STUDIES ON FISH EGGS AND LARVAE FROM INDIAN WATERS
I. DEVELOPMENT OF EGG AND LARVAE OF *HIRUNDICHTHYS (HIRUNDICHTHYS) COROMANDELENSIS* (HORNELL)

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ABSTRACT

The development of *Hirundichthys (Hirundichthys) coromandelensis* (Hornell) from egg through post-larval stage is described. Results of observations carried out in the laboratory on the hatching of the eggs and the factors affecting the development are discussed. Details of the different stages are given, along with general observations on the spawning and feeding of adults and colouration of the larvae. A brief note on the identification of the species is also appended.

INTRODUCTION

Details of the spawning habit of *Hirundichthys* (*Hirundichthys*) *coromandelensis* (Hornell) and its fishery in India, are available in the publications of Hornell (1923), Panikkar (1949) and Arora and Banerji (1957).

Observations on the eggs and larvae of Indian species of flying fishes are limited to the description of the egg and early embryonic development of *H* (*H*) *coromandelensis* from Negapatam by Nayudu (1923), egg and early larval stages of *Cypselurus comatus* reared in the Trivandrum Aquarium by Padmanabhan (1963), egg and juveniles of *Exocoetus volitans* collected from the Bay of Bengal by Kovalevskaja (1964), the development of artificially fertilized eggs of the latter species, also obtained from the Bay of Bengal, by Parin and Gorbunova (1964) and the post larval and juvenile stages of *H* (*H*) *coromandelensis* and *E. volitans* collected during the cruises of INS KRISHNA by Balasubrahmanyan *et al.* (1967).

Besides the papers of Nayudu and Balasubrahmanyan cited above, publications concerning the embryology and larval development of members of the genus *Hirundichthys* are those of Munro (1954) which describes the egg and larvae of *H. sp culiger* from Australian waters, the description of larvae and juveniles of *H. oxycephalus* from the Pacific Ocean and waters adjacent to Japan by Imai (1959) and the study of the early development of *H. affinis* from Barbados by Evans (1961).

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The present paper describes the eggs of *H (H) coromandelensis* collected at Portonovo (lat. 11° 29′ N and long. 79° 47′ E) with observations on the development of its embryo and larvae. A brief note on the identification of this fish is also appended. (Appendix 1.)

Material and Methods

During the summer of 1959 between 10th May and 25th June the flying fish fishery was concentrated unusually close to the shore at Portonovo near the Vellar estuary, which landed *H (H) coromandelensis* in great numbers. The nearness of the fishing activity to the shore enabled the collection of many oozing specimens of this species as well as large numbers of their naturally fertilized eggs which were found in fresh condition clinging to the fish lures and gear of homing catamarans. Though the fish were invariably dead when they were brought ashore, the milt and eggs of those which appeared very fresh and in running condition were stripped into wide-mouthed two liter glass jars containing fresh filtered sea water at 27° ±1.5° C. After many trials a bunch of over 200 eggs were artificially fertilized, 68% of which subsequently hatched. Since these larvae were identical with the progeny of naturally fertilized eggs, they were not treated separately in the selection of type specimens for the stages described in this paper though they were of course kept separately for observations throughout this investigation.

Fertilized eggs were removed individually from the egg masses for sketching and closer attention and were held in glass jars similar to those in which artificial fertilization was performed.

There was no provision for circulating the sea water in the rearing jars. The usual procedures of controlling the growth of harmful microbes and the slime formation in such stagnant cultures by the addition of disinfectants like gention violet, acriflavin and hydrogen peroxide to the medium or by the frequent rinsing of eggs with healthy sea water, which had proved helpful in rearing the eggs of various other fishes, was found to affect the hatching of flying fish eggs during the present work. Hatching mortality was minimal in jars wherein the slime formation was not totally arrested. In the absence of this slime the chorion of the eggs failed to rupture at the proper moment. Thus, hardpressed for space as the development progressed, the embryos became highly disproportionate morphologically and eventually died within the egg case itself or when artificially liberated from the egg capsule, succumbed after swimming about clumsily for a few hours. Presumably, under laboratory conditions, the softening of the egg capsule which seems to be a prerequisite for normal hatching, is aided in some manner by the slime though the presence of it in excess was also accompanied by pronounced mortality. Change of sea water once per day yielded satisfactory results. It is probable that enzymes like bacterial and mold proteases (Hagihara, 1960) may be involved in the seemingly benificial influence of the slime on the

hatching of the eggs. It is of interest to note that the flying fish eggs under study occurred at a time when the salinity of the environment was high. Though the fishery was close to the estuary, due to drying up of the river mouth and the formation of sand bars, the eflux of fresh water from the river was reduced to a mere trickle. The eggs were reared at salinities ranging from 36 to 37.2‰ which corresponded to that of the natural environment.

Another factor known to influence the timing of hatching is the concentration of O_2 in the water which triggers the release of hatching enzymes (Hayes, 1942). A decrease in the O_2—availability below the critical level has been found to hasten hatching (Alderdice *et al* 1958, Hamdorf, 1961). However, four batches containing 25 numbers in each, of *H* (*H*) ***coromandelensis*** eggs held in slime free water having dissolved O levels of 4.56, 4.15, 3.34 and 2.71 ml/L, failed to shorten the incubation time and all the embryos remained entrapped and alive within the chorion even 20 hours past the maximum time required for the normal emergence of the hatchling while those which were kept in the jar having 2.71 ml/L O_2 were all dead within 12 hours of the experiment. This again points to the possible role of the slime in softening the egg capsule and its timely hatching. The dissolved O_2 in the surface sea water samples collected for maintaining the aquaria ranged from 4.06 to 4.59 ml/L.

The larvae thrive well between 26 and 28° C. 20 hatchlings in a jar which was accidentally left near a window happened to be exposed to direct sun light and were found dead, the temperature of the water having risen to 29.5° C. Details of feeding the larvae are discussed elsewhere in this paper.

Among the larvae raised in the laboratory there were many with various structural deformities. The descriptions and sketches of the different stages are based on apparently healthy and normal ones which appeared to be typical specimens. Since all but the black pigments fade within a short time after preservation they were sketched and described as they were in life. The larvae were anaesthetized in 1 : 3000 solution of Tricaine methanesulphonate (MS-222, Sandoz Pharmaceutical Co.) for making sketches and morphometric observations. The type specimens were preserved after such observations and the rest were allowed to recover in fresh sea water. Loss of hydrostatic ability was taken as the critical point in anaesthetizing the larvae, the depth of narcosis being manipulated by the duration of their exposure to the solution after the loss of equilibrium. It may be mentioned here on that after testing 21 substances that could induce anaesthesia in fishes 15 were found by McFarland (1959) to be without side effects. MS-222 which produces rapid and prolonged immobility seems to be the most widely used. The specimens are deposited in the reference collection museum of the Central Marine Fisheries Research Institute, Mandapam Camp.

DESCRIPTION OF THE EGG

The eggs (Fig. 1) are spheroid having a mean diameter of 1.87 mm, colourless and transparent with a capsule which is remarkably tough and resilient. They are heavier than sea water and possess transparent filaments of adhesion as in most synentognaths. These filaments which arise from the surface of the egg membrane are of three distinct types.

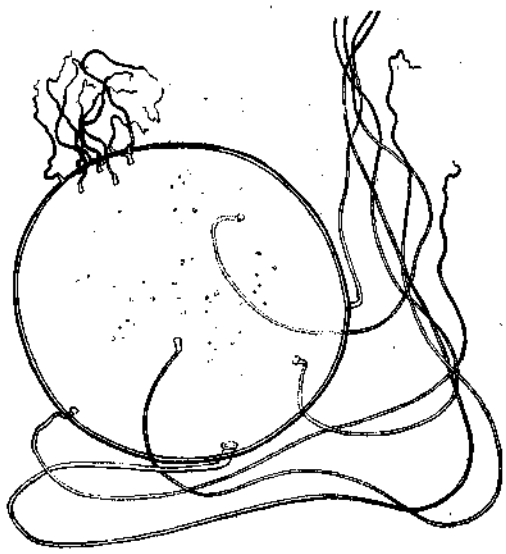

Fig. 1. *H (H) Coromandelensis* unfertilized egg 2.01 mm diameter

A single stout filament, 0.036 mm in average diameter at its base, which is the largest, arises from the basal pole. It serves as the main anchoring chord being inter-twined with similar ones from adjascent eggs to form a central rope holding the tangled mass of eggs around it. Its mean length was found to be 102.5 mm.

Situated at the distal pole is a cluster of 5-12 small filaments 1.1 mm in mean length and average thickness of 0.009 mm at their base, their extremely thin ends floating freely. They occupy a roughly circular area having an average diameter of 0.46 mm. Very rarely more than one filament might arise from a common base.

Thirdly, 3-5 medium sized filaments 4.6 mm in mean length and 0.017 mm in mean diameter, scattered irregularly over the zona radiata constitute a further means of attachment which add to the formation of the central rope that holds the mass of eggs together. The distribution of these filaments is generally confined to the basal half of the egg's surface wherefrom the main anchoring filament arises, though occasionally, some may occur more distally also.

TABLE 1. *Measurements (in mm) of egg and filaments of* Hirundichthys (Hirundichthys) coromandelensis *(Hornell)*

	Diameter of egg	Main anchoring filament			Medium size filaments			Small filaments			
		Number	Length	Diameter	Number	Length	Diameter	Number	Length	Diameter	Diameter of the area of occurrence
Range	1.60-2.11	1	48-191	0.32-0.56	3-5	2.4-7.2	0.016-0.024	5-12	0.4-2.2	0.007-0.011	0.22-0.92
Mean	1.87	1	102.5	0.036	4.08	4.60	0.017	8.50	1.10	0.009	0.46
Nayudu (1923)	1.75-1.80	1	...	...	4.6	...	...	7-16	...	...	...
Number of eggs examined	75	200	15	30	40	44	46	40	45	60	20

The base of every filament is thick and usually somewhat trumpet-shaped, the broad end of which is attached to the surface of the egg capsule. It is more refractive in oblique light and less flexible than the filament proper. A celar line of demarkation is discernible between the two. In preserved material, where the filaments break off more easily, the severance occurs usually at the point of connection of the filament with its base and in fresh eggs this occurred less frequently on the application of force. The tendency to break at the plane of cleavage was much higher in eggs in the rearing jars which were more than two days old.

On the surface of freshly spawned eggs the impressions caused by the filaments during their compact overain existence are often faintly visible as criss-cross or, more usually, parallel striations like finger prints. These impressions occasionally persist through the early phases of incubation and are seldom visible in preserved material.

The yolk which fills the egg almost enitrely is colourless and fairly transparent. Sometimes a few minute colourless oil globules of varying sizes are scattered irregularly within the yolk. In some eggs the perivitaline space was found to be very large, its depth from the chorion varying from 0.2 mm to 0.4 mm (Fig. 7). But such abnormal eggs with developing embryo, which constituted roughly 2% of the eggs in a bunch, have never survived up to the hatching.

From the known descriptions of flying fish eggs it is seen that the egg of *H(H) coromandelensis* is unique in the possession of three distinct types of filaments and their characteristic distribution, features shared only by the eggs of *Hirundichthys oxycephalus* (Kovaleskaja, 1965). The similarities between the eggs of *H(H) coromandelensis* and *H. oxycephalus* in regard to the size of eggs and the number and distribution of the filaments are great. However, in the latter species, the group of shortest filaments which arise from the pole opposite to the main anchoring filament are much longer and are more uniform in their length. Hubbs and Kampa (1946) have characterized this egg as "peculiar." The various measurements of the present egg and their filament counts presented in table I along with the egg diameter and filament numbers of the eggs attributed to *H(H) coromandelensis* by Nayudu (1923) clearly show that both are identical despite the slightly greater range of variation in the size of the eggs and the number of filaments met with in the former. The only other flying fish egg which seems to possess three types of filaments is that of *H. affinis*, as far as one can surmise from the details given by Evans (1961). Earlier workers like Hubbs and Kampa (1946) and Brunn (1935) however have mentioned only two kinds of filaments in *H. affinis*

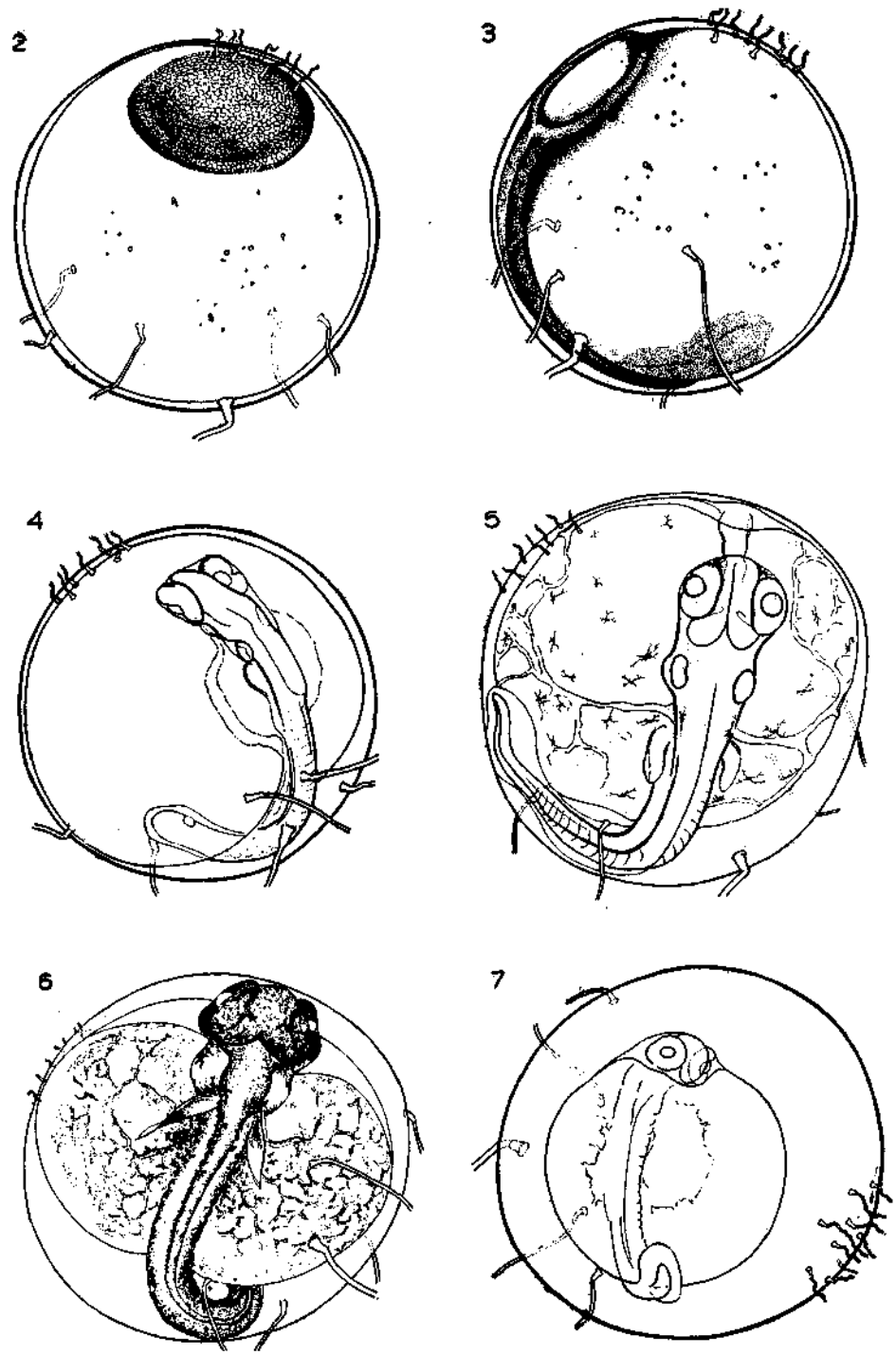

Fig. 2-7. *H (H) coromandelensis*, development of embryo. Fig. 2. Stage I : 4 hrs after fertilization. Fig. 3. Stage II : 10 hrs after fertilization. Fig. 4. Stage III : 24 hrs after fertilizasion. Fig. 5. Stage IV : 48 hrs after fertilization. Fig. 6. Stage V : 72 hrs aftar fertilization. Fig. 7. An abnormal egg with 18 hrs old embryo.

DEVELOPMENT OF THE EMBRYO

Stage I—4 hours old (Fig. 2)

Within three to four hours after fertilization a blastular cap about 0.8 mm in diameter is formed at the distal pole of the egg beneath the cluster of small filaments. With the gradual organization of the embryonic axis and consequent increase in its mass, the blastula slides towards gravity causing the yolk mass to turn along with it within the chorion and comes to rest with the yolk above.

Stage II—10 hours old (Fig. 3)

The rate of development of the embryo is highly variable between eggs that are normal and identical in every other respect. In over 70% of the eggs examined, the embryonic axis was formed six hours after the blastoderm stage shown in Fig. 2. The closure of the blastopore and the formation of the Kupffer's vesicle takes place within another two hours. In Ca 28% of the eggs development was slower in varying degrees, the closure of blastopore occurring as late as 24 hours after fertilization in a number of cases. Such variation in the rate of growth was fairly common throughout the embryonic development.

Stage III—24 hours old (Fig. 4)

After 24 hours the embryo in most cases is well defined having about 23 myotomes and extends over half the circumference of the egg. Eyes, otic vesicles and rudiments of the pectoral fins are distinct. The heart which pulsates feebly and irregularly is situated under the head between the eyes. Therefore Orton's (1955) observation that the forward position of the latter is diagnostic of synentognath eggs is relevant only to later stages. This will be clear from the description of the following stage. A simple vitalline circulatory system is visible as single semicircular arches emerging from beneath the head and skirting round the pectoral rudiments on either side of the trunk. The blood is corposcular and colourless, and the circulation feeble. Anteriorly, between the eyes and frontal lobes of the brain a few greyish pigment cells are present.

Stage IV—48 hours old (Fig. 5)

The most arresting feature of the egg at this stage is the prominent vitalline circulation. The heart which has become conspicuous in size now lies anterior to the head, the sinus venosus pointing anteriorly. This forward displacement of the heart is followed by the branching out and spreading of the blood vessels. A large median canal orginates from the sinus venosus and proceeds forward roughly dividing the surface of the yolk into lateral hemispheres. A lateral vessel which issues forth anterior to the pectoral fin on either side branches out and joins the median canal at numerous points. Pulsation is regular and corpuscles are light pink in colour. The embryo occupies two-thirds the circumference of the egg and has 25 myotomes. Yolk mass is reduced to nearly threeforth its original size. The head is much enlarged and the tail which is now independent of the yolk sac

occasionally changes position accompanied by somatic twitches of the trunk. The caudal tip is slightly curved upward with a widening of the fin fold around it. The rudiments of the pectoral fins are no longer adherent to the yolk. Besides an increase in concentration of the grey cells at the anterior angle of the eyes and a cluster of similar pigment cells which has appeared latterally between the otic vesicles and the pectoral fins, the embryo is devoid of any pigmentation. A number of large spidry chromatophores which are brick red are scattered on the surface of the yolk membrane. They first appear in the vicinities of the blood vessels and increase in number as the latter spread.

Stage V—72 hours old (Fig. 6)

There is remarkable increase in size of the head with a large midbrain, very prominent eye balls with open choroid fissure and the region of the otic vesicle bulging out. The yolk is two-thirds its original size with a greater portion of the embryo free from it posteriorly. The urostyle is curved upward and the hypeurals are indicated as faintly pinkish concentrations of mesenchyme cells. Incessant flapping of the much enlarged pectoral fins and the wriggling of the free tail region are characteristic of this stage. Viewed dorsally through the yolk, in living condition, the liver is visible on the left side of the trunk as a pale yellow blob, about the size of the optic lens of the embryo, immediately behind the main lateral blood vessel. On dissection it was seen to be a faintly alviolar protruberance of the alimentary canal containing a pale yellow highly viscuous or almost gelatinous liquid which was characteristically bilious in reaction (Hawk, 1954) to indicators such as Neutral red, Phenolphthalein and Thymol blue (acid range). Corresponding to the position of the liver, on the right side, the rudimentary stomach has developed as a short thumb-shaped pouch of the alimentary tract. Finely ramifying yellow to brownish yellow chromatophores cover almost the entire body of the embryo up to a short distance before the caudal peduncle and extend partly over the yolk surface in the region where it is connected with the embryo. They are densely packed over the eye ball except the lens and are absent on the fins. The greyish pigment cells which were at the anterior angle of the eyes appear now as fairly large branching black cells. Ten to twelve similar ones have appeared on the roof of the head. A solitary highly branched melanophore is present above the otic vesicle. A dorsal series of medium sized irregularly branching melanophores begins from above the origin of the pectorals and extends backwards along either side of the ridge formed by the neural canal up to the middle of the free posterior part of the trunk. The anteriormost pair of cells of this series is as large as those on the head and the succeeding ones are progressively smaller. Almost parallel to this series of chromatophores there is an irregular midlateral row of chromatophores starting from under the pectoral fin insersion where they are more concentrated and invade the surface of the yolksac. The intensity of pigment and the denseness of pigment cells are highly variable although the overall pattern is fairly constant. To the naked eye the eggs appear brownish-yellow or light brown which ultimately become amber to dark brown.

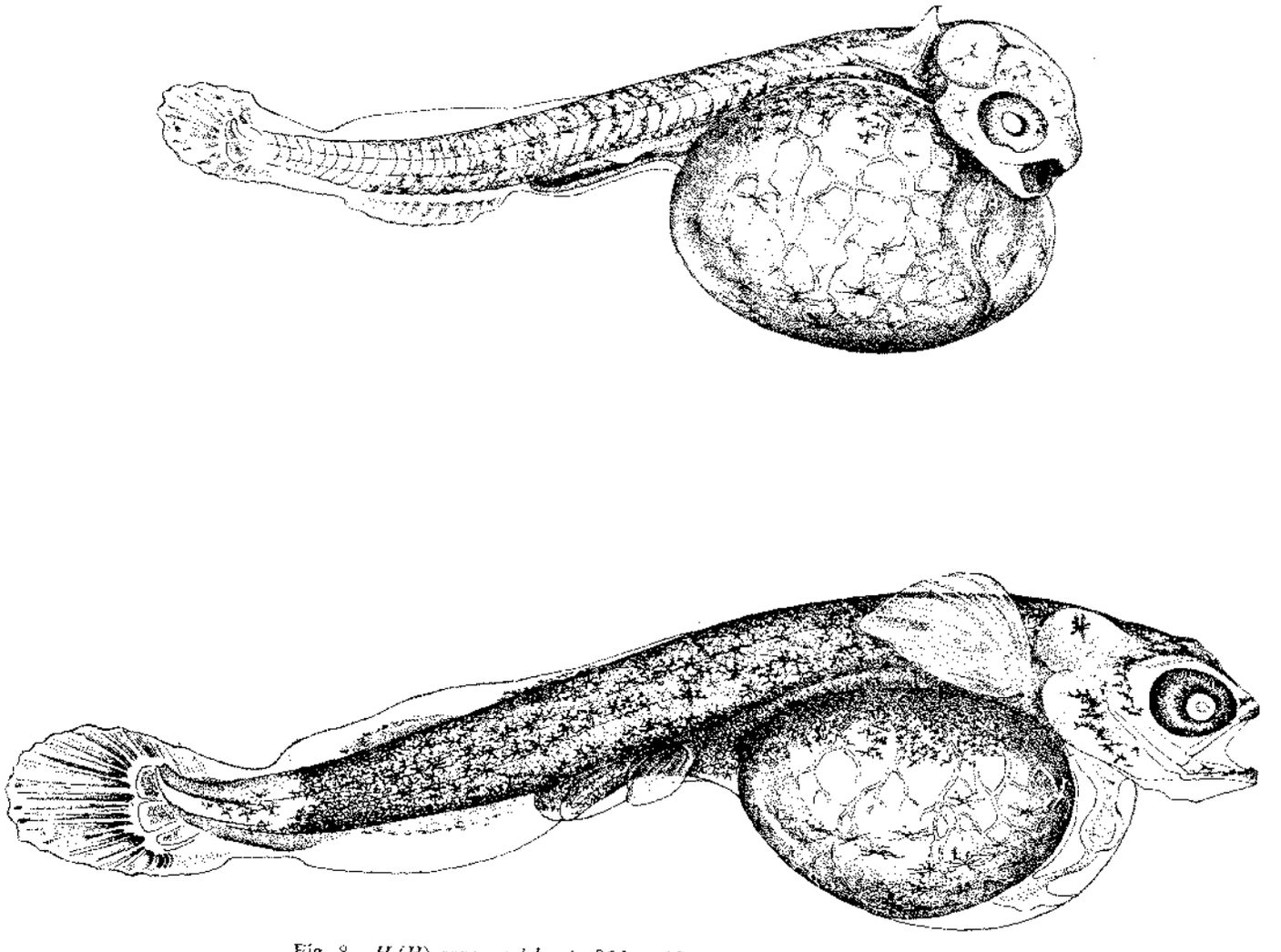

Fig. 8. *H (H) coromandelensis*, 96 hrs old embryo removed from egg capsule.
Fig. 9. *H (H) coromandelensis* larva on the first day, 4.23 mm TL.

Stage VI—96 hours old (Fig. 8)

Visibility across the yolk becomes increasingly reduced due to the crowding of pigment cells and ramification of vitalline circulation during the final stages. Consequently, at 96 hours the embryo along with yolksac had to be removed from the egg capsule to facilitate better observation and sketching. Yolk has shrunk to half its original size and the embryo fully encircles it, the caudal tip reaching well beyond the nape. Including the urostyle 44-45 somites could be counted. The hypeurals are hyaline with clear outlines. The cleft of the mouth is open and the gut, which is a straight tube extending from the posterior margin of the yolk sac, ends bluntly below the 22nd or 23rd somite. The anal and dorsal fins are recognizable as broadenings of the median fin fold at their respective regions. The development of rays is indicated by diffuse corrugations in the caudal and anal lobes. The pelvic fin appears as a fleshy bud ventrolaterally between the 15th and 18th somites. The choroid fissures is closed and in its place a small depression alone remains. Melanophores have appeared along the ventral margin of the body also. Over a background of brownish yellow pigmentation on the eye there are numerous small melanophores. The caudal peduncle is unpigmented.

Hatching

Hatching occurs mostly during the night. The tail usually emerges first from the egg. The head and bulging yolk sac take some time to get free from the egg membrane. The period of incubation ranged from 114-138 hours, but a majority of the eggs hatched within 114-126 hours. Such differential rate of development was observed in the growth of the larvae also. Though the latter could not be kept alive for more than 5 days, it became apparent in this short period itself that those which took the least time for hatching were more viable compared to those which had a protracted incubation. The latter often produced larvae with abnormal body proportions and degenerate fins, though however, all hatchlings generally appeared to be in the same state of development.

The Larvae

First day—3.47-4.23 mm (Fig. 9)

The hatchlings swim actively, by the vigourous flapping of the large transparent pectoral fins, the conspicuous yolk sac facing downward. The heart which lies on the yolk is still anterior in position. The median fin fold is continuous throughout, though the dorsal, caudal and anal fin lobes are well defined. The dorsal fin originates (indicated by (a) in Table 2) far in advance of the anal as a narrow membrane which abruptly broadens (indicated by (b) in Table 2) opposite or slightly before the origin of the anal and continues backwards as far as opposite the hind margin of the anal lobe. The latter is always slightly broader than the dorsal. All fins except the dorsal show indications of developing rays as hyaline streaks. They are distinct on the caudal.

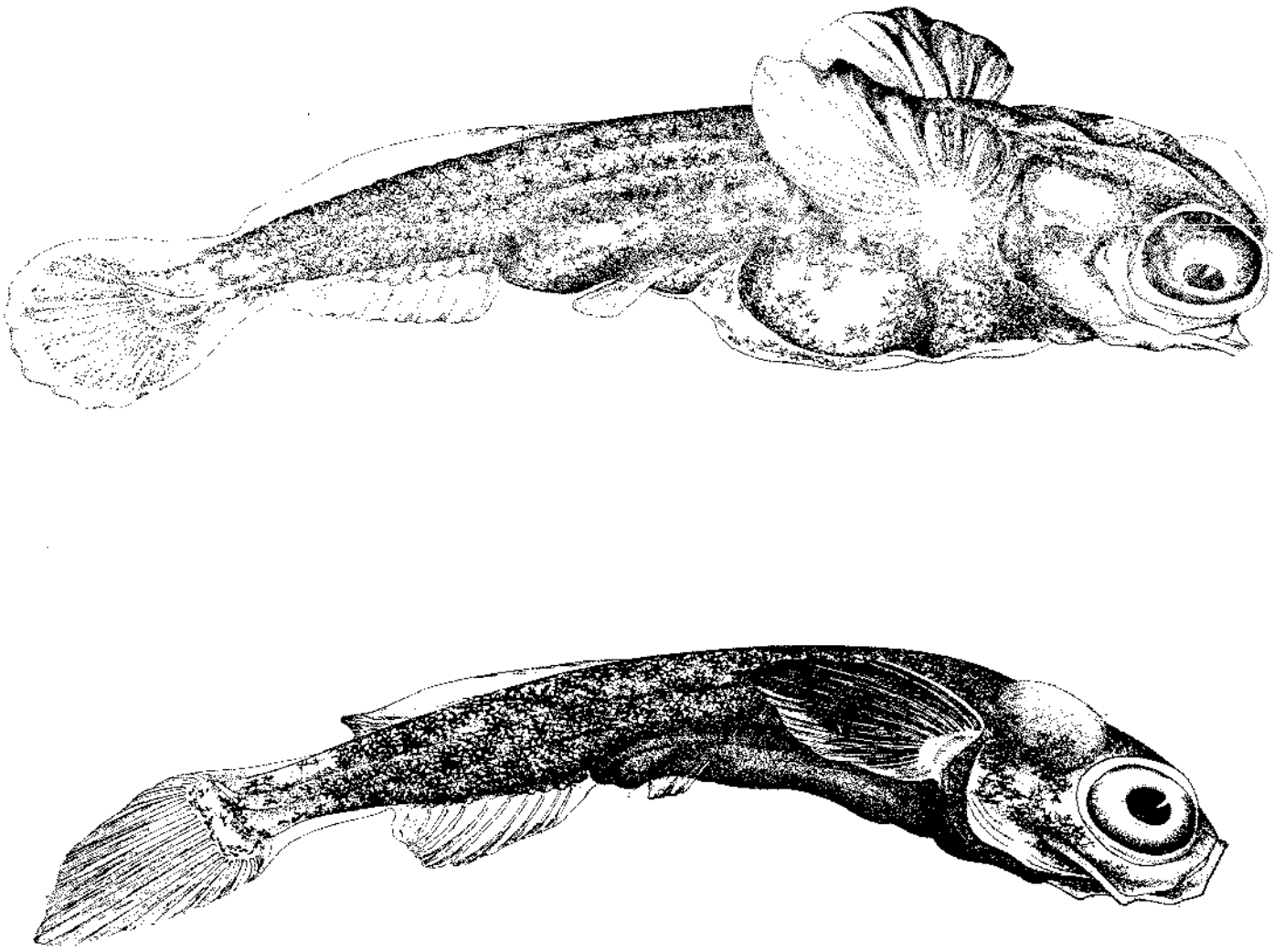

Fig. 10. *H (H) coromandelensis* larva on the third day 4.58 mm TL.
Fig. 11. *H (H) coromandelensis* larva on the fifth day 5.07 mm TL.

Often, as in the specimen sketched (Fig. 9), the development of the anal rays is somewhat delayed and may be recognizable only by the thickening of the base of the finfold in that area. The caudal lobe is oblong with a wavy outline. The mouth is supperior and the jaws toothless and movable. Eyes are black. There is no trace of the choroid fissure. Except for the fins and the caudal peduncle the whole body is pigmented by large highly branched melanophores superimposed over yellow-brown labrynth of finly ramifying xanthophores. The face as well as region above the otic capsule are sparsely pigmented. There is no clear alignment in the arrangement of melanophores. They are evenly scattered all over the body except along the region of attachment of the yolk sac with the trunk on either side where they are denser and extend over the alimentary canal up to the vent.

Second day—4.0-4.39 mm

But for a slight increase in size of the pectoral fins and in some cases the caudal fin as well, the larva appears much as it did on the previous day. A few black pigment spots appear along the outer margin of the hypeurals.

Third day—3.9-4.99 mm (Fig. 10)

The larvae are robust in appearance. The yolk persists though much reduced. The pectoral fins are further enlarged with the first five rays clearly developed, of which, the outer most is the shortest and the succeeding ones progressively longer. All the rays are unbranched. The pelvic fin in most of the larvae possess two to three rays while they are undeveloped in some. The basal thickening of the anal fin fold is differentiated into nine to ten nodes which bear rays. Even to an unaided eye the larvae are distinguishable from the earlier stages by their metallic blue colour which is the result of a combination of dense dentretic melanophores and newly acquired iridophores which lie under them. These pigments greatly obscure the underlying yellow-brown chromatophores and cover the head and trunk almost entirely except the opercular region, the region above the otic capsules and the caudal peduncle where they are scanty. A few black pigment spots extend further back on to the caudal fin and are arranged on the membrane intervening the caudal rays, the margin of hypeurals and parallel to the margin of the caudal lobe a short distance from the edge forming a discontinuous border. The iridophores are dense over the belly and the hind gut. Eyes are silvery and the pupils black. The portion of the pectoral fin supported by rays is purplish black, the intensity of which is greatest at the outer margin and along the rays.

Fourth day—4.41-5.03 mm

The yolk is completely absorbed or only a trace of it remains. The larvae thus appear lean compared to the previous day. In a majority of them the median fins are barely united by an incipient finfold while in some the separation is complete. The dorsal fin is devoid of rays. Its declining anterior extension has

disappeared and its origin is now more or less opposite the origin of the anal fin. The latter is as it was on the previous day. The pectorals carry six to eight unbranched rays, the fifth or the sixth being the longest. The pelvic fin has two to three rays. The colouration of the larvae is the same as on the previous day.

Fifth day—4.43-5.17 mm (Fig. 11)

Now they are typical post-larvae (as defined by Hubbs, 1943) and can be readily recognized as the young ones of the flying fish, by their large purplish black pectoral fins, metallic blue lustre and general appearance of the body. The mouth is superior in position and jaws toothless. The pectoral fins reach beyond three-fourth the distance from its base to the insertion of the pelvic fin. They are roughly lanceolate in shape and possess nine to ten unbranched rays. The fifth ray is usually the longest. The ventral fins are supported by three, rarely four, rays. The membranous connections between the median fins are no more present in most of the post-larvae. But occasionally, as in the specimen sketched (Fig.11), it is still persistent between the caudal and the anal fins. The rays on the dorsal fin are too indistinct to enable counting. The anal fin has nine to ten, rarely twelve, rays. A slight elongation of the rays in the lower half of the caudal fin presages the typical asymetry of the caudal lobes in the adult. Colouration of the post larvae is similar to the previous day though its intensity has increased. The upper half of the pectorals is purplish black up to the longest ray after which the pigmentation is confined to the centre of the fin leaving its entire lower margin and the portion nearer the base uncoloured. The pelvic fins and posterior margin of the dorsal fin are faintly blackish. In some post larvae where the growth has been faster the caudal fin has a diffuse vertical band across its middle which sometimes extends backwards along the long lower rays to their very tip. The anal fin is colourless.

Some General Observations

Feeding

From the second day after hatching the normal swimming activity of the larvae which hitherto consisted of smooth cruises was frequently interrupted by movements suggestive of typical feeding attempts, though however, actual ingestion of food by the larvae was observed only on the fourth day when they fed on unsorted zooplankton obtained from surface tow net collections and ciliates, the latter obtained from decomposing eggs following the example of Munro (1954). In the absence of live food the larvae fed on dead ones from the bottom of the rearing jars. The excreta, which were not in pellets, revealed only remnants of copepods. The faecal material was voided within 150-280 minutes of the consumption of food by the four and five day old larvae. Feeding appeared to be by sight and was restricted to day time, the larvae remaining quiescent in the night. The presence of artificial light (fluorecent lamp) during night made them agile though it did not induce feeding activity.

Spawning

Normally the spawning season of *H (H) coromandelensis* lasts from May to August in the Coromandel coast (Arora and Banerji, 1957). According to Hornell (1923) when the summer rains are greatly delayed the season may extend on to September and the termination of the fishery in this region is associated with the discharge of flood waters fromthe rivers. In 1959 when present study was made-fresh egg masses have been found washed ashore as late as the 24th and 28th of September though the flying fish fishery had abruptly ended by 25th June, due to adverse winds and not flood or rain. Owing to delayed south west monsoon the Coleroon and adjacent rivers were not in floods until October during that year. Thus, although the fishery had terminated due to unfavourable winds, the spawning appeared to have continued up to end of September, apparently due to delayed monsoon, which partially confirms Hornell's observation.

As suggested by Hornell (1923) and later by Chandy (1954) the "Sargasso, weed" would appear to be the usual object upon which this species naturally deposits its eggs and rarity of the fish in a season may possibly be correlated with the rarity of this sea weed. The egg masses which were washed ashore were invariably attached to long fresh *Sargassum* shoots. Though the freshness of *Sargassum* is no criterion to determine the distance of its source, since *Sargassum* populations are capable of self-sustained pelagic existence (Wingel 1923). the eggs attached to them were so fresh and in early stages of development that their origin would not have been very far from the shore. About 10-12 miles off the coast of this district, where the depths range from 20-30 fathoms, there are areas of rocky substratum known locally as Paars. *Sargassum* sp., *Turbinaria concoides* and *Cystophyllum muricatum* seem to be the dominant flora of these rocks, as they are the commonest weeds cast ashore during stormy weather.

Data (given below) on the sex ratio of the spawning population collected at Portonovo indicate that sexes are more or less evenly distributed. Whether this is indicative of pairing among spawning individuals remains to be confirmed, though such a behaviour has been directly observed by Miller (1952) in *Cypselurus* sp. Incidentally, an identical behaviour by an unidentified species of *Hemirhamphus* was observed by K. N. Krishna Kartha (personal communication) of this Institute during the cruises of R. V. KALAVA in the Arabian Sea.

Sex composition of spawning *H (H) coromandelensis*

Year	% Male	% Female
1959	56.7	43.3
1960	41.8	58.2
1961	47.6	52.4

Colouration

Pigmentation of the larvae conforms in general to the overall pattern in *Cypselurus* and *Hirundichthys* (D' Ancona 1932, Barnhart 1932, Hiroshi 1959). However, there is closer similarity to *Hirundichthys speculiger* (Munro 1954) in the dearth of pigmentation over the caudal peduncle while the head and trunk are very heavily pigmented. The arrangement of chromatophores is not as regular as in most of the *Hirundichthys* larvae so far known. The faint blackish colour of the ventral fins which is found in the five days old post larvae was seen to disappear on preservation and this colouration has not been recorded by Balasubrahmanyan *et al.* (1967) in their description of the 4.6 mm post-larva of this species which apparently was made from preserved material.

The extent of colour variation among individuals of like stages during embryonic and larval development in *H (H) coromandelensis* during the present investigation was remarkable. To the unaided eye they ranged from dusky grey, purplish black and silvery blue to metalic black and from straw brown, yellowish brown and deep brown to amber. All these colour types are the results of varying combinations of the basic complement of pigmet cells, visible only on magnification, which has been already described in the sections dealing with the different stages. The variations in colour are accentuated usually by the difference in the abundance of chromatophores and in some cases due to differences in the intensity of pigment in the chromatophores themselves. The yellow pigment cells were more constant in these respects.

In flying fishes colour differences among larvae of the same species was first recorded by Mowbray (1931). Barnhart (1932) found the colour of the larvae of *Cypselurus californicus* to range from jet black, dark brown and black blue to varying shades of light brown, light blue, cream and white, in all, thirteen different combinations! Breder (1932) has described how the great change in colouration of the young of the same species of *Cypselurus* created confusion about their identity. The embryo and larvae of several species of *Cypselurus* were reported from Japanese waters by Hiroshi (1959) to have varying colours within the same species. However, in *Paraexocoetus* similar sized young ones are found to be uniform in colour and in Breder's opinion, "... it may well be that this variable condition is principally a feature of the *Cypselurinae*."

Besides such differences in colouration between the larvae and from day to day, it was seen during the present study that each larva by itself exhibited ability for colour change by the expansion or shrinkage of pigment cells under varying direct or background illuminations. The expansion and contraction of melanophores in *H. speculiger* according to the intensity of light has been noted by Munro (1954). In *H (H) coromandelensis* melanophores were found to be the most photo-sensitive of the pigment cells and their response to the stimulus was almost instantanous. The greater the illumination the lighter became the colour of the larvae and *vice versa*. The maximum contraction of melanophores was seen at

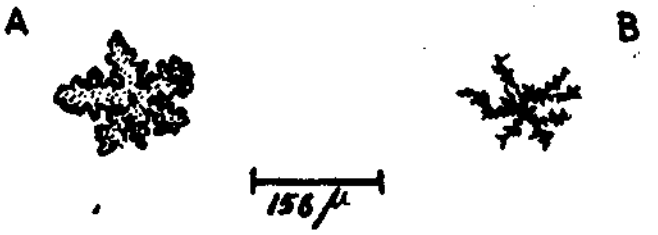

Fig. 12. *H (H) coromandelensis*, response of melanophore to direct white light. A, Before exposure, B, on exposure to 17.5 lux illumination.

light intensities of 17.2–17.5 lux at 26.5°C (Fig. 12a & b). The reaction to background illumination was more pronounced compared with the response to incident light. Equally noteworthy was the colour reaction of the larvae to the presence of dark objects such as dark brown scrolls of wood shaving and pieces of cork and *Sargassum* fronds dropped inside the rearing jars, which recalls the observations of Breder and Rasquin (1955) on the behaviour of *Chaetodipterus* in the presence of floating seaweed in the aquarium. The adaptive advantage of such chromatic reaction of the larvae is obvious in the present species since as already mentioned the fish seem to prefer *Sargassum* like weeds to spawn.

Variations and abnormalities

There is a high degree of variation in the embryonic and larval characters among identical stages in this species. They encompass, besides colouration that has been discussed above, variations in the size of the perivitelline space in many eggs (Fig. 7) and differences in the body proportions of the larvae, chiefly in regard to the position and the degenerate appearence of fins as well as the stunted or arched vertebral column. They present examples of deviations that are large enough to be recognized as abnormalities at sight (Fig. 13a–f) and others where the variations are such as can be disserned only by actual measurements which are presented in Table 2.

While the majority of exocoetid eggs do not have conspicuous perivitelline space, it is somewhat prominent in the eggs of *Exocoetus volitans* Linne, *Cypselurus comatus* (Mitchil), *C. heterurus* (Rafinesque), *C. opisthopus hirai* Abe, *Cheilopogon unicolour* (Cuv. and Val.) and *Prognichthys* sp? of Parin and Gorbunova (1964). However, there is no record of any synentognath egg possessing such abnormally large perivitelline space as encountered in some of the eggs of *H (H) coromandelensis*. Though such eggs (Fig. 7) were found to be fertilized and with growing embryos, none of them went through development successfully beyond 48 hours.

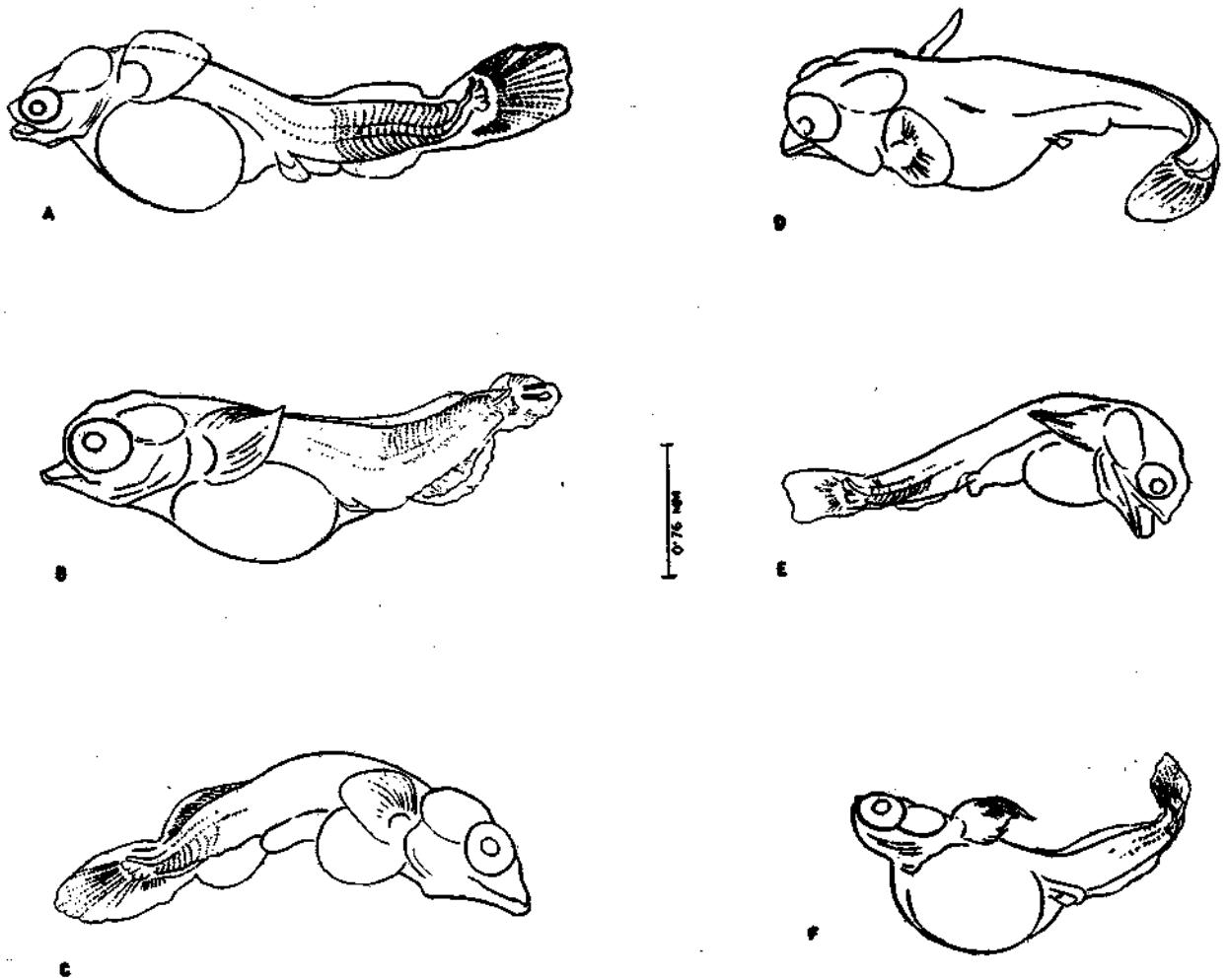

Fig. 13. Abnormal larvae of *H* (*H*) *coromandelensis*.
A, One day old larva ; B, three days old larva ;
C, two days old ; D, three days old .
E, hatch'ng ; F, hatching.

TABLE 2. *Measurements (in mm) of the larvae of* Hirundichthys (Hirundichthys) coromandelensis *(Hornell)*

Number examined	First day				Second day		
	16				13		
	Range	Mean	% of standard Length	Specimen Sketched	Range	Mean	% of Standard Length
Total length	3.47-4.23	3.91	...	4.23	4.00-4.37	4.23	...
Standard length	2.98-3.82	3.47	...	3.71	2.96-3.74	3.45	...
Predorsal length (a)[1]	1.56-2.07	1.86	53.60	1.87	1.66-2.13	1.96	56.80
Predorsal length (b)[2]	1.76-2.46	2.25	64.80	2.34	2.18-2.55	2.44	70.70
Dorsal base	0.43-1.05	0.81	23.30	0.96	0.70-0.09	0.76	22.00
Preanal length	2.11-2.55	2.35	67.70	2.54	2.15-2.57	2.49	72.20
Anal base	0.49-0.88	0.69	19.90	0.88	0.68-0.86	0.75	21.70
Prepectoral length	0.59-0.88	0.75	21.60	0.78	0.68-0.84	0.78	22.60
Pectoral length	0.45-0.82	0.59	17.00	0.57	0.59-0.74	0.66	19.10
Prepelvic length	1.64-2.09	1.88	54.00	2.09	1.76-2.18	2.00	58.00
Pelvic length	0.14-0.29	0.21	6.10	0.18	0.18-0.23	0.21	6.10
Preventral length[3]	2.11-2.55	2.35	67.70	2.54	2.15-2.57	2.49	72.20
Body depth	0.31-0.57	0.43	12.4	0.43	0.39-0.53	0.48	13.90
Head length	0.59-0.88	0.74	21.3	0.78	0.68-0.84	0.77	22.30
Head thickness	0.53-0.76	0.62	17.90	0.70	0.59-0.70	0.65	18.80
Head height	0.45-0.62	0.51	14.70	0.45	0.55-0.68	0.63	18.30
Orbital diameter[4]	0.29-0.33	0.30	8.60	0.29	0.31-0.39	0.37	10.70
Orbital diameter[5]	0.20-0.25	0.22	6.30	0.22	0.22-0.35	0.29	8.40

[1] and [2] Predorsal lengths (a) and (b): see description of the larva on the first day.
[3] From snout to anus.
[4] Horizontal.
[5] Vertical.

(continued)

TABLE 2. (*continued*)

Number examined	Third day				Fourth day			Fifth day			
	15				22			19			
	Range	Mean	% of Standard Length	Specimen sketched	Range	Mean	% of standard Length	Range	Mean	% of standard Length	Specimen sketched
Total length	3.90-4.99	4.45	...	4.58	4.41-5.03	4.70	...	4.43-5.17	4.94	...	5.07
Standard length	3.22-4.21	3.85	...	4.06	3.90-4.39	4.22	...	3.74-4.39	4.19	...	4.13
Predorsal length (a)[1]	1.66-2.54	2.23	57.90	2.18	...	...	...	...	...	...	...
Predorsal length (b)[2]	2.18-2.71	2.80	67.50	2.71	2.44-2.93	2.60	61.40	2.38-3.04	2.72	64.90	2.63
Dorsal base	0.68-0.99	0.82	21.30	0.99	0.82-1.13	0.96	22.70	0.72-1.03	0.90	21.50	0.92
Preanal length	2.48-2.73	2.61	67.80	2.67	2.57-3.04	2.72	64.50	2.48-3.06	2.80	66.80	2.71
Anal base	0.62-0.86	0.72	18.70	0.74	0.66-0.94	0.81	19.20	0.59-0.90	0.79	18.90	0.82
Prepectoral length	0.70-1.01	0.86	22.30	1.01	0.94-1.11	0.98	23.20	0.92-1.11	1.34	32.00	1.07
Pectoral length	0.64-0.86	0.78	20.30	0.86	0.59-0.96	0.76	18.00	0.68-1.09	0.87	20.80	1.09
Prepelvic length	1.91-2.20	2.04	53.00	2.18	1.93-2.54	2.19	51.90	1.99-2.54	2.25	53.70	2.54
Pelvic length	0.23-0.29	0.26	6.80	0.27	0.20-0.41	0.26	6.20	0.22-0.41	0.35	8.40	0.37
Preventral length[3]	2.48-2.73	2.61	67.80	2.67	2.57-3.04	2.72	64.50	2.48-3.06	2.80	66.80	2.67
Body depth	0.51-0.66	0.58	15.10	0.64	0.55-0.64	0.58	13.70	0.49-0.74	0.62	14.80	0.62
Head length	0.70-0.94	0.85	22.10	0.92	0.88-1.07	0.98	23.20	0.92-1.11	1.02	24.30	1.07
Head thickness	0.59-0.90	0.71	18.40	0.78	0.70-0.94	0.82	19.40	0.72-0.96	0.84	20.00	0.96
Head height	0.59-0.92	0.70	18.20	0.72	0.59-0.78	0.74	17.50	0.74-0.88	0.80	19.10	0.78
Orbital diameter[4]	0.37-0.49	0.40	10.40	0.49	0.37-0.41	0.38	9.00	0.39-0.51	0.42	10.00	0.51
Orbital diameter[5]	0.27-0.41	0.30	7.80	0.41	0.27-0.35	0.30	7.10	0.27-0.43	0.31	7.40	0.43

Literature on the structural variations in larval characters resulting from various causes is too extensive and well known to need recounting. Much of it deal with variations, chiefly on meristic counts and to a lesser extent on the proportions of corporal dimensions, caused by environmental and genetic factors. Degeneration involving retention of embryonic characters have been attributed to modifications in the developmental rate by Hubbs (1926) and later workers. Here again, the developmental rate itself is found linked with environmental factors. Difference in the rate of development was observed by Miller (1952) in *Cypselurus* eggs from Baja, California. The rate of embryonic development had been found to vary among the eggs in the present species and in extreme cases where the eggs failed to hatch at the proper time the embryos became morphologically abnormal. It has also been observed during the present study that the eggs which took less time for hatching produced larvae which were more viable, compared to those which had protracted incubation, the larvae from the latter being structurally abnormal or degenerate. Such examples of abnormal embryos resulting from their prolonged stay within the egg case on the one hand and the greater number of normal and more viable offspring brought forth by briefer incubation on the other hand, emphasis the influence the rate of development has on embryonic and larval characters. But it may be pointed out that in the above case the observed variations and abnormalities occured under identical environmental conditions, namely, within the same aquaria and among products of the same parents. It is, therefore, not improbable that the divergenses may have sprung from some inherent qualities of the eggs themselves, genetic or congenetically acquired. The observed abnormalities, in the present study, greatly resemble those met with in the socalled "monsters" so familiar to hatchery managements and would appear to be similar to the deformities considered as phenodeviants in other organisms which have been shown by Lerner (1954) to be genetic in origin and related to inbreeding depression.

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APPENDIX 1

ON THE IDENTIFICATION OF *HIRUNDICHTHYS (HIRUNDICHTHYS) COROMANDELENSIS* (HORNELL)

Though Day (1877, 1889) had described six species of flying fishes from India and Weber and De Beaufort (1922) had recorded a number of species from the Indo-Australian Archipelago, *Hirundichthys* (*Hirundichthys*) *coromandelensis* (Hornell) which supports a sizeable fishery along the Coromandel coast was first described by Hornell (1923) based on a specimen from Nagapatanam and five specimens from Madras. Chandy (1954) who had access to a large collection of this fish, from various places between Mandapam and Madras, added more details to the existing description and confirmed Hornell's tentative identification of this fish as a hitherto undescribed species. However, she has retained the species under the genus *Cypselurus* Swainson, without any comments, though as early as in 1928 *Exocoetidae* had been revised by Breder who had unambiguously set up the genus *Hirundichthys*, with a subsequent (1938) detailed analysis of the phylogenic and taxonomic aspects of the family *Exocoetidae* in which the genera *Hirundichthys* Breder, *Danichthys* Bruun, *Prognichthys* Breder and *Cypselurus* Swainson were clearly defined under the subfamily *Cypselurinae*, and accordingly, the species *coromandelensis* ought to come under the genus *Hirundichthys* in the same way as *Cypselurus speculiger* (C. V.) has been removed to the genus *Hirundichthys* (Breder, 1938; Bruun, 1935).

Though Hubbs and Kampa (1946) had classified *Hirundichthys* as a subgenus under genus *Cypselurus*, in his recent revision of the genera of *Exocoetidae*, Parin (1961) has retained the generic status of *Hirundichthys* and has placed the existing (*i. e.*, Breder's and Bruun's) genera of *Danichthys* and *Hirundichthys* as subgenera under genus *Hirundichthys*; an arrangement which seems appropriate, whereas a similar splitting of the *Cypselurus* by Parin is not accepted by Staiger (1965) on the ground that the distinguishing characters of the proposed subgenera are either overlaping, intermediate or are similar. As far as subgenera *Danichthys* and *Hirundichthys* are concerned, the two are clearly separable on the basis of the first pectoral ray alone being simple in the latter and the first two of the pectoral rays being simple in the former, despite many close similarities in various other characters which are apparent from the comparative tabular statements presented by Parin (1961).

A good number of specimens of *H* (*H*) *coromandelensis* has been collected by Parin from the northern part of the Indian Ocean and juveniles and larvae from the western Indian Ocean (Parin 1961, 1963). But he has not given a description of the fish, as he has in the case of the other species, nor any table of morphological and meristic characters.

The morphological and meristic characters of this species collected from Portonovo in 1959 is presented here.

TABLE 1. *Morphometric*[1] *and meristic characters in*

Serial number	1	2	3	4	5	6	7	8	9
Sex, maturity	♀ VII	♀ VII	♀ VI	♀ VII	♀ VI	♂ VII	♀ VII	♀ VI	♂ VII
Total length	204·0	214·8	220·2	220·0	216·8	217·1	210·0	210·0	216·0
Standard length	189·4	177·9	170·1	170·1	170·1	169·1	169·1	168·8	168·0
% of Standard length :									
Length of head	19·2	21·0	23·5	22·6	22·9	21·9	23·3	22·2	22·6
Length of snout	4·9	4·9	5·4	5·4	6·2	5·9	5·9	5·3	6·2
Height of body	14·8	15·6	16·8	17·5	17·1	16·5	17·1	18·2	18·4
Breadth of body	12·0	14·6	14·0	13·5	15·3	15·4	13·9	13·1	14·2
Depth of caudal peduncle	5·9	6·2	6·8	6·8	7·1	6·4	6·5	7·2	7·2
Diameter of eye	6·3	7·4	7·8	7·6	8·1	7·5	8·3	7·8	7·8
Interorbital width	7·2	7·9	8·5	8·5	8·2	8·0	7·9	7·8	8·0
Predorsal length	65·5	73·5	76·5	77·1	75·9	76·7	75·6	76·2	75·6
Preanal length	65·0	74·3	74·7	74·4	75·2	76·1	74·9	74·0	74·6
Preventral length	50·6	58·6	59·4	58·8	60·0	61·6	59·0	60·5	58·6
Length of :									
pectoral	59·2	65·8	66·7	67·6	69·1	66·8	63·9	65·1	67·7
ventral	20·3	24·2	27·0	25·3	...	27·2	25·1	23·1	25·9
longest dorsal ray	6·7	6·7	7·9	7·7	7·6	8·3	8·9	7·1	8·2
longest anal ray	4·9	5·3	6·2	8·3	6·5	7·4	6·4	6·5	5·4
dorsal base	12·6	14·6	14·8	14·1	13·5	14·7	14·2	16·0	15·5
anal base	11·3	13·8	14·0	12·6	13·0	14·1	14·2	14·5	14·3
upper caudal lobe	17·5	20·3	...	23·4	...	...	...	...	23·8
lower caudal lobe	24·9	27·6	35·3	30·0	30·6	33·5	29·0	34·5	30·8
Origin of anal[2]	+1	1	+1	+1	+1	1	+1	+2	+1
Number of :									
pectoral rays	1+16	1+15	1+15	1+16	1+15	1+16	1+16	1+15	1+15
dorsal rays	11	11	11	10	10	10	10	12	11
anal rays	11	11	10	10	10	11	11	11	10
predorsal scales	30	30	30	32	29	31	30	31	29
transverse scales above lateral line	7	7½	6½	7½	8	8	7½	7½	7½
lateral line scales	50	49	47	45	48	49	49	50	48
gill rakers	8+23	7+21	8+24	5+25	7+23	6+22	9+22	9+25	6+22
vertebrae[3]	27+15	...	...	...	...	...	...	...	29+14
100 mm. index of upper jaw teeth	...	...	0·12	0·11	0·12	...	...	...	...
Longest pectoral ray	3rd	3rd	3rd	3rd	3rd	3rd	3rd	3rd	3rd
Longest dorsal ray	2nd	2nd	2nd	2&3	2nd	2nd	3rd	2nd	2nd
Longest anal ray	2nd	2nd	2nd	3rd	2nd	2nd	3rd	2nd	2nd
Pectoral reaching up to[4]	D·11	D·11	D·11	C·	C·¼	D·10	...	D+	C·½
Ventral reaching up to	...	...	A·5	...	...	...	...	A.5	...

[1]Measurements (in mm) were made as described by Bruun (1935)

[2]Position of first anal ray in relation to vertical through first dorsal ray, thus +1 indicates that the second anal ray lies on this vertical (vide Bruun 1935).

[3]Three damaged specimens not included in this table had the following vertebral counts : 28+15, 27+16 and 27+15.

[4]C., C.¼ and C.½ indicate, up to origin, half and threefourth respectively of the caudal fin.

Hirundichthys (Hirundichthys) coromandelensis *(Hornell)*

10	11	12	13	14	15	16	17	18	19	20*	21
♂VI	♀VII	♀VI	♂VI	♀VII	♀VII	♀VII	♀VII	♂VII	♀VII	♂V	♂VI
214·0	220·9	210·0	219·9	206·0	211·0	211·0	204·0	198·1	203·9	204·0	204·0
167·8	167·2	164·8	164·3	164·1	164·0	163·9	162·3	162·2	160·5	157·5	157·0
17·6	23·4	24·6	23·3	23·0	22·6	22·1	21·1	22·2	23·6	23·7	22·9
5·1	5·5	6·1	4·8	5·0	6·4	5·5	5·0	5·5	6·7	6·1	6·3
15·8	18·5	18·2	18·3	16·4	15·9	13·8	16·9	18·0	18·0	16·6	18·1
12·8	15·0	14·9	14·7	14·0	14·3	13·7	14·2	14·5	14·3	14·0	15·3
6·2	7·2	6·9	7·1	6·7	6·8	6·6	6·8	6·2	7·2	6·4	7·3
6·6	8·0	8·1	7·4	7·9	7·2	8·2	7·3	6·8	7·4	7·6	7·7
6·9	8·4	7·8	7·9	7·8	7·6	8·2	7·9	7·4	8·4	7·7	7·6
64·5	77·1	75·9	74·8	74·8	75·8	75·0	74·2	73·4	74·3	75·0	76·1
64·5	75·5	73·5	73·7	75·5	75·8	74·5	73·9	73·4	75·4	74·9	75·2
51·3	60·8	59·5	59·7	59·1	61·7	60·1	58·3	56·8	61·7	58·5	58·6
57·4	68·4	66·2	68·2	67·9	66·5	63·7	64·8	63·6	68·0	66·2	65·0
23·1	25·2	27·0	23·3	26·1	26·8	24·8	24·6	23·6	26·9	25·4	26·4
5·6	8·3	7·6	7·2	7·4	9·1	7·5	7·4	6·8	8·7	8·6	7·6
6·0	6·6	6·8	6·6	6·0	7·3	5·5	6·1	...	...	5·1	7·0
12·8	15·0	14·1	15·8	14·3	15·3	12·9	14·3	14·6	15·5	14·0	15·0
11·5	14·4	14·0	15·8	12·6	13·9	12·3	13·1	13·3	15·6	13·0	13·6
20·5	22·4	...	25·3	19·6	23·8	...	20·0	...	...	23·0	23·6
26·7	35·3	35·3	32·3	30·0	31·7	29·3	28·0	29·0	31·5	31·1	34·7
1	+1	+1	+1	1	1	+1	+1	1	1	1	+1
1+15	1+15	1+15	1+14	1+16	1+15	1+15	1+15	1+15	1+15	1+16	1+15
12	10	11	10	11	11	9	10	10	10	10	10
12	11	12	11	12	11	10	11	11	12	10	10
30	30	30	30	30	30	30	31	30	30	30	30
7½	7½	8	7½	7½	7	7½	7½	7½	7½	7½	7½
49	50	49	46	50	49	49	50	47	50	47	50
5+21	8+22	7+23	6+22	7+23	8+23	6+22	8+24	8+23	5+21	7+21	9+23
...	...	28+15	...	...	..	...	...	...	...	...	...
...	...	...	...	.	0·11	...	...	.	...	...	0·10
3rd	3rd	3rd	3rd	3rd	3rd	3rd	3rd	3rd	3rd	3rd	3rd
2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd
2nd	2nd	2nd	2nd	2nd	2nd	2nd	3rd	3rd	2nd	2nd	2nd
D·12	D·10	D·11	D·10	C·½	D·11	D·5	...	D·5	D·10	D·10	D·5
...	A·5	A·6	...	A·6	...	A·5	...	...	...	A·5	...

*The specimen shown in FIG. 1.

(Continued)

TABLE 1. (*Continued*)

	22	23	24	25	26	27	28	29	30
Sex, maturity	♂V	♂VI	♂V	♂V	♂V	♂V	♂V	♂V	♂V
Total length	201·9	201·0	199·2	201·1	199·3	192·1	195·2	201·0	195·1
Standard length	156·2	156·1	155·2	155·1	154·5	154·0	151·5	150·0	150·0
% of Standard length:									
Length of head	24·3	22·8	23·5	23·0	23·3	21·8	24·5	23·3	22·7
Length of snout	6·3	5·4	6·2	7·1	6·1	6·5	6·0	5·9	6·6
Height of body	18·6	18·6	16·7	17·4	17·6	16·3	16·6	17·3	17·3
Breadth of body	15·3	14·7	14·2	14·3	14·3	14·3	13·9	15·0	14·1
Depth of caudal peduncle	7·1	7·0	7·1	7·1	7·4	7·1	7·3	7·3	7·5
Diameter of eye	8·3	8·2	7·7	8·1	8·1	7·8	7·9	7·9	7·7
Interorbital width	8·3	8·2	7·7	8·4	8·3	7·8	8·5	7·9	7·7
Predorsal length	76·7	76·5	74·8	76·6	76·5	75·8	76·0	76·0	74·8
Preanal length	75·5	74·4	73·7	75·5	73·2	74·3	75·9	75·0	74·8
Preventral length	59·8	61·0	58·9	60·6	60·3	60·2	62·9	60·7	59·4
Length of:									
pectoral	68·5	69·5	67·4	69·9	70·2	65·8	66·0	72·1	71·0
ventral	27·5	26·9	25·1	27·2	28·0	26·1	26·0	27·2	27·7
longest dorsal ray	8·3	7·4	8·4	7·3	7·6	7·9	8·6	8·7	8·7
longest anal ray	5·8	6·5	6·4	5·8	7·1	5·2	6·1	5·7	5·9
dorsal base	14·5	13·5	14·6	15·8	14·3	14·3	14·5	15·6	15·4
anal base	14·0	14·1	12·2	15·2	14·2	14·5	13·9	15·6	15·3
upper caudal lobe	23·6	23·1	22·9	...	23·9	...	21·6	27·7	...
lower caudal lobe	36·2	31·4	32·2	32·2	31·1	29·3	32·7	33·7	32·0
Origin of anal[2]	+1	+2	+1	+1	+3	+1	1	+2	1
Number of:									
pectoral rays	1+15	1+15	1+15	1+14	1+15	1+15	1+14	1+15	1+15
dorsal rays	10	10	11	11	9	10	10	11	10
anal rays	11	11	12	12	11	11	11	11	11
predorsal scales	31	30	30	29	30	30	29	30	31
transverse scales above lateral line	7½	7½	7½	7½	7½	7½	7½	7½	7½
lateral line scales	50	49	48	45	47	46	50	49	46
gill rakers	6+20	7+22	7+21	6+24	7+24	9+22	7+23	6+22	9+23
vertebrae[3]	...	...	...	...	...	...	...	...	...
100 mm. index of upper jaw teeth	...	...	0.12	...	0.11	0.12	...	0.12	0.11
Longest pectoral ray	3rd	3rd	3rd	3rd	3rd	3rd	3rd	3rd	3rd
Longest dorsal ray	2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd
Longest anal ray	2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd	2nd
Pectoral reaching up to[4]	C-½	C-¾	...	C-½	C-½	C-½	...	C-½	C-¾
Ventral reaching up to	...	...	...	...	...	...	...	...	

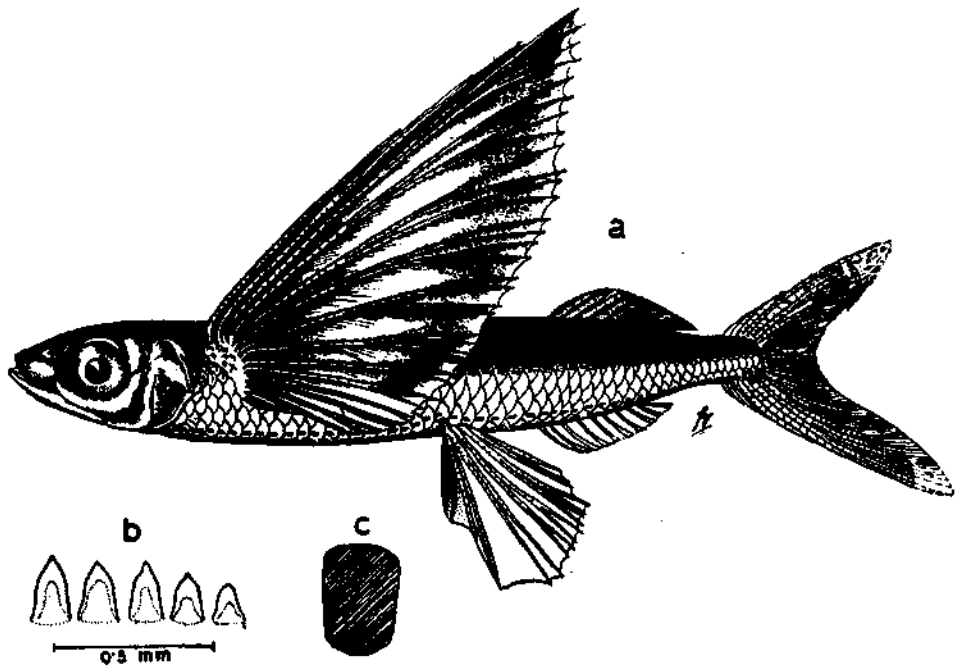

Fig. 1. *H (H) coromandelensis* (Hornell)
a, Adult, male, No. 20, 157.5 mm S. L.
b, Intermaxillary teeth
c, Cross section of the body.

DESCRIPTION

Hirundichthys (*Hirundichthys*) *coromandelensis* (Hornell),

Fig. 1-a, b, c., Table 1

Cypsilurus coromandelensis Hornell, Madras Fish. Bull. Vol. XV, (4), p. 100, 1923.

Cypselurus coromandelensis (Hornell), Chandy, Rec. Indian Mus. Vol. 52, p. 180, text fig. 1-a, 1954.

Hirundichthys (*Hirundichthys*) *coromandelensis* (Hornell), Parin, Trudy Inst. Okeanol., Vol. 43, p. 85, text fig. 18, a and b, 1961.

Local name: *Kola* or *Paravai-kola*.

D. 9-12; A. 10-12; P. I, 14-16; Spred*. 29-32; L1. 45-50; Ltr. 6½-8; GR. 5+21-9-25; Vert. 42-43.

*Predorsal scales

Body slender, somewhat flat dorsally, ventrally and laterally, the cross-section of the torso being more or less quadrangular. Body height and breadth respectively 5.3-6.7 and 6.5-8.3 in standard length. Head 4.1-4.8 in standard length. Eye 2.6-3.3 (exceptionally 2.1) in head length. Interorbital width slightly greater or equal but rarely less than eye diameter. 3-4 irregular rows of teeth in both jaws, but absent in palatines. Teeth conical, without extra cusp; the 100 mm index of upper jaw teeth 0.10-0.12. Pectoral fin 1.4-1.5 in body length, reaching between 5th dorsal ray and ¾ of caudal peduncle. First pectoral ray unbranched, third ray the longest. Origin of dorsal 29-32 scales away from occiput. Length of dorsal base greater than the base of anal. Origin of anal opposite or one ray (rarely 2-3 rays) ahead of the dorsal origin, second ray usually the longest in both the fins. Ventrals situated rather backward, 3.6-4.9 in body length, reaching up to middle of anal base. Colour: In life, body deep metallic blue above up to the dorsal half of the body, silvery below. In formalin preserved specimens the body is blue-black above and silvery below. Pectoral deep purplish with a fairly large unpigmented or lightly pigmented area in the centre which usually extends up to the lower margin, a narrow hyaline upper edge and broader hyaline posterior margin. Dorsal and caudal dusky, the ventral partially so in its outer half, anal colourless.

Remarks: This species has less number of vertebrae than all other members of this genus. Though it closely resembles *H. affinis* and *H. speculiger*, it can be distinguished from *H. affinis* whose teeth are comparatively large by the colouration of pectoral fin. From *H. speculiger* which has a more slender body, it differs in the absence of teeth on the palatine and colour of the pectoral fin.

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