

NOTES ON THE LARVAL AND POST-LARVAL STAGES OF FISHES FOUND ALONG THE TRIVANDRUM COAST.

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(Communicated by Rai Bahadur S. L. Hora, D.Sc., F.N.I.)

(Received August 13, 1945.)

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INTRODUCTION.

In a preliminary note on the distribution and feeding habits of the post-larval stages of the fishes found along the Trivandrum coast (Gopinath, 1942), it was pointed out that larval and post-larval stages of marine fishes make their appearance in large numbers along this coast from the beginning of November and continue to be present till the middle of March and that towards the close of March the larvae gradually diminish in numbers up to April, when post-larvae alone constitute the catches. These post-larvae again gradually diminish in numbers and after May disappear from the catches, but on rare occasions they reappear in small numbers. It was also pointed out that the maximum abundance of these is usually recorded in February-March and that each month has its own predominant species. It was further shown that larvae and post-larvae obtained in one collection usually vary in length, depending on the period at which the spawning took place.

In the present paper are described the larvae and post-larvae obtained in tow nets and other close meshed nets¹ along this coast during the two years, October, 1941 to August, 1943, constituting two definite seasons. A rough indication of the period of occurrence and the period of maximum abundance of each species is also given. The identification of the larvae and post-larvae had been somewhat difficult owing to lack of sufficient literature on the subject. Apart from a few descriptions of the larvae and post-larvae of some of the marine and brackish water fishes by authors like Battacharya (1916), Sundara Raj (1916), Sewell and Prashad (1919), Jones (1937), Job and Jones (1938), Rao and Hora (1938), Nair (1940), Chidambaram (1941) and Devanasan and Varadarajan (1942), no attempt seems to have been made to study exclusively the larvae and post-larvae of a particular region.² The work of Delsman (1921-35) on the fish eggs and larvae collected from the Java Sea is probably the only standard work dealing with the developmental stages of the fishes of the Indo-Pacific region. But he confines himself mainly to the description of eggs, embryonic and early embryonic forms.

Twenty-four species belonging to 17 families have been described in this paper. These include 4 species mentioned in the previous note and 20 additional forms collected during the second season. Seven species mentioned in the previous note have been left out since they were too advanced to need any description and since earlier stages of these species have not been collected during the second season. Out of the total number of species described, the larval and post-larval stages of 14 are probably described for the first time from Indian waters. Earlier stages of some of the species described here have been dealt with by some other workers and in such

¹ *Nonnavu madi*; a shore seine having a cod end with a mesh limit of 8 to an inch, commonly employed for fishing post-larvae, young crustaceans and cephalopods.

² An unpublished work by Mr. M. A. John, in which he describes the fish eggs and larvae of the Madras coast, is probably the first attempt in this line in India.

instances, only the post-larvae which show marked differences from the embryonic forms have been described. For, as Clerk (1920) has observed, the post-larvae are so different from the adult that characters well-known for the identification of the latter are of little use in the identification of the former, while the development of additional characters renders them entirely different from the embryonic forms.

There is considerable variation regarding definition of larva and post-larva of fish among authors. McIntosh (1897) defines larval stage as that which extends from the hatching of the egg to the complete absorption of yolk sac and post-larva as that which extends from this stage to the assumption of adolescent characters. Delsman, on the other hand, offers no clear definition and indiscriminately terms them larvae and post-larvae. McIntosh's definition of larva and post-larva is more accepted since it is based on certain specific characters. In the present paper, however, the specimens belonging to families Albulidae, Elopsidae, Congridae, Bothidae and Cynoglossidae, even though they are post-larvae according to the definition of McIntosh, are termed 'larvae' since these undergo a complete metamorphosis before the assumption of adolescent characters.

The descriptions are based on examination of fresh specimens as well as Alizarin stained transparent preparations, and, as far as possible, the smallest specimens from the collections have been selected for description. For identification of the species, vertebrae count, count of fin rays, relative position of anus and the number of branchiostegals have been mainly relied on. In the genera *Stolephorus* and *Engraulis*, where there is not much difference between the various species, a series of stages from the post-larvae to the probable adult have been examined and the identification confirmed. In the case of the genera *Pempheris* and *Jhoniis*, it had been very difficult to arrive at the exact species. But since *Pempheris moluca* C. & V. and *Jhoniis belangeri* (C. & V.) are the species commonly obtained along the Trivandrum coast, the two post-larvae have been related to the above two species.

CLASSIFICATION.

- | | |
|---|---|
| Family: Albulidae.
Genus: <i>Albula</i> Bloch & Schn.
<i>Albula vulpes</i> (Linn.). | Family: Centropomidae.
Genus: <i>Ambassis</i> C. & V.
<i>Ambassis ambassis</i> Lacép. |
| Family: Elopsidae.
Genus: <i>Elops</i> Linn.
<i>Elops indicus</i> (Swainson).
Genus: <i>Megalops</i> Lacép.
<i>Megalops cyprinoides</i> (Brouss.). | Family: Theraponidae.
Genus: <i>Pelates</i> C. & V.
<i>Pelates quadrilineatus</i> (Bloch). |
| Family: Clupeidae.
Sub-family: Engraulinae.
Genus: <i>Stolephorus</i> Lacép.
<i>Stolephorus commersonii</i> Lacép.
Genus: <i>Engraulis</i> Cuv.
<i>Engraulis mystax</i> (Bl. & Schn.). | Family: Sillaginidae.
Genus: <i>Sillago</i> Cuv.
<i>Sillago sihama</i> (Forsk.). |
| Sub-family: Dussumierinae.
Genus: <i>Dussumieria</i> C. & V.
<i>Dussumieria hasselti</i> Blkr. | Family: Sciaenidae.
Genus: <i>Jhoniis</i> Bloch.
<i>Jhoniis belangeri</i> (C. & V.). |
| Family: Congridae.
Genus: <i>Congrellus</i> Ogilby.
<i>Congrellus anago</i> (Schleg.). | Family: Carangidae.
Genus: <i>Caranx</i> Lacép.
Sub-genus: <i>Selar</i> Blkr.
<i>Caranx (Selar) kalla</i> C. & V. |
| Family: Scopelidae.
Genus: <i>Saurus</i> Cuv.
<i>Saurus indicus</i> Day.
<i>Saurus myops</i> (Forsk.).
Genus: <i>Saurida</i> C. & V.
<i>Saurida tumbil</i> (Bloch). | Family: Lieognathidae.
Genus: <i>Lieognathus</i> Lacép.
<i>Lieognathus blochii</i> (C. & V.). |
| Family: Atherinidae.
Genus: <i>Atherina</i> Linn.
<i>Atherina forskali</i> Rüpp. | Family: Bothidae.
Sub-family: Bothinae.
Genus: <i>Bothus</i> Rafinesque.
<i>Bothus pantherinus</i> (Rüpp.). |
| Family: Pempheridae.
Genus: <i>Pempheris</i> C. & V.
<i>Pempheris moluca</i> C. & V. | Sub-family: Paralichthinae.
Genus: <i>Pseudorhombus</i> Blkr.
<i>Pseudorhombus arsius</i> (Ham.).
<i>Pseudorhombus triocellatus</i> (Bl. & Schn.). |
| | Family: Cynoglossidae.
Genus: <i>Paraplagusia</i> Blkr.
<i>Paraplagusia bilineata</i> (Bloch). |

Family: *Gobiidae*.
 Genus: *Gobius* Artedi.
Gobius sp?

Family: *Triacanthidae*.
 Genus: *Triacanthus* Cuv.
Triacanthus brevisrostris Temm. &
 Schleg.

DESCRIPTIONS OF THE LARVAL AND POST-LARVAL STAGES.

Family ALBULIDAE.

Albula vulpes (Linn.).

Ribbon shaped larvae of *Albula vulpes*, varying in length from 55–65 mm., are abundant along this coast during December and January and are obtained in very large numbers in December. It is interesting to note that this species, which is considered to be very rare in Indian waters, appears as larvae in large numbers along this coast.

This larva was first described by Meek and Hildebrand (1923) and later by Delsman (1926), who gave details regarding the number of myotomes in the body, position of anus and fins and also the number of fin rays. The present specimens agree with Delsman's description, except in the number of dorsal fin rays. He has observed only 16 rays, whereas in the present specimens 18 rays are clear, probably owing to the difference in the growth of the larvae. One more character to be mentioned here is the nature of the dentition. Both jaws have powerful teeth, those of the upper jaw being longer and slanting in a forward direction.

The dorsal fin is situated between segments 53 and 59 and has 18 rays. Both the dorsal and anal fin folds are continued on to the caudal. The anal is short and placed nearer the tail. The ventrals are feebly developed and are placed much in advance of the dorsal, *i.e.*, below segment 34. As in the Clupeids, probably there is a shifting of the fins in this species also since it is found that in the adult the ventral fin is placed immediately below the dorsal. The pectorals are developed and about 10–12 rays could be distinguished.

Family ELOPSIDAE.

Elops indicus (Swainson).

Larvae of *Elops indicus* appear during December and January along with those of *Albula vulpes* and are obtained both in tow nets as well as seine nets with close meshed cod ends. The specimens in the collection vary in length from 29–35 mm.

Meek and Hildebrand first gave a description of the ribbon larva of *Elops affinis*, and later Delsman (*op. cit.*) described the larva of *Elops hawaiiensis*. The present specimens closely resemble the above two, but differ from them mainly in the number of dorsal and anal fin rays and number of segments in the body. *Elops hawaiiensis* possesses 60 segments in the body, 20 rays in the dorsal and 14 rays in the anal, while in the present larvae there are 62–63 segments, 22 rays in the dorsal and 15 rays in the anal fins.

The head is small, pointed and is contained about 10 times in the total length. The jaws are pointed and both possess dentition. There are 18 teeth in the upper jaw, and they are placed at wider intervals than those of the lower. There are 28 teeth in the lower jaw and they show some variation in their arrangement. The posterior teeth are small, weak and closely placed, while the anterior ones are long, strong and placed alternately with short ones.

Megalops cyprinoides (Brouss.).

Ribbon shaped larvae of *Megalops cyprinoides* appear during December and are obtained in large numbers towards the close of the month. These are caught both in tow nets and seine nets with close meshed cod ends. Raj (1916) has observed that larvae of *Megalops cyprinoides* are abundant in River Cooum, in Madras, during October and November.

The larva of *M. cyprinoides* was first described by Van Hampen (1908) and later by Delsman (*op. cit.*). The present specimens differ from Delsman's description mainly in the number of dorsal fin rays. While Delsman has recorded 13–14 dorsal fin rays, in the present specimens 19 rays could be clearly counted and this, in all probability, is due to the difference in the relative development of the two specimens. In all other respects these specimens agree with the larva described by Delsman from the Java Sea.

Family CLUPEIDAE.

Stolephorus commersonii Lacép.

Post-larval stages of *Stolephorus commersonii* occur along the Trivandrum coast from November to January and are obtained in very large swarms during January. Larval and post-larval stages of *S. commersonii* have also been recorded from Madras coast during November to January (Panikkar, 1937).

Embryonic and early larval forms of *S. commersonii*, up to the stage when the yolk is completely absorbed, have been described by Delsman (1929, 1931). The post-larva differs from the larva, mainly in the formation of fin rays, teeth and certain other minor characters. The body is slightly compressed and broadest at the abdominal region and is transparent. The head is pointed and is marked off from the body by a faint constriction, which is better seen from the dorsal side. The mouth is oblique and both jaws possess very minute teeth. The eyes are prominent with well developed *tapitum lucidem*. The dorsal and anal fins possess the full complement of rays, viz., 14 and 19 respectively. The pectorals are developed, but the rays could not be clearly counted. The ventral is placed below the 15th vertebra and carries 7 rays.

The movement of fins with the resultant change in the proportion of the various parts of the body during larval development of Clupeids, observed by Ehrenbaum (1905), Ford (1931), Delsman (1929, 1931), Nair (1940) and others has been borne out by the examination of the present species also.

Engraulis mystax (Bl. & Schn.).

Post-larvae of *Engraulis mystax*, varying in length from 20–27 mm., occur during January to February and are obtained in large numbers in February. From Madras, post-larvae of *E. mystax* have been recorded during November to January (Panikkar, *op. cit.*).

Early larval forms of *E. mystax* were first described from the Java Sea by Delsman (1929). The post-larva, after the yolk has been absorbed, is elongate and slightly compressed from side to side. It is broadest at the region of the dorsal fin. The body is colourless, except for a row of chromatophores at the base of the anal fin. The snout is large and has assumed the typical engraulid shape. Both jaws possess well-developed teeth. The alimentary canal is straight and the intestine is enclosed within a transparent abdomen. The dorsal fin carries the full complement of 14 rays, while the anal has 38 rays, which regularly decrease in length from the first to the last. Only 7-8 clear rays could be distinguished in the pectoral. Ventral has 7 rays.

Dussumieria hasselti Blkr.

Post-larvae of *Dussumieria hasselti* are usually obtained in February. During the two years under investigation, they appeared only for a few days during February and thereafter were completely absent from collections. The specimens varied in length from 32–40 mm.

Larva and post-larva of *D. hasselti* have already been described by Delsman (1925) and the present specimens agree with his description. They can be easily distinguished in a collection by their long and pointed snout and a large number of sharp and powerful teeth on both jaws. The alimentary canal is straight and is enclosed within a transparent abdomen, through which the intestinal folds could be clearly seen.

Family CONGRIDAE.

Congrellus anago (Schleg.).

Leptocephali of *Congrellus anago* appear in good numbers from the beginning of November and are common in collections till the end of February. The maximum number is recorded in February, and the specimens vary in length from 116–132 mm. Elvers are also occasionally taken during this period and they vary in length from 110–112 mm.

The body of the Leptocephalus is completely transparent and there are 115 segments in the body. Each intersegmental septum has a row of small chromatophores arranged on it and these rows extend right up to the tip of the tail. Each ray of the dorsal and anal fin carries a chromatophore at its base and in this respect it resembles the Leptocephalus described by Sewell and Prashad (*op. cit.*). The head is comparatively small and is contained about 30 times in

the total length. The snout is bluntly pointed and the upper jaw is slightly longer. There are minute teeth on both jaws, those of the upper jaw being more prominent.

The dorsal fin and the anal fin are continuous with the caudal, there being no notches to demarcate them. The dorsal has 115–120 distinct rays and a number of closely packed rays at the anterior region which cannot be counted. The anal has 100–104 distinct rays and a number of indistinct rays at the anterior region. The caudal has 10 rays. The anal fin is placed slightly in advance of the dorsal, behind the anal opening situated between segments 77 and 78.

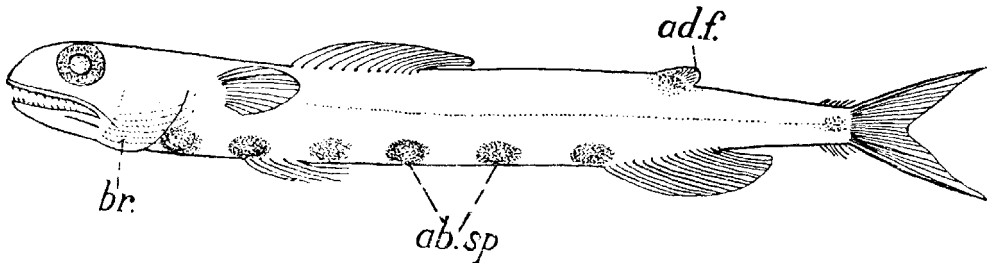
The elver measures 110–112 mm., and is transparent, long cylindrical and devoid of conspicuous pigment spots. The fins are well developed and the dorsal has 184 rays and is continuous with the anal through the caudal. The anal carries 145 rays. The pectorals are feebly developed and have 13–14 distinct rays in each.

Family SCOPELIDAE.

Saurus indicus Day.

Post-larval stages of *Saurus indicus* occur during January to February and are obtained in very large swarms during the second half of January and the first half of February. The specimens in the collections vary in length from 30–32 mm., and no earlier stages have been so far obtained.

The post-larva is long and cylindrical with a comparatively large head, and bulges at the opercular region. The body is transparent and there is a row of chromatophores at the base of the anal fin, and a concentration of chromatophores at the commencement of the caudal fin. Two pairs of branching chromatophores are found on the occipital region. The post-larvae are easily recognised in a collection by their eleven pairs of conspicuous black spots on each side of the abdomen, the first pair on the posterior border of the gill cleft, below the end of the opercular flap and the last pair in front of the anal fin (Text-fig. 1). The spots lie on each side of the abdomen and are clearly visible through the transparent body wall in fresh specimens and only partially visible in preserved specimens.



TEXT-FIG. 1. Post-larva of *Saurus myops* (Forsk.), 29.5 mm.
ab.sp., abdominal spot; *ad.f.*, adipose fin; *br.*, branchiostegals.

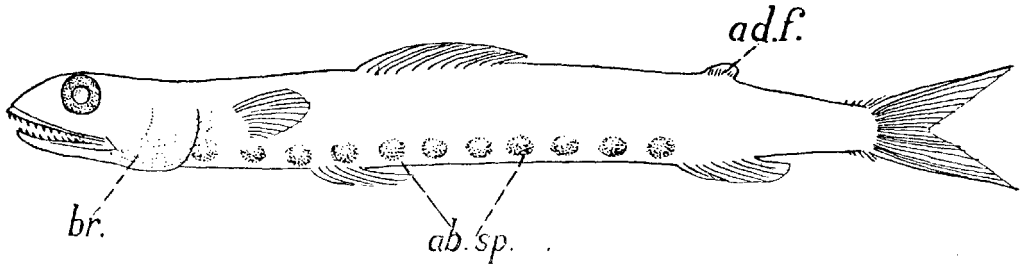
The snout is pointed and the gape of the mouth extends far beyond the posterior limit of the orbit. The eyes are prominent and large. The teeth are slender and are arranged in two rows, there being 30–32 teeth in each jaw. The first dorsal fin is situated above myotomes 15–22 and has 12 rays. At the caudal portion of the trunk, slightly in front of the caudal fin, is found a membranous and fibrous fold which subsequently forms the adipose fin. The anal is placed below myotomes 39–45 and has 9 rays. The pectorals are well developed and carry 12–14 rays in each. The ventral fin starts below the third abdominal pigment spot and carries 8 rays.

Saurus myops (Forsk.).

Post-larvae of *Saurus myops* occur along with those of *Saurus indicus* during January to February. They vary in length from 27–35 mm., and closely resemble the latter in shape and general appearance. Earlier stages have not been recorded from the Trivandrum coast.

The body of the post-larva is transparent and there are four chromatophores on the occipital region arranged in a semicircle, the curve of which is directed towards the tail. In front of

this are found a varying number of chromatophores. A row of chromatophores is found along the lateral line, and a concentration of small chromatophores on each side of the adipose fin gives it a dark appearance. Between the first dorsal and the adipose fins, there is an interrupted row of large branching chromatophores along the mid-dorsal line. One important difference between *S. myops* and *S. indicus* is in the number of abdominal pigment spots. In the latter, there are eleven pairs of spots, while in the former there are only six. These spots are, however, comparatively large and ovoid (Text-fig. 2).



TEXT-FIG. 2. Post-larva of *Saurus indicus* Day, 30 mm.
ab.sp., abdominal spots; *ad.f.*, adipose fin; *br.*, branchiostegals.

The dorsal fin is placed above myotomes 16-23 and has 13 rays. The anal, which is placed below the adipose fin, is situated between myotomes 37 and 45 and carries 16 rays. Pectorals have 12 rays in each and the ventral, which is placed below the third abdominal spot, carries 8 rays.

Saurida tumbil (Bloch).

Post-larval stage of *Saurida tumbil*, varying in length from 25-37 mm., appears along with those of *Saurus indicus* and *S. myops* during January to February and are obtained in large numbers in shore seines. No earlier stage has so far been recorded.

In general appearance, *Saurida tumbil* resembles *Saurus indicus* and *S. myops*, but differs from them in the number of abdominal spots, there being only seven in the former, whereas in the latter two species there are eleven and six respectively. Of the seven pairs of spots, the last two are placed nearer to each other than any two successive spots in the row. These spots, which are on each side of the alimentary canal, are seen through the transparent body wall. Branching chromatophores are only found on the caudal portion of the trunk, there being three to four immediately behind the anal fin, along the mid-ventral line, one or two irregular groups at the commencement of the caudal fin and a small aggregation on the sides of the caudal peduncle.

The snout is pointed and the lower jaw is longer than the upper. Both jaws possess well-developed teeth. Two kinds of teeth are distinguished mainly on the basis of size, *viz.*, one short and conical, and the other long and narrow and very often these two types of teeth alternate with one another in the same row. In front of the eye, there is a very prominent nostril. There are two dorsal fins; the first one has 11 rays and the second one is membranous with a backwardly directed lobe. This subsequently develops into the adipose fin. The anal fin is placed immediately below the adipose and carries 10 rays. The pectorals are situated above the first pair of abdominal spots and possess 15 rays in each. The ventrals are placed below the second pair of spots and have 9 rays in each. There are 19 rays in the caudal fin.

Family ATHERINIDAE.

Atherina forskali Rüpp.

Advanced post-larvae of *Atherina forskali* occur during December and January and usually vary in length from 12-17 mm. This is a comparatively rare species.

Most of the adolescent characters are developed in the specimens, but they differ from the adult mainly in the nature of their fins and coloration. The post-larva is transparent and pigment spots are practically absent. The fins possess the adult number of rays, but the rays are placed at wider intervals. The dorsal extends from the 10th to the 17th vertebra and the

anal, from the 13th to the 18th. In this respect these differ from the adult, in which the rays are closely set and more compact.

Family PEMPHERIDAE.

Pempheris moluca C. & V.

A few specimens, varying in length from 7.5-9.0 mm., were obtained in February, 1943. The following description is based on a specimen measuring 7.5 mm.

The body is transparent and the few chromatophores present are restricted to the anterior portion of the trunk. In front of the dorsal fin, there is a group of three light-coloured chromatophores along the mid-dorsal line and a large chromatophore at the occipital region. A triangular group of three branching chromatophores is present above the pectoral fin and of these, the one which forms the apex of the triangle is placed at the base of the fin. A number of small chromatophores at the abdominal region give it a dark appearance. Two large chromatophores are also found on the posterior border of the opercular flap.

The abdominal profile is more convex than the dorsal, and the abdomen is conspicuously bulging. The greatest height of the body is in the abdominal region, and beyond the anal opening the trunk abruptly tapers to the tail. The mouth is very oblique and both jaws possess minute teeth on their anterior half. The preopercle is serrated and the opercle has four well-developed spines along its margin, the middle two of which are the longest. All the fins show the adult number of fin rays.

Family CENTROPOMIDAE.

Ambassiss ambassiss Lacép.

Post-larvae of *Ambassiss ambassiss* appear along the Trivandrum coast in November. It is obtained only rarely in collections, although advanced post-larval stages of *Ambassiss gymnocephalus* have been found in large numbers in the Veli lake, about two miles north of Trivandrum. Raj (*op. cit.*) has observed that fry of *A. miops* is abundant in River Cooum during November and December.

The post-larva is transparent, and the sides of the abdomen and opercles are bright silvery in colour. There is a row of chromatophores at the base of the anal fin, and there are five large chromatophores between the anal and caudal fins. The air bladder is visible through the transparent abdomen as a small bubble of air at its postero-dorsal border. All fins are fully developed and show the adult number of rays.

Family THERAPONIDAE.

Pelates quadrilineatus (Bloch).

A few advanced post-larval stages of *Pelates quadrilineatus* were obtained in tow net during the months of November and December, 1943. The specimens obtained varied in length from 10-13 mm.

The body of this post-larva is transparent, and a number of chromatophores are found to be thickly distributed on the dorsal side of the head. There are also a few large chromatophores on the sides of the abdomen. In between each ray of the anal fin, there is a deeply coloured chromatophore, and there are four groups of small chromatophores at the commencement of the caudal fin. The snout is pointed and the lower jaw is longer than the upper. Both jaws possess teeth. The preopercle is serrated, both along its vertical and horizontal borders and the serrations at the angle are longer than the rest.

All the fins are developed and show the adult number of fin rays. But the spinous portion of the dorsal and anal fins show simple unarticulated rays only, and not the strong spines.

Family SILLAGINIDAE.

Sillago sihama (Forsk.).

Advanced post-larvae of *Sillago sihama* begin to appear in collections from the end of December. The author, in his previous note (*op. cit.*), has mentioned April as the period of abundance for this species. But this referred only to big specimens, 25 mm. and above in

length. During the second season of investigation, a large number of smaller specimens were collected, the majority being obtained during February.

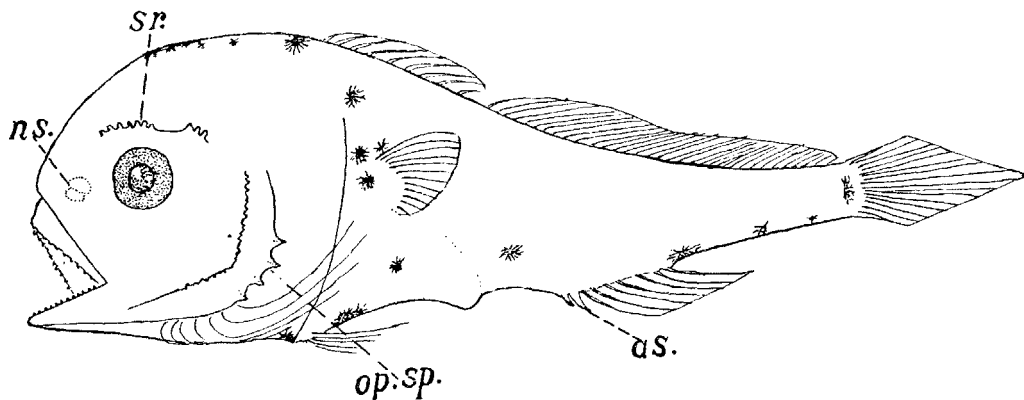
The body is transparent, and there is a row of chromatophores at the base of the anal fin, each ray having one chromatophore at its base. Behind the dorsal and anal fins, there is a row of chromatophores along the mid-dorsal and mid-ventral lines respectively. The snout is pointed and there are about 20 teeth present on the upper jaw and an equal number on the lower jaw. The fins are fully developed and show the adult number of rays.

Family SCIAENIDAE.

Jhonius belangeri (C. & V.).

Two specimens, measuring 8.0 and 10.0 mm. respectively, were obtained in March, 1943.

The post-larva of *Jhonius belangeri* has comparatively a large head and a narrow tail region. The dorsal profile is convex, while the ventral surface of the abdomen is concave. The anal opening is situated on a prominent bulge in front of the anal fin. In front of the dorsal fin, on the dorsal side, is found a large chromatophore and a triangular group with its apex towards the ventral side is found immediately in front of the pectoral fin. Two chromatophores are found behind the anal fin, along the mid-ventral line and there is also another large one behind the ventral fin. At the commencement of the caudal fin, there is an elongated branching chromatophore.



TEXT-FIG. 3. Post-larva of *Jhonius belangeri* (C. & V.), 8 mm. long.
as., anal spine; ns., nostril; op.sp., opercular spine; sr., supra-orbital ridge.

The mouth opening is slightly oblique, and there are about 48 pointed teeth in the upper jaw and about 40 in the lower jaw. An inner row of very small teeth is also distinguished. The supra-orbital ridge is serrated with knob-like structures, of which there are seven in the anterior region and three in the posterior (Text-fig. 3). The preopercle is finely serrated along the anterior edge and has four well-developed teeth on the vertical border.

The fins are fully developed and show the adult number of rays, although the spinous portions are not definitely formed. Only 15 rays could be distinguished in the pectoral fin. The caudal is deeply pointed and carries 17 rays.

Family CARANGIDAE.

Caranx (Selar) *kalla* C. & V.

Post-larval stages of *Caranx kalla* are obtained in small numbers in tow nets during November. The specimens in the collections vary from 5–8 mm. in length.

Early larval stage of *Caranx kalla* has been described by Devanesan and Varadarajan (1942)¹ from the Calicut coast. The post-larva, measuring 5–8 mm., is transparent and the head and

¹ Only the abstract was referred.

abdomen are broad. Chromatophores are thick on the dorsal surface and also on the upper half of the lateral region. The lower jaw is longer and no teeth could be distinguished at this stage. The fins are not differentiated, but a total of 22 rays could be counted on the dorsal fin fold. Of these, the first 8 are simple and all the rest show signs of articulation. The first 8 rays become the spinous portion of the dorsal fin. The anal fin fold has 22 rays, the first 3 being simple and unarticulated. The dorsal and anal fin folds are continuous with the base of the caudal, which unlike the adult, is circular in shape and carries 17 rays.

Family LIEOGNATHIDAE.

Lieognathus blochii (C. & V.).

Post-larvae of *Lieognathus blochii*, varying in length from 11–16 mm., appear along with young fish of 2 cms. and above during December to March. They are obtained in very large swarms in shore seines during February. Whitehouse (1923) has recorded that young stages of *Lieognathus* are abundant on the Tuticorin coast during October.

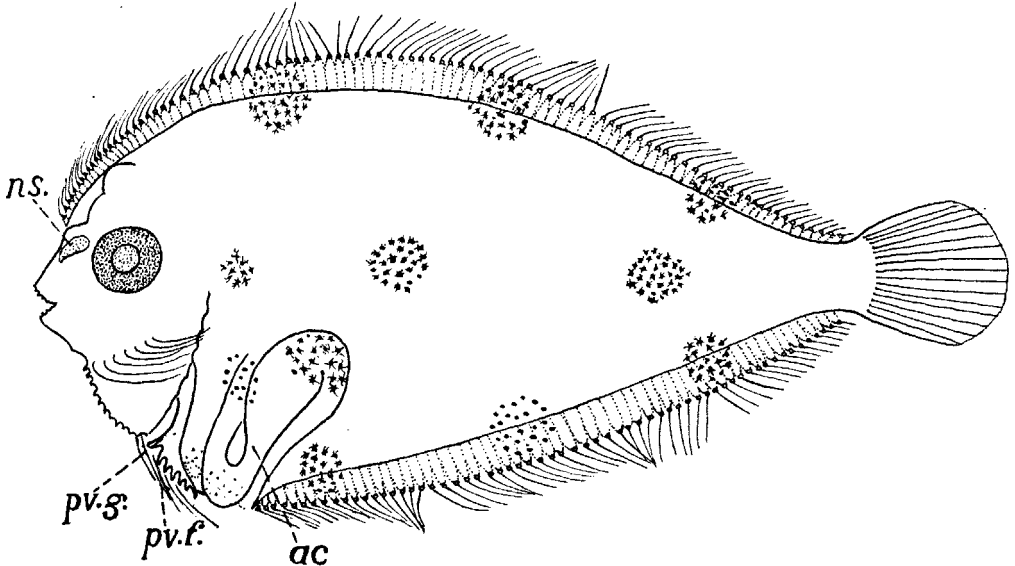
The post-larva (up to 15 mm.) is transparent, and there are a number of chromatophores thickly distributed along the dorsal side of the head and body. The head is large, and the mouth opening median. The lower jaw is longer than the upper and has assumed the typical concave shape of the adult. Both jaws possess minute teeth. The preopercle is serrated along its horizontal border, and the angle of the preopercle has two well-developed and prominent spines. The dorsal surface of the head carries a median longitudinal serrated ridge, and this occipital blade is characteristic of most of the carangid larvae and post-larvae (Ehrenbaum, 1905).

All the fins show the adult number of fin rays, but the spines are not strong and serrated as in the adult. The caudal fin has not assumed the true shape of the adult and carries 17 rays.

Family BOTHIDAE.

Bothus (Platophrys) pantherinus (Rüpp.).

Advanced larval forms of *Bothus (Platophrys) pantherinus* appear during December to middle of March and are obtained in large numbers in tow nets and shore seines with close meshed cod



TEXT-FIG. 4. Post-larva of *Bothus (Platophrys) pantherinus* (Rüpp.), 17 mm.
ac., alimentary coil; pv.f., pelvic fin; pv.g., pelvic girdle; ns., nostril.

end, during January and February. The specimens in the collections vary in length from 17–19 mm., and the following description is that of a specimen measuring 17 mm.

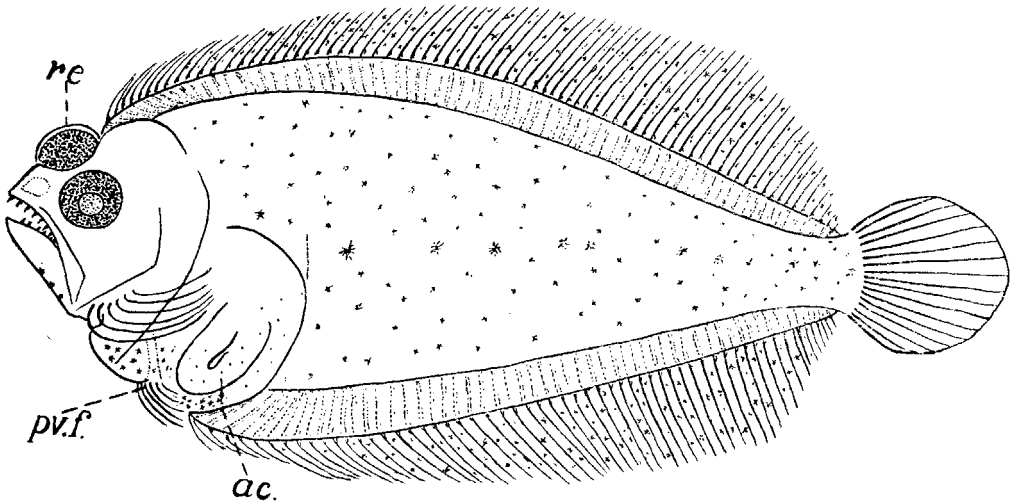
The larva is bilaterally symmetrical and completely transparent, with ten to eleven orange-red pigment concentrations on the body; three on the dorsal fin, three on the anal, two along the mid-lateral line and two on the abdominal region (Text-fig. 4). The body is laterally compressed and the greatest height is contained about $1\frac{3}{4}$ -2 times in the total length. The mouth is median and the opening small. There are about 8-10 small villiform teeth in each jaw. The alimentary canal is coiled like an upturned S, '∞', and opens ventrally behind the first ascending portion of the loop.

The various fins have begun to differentiate, and 80-83 rays could be counted on the dorsal side, commencing from just above the eyes. The dorsal and anal fins reach up to the caudal and are separated from the latter by deep notches. About 61 rays are counted on the ventral side, behind the anal opening. The pectorals are feebly developed and the rays are difficult to count. The caudal, which is rounded, carries the adult number of rays, viz., 17.

Pseudorhombus arsius (Ham.).

Unlike the larvae of *Bothus* (*Platophrys*) *pantherinus*, larvae of *Pseudorhombus arsius* are very rare. Only three specimens were collected during the period of investigation; two in November and one in December, 1943, and each measured 9.5 mm.

The larva is transparent, bilaterally symmetrical and strongly compressed from sides. There are stellate chromatophores all over the body. These chromatophores are thick on the dorsal and anal fins, and those on the mid-lateral line are comparatively large. Three chromatophores below the jaws, a group of deeply coloured chromatophores on the anterior part of the pelvic fins and another collection on the ventral portion of the abdomen can also be seen. The jaws are small and there are minute teeth in both, the upper having six and the lower eight, in each half. The right eye is seen migrating towards the left side and is partially visible over the ridge (Text-fig. 5).



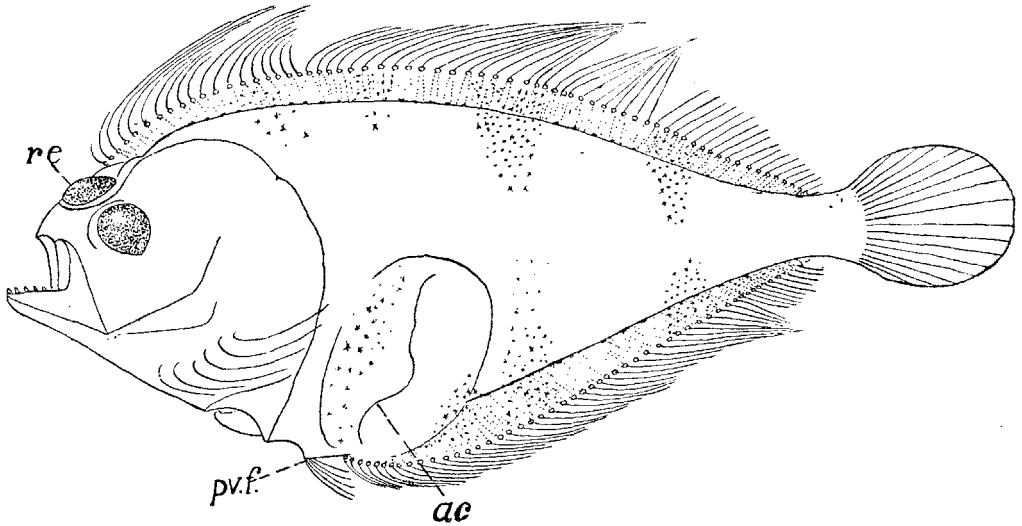
TEXT-FIG. 5. Post-larva of *Pseudorhombus arsius* (Ham.), 9.5 mm.
ac., alimentary coil; pv.f., pelvic fin; r.e., right eye.

The dorsal fin commences immediately above the posterior limit of the eye and has 75 rays. The anal fin is similar to the dorsal and has 59 rays. Both these fins are broadly triangular in shape, with the apex more towards the tail. These fins reach up to the caudal, from which they are separated by notches. The pectorals are feebly developed and the rays could not be counted. The caudal and ventral show the adult number of rays.

Pseudorhombus triocellatus Bl. & Schn.

About six larvae of *Pseudorhombus triocellatus* were collected in March, 1943, and they varied in length from 14-16 mm. The following description is that of a specimen measuring 14 mm.

The larva is transparent, symmetrical and laterally compressed. The greatest height of the body is contained about $2-2\frac{1}{2}$ times in the total length. There is a row of chromatophores at the base of the dorsal and another one at the base of the anal fin. There are a number of chromatophores on the ventral portion of the abdomen, and four groups of small chromatophores on the sides. These groups are arranged in pairs, one above the other, so as to give the appearance of two pale vertical bands (Fig. 6).



TEXT-FIG. 6. Post-larva of *Pseudorhombus triocellatus* Bl. & Schn., 15 mm.
ac., alimentary coil; pv.f., pelvic fin; r.e., right eye.

The lower jaw is slightly longer than the upper, and there are small villiform teeth in both, those at the symphyses being longer than the rest. The opercular bones are complete, and six branchiostegals can be distinguished. The eyes are bulging and that of the right side is seen mounting towards the left side, and is partially visible over the dorsal ridge. The dorsal fin commences immediately above the posterior limit of the eye and carries 68 rays. Of these, the anterior ones are longer, with the exception of the first one, which is very short. The anal, ventral and caudal fins show the adult number of rays. The pectoral rays could not be counted.

Family CYNOGLOSSIDAE.

Paraplagusia bilineata (Bloch).

Only two larvae of *Paraplagusia bilineata* were collected during the period of investigation, and both were obtained in tow nets during November 1943. Each specimen measured 10 mm.

The larva is transparent, flat and is longer than broad, and tapers to the tail region. There are fourteen groups of chromatophores on the body; seven along the base of the dorsal fin and seven along the base of the anal fin. There are also three chromatophores on the occipital region, a large one below the lower jaw, and two groups of small chromatophores on the sides of the abdomen. The mouth is small, and both jaws possess minute teeth. The eyes are situated on both sides and migration has not begun. The alimentary canal is looped, and is placed inside a conspicuously bulging abdomen and appears as if it were hanging from the body.

The dorsal fin fold takes the shape of a tongue-like projection above the nasal region, and the rays commence only from above the eye, the anterior part being devoid of rays. The first two dorsal fins are very long and slender, and is typically characteristic of some of the flat fish larvae. The rest of the rays are comparatively short. The dorsal has 106 rays, and the anal 81 rays, and both fins are continuous with the caudal. The ventral and caudal fins show the adult number of rays.

Family GOBIIDAE.

Gobius sp.?

A few advanced post-larval forms were collected in September, 1943, about two months prior to the usual appearance of post-larvae along this coast. The specimens varied from 15-17 mm., and could not be related to any exact species. The following description is that of a specimen measuring 15 mm.

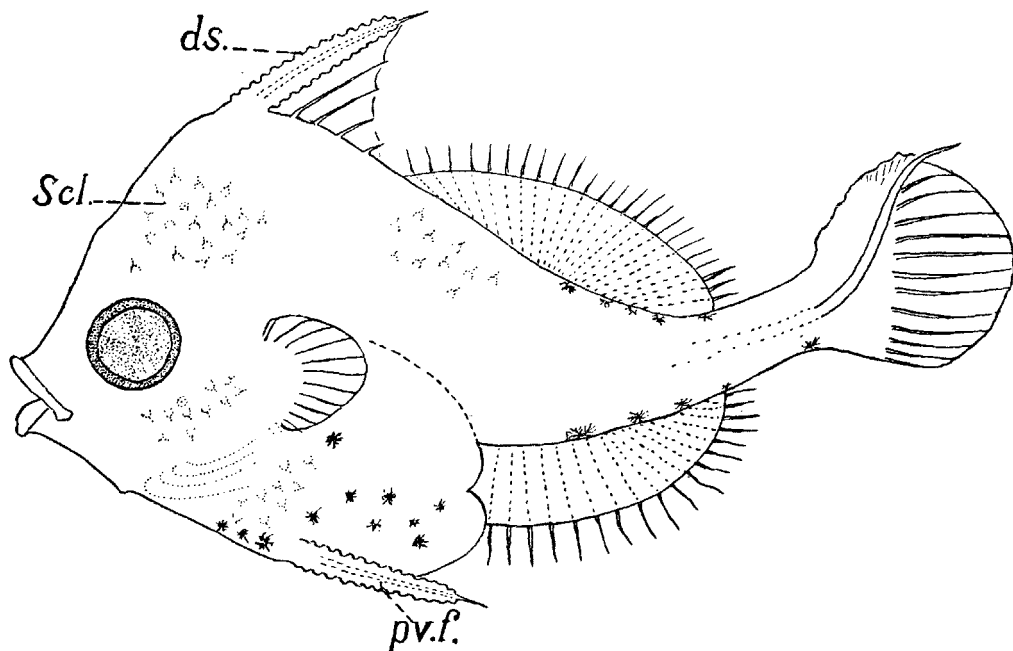
The body is elongate, cylindrical and transparent. When examined in the fresh condition, a brown tint is found to be conspicuous behind the heart and the air bladder, in front of the caudal peduncle roughly about the 22nd vertebra, and lastly at the commencement of the caudal fin. The dorsal border of the air bladder is black, while from this region yellowish-brown streaks spread towards the sides. There are two large chromatophores at the jugular region and a row of chromatophores at the base of the anal fin. In these respects, these specimens resemble the *Gobius* larva described by Delsman (1926) from the Java Sea.

The jaws are small and carry minute teeth. The alimentary canal opens below the 10th vertebra and the air bladder, which appears as a tiny bubble of air, is situated in the postero-dorsal border of the abdomen. The dorsal fin carries 6 spines and 11 weak rays. The anal is similar to the dorsal and carries 10 rays. The pelvic fins have not been fused together to form the characteristic sucker of the adult.

Family TRIACANTHIDAE.

Triacanthus brevirostris Temm. & Schleg.

Although advanced stages of *Triacanthus brevirostris* are commonly obtained in tow nets and shore seines, real larval and post-larval forms are not usually collected. The following description is that of a single specimen measuring 5 mm. obtained during December, 1943, along with the bigger specimens.



TEXT-FIG. 7. Post-larva of *Triacanthus brevirostris* Temm. & Schleg., 5 mm.
ds., dorsal spine; pv.f., pelvic fin; scl., sclera.

The body is laterally compressed and roughly rhomboid in shape, the greatest height being at the region of the first dorsal ray. It is transparent and there are a few irregularly scattered chromatophores. The body is covered over by spine-bearing sclera, which are clearly seen

only on certain areas. The mouth is small, opens dorsally and is bounded by very thick lips. Only a few feebly developed teeth could be distinguished at this stage. The eyes are prominent and they are placed high up and more towards the snout.

There are two dorsal fins, and both show the adult number of spines and rays. The anal is similar to the soft dorsal, and is placed below the latter. The first and second dorsals are placed very close together, and in this respect the post-larva differs from the adolescent, in which the second dorsal is placed far behind the first. The caudal fin, unlike that of the adult, is rounded, and carries 12 rays. The pectorals are well developed and about 13 rays could be counted in each.

DESTRUCTION OF IMMATURE FISH.

Large quantities of post-larval fishes are annually landed along the Trivandrum coast, and they find an immediate market among the poor people owing to their cheaper price and suitability as a substitute for fish. These post-larval forms, along with young Cephalopods and Sergistids, are known as *nonnavu*, and fishing for this *nonnavu* is conducted from November to April or even May, intensely so from December onwards when there are no other fish available. With the close of the North-east monsoon, the volume of catches of various fishes along this coast diminishes, and inshore fishing is gradually discontinued. Although post-larvae are obtained in fewer numbers along with other fishes in ordinary seines, fishermen of this country use a special type of seine, with a mesh limit of 8 to an inch, for fishing them.

From November onwards, the North-east monsoon drift, sweeping up the coast of Ceylon, creeps up the west coast of Ceylon and India (Sewell, 1937), and forms a strong coastal current in a northerly direction along the Trivandrum coast. Hence, in all probability, the larval and post-larval stages arrive along this coast in the course of their migration with the drift from a spawning ground, situated somewhere to the south and away from this coast. The annual migration of these larval and post-larval forms to these coastal waters and the enormous quantities obtained in collections tend to indicate that, probably, this coast is a good nursery.

In the previous note (*op. cit.*), it was mentioned, as a result of a preliminary study for one year, that the maximum quantity of post-larvae was recorded in February to March. From the analyses of collections during the two years of investigations it is clear that the maximum number of species was recorded during December. There are 7 species recorded in November, 13 during December, 9 during January, 9 during February, 3 during March and no recordings thereafter. Each month has a predominant species, but sometimes there may be more than one. The January collection is noteworthy for the preponderance of Clupeid and Scopelid post-larvae, which occur in very large swarms. During this month, sometimes hauls contain even monotonous collections of either one or the other of the species of these families.

In accordance with the occurrence of these post-larval forms, they may be divided into three groups, *viz.*, those which are very abundant, occurring in huge swarms, those which commonly occur but in lesser numbers, and those which are very rare. *Stolephorus commersonii*, *Engraulis mystax*, *Saurus indicus*, *S. myops*, *Saurida tumbil*, *Congrellus anago*, *Bothus (Platophrys) pantherinus*, and *Lieognathus blochii* usually occur in large swarms. Among these, *Stolephorus commersonii*, *E. mystax*, *Congrellus anago*, and *Lieognathus blochii* are observed to occur over a longer range of period, *i.e.*, for two to three months, whereas other species, though they occur in large swarms, are present in collections only for a shorter period. *Megalops cyprinoides*, *Elops indicus*, *Albula vulpes*, *Pelates quadrilineatus*, *Sillago sihama*, and *Ambassis ambassis* are obtained in comparatively smaller numbers. All other species are very rare.

Out of the 24 species of post-larval stages recorded during the present investigation, 13 belong to important food fishes. *E. indicus*, *M. cyprinoides*, *S. commersonii*, *Engraulis mystax*, *D. hasselti*, *Saurus indicus*, *S. myops*, *Saurida tumbil*, *A. ambassis*, *Sillago sihama*, *Jhonijs belangeri*, *Caranx (Selar) kalla*, and *Lieognathus blochii* are some of the important food fishes of this country. Large specimens of *Elops indicus* are occasionally taken from the sea, and their post-larvae are abundant along this coast. *Megalops cyprinoides*, up to one foot in length, are caught in plenty from the sea and the Veli lake, two miles north of Trivandrum. Adult specimens of *Saurus indicus*, *S. myops*, and *Saurida tumbil*, which are deep water forms, are obtained during December and January along with their post-larvae and are commonly used as food, although they have been termed 'insipid' by Day (1886). *Sillago sihama* and *Jhonijs belangeri* constitute an important fishery during August to October and they are obtained in large numbers in shore seines.

Ambassis ambassiss, although not obtained in large numbers from the sea, are caught in plenty along with other species of the same genus from the Veli lake during September to October. Intensive fishing is carried on for *Stolephorus commersonii*, *Engraulis mystax*, *Dussumieria hasselti*, *Caranx (Selar) kalla*, and *Lieognathus blochii*, which constitute some of the very important commercial fishes. *S. commersonii* and *Engraulis mystax* appear along this coast in large shoals during April to June and September to December, and *Dussumieria hasselti*, generally during September to November (Menon¹). *Caranx (Selar) kalla*, along with other species of the genus, are common all through the year, but are caught in large numbers during September. *Lieognathus blochii* are abundant during September and October.

Bothus (Platophrys) pantherinus, *Pseudorhombus arsius*, *P. triocellatus*, and *Paraplagusia bilineata* constitute the largest number of species recorded from one group, viz., flat fishes. Adult flat fishes, measuring from nine inches to one foot, are commonly caught in shore seines, but are not relished as a food fish at present.

Regular fishing for post-larval forms is carried on only between Poovar, a fishing village about 12 miles south of Trivandrum, and Quilon about 44 miles north. Even in this region, intensive fishing is done only along Trivandrum and neighbouring coasts, where the absence of rocks on the sea bottom permits operation of any type of seine net. A casual statistics shows that there are about 36-40 such seine nets with close meshed cod ends along the Trivandrum coast, within a limit of two miles. Presuming that fishing is done on six days during a week and that on an average day nets are shot from two to three times, fetching one to two baskets per haul, it could be seen that thousands of pounds of post-larval fishes are destroyed along this coast alone in one year. While these *nonnavu* are not of any great economic value, they are destroyed for the sake of the meagre remuneration they fetch, especially when other fish are not available in plenty. These larvae and post-larvae are not given enough chance to recruit themselves into the respective year classes, and this failure may affect the future fisheries, if not of this coast, at least of other regions.

The basic problem in fisheries should be to make the greatest use of the food resources of the sea that is compatible with avoiding danger of over-fishing and depletion, and at the same time to help the industry in its attempts so that it will not suffer from such fluctuations which could be normally prevented. With this view in mind, and on the basis of certain preliminary investigations, some recommendations have been made. Although restrictions on small meshes and the use of small meshed nets have been imposed, so far the protective measures have not been strictly adhered to. Unless means are employed for preventing this wanton destruction of life, the defect may become irreparable, leading to the ruin of the inshore fisheries, on which depend the maintenance of thousands of fishermen.

ACKNOWLEDGMENTS.

I am indebted to Dr. C. C. John, Professor of Marine Biology and Fisheries, for suggestions and criticisms, and also for correcting the manuscript. I am also thankful to Rai Bahadur Dr. S. L. Hora, Director of Fisheries, Bengal, for going through the typescript and making some valuable suggestions, and for kindly arranging the publication of the paper.

SUMMARY.

1. All the larval and post-larval stages of fishes obtained along the Trivandrum coast during the two years, October, 1941 to August, 1943, are described. Of the 24 species recorded, 13 are early stages of important food fishes. Fourteen species are probably described for the first time from Indian waters.

2. The range of occurrence and period of maximum abundance for each species are also roughly indicated. According to their occurrence, the larvae and post-larvae are divided into three groups, viz., those which commonly occur in large swarms, those which are common but occur in lesser numbers and lastly those which are very rare.

3. During November to April, or even May, these larval and post-larval forms are caught in very large quantities in close meshed seines, and this destruction of immature fish, without giving them enough chance to recruit themselves into the respective year classes, is deprecated.

¹ Unpublished work.

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