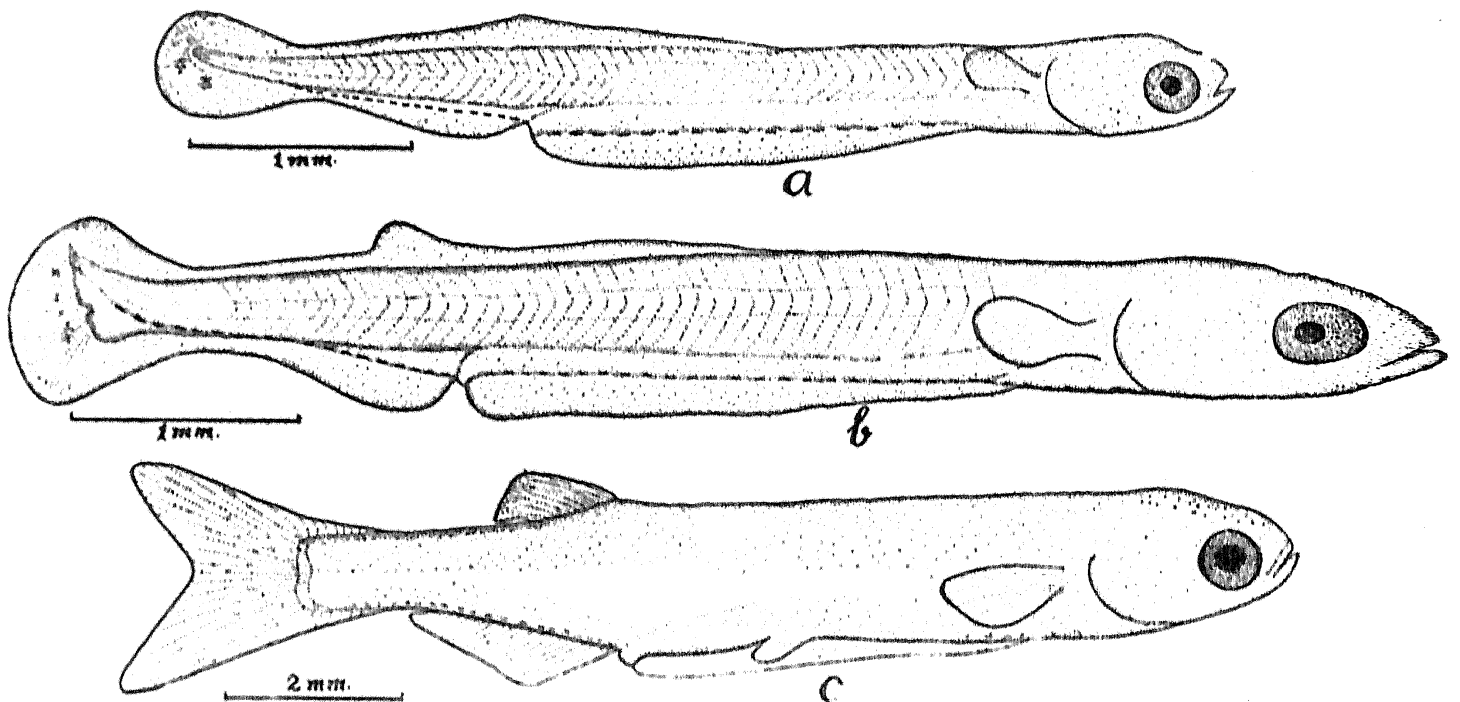
Length of post-anal region of body .. 1.545 mm.

Mouth is terminal and somewhat upturned. The embryonic fin fold is still continuous, with a slight broadening of the dorsal fin fold at about the level of the anus, indicating the position of the dorsal fin. The caudal is rounded. The tip of the notochord is slightly upturned. The ventral fin fold behind the anus is also somewhat broadened indicating the origin

of the anal fin. The number of chromatophores along the mid-ventral line is much less than in the 48-hour old larva, there being only 16 pre-anal and 17-18 post-anal chromatophores. This apparent reduction in number which occurs only in some larvæ is due to the merging of adjacent chromatophores which therefore appear larger and more conspicuous than in the larva. The young fish has obviously begun feeding as rotifers and rotifer eggs in the gut indicate.

*Post-larva, 5.890 mm. long (Fig. 4 b).—(Collected from Killa nursery No. 29, Cuttack, on 2-6-1951).*

Length of post-anal region of body .. 1.957 mm.



TEXT-FIG. 4. Post-larval development of *Chela phulo* Ham.

(a) Post-larva, 4.815 mm. long; (b) Post-larva, 5.890 mm. long; (c) Post-larva, 13.0 mm. (All collected from pond and sketched immediately after preservation.)

The shape of the mouth resembles that of the adult. The dorsal and anal fin rudiments are more distinct but without fin rays in either. The rounded caudal fin is better differentiated though still continuous with the embryonic fin fold. Tip of the notochord is distinctly upturned and 12 rudimentary rays are present in the caudal fin. There are only 32 ventral chromatophores in a continuous line as those anterior to the anus have not yet merged into their adjacent ones. The 5-6 chromatophores on the caudal fin are more distinct than in the previous stage.

*Post-larva*, 13.0 mm. long (Fig. 4 c).—The dorsal, anal and caudal fins have been fully differentiated with the full complement of rays, 2/7–8, 2/19 and 20 respectively. The ventral embryonic fin fold persists in front of the anus. The bud-like rudiments of the ventral fins are distinct with 3–4 rudimentary rays. More chromatophores have appeared on the body, particularly on the dorsal aspect of the head and snout and also along the back from the level of the dorsal fin upto the caudal. The ventral row of chromatophores is now concentrated in the pectoral region behind the head and at the base of the anal fin upto the caudal.

Specimens 14.5 mm. long, have the ventral fin rudiments slightly better developed, with the ventral fin fold, persisting.

*Post-larva*, 16.0–17.0 mm. long.—Ventral fin fold has almost disappeared, though in some it is still seen as a very narrow strip. Ventral fins are fully differentiated with rays. Pectoral fins are elongated reaching halfway to the ventrals. The chromatophores are prominent at the nape, along the base of the anal fin, and behind the dorsal fin. The post-larva now bears considerable resemblance to the adult in all salient features.

#### FOOD AND FEEDING HABITS

Specimens of *Chela phulo* collected from nursery and stocking ponds in different months were examined to correlate the stomach contents with the items of food dominant in water at the time of collection. A detailed analysis of the gut contents of 158 specimens, 14.5 to 85.0 mm. in total length, made during the present study is briefly presented in Table II.

The number of items in the gut is relatively small. Cladocerans (*Moina* sp., *Pseudosida* spp.), copepods (*Diaptomus* spp., *Cyclops* spp. and *Nauplii*), Rotifers (*Brachionus pala*, etc.) insects (Chironomid and other dipteran larvæ) and the filamentous green alga, *Spirogyra* constituted the main items of food consumed. Planktonic algæ (*Euglena*, *Closterium*, *Microcystis* and Naviculid diatoms) were seldom encountered in the gut and formed only a very insignificant portion of the feed. The proportion of vegetable debris was likewise very limited in the gut, which occasionally had some sand or mud particles also. It is fairly clear that the nature of the food taken depends to a large extent, on the item of food predominant in the environment at the time, but it is of interest to note that while the fish generally subsists on a predominantly zooplankton diet, will also feed on non-planktonic bottom living forms, like *Spirogyra*, aquatic insects, etc., in the absence or paucity of zooplankton. It has been observed that whenever zooplankton was rich in water the fish fed on it, the few algæ or insects taken with it perhaps being only

TABLE II  
*Chela phulo Ham.; analysis of food consumed during different months in selected environments*

Date of collection	Time, Hours	Place	Nature of plankton	No. of fish examined	Range of total length (mm.)	Extent of feed (%)	Gut contents : Range and average % of items					
							Cladocera	Cope-poda	Rotifers	Insects	Spirogyra	Others
March 30-3-1950	15.00	Zobra, Cuttack, Pond No. 3	Zooplankton very poor	6	61.0-81.0	50-60	..	..	100.0	..	..	..
April 22-4-1952	8.30	Killa Channel, inlet section, Cuttack	Zooplankton poor; patches of algæ	15	60.0-74.0	30-80	0-40.0 (3.2)	0-3.0 (0.7)	0-25.0 (4.4)	50-100 (91.0)	0-3.0 (0.7)	0-3.0 (0.7)
April 22-4-1952	9.30	Do; section near nurseries	Algal growth less, zooplankton richer	16	48.0-57.0	40-80	0-100.0 (60.3)	0-20.0 (2.0)	0-100.0 (27.1)	0-40.0 (10.1)	0-9.0 (0.5)	0-9.0 (0.5)
April 26-4-1952	9.30	Killa, Cuttack, Pond No. 54	Zooplankton rich, sparse algal growth	12	58.0-83.0	60-100	30.0-100.0 (82.6)	..	0-20.0 (2.7)	0-70.0 (14.7)	..	..
May 26-5-1951	10.00	Killa, Cuttack, Pond No. 29	Zooplankton rich	14 1	14.5-40.0 60.0	50-100 80	40.0-100.0 (87.0) 40.0	0-60.0 (13.0)	..	..	..	..
June 14-6-1952	9.30	Killa Channel, near nurseries, Cuttack	Do	40	19.0-68.0	60-100	97.0-100.0 (99.7)	0-1.0 (0.09)	0-2.0 (0.21)	..	..	..
September 11-9-1951	10.00	Do Pond No. 50	Do	4	64.5-78.0	70-100	80.0-100.0 (88.7)	0-15.0 (3.8)	0-20.0 (7.5)	..	..	..
December 12-12-1951	13.00	Do Pond No. 54	Do Rotifers	18	49.0-70.0	50-100	..	..	40.0-100.0 (77.0)	0-45.0 (16.5)	..	0-25.0 (6.5)
December 12-12-1951	12.00	Killa, Channel, near nurseries	Zooplankton poor	26	40.0-82.0	40-100	..	..	..	0-100.0 (77.4)	0-100.0 (22.6)	..
December 28-12-1951	11.00	Do	Do	6	51.5-72.0	70-100	..	..	0-3.0 (0.5)	0-15.0 (5.2)	80.0-100 (92.5)	0-5.0 (1.8)

accidental inclusions, but when the plankton was poor there was a much larger proportion of *Spirogyra* and/or insects in the gut. Juvenile specimens feed almost entirely on zooplankton.

*C. phulo* appears to be an active, continuous feeder, judging from the fact that specimens with empty stomach were very rarely found. Even when the collections were made in the morning hours the amount of feed ranged from 30% to 80% showing that feeding activity had commenced early. Though the somewhat upturned mouth indicates a plankton feeding habit, the gut contents reveal that the fish feed also on insect larvæ and filamentous algæ at or near the bottom. Early post-larvæ feed largely on rotifers.

#### DISCUSSION

Like the majority of carp minnows, *C. phulo* breeds in stagnant waters, with a peak period of breeding just before the monsoon rains. The allied species, *C. argentea* and *C. untrahi* are reported to breed in running waters during the monsoons (Chacko *et al.*, *op. cit.*). The sexual dimorphism in the species, referred to above, occurs in the breeding season in *C. argentea* and *C. untrahi* also, the female exhibiting a patch of yellow or orange on the ventral portion of the body (Chacko *et al.*). Such pigmentation on the body proper is absent in *C. phulo* in which the males are more brightly coloured than the females. The ovarian eggs of *C. phulo* are less than 0.5 mm. in diameter, comparable in size to those of the larger species *C. gora* (0.65 mm.) and *C. bacaila* (0.6 mm.) (Alikunhi and Chaudhuri, unpublished). The ripe ovarian eggs of *C. untrahi* (diameter 0.75 mm. to 0.95 mm., Chacko, *op. cit.*) and of *C. argentea* (1.20 mm. to 1.50 mm. in diameter—Chacko *et al.*, *op. cit.*) are much bigger than the above. The size of eggs of *C. argentea* is unusually large for such a small-size fish and is almost as big as that of the ovarian eggs of the largest Indian carp, *Catla catla*. In the light of our observations on the eggs and fecundity of *C. phulo*, *C. bacaila* and *C. gora*, and in view of the similarity in the habits of the different species of the genus, this extraordinary size of the eggs in *C. untrahi* and *C. argentea*, if proved constant and a correct observation, would have to be correlated with the specialised environmental conditions, if any.

The fully swollen fertilised egg in *C. phulo* has a much less spacious perivitelline area than in the major Indian carps. No details of the embryonic and larval development of *C. argentea* and *C. untrahi* are available, but the cleavage and differentiation of the embryo observed in *C. phulo* show that the processes are rather rapid. The period of incubation in *C. phulo* is shorter by at least 8 hours than in its congeners, *C. argentea* and *C. untrahi*. The hatchling is very small, without a mouth, gill slits or pectoral fins, and the

yolk is fully absorbed  $1\frac{1}{2}$  days after hatching. According to Chacko *et al.* (*op. cit.*) the hatchling of *C. argentea* has 4 gill slits at hatching, the mouth and eyes well formed, the yolk fully absorbed and is 8 mm. long in the next 4 hours. Similar conditions seem to prevail in *C. untrahi* also (Chacko, *op. cit.*). As compared to *C. phulo*, the rate of differentiation of structures in the above allied species is unusually rapid. The somewhat longer period of incubation of the egg (20 hours) in these latter may lead to a more advanced stage of differentiation of the embryo at hatching, but even so, it is doubtful whether the yolk would be completely absorbed within 4 hours after hatching.

*C. phulo* subsists largely on zooplankton, though often feeds on filamentous algæ and aquatic insects if zooplankton is scarce, but not on planktonic algæ as *C. argentea* does, in which the preference is appreciably less for micro-crustaceans (Cladocerans and Copepods). These comparisons can only give a very general picture of the food habits, when it is seen that the food consumed largely depends on the dominance of items of food present in a given environment.

As *C. phulo* draws largely on the zooplankton resources of the pond, it may be deemed an active competitor to the young fry of major carps which are almost entirely dependent on zooplankton (Alikunhi, 1952). The very careful eradication of this species from carp nurseries thus becomes a necessity to safeguard survival and growth of carp fry. In rearing tanks also the food habits of *C. phulo* will be incompatible, particularly with those of *Catla catla*, which, even after the early stages, continues to feed largely on zooplankton.

#### SUMMARY

The common carp minnow, *Chela phulo* Ham., breeds in ponds from February to September. Intensive breeding takes place during May-June.

During the breeding season the mature males are easily distinguished from the females by their conspicuous yellow-tinged ventral and anal fins, and by other differences in pigmentation.

The fecundity of the species is relatively much higher than that of the major carps.

Eggs are generally laid in the morning, in the marginal shallows of ponds. The fully swollen fertilised egg is less than 0.75 mm. in diameter.

With the temperature of water ranging from 29.3 to 33.3° C., the early cleavages are completed and the morula stage reached within  $1\frac{1}{2}$  hours after fertilization, and the embryo hatches out within 12 hours.

The hatchling, just over 2 mm. long, is extremely frail, small and rather undeveloped, with the mouth and pectoral fins wanting. Absorption of yolk is completed 36 hours after hatching when probably the larva begins feeding. All except the ventral fins are differentiated when the post-larva is 13.0 mm. long. Ventrals are also fully formed in specimens 16.0 to 17.0 mm. long.

*C. phulo* is essentially a zooplankton feeder, but takes in appreciable quantities of filamentous algæ and aquatic insects also. No significant changes in the feeding habits have been observed in the different stages of its life. Food consumed, however, largely depends on the items of food available in the environment.

The feeding habits of *C. phulo* are incompatible with those of the early fry of the major Indian carps and of all stages of life-history of *Catla catla*.

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