STUDIES ON FISH EGGS AND LARVAE FROM INDIAN WATERS
3. DEVELOPMENT OF EGG AND EARLY LARVA OF *CYPSELURUS SPILOPTERUS* (CUVIER AND VALENCIENNES)

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ABSTRACT

The egg, embryonic development and early pro-larvae of *Cypselurus spilopterus* (Cuvier and Valenciennes) are described. Their general appearence is compared with those of the eggs and larvae of other flying fishes reported from this region.

INTRODUCTION

Cypselurus spilopterus (Cuv. and Val.) is one of the large sized flying fishes of the Indian waters and is known among the fishermen of the Coromandel coast as *Thai-kola*. It is usually caught in small numbers along with *Hirundichthys* (*Hirundichthys*) *coromandelensis* which accounts for nearly ninety per cent of the flying fish landings of this country, the fishery of which is confined to the east coast. Egg masses of *C. spilopterus* is less frequently brought up by the fish lures used in the fishery as compared to the eggs of the latter, and occasionally when the eggs of both occur together they are easily distinguishable by their bright golden yellow colour and slightly larger size.

Observations on flying fish eggs and larvae from Indian waters are not many and the available literature has been briefly referred to by the author in a recent article (Vijayaraghavan, 1973). The egg or early development of *C. spilopterus* has not been recorded so far. Basheeruddin and Nair (1961) recorded the occurrence and food of the juveniles ranging from 40 to 100 mm in size from the coastal waters off Madras and young ones of size 55 to 163 mm were described by Parin (1961).

The embryonic development and early larve of *C. spilopterus* from Portonovo, Madras State, are described here.

MATERIAL AND METHODS

On the afternoon of June 24, 1959, a bunch of these eggs were seen attached to a bundle of *Pendanus* leaves which were being unloaded from a

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catammaran that had just returned with a catch of flying-fishes at Portonovo. Leaves of *Pendanus* and *Tephrosia* are used as lures to attract flying fish. The egg mass contained a good number of live eggs and they were quickly removed to the laboratory in a pot of sea water. The methods of maintenance of the eggs and larvae were the same as has been described by the author (Vijayaraghavan, 1973). The temperature and salinity of the water in which they were held were 26 to 28°C and 36 to 37‰ respectively. A few oozing females that were taken from the fish landing place yielded eggs identical in colour, size, number and distribution of filaments etc. to those that were collected from the *Pendanus* leaves. But no attempt to fertilize them artificially could be made since there was no male in the catch at that time.

The eggs of this species seemed to be rather delicate despite their tough chorion. From a total of over 500 eggs that were kept for incubation only one hatched normally. As the hatchling showed symptoms of dying after being in the aquaria for twentysix hours it was fixed and sketched. Due to their extreme vulnerability the advanced embryos or the hatchling were not anaesthetised for detaild examination and sketching as was done in the case of *H. (H) coromandelensis* by the author. Thus, the descriptions were made from unanaesthetised living specimens except in the case of the hatchling which was fixed before sketching. Many egg masses which were collected subsequently were all dead.

The specimens are deposited in the Reference Collection Museum of the Central Marine Fisheries Research Institute.

The Egg

The eggs (Fig. 1) are demersal, bright golden yellow in colour which does not fade much on preservation. They are spherical, 1.79 to 2.17 mm (average 2.02 mm) in diameter, with 12 to 19 (usually 13) very long adhesive filaments of almost identical length which are uniformly distributed over the entire egg. The filaments are fairly uniform in thickness, 0.34 to 0.60 mm (average 0.48 mm) in diameter at the base and are fixed to the surface of the egg capsule by a trumpet shaped base somewhat as in *H. (H) coromandelensis*. However, the connection between the base and the filament proper, in the present species, is more like a distinct immovable joint as though the basal piece has been squeezed into the filament. In many filaments, from this joint to some distance upwards, there are to be found a series of spiral or circular wrinkles which sometimes appear like clear segmentations. The bright yellow coloured yolk is homogeneous, translucent and devoid of oil globules. The perivitelline space is narrow though abnormal eggs with wide perivitelline space are occasionally met with. Such eggs were observed in the case of *H. (H) coromandelensis* also.

DEVELOPMENT OF THE EMBRYO

Stage I — The blastodisc stage (Fig. 1).

At 16.00 hours, that is, one hour after they were collected, all the eggs were more or less in the same stage of development, having well formed blastodisc.

Stage II — 42 hours after blastodisc stage (Fig. 2).

In eighteen hours the germ ring is seen on the equator of the majority of eggs. 24 hours later, that is, 42 hours after the blastodisc stage (Fig. 2) the blastopore is completely closed and the optic lobes, neural canal and the Kupffer's vesicle are visible in the embryo which occupies about one third the circumference of the egg. The auditory vesicle is in the process of formation. As the embryo gains size it lies with yolk facing upward.

Stage III — 72 hours after blastodisc stage (Fig. 3).

30 hours hence, that is, 72 hours after the blastodisc stage the embryo is well developed possessing 28 to 30 myotomes, of which, the posterior 18 are more distinct. The eyes are prominent possessing the lens. The auditory vesicles have fully formed. The pectoral fins have developed as flat semicircular buds situated at the ninth or tenth myotome. The heart which is very conspicuous and lies anterior to the head pulsates feebly but regularly. Pale orange blood corpuscles flow through the vitelline circulatory system which is visible as two unbranched lateral loops, one on either side of the embryo and lying on the yolk sac. These blood vessels come out of the embryo slightly behind the auditory vesicles and join the sinusvenosus anteriorly. The embryo is unpigmented, but a few pigment cells which are stellate or mere spots of yellowish-orange colour are strewn on the surface of the yolk membrane near the blood vessels. The embryo exhibits occasional twitching movements.

Stage IV — 96 hours after blastodisc stage (Fig. 4).

The embryo encircles three fourth the way around the yolk sac, and has a very prominent head with bulging cephalic lobes. At this stage 30 to 32 myotomes can be counted. The vitelline bloodvessels are very much branched and the pulsation of the heart is vigourous and rhythmic. Pectoral fins have become large and ellipsoid and they faintly quiver occasionally. The median finfold is confined to the caudal region. The yellowish-orange pigment cells have become very much branched and they are scattered all over the embryo and in fair numbers on the yolk membrane also, those on the yolk membrane being more reddish. A few spidery melanophores have appeared on the yolk membrane usually farther away from the embryo. But on very rare instances they may be present on the embryo itself. All these pigmentations disappear on preservation.

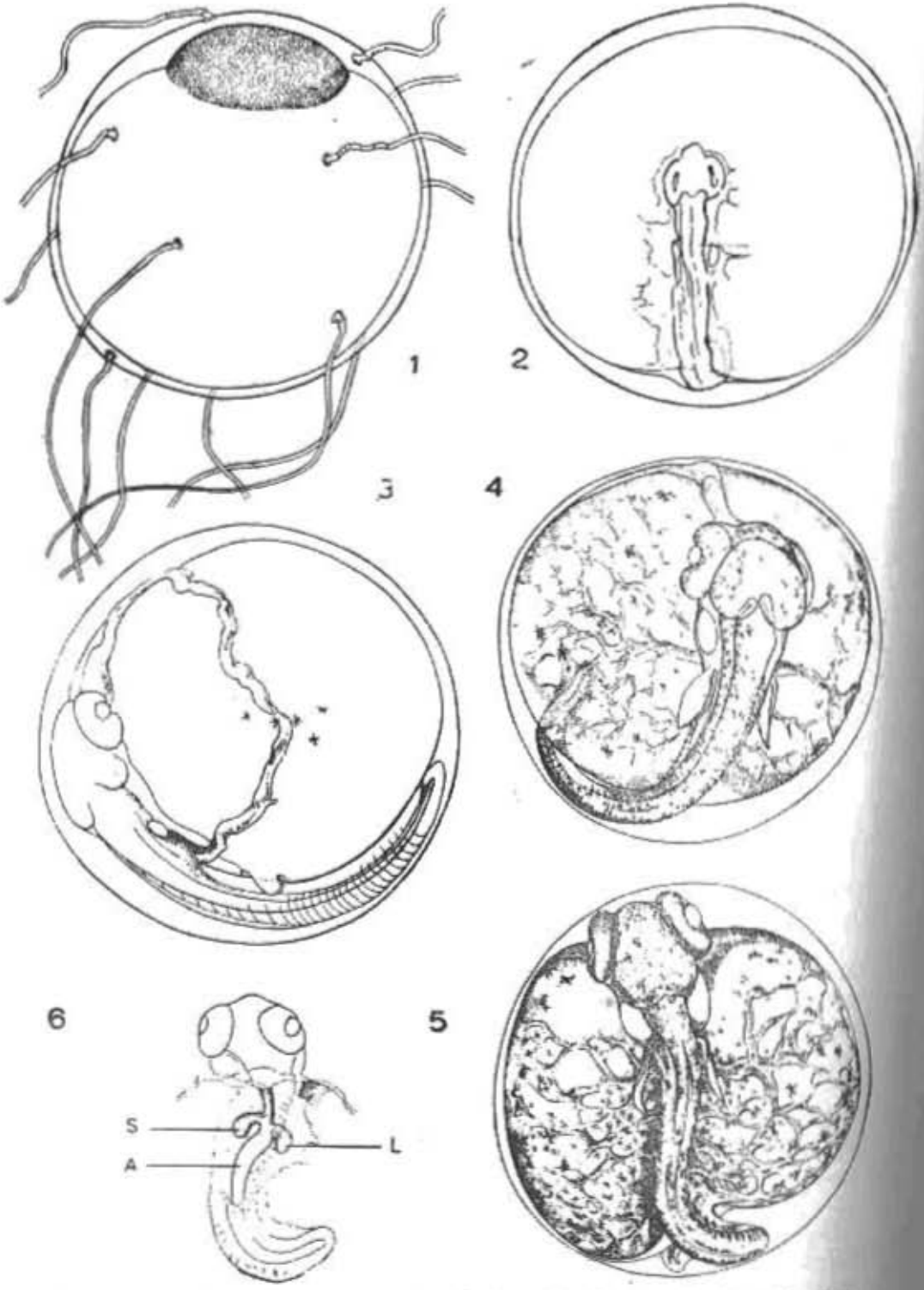


FIG. 1. Stage I: blastodisc stage. FIG. 2. Stage II: 42 hours after blastodisc stage. FIG. 3. Stage III: 72 hours after blastodisc stage. FIG. 4. Stage IV: 96 hours after blastodisc stage. FIG. 5. Stage V: 120 hours after blastodisc stage. FIG. 6. Microdissection of embryo showing the relative position of liver: L. liver, S. stomach, A. alimentary canal.

Stage V — 120 hours after blastodisc stage (Fig. 5).

There is considerable increase in the size of the embryo. The volume of the yolk mass is still great though there is visible reduction in its size compared to the previous stage. The tail is free from the yolk mass. The urostyle is curved up and hypurals have begun to appear. The caudal finfold extends dorsally as a very narrow membrane up to the nape and ventrally up to the yolk sac. The mouth is absent. The alimentary canal is a straight tube ending bluntly beneath the 21st somite. The heart is still anterior in position and the vitelline circulation is well established. The liver, pale yellow in colour, is visible on the left side of the embryo posterior to the main lateral branch of the vitelline bloodvessel, just behind the left pectoral fin. A camera lucida sketch (Fig. 6) of a microdissection of the embryo shows the position of the liver in relation to the stomach and intestine. The eyes are almost entirely covered with extremely fine ramifying melanophores. The orange coloured pigments have spread all over the embryo and occur in large numbers on the yolk membrane. The spidery melanophores on the yolk sac have increased in number, a few being present on the embryo as well. However, in many specimens, the embryo was free of melanophores. Due to the denseness of pigmentation on the embryo the myotomes were not properly visible and 33 to 35 could be counted. On preservation all pigments faded away execpt the grey chromatophores on the eye which became brownish. There is occasional twitching movements in the pectoral fins.

By now only ten eggs were surviving. Thus, the mortality was very great in this species compared to *H. (H) coromandelensis* whose eggs were also reared by the author during the same period under identical conditions.

Stage VI — 144 hours after blastodisc stage.

The yolk sac is reduced to half its original size, the embryo encircling the yolk mass fully, the entire caudal fin reaching well beyond the head. The mouth is seen as a semicircular cleft. The pectoral fins flutter occasionally and the posterior half of the embryo which is now free from the yolk sac changes position quite frequently causing the whole embryo to turn. The hypurals are clearly seen. The pigmentation has further intensified obscuring the myotomes, of which 20 to 23 preanal ones could be counted with difficulty. The constant movement of the tail region made it practically impossible to count the postanal somites, while preservation made it immediately indistinct. The orange coloured pigment cells have all become sepia-brown in colour. They are present all over the embryo except its caudal region. The eyes are deep grey caused by finely branched melanophores which cover them almost entirely. The iris is unpigmented.

Stage VII — 168 to 176 hours after blastodisc stage (Fig. 7).

The embryo wriggles quite frequently and violently 168 hours after the blastodisc stage causing the egg capsule to stretch. The movements appeared

like attempts of the embryo to come out. As it was not possible to make detailed observations due to the movement of the embryo, from two out of the six eggs that were remaining alive at this stage the embryo were artificially liberated and kept in sea water (Fig. 7). These measured 4.12 and 4.85 mm in length. The large yolk sac made them sink to the bottom and they moved sluggishly by the vigourous flapping of the pectoral fins. Their bodies remained bent sideways almost in a semicircle for nearly five hours before they straightened. The pigmentation was the same as in the previous stage except that the iris of the eye has become black. The body is devoid of melanophores while they are present on the yolk membrane. The anus is not open and is situated below the 22nd myotome. The jaws are present and movable. The dorsal, anal and caudal fins are indicated by the broadening of the finfold in their respective regions. The dorsal originates above the 16th or the 17th somite. The caudal lobe which has a wavy margin is supported by nine lepidotrichia. A fleshy thickening indicates the anal fin. The ventral fins are seen as fleshy transparent lateral lobes just below the intestine between the 14th and the 16th somites.

These liberated embryos died eight hours later (176 hours after the blastodisc stage). When they died a few melanophores with metallic sheen had appeared on the dorsal side of the head and trunk which were so far free of them. These pigments were dense on the dorsal side of the intestine along its entire length. The jaws were better developed, the lower jaw showing a tendency to protrude forward beyond the upper jaw. There were signs of developing rays in dorsal, anal and the ventral fins.

The Larva

The hatchling

Two hours after the artificially liberated embryos died, that is, 178 hours after the blastodisc stage, a single egg hatched, all the others having died by this time. This hatchling was exactly like the artificially liberated one and measured 4.52 mm. It swam about the rearing jar actively though the large yolk sac kept it sinking to the bottom frequently.

26 *hours old larva* — (Fig. 8).

By 26 hours the larva appeared to be dying and therefore it was preserved. The yolk sac was still conspicuous. The larva had an over-all length of 5.4 mm. The morphometric measurements of the larva are presented in table 1.* The total length, 5.2 mm, given in the table is the distance from the tip of the snout to the caudal tip and not from the tip of the lower jaw which projects 0.20 mm

* Since the dorsal finfold extends anteriorly far beyond the origin of the first basal of the dorsal fin, the distances between the tip of the snout and the anterior origin of the dorsal finfold and also the first basal of the dorsal fin are depicted as predorsal lengths (a) and (b) respectively in the table.

beyond the snout. A trace of the median finfold connects the caudal fin lobe with the dorsal and the anal fins. The caudal has 14 and the anal 16 distinct rays while in the dorsal 13 rays are indicated by diffuse thickenings of the membrane. The pectoral fin with an upper wavy margin and a pointed tip has indications of 8 rays, the 7th being the longest. The pelvic fin has just developed. Only the postanal myotomes are visible. To the unaided eye the larva appears shining darkbrown with silvery eyes. Under the microscope the

TABLE 1. *Measurements* (in mm) of the larva of* Cypselurus spilopterus *(C&V)*

Total length	5.20	Prepelivic length	2,26
Standard length	4.52	Pelvic length	0.40
Predorsal length (a)	2.64	Preventral length †	2.96
Predorsal length (b)	2.91	Body depth	0.44
Dorsal base	0.97	Head length	1.11
Preanal length **	3.06	Head thickness	0.87
Anal base	0.73	Head height	0.75
Propectoral length	1.11	Orbital diameter (horizontal)	0.49
Pectoral fin length	0.68	Orbital diameter (vertical)	0.44

* All body measurements are made from snout. ** From snout to origin of anal fin.
† From snout to anus.

entire body is seen covered with branching brown pigment cells with branching black and iridescent chromatophores which are concentrated mainly along the dorsal side of the head, trunk and the intestine. The black and iridescent pigment cells are found on the yolk sac also. On preservation these pigment cells lose their clarity and appear as diffuse colouration of the skin. The fins are all pale yellow to light brown near their base. The base of the pectoral fins and the membrane between their longest rays are pinkishgrey in colour. The tip of the lower jaw and the membrane between the pelvic rays are also similarly coloured. The eye ball is silvery with black chromatophores on it and the pupil is black. Black spots are present along the caudal fin rays.

REMARKS

Besides the present observations on the eggs of *C. spilopterus* the only flying fishes whose eggs have been collected from the coastal waters of India and described are *H. (H) coromandelensis* and *C. comatus*. The eggs of *H. (H) coromandelensis* are colourless, 1.60 to 2.11 mm (average, 1.87 mm) in diameter and have three types of filaments — a single stout one, which is the longest, surrounded by three to five thinner medium sized ones and a tuft of five to twelve small ones at the opposite pole (Nayudu 1923 and Vijayaraghavan 1973). The eggs of *C. comatus* (Padmanabhan 1963) are brown, much larger, having a mean diameter of 3.1 mm. Though Padmanabhan does not give the number of filaments, it would appear, from his figures, to be five. He has

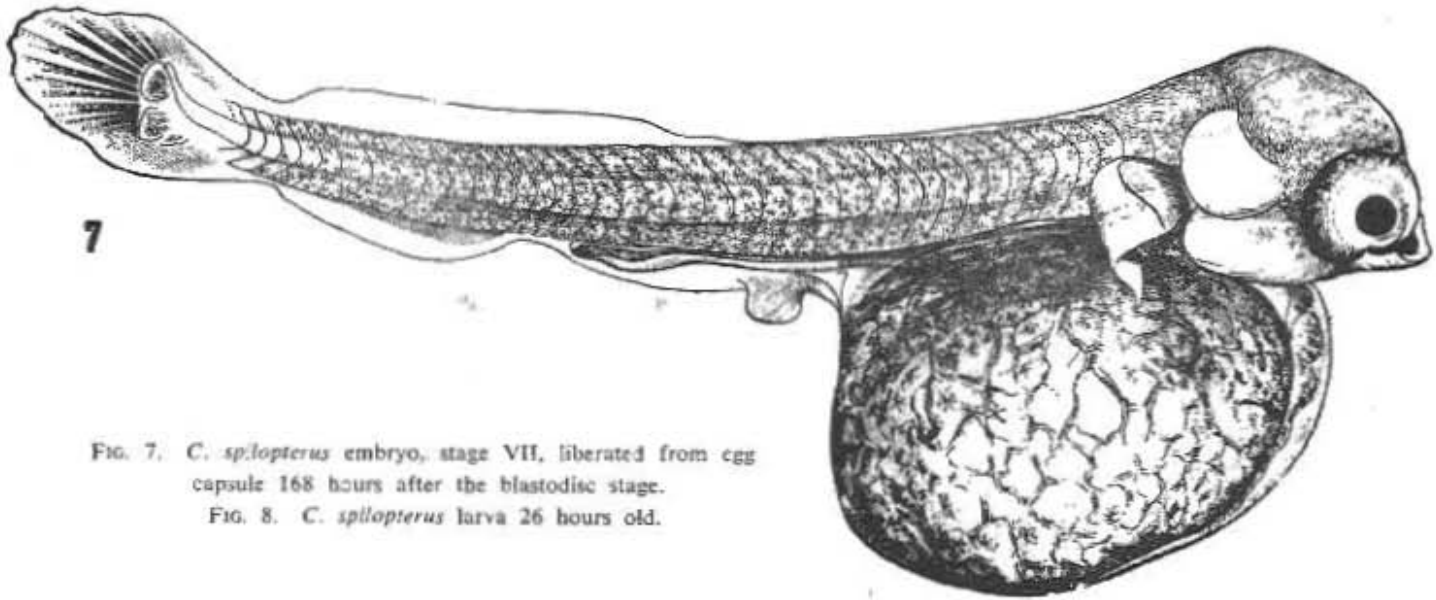
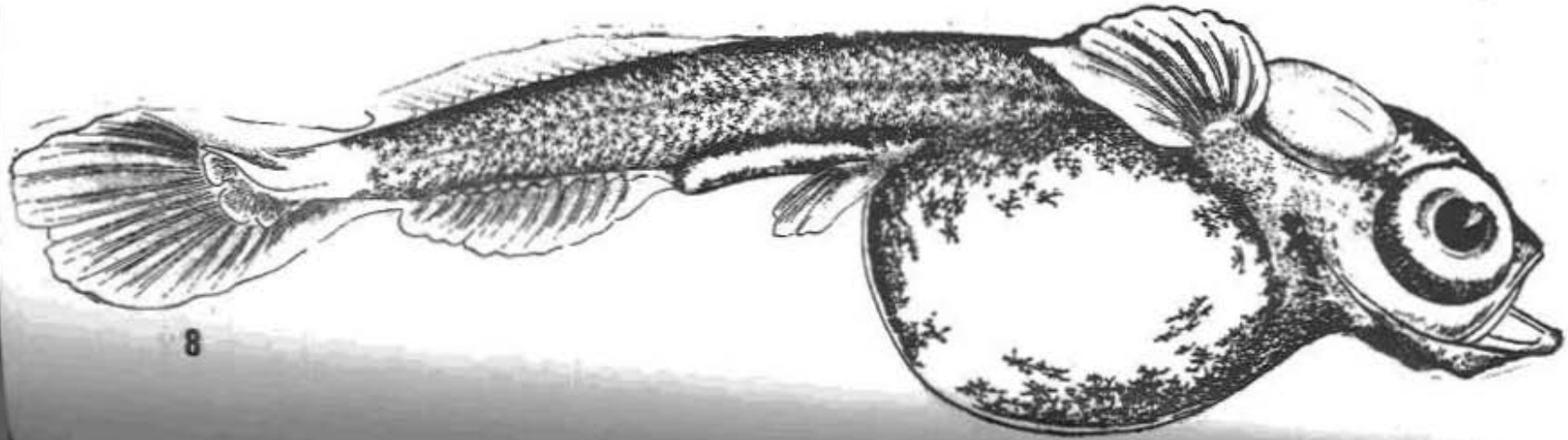


FIG. 7. *C. spilopterus* embryo, stage VII, liberated from egg capsule 168 hours after the blastodisc stage.
FIG. 8. *C. spilopterus* larva 26 hours old.



noted that there is no definiteness in the origin of these filaments, and that those that originate from the side of the egg nearer to the point of attachment are generally longer. It may be noted in this connection that Breder (1927 and 1938) has recorded the diameter as 1.20 to 1.45 mm (average 1.28 mm) for the eggs of *C.* (*C*) *comatus* and his figure shows 57 filaments on one hemisphere.

The hatchling of *C. comatus* described by Padmanabhan (1963) is 5 mm in size with stellate chromatophores over the head and yolk sac whereas the hatchling of *C. spilopterus* is only 4.52 mm and is almost entirely covered by brown branching pigmentation except the caudal region. Melanophores having metallic lustre are present on the dorsal side of the head, trunk and the intestine in the latter species. The just hatched larva of *H.* (*H*) *coromandelensis* is the smallest among the three species, being 3.47 to 4.23 mm. Black and yellow-brown pigment cells cover the body except the caudal peduncle. There is no iridescent pigment on the body except the eye balls. Further, black pigment spots are present along the caudal fin rays in *C. spilopterus* whereas in *H.* (*H*) *coromandelensis* the spots are found along the membrane intervening the rays.

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