

# NOTES ON EGGS, LARVAE AND JUVENILES OF FISHES FROM INDIAN WATERS

## III. *Katsuwonus pelamis* (Linnaeus) and IV. *Neothunnus macropterus* (Temminck and Schlegel)

BY S. JONES

(Central Marine Fisheries Research Station)

### III. *Katsuwonus pelamis* (Linnaeus)

IN this article, larval stages of the oceanic skip-jack, *Katsuwonus pelamis* (Linnaeus) collected from the Laccadive Sea during the cruises on board the Research Vessel *Kalava* are described. Though the adults of this species are caught only rarely from the coastal waters of the mainland of India, it is found in appreciable numbers around the islands of the Laccadive Archipelago and forms a very important fishery in the Southern Island of Minicoy (Jones and Kumaran, 1959).

The species of thunnids known to occur along the Indian coast are, *Katsuwonus pelamis*, *Neothunnus macropterus*, *Euthynnus alleteratus affinis*, *Kishnælla tonggol*, *Auxis thazard* and *A. tapeinosoma*, but larval stages of none of these have been described so far from this area. The Danish Dana Expedition of 1928-30 around the world obtained a large number of tuna larvæ from the Indian Ocean and examination of the specimens from between Stations 3905 and 3975 has revealed the presence of larval *K. pelamis* along with those of other species. Since the work on the Dana collection is being attempted on a comparatively comprehensive basis as mentioned in the first article under the present series (Jones, 1958) it is felt that correlation of the larval material from the seas around India with the adults known to occur there will be helpful as background work. For the above reason the accounts in this series are essentially descriptive and comparison and discussions are reserved for the final report.

The collections were all made on board the Research Vessel *Kalava* of the Indo-Norwegian Project except specimens under serial numbers 4 and 23 which were collected on board *I.N.S. Jumna*, and specimens under serial numbers 18 and 27 which were collected on board *M.V. Asoka* while at anchor in the Minicoy lagoon (Table I). Most of the specimens were collected by the author during the first and third cruises of *R.V. Kalava* in the Laccadive Sea.

TABLE I

*Larvae of Katsuwonus pelamis (Linnaeus)*

S. No.	Date	Station No.	T.L.	St.L.	Head	Max.W.	Snout	Eye	Sn. to D.	Sn. to Vent.
1	8-4-1959	428	2.63	2.51	0.85	0.76	0.24	0.34	0.74	1.20
2	8-4-1959	428	2.97	2.85	0.86	0.85	0.24	0.34	0.74	1.26
*3	6-4-1959	424	3.48	3.37	1.26	1.03	0.34	0.40	1.20	1.60
4	27-2-1958	Kalpeni	3.60	3.43	1.26	1.08	0.46	0.46	1.26	1.71
5	28-2-1958	Kalpeni	3.71	3.54	1.65	1.25	0.62	0.54	1.65	1.82
†6	7-1-1959	73° 17' E 9° 39' N	3.85	3.71	1.46	1.20	0.51	0.43	1.43	1.77
7	1-3-1958	219	3.94	3.76	1.37	1.08	0.43	0.47	1.48	1.71
8	27-4-1959	444	4.17	4.05	1.65	1.31	0.62	0.57	1.65	2.11
9	27-4-1959	Chetlat	4.34	4.11	1.65	1.26	0.65	0.53	1.65	2.06
10	27-4-1959	Bitra	4.45	4.11	1.77	1.54	0.67	0.57	1.82	2.17
11	1-3-1958	219	4.51	4.28	1.60	1.37	0.59	0.50	1.66	2.06
12	1-3-1958	219	4.51	4.28	1.54	1.37	0.59	0.49	1.59	2.06
13	27-4-1959	444	4.57	4.40	1.65	1.42	0.63	0.51	1.71	2.11
14	27-4-1959	444	4.74	4.45	2.00	1.59	0.81	0.67	2.11	2.39
15	26-2-1958	215	4.85	4.68	1.82	1.42	0.66	0.54	1.77	2.22
16	27-4-1959	444	4.91	4.63	1.94	..	0.74	0.64	1.99	2.42
17	1-3-1958	219	4.98	4.74	1.71	1.48	0.68	0.54	1.77	2.23
‡18	5-12-1958	M.L.	5.08	4.85	2.05	1.60	0.83	0.67	2.06	2.45
19	1-3-1958	219	5.25	4.86	2.06	1.66	0.83	0.67	2.11	2.51
20	1-3-1958	219	5.42	5.08	2.00	..	0.70	0.63	2.11	2.62
21	1-3-1958	219	5.54	5.19	2.00	..	0.79	0.63	2.11	2.62
22	20-2-1958	209	5.60	5.31	2.06	1.60	0.74	0.63	2.12	2.51
23	27-4-1959	444	5.65	5.20	2.28	1.77	0.97	0.79	2.28	2.91
24	23-2-1958	210	5.71	5.31	2.16	1.60	0.85	0.65	2.28	2.63
†25	6-1-1959	73° 04' E 8° 25' N	5.71	5.12	2.11	1.71	0.80	0.65	2.23	2.79
26	27-4-1959	444	5.82	5.31	2.34	..	0.86	0.68	2.40	3.08
‡27	5-12-1958	M.L.	6.17	5.71	2.39	1.88	0.91	0.70	2.51	2.91
28	1-3-1958	219	6.62	6.13	2.40	1.85	0.99	0.74	2.46	2.91
29	5-12-1958	Minicoy	6.85	6.11	2.62	1.99	1.05	0.80	2.74	3.31
30	26-2-1958	215	7.08	6.34	2.63	1.94	1.08	0.80	2.68	3.14

M.L. = Minicoy lagoon; T.L. = Total length; St.L. = Standard length; Max.W. = Maximum width; Sn. to D. = Snout to dorsal. Sn. to Vent. = Snout to Vent.

\* Collected by Dr. R. Raghu Prasad.

† Collected by Mr. K. N. Krishna Kartha.

‡ Collected by Mr. M. Kumaran.

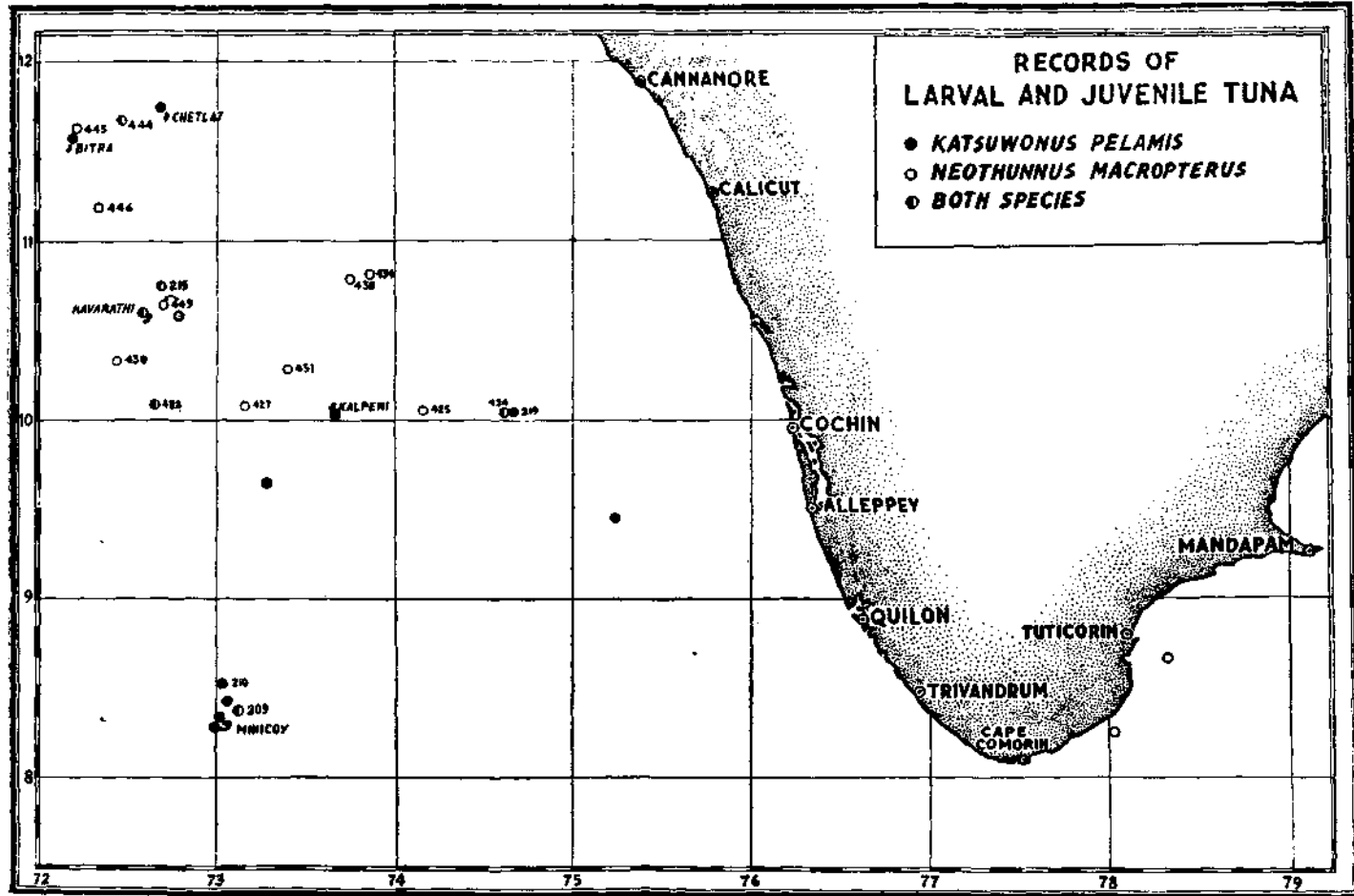


FIG. 1.

There are 38 larval specimens ranging in length from 2.63–7.08 mm. which could be definitely identified as *K. pelamis* of which 8 are in a damaged condition. Measurements of the 30 specimens in good condition are given in the table and typical stages among these are described below. In addition to the above an early juvenile specimen measuring 27 mm. is also described. The distribution of larval and juvenile specimens of *Katsuwonus pelamis* along with those of *Neothunnus macropterus* is shown in Fig. 1.

2.97 mm. stage (Fig. 2).—This specimen is No. 2 of the series, and was obtained from Station No. 428 on 8-4-1959 along with No. 1 measuring

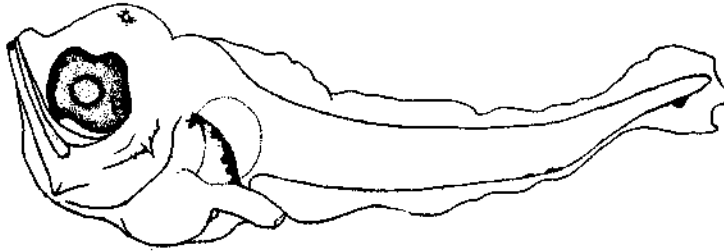


FIG. 2. 2.97 mm. stage of *Katsuwonus pelamis*.

2.63 mm. which was the smallest of the lot that could be identified as *Katsuwonus pelamis*. The latter was lost while a diagram of it was being prepared and hence is not being described here. They were similar in all essential details except that the mouth was not tilted to such an extent as in specimen No. 2 caused by the inordinate shrinking of the upper jaw. The floor of the mouth had given way but this has been reconstructed in the figure. The spines of the preoperculum are very inconspicuous.

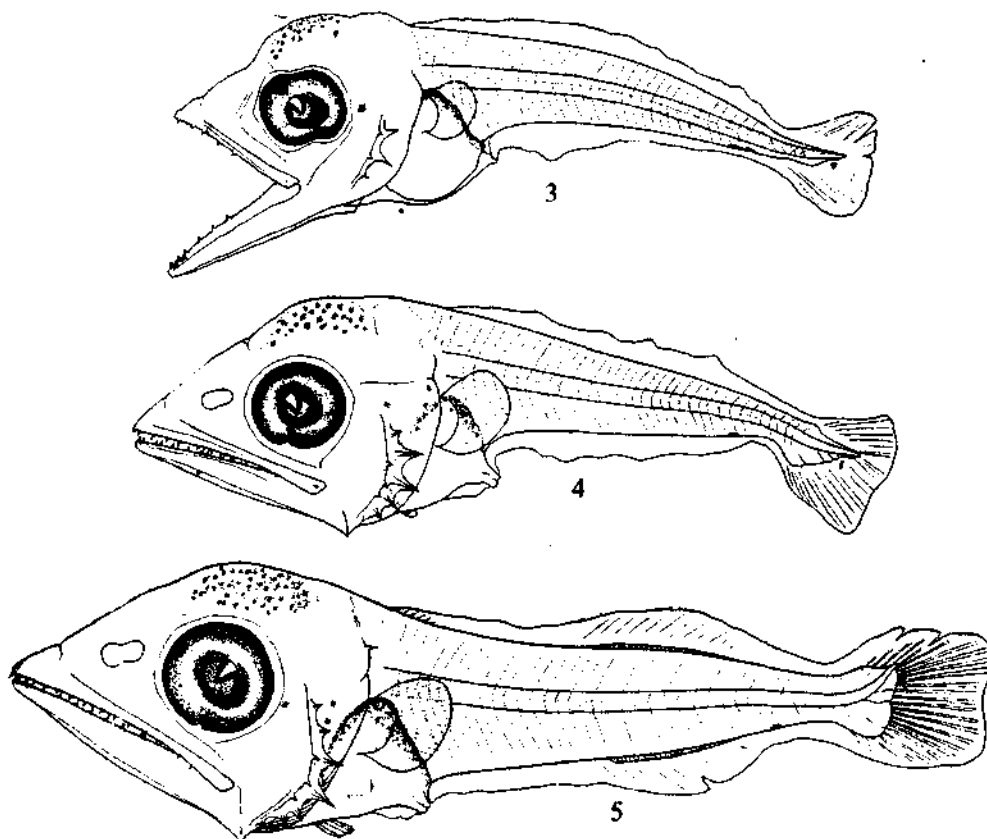
Median fins are continuous without any trace of fin-rays and the caudal fin is distinctly protocercal. The myotomes are not very clear and hence are not indicated in the figure. There are 4 chromatophores over the mid-brain, but only one of them is visible on the left side as is seen in the figure. There is a small patch of chromatophores at the tip of the lower jaw. A fairly large-sized chromatophore is present at the base of the caudal fin just below the tip of the notochord. On the mid-ventral line a little anterior to the caudal peduncle there are two chromatophores placed close to each other of which the posterior one is comparatively large. Small chromatophores pigment the dorsal surface of the abdominal sac.

3.60 mm. stage (Fig. 3).—This specimen, No. 4 in the series was collected during the night of 27-2-1958 while *Kalaya* was at anchor at Kalpeni. The

measurements are given in the table. The snout is distorted a little but the lower jaw has retained its shape thus making the jaws appear subequal. The angle of mouth reaches to about a vertical below the middle of the eye. A few teeth are present in the anterior portion of the jaws and the preoperculum has the characteristic spinous projection though not so conspicuous as in the later stages. The abdominal sac is "roundly triangular" and the vent is situated anterior to the mid-point of the total length of the body. The myotomes at the caudal end are not distinct. The median fins are continuous, the caudal being almost protocercal and all are devoid of any distinct fin-rays. Pelvic fins are absent. Most of the pigmentation is subcutaneous. There is a group of chromatophores on the head over the region of the mid-brain, an isolated one just behind the eye and another at the tip of the lower jaw. The chromatophore in the peritoneal lining of the abdominal cavity could be seen through the body wall, as shown in the figure. There is a conspicuous chromatophore at the ventral side of the caudal peduncle and another small at the base of the caudal fin below the tip of the notochord.

*5.08 mm. stage (Fig. 4).*—This specimen is No. 18 in the series and was collected from Minicoy lagoon on 5-12-1958 in an ordinary tow net. The measurements are given in the table. The jaws are equal and provided with more teeth. The maxilla extends to a vertical below the posterior margin of the eye. The preopercular spines are prominent and the pelvic fins, which are jugular in position, could be seen as small buds. The pectorals and the caudal fin show rudiments of fin-rays. Forty myotomes *plus* the urostyle portion of the caudal region could be counted. The caudal fin shows a tendency towards heterocercal condition. In addition to the small patch of dermal chromatophore at the tip of the lower jaw, an isolated one on each side is present about midway between the tip of the jaw and the angle of the mouth. The postorbital chromatophore seen in the previous stage is absent in this particular specimen though it is present in others of about the same stage. A few isolated chromatophores have developed on the upper aspect of the opercle. The general pattern of distribution of other chromatophores is the same as for the previous stage.

*7.08 mm. stage (Fig. 5).*—This specimen, No. 30 in the series, was collected from Station No. 215 on 26-2-1958. The head appears conspicuously large and the nasal openings show a constriction in the middle. A small post-temporal spine is present above the upper angle of the opercle. About 5 rudimentary spines are discernible in the anterior portion of the dorsal fin which later differentiates as the spinous dorsal. Rudiments of fin-rays are present in the posterior part of the soft dorsal and in the anal



FIGS. 3-5. Larval *Katsuwonus pelamis*. Fig. 3. 3.60 mm. stage, Fig. 4. 5.08 mm. stage. Fig. 5. 7.08 mm. stage.

fin while well developed rays are present in the pelvic fins. The chromatophores over the mid brain are more dense and a few are present over the region of the fore brain also.

No older larval stages are available in the collections and the only other specimen present is an early juvenile which is described below.

27 mm. stage (Fig. 6).—This specimen was collected from Station No. 205 on 19-2-1958. It had a deep cut in front of the dorsal fin and the figure drawn is a partially reconstructed one.

The general colour of the specimen in formalin is light brown due to the presence of chromatophores over the body. Head is nearly  $\frac{1}{3}$  of the total length, snout  $\frac{1}{3}$  and eye  $\frac{1}{4}$  of the head and the latter  $\frac{7}{10}$  of the snout length. The maximum width is at the pectoral region and is nearly  $\frac{1}{5}$  of the total length.

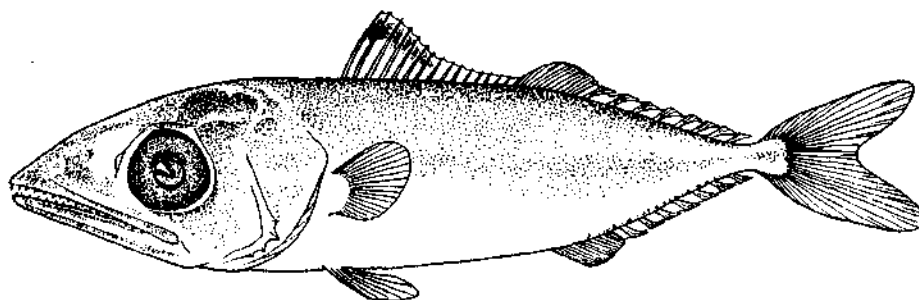


FIG. 6. Juvenile *Katsuwonus pelamis*. 27 mm. total length (Reconstructed).

The teeth are distinct and angle of the mouth reaches to about a vertical below the middle of the eye. The rudiments of 4 preopercular spines are still present. The pelvics are as long as the pectorals. The full complement of spines, rays, and finlets have developed. The finlets on each side are connected together by a thin membrane.

The pigmentation in the specimen is comparatively denser on the dorsal aspect of the head and body. The spinous dorsal has patches of chromatophores on the upper half of the fin membranes between the anterior eight rays. The ventral side of the body is practically devoid of chromatophores except for a row on each side along the base of the anal fin and finlets.

Shaeffer and Marr (1948) while referring to the spawning habits and juvenile stages of *Neothunnus macropterus*, and *Katsuwonus pelamis* in the Pacific off Central America have discussed the previous work on the larval and juvenile stages of the above species and notably the contributions on the subject by Lütken (1880), Ehrenbaum (1924), and Kishinouye (1919 and 1926) and gave reasons for fixing the identity of the forms examined by them. The descriptions by Wade (1951), and Matsumoto (1958) have been helpful in identifying the larval *K. pelamis* collected from the Laccadive Sea. The larval skipjack drawn and described by Yabe (1953 and 1955) are also similar to the above. Further, the pattern of occurrence of the larval forms is in agreement with the distribution of the adult in the Laccadive area and for reasons already detailed by the previous workers it could be said that there is little doubt about the identity of larval *K. pelamis*.

The 27 mm. juvenile described in the present account agrees in all essential details with the juvenile of the corresponding length described by Wade (1950) and with the early juveniles recorded by Shaeffer and Marr (*op. cit.*), and Shimada (1951).

The observations carried out in the Laccadive Sea and the collections made are too meagre for drawing any conclusions about the spawning of

this species in this area. From the condition of the gonads of the skipjack caught in the Minicoy area it appears that January to March is the peak breeding time there, but it is likely that the breeding period is rather quite an extended one. According to Wade (1951) *K. pelamis* spawns throughout the year in the Philippine waters with indications of September to April as the principal period of spawning.

#### IV. *Neothunnus macropterus* (Temminck and Schlegel)

There are 36 specimens of larval stages of the yellowfin, *Neothunnus macropterus* in the collection of which 33 were made on board *Kalava* of the Indo-Norwegian Project. Most of the specimens were collected by the author during the first and third cruises of the Research Vessel in the Laccadive Sea. Specimen No. 18 in the series was collected on board *I.N.S. Jumna* and specimens Nos. 14 and 24 from a country craft (Table II). The measurements of all the specimens are given in Table II and some of the typical stages are described below.

3.88 mm. stage (Fig. 7).—This is the earliest larva that could be definitely assigned to *N. macropterus* and was collected from Station No. 434 on 9-4-1959.

The jaws are equal and teeth are few and rudimentary. The pre opercular spines though present are not prominent as in the later stage. Pelvic fins have not yet developed and the caudal fin is almost protocercal. All the fins are devoid of any distinct fin rays. There is a small patch of chromatophores on the head over the region of the mid brain and in addition a small isolated chromatophore is present in the caudal fin just below the tip of the notochord.

5.25 mm. stage (Fig. 8).—This specimen, No. 12 in the series, collected from Station No. 446 on 28-4-1959, exhibits more developed characters than the previous one.

More teeth, relatively larger are present in the jaws. The perpendicular spines are prominent. Pelvic fins are present as small buds. The tail is heterocercal and rudimentary rays could be seen in all fins in addition to the two anterior spines of the first dorsal. Besides the chromatophores mentioned in the previous stage, which have slightly increased in their intensity, there are two small patches, one each at the tip of the upper and lower jaws.

6.85 mm. stage (Fig. 9).—This specimen was collected on 6-4-1959 from Station No. 424.



TABLE II  
*Larvae of Neothunnus macropterus (Temminck & Schlegel)*

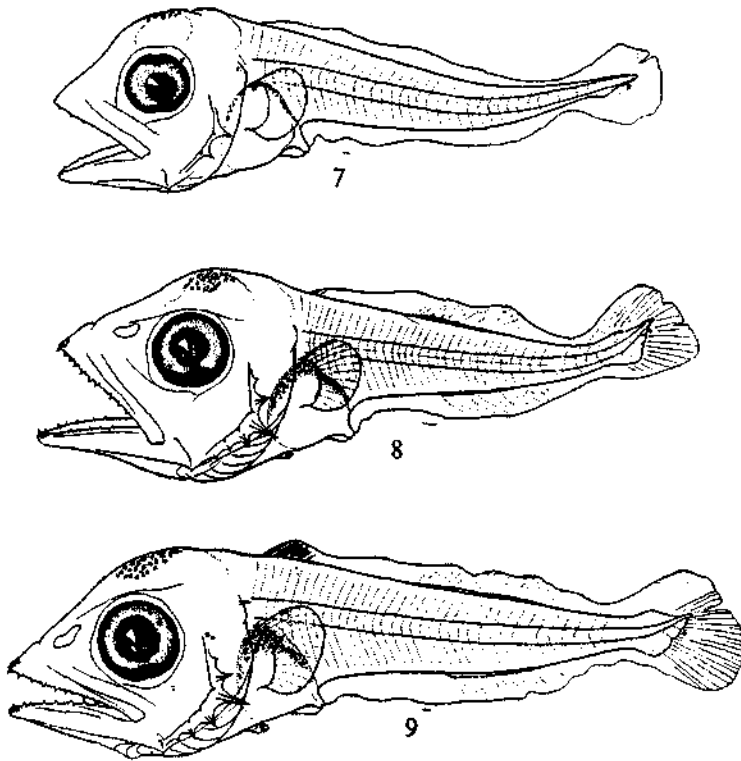
S. No.	Date	Station No.	T.L.	St.L.	Head	Max.W.	Snout	Eye	Sn. to D.	Sn. to Vent.
*1	9-4-1959	434	3.88	3.71	1.20	1.08	0.40	0.40	1.26	1.64
2	30-4-1959	451	3.88	3.54	1.37	..	0.40	0.47	1.37	1.77
3	21-2-1958	209	4.11	3.91	1.49	1.19	0.48	0.48	1.60	1.87
4	27-4-1959	445	4.23	4.11	1.54	1.26	0.52	0.57	1.60	1.97
*5	8-4-1959	430	4.28	4.16	1.32	1.20	0.71	0.46	1.43	1.97
6	20-2-1958	209	4.28	4.11	1.65	1.37	0.57	0.57	1.71	2.1
7	21-2-1958	209	4.34	4.17	1.49	1.31	0.51	0.51	1.77	2.07
8	30-4-1959	451	4.57	4.34	1.80	..	0.57	0.57	1.88	2.36
9	27-4-1959	444	4.57	4.39	1.71	..	0.57	0.54	1.71	2.2
10	21-2-1958	209	4.68	4.51	1.60	1.42	0.57	0.54	1.77	2.1
11	29-4-1959	449	4.80	4.57	1.94	..	0.65	0.60	1.99	2.5
12	28-4-1959	446	5.25	4.91	1.94	1.71	0.74	0.65	2.00	2.37
13	30-4-1959	451	5.25	4.68	2.00	1.71	0.68	0.68	2.00	2.47
†14	23-3-1959	Off K.	5.31	4.97	2.06	1.55	0.70	0.63	2.11	2.5
*15	9-4-1959	434	5.65	5.42	2.00	1.71	0.68	0.63	2.06	2.6
16	26-2-1958	215	5.74	5.25	2.16	1.77	0.79	0.63	2.11	2.6
*17	6-4-1959	424	5.82	5.42	2.06	1.77	0.67	0.67	2.06	2.7
18	25-3-1959	78° 03' E 8° 15' N	5.82	5.25	2.28	1.88	0.91	0.74	2.34	2.8
19	24-4-1959	438	5.88	5.20	2.23	1.83	0.87	0.68	2.23	2.7
*20	7-4-1959	427	5.94	5.59	2.11	1.77	0.74	0.62	2.23	2.8
21	25-2-1958	K.A.	6.22	5.71	2.46	1.94	0.94	0.80	2.56	3.0
22	25-2-1958	K.A.	6.45	5.88	2.57	2.00	0.97	0.86	2.63	3.1
*23	8-4-1959	428	6.45	5.71	2.51	1.94	0.94	0.74	2.56	3.0
‡24	23-3-1959	Off K.	6.51	5.82	2.57	2.11	0.99	0.80	2.68	3.3
*25	6-4-1959	424	6.62	6.00	2.39	1.94	0.88	0.80	2.57	3.1
26	6-4-1959	424	6.85	6.33	2.23	1.83	0.76	0.74	2.28	2.8
27	6-4-1959	424	7.19	6.57	2.51	1.99	0.91	0.80	2.57	3.3
28	6-4-1959	424	7.42	6.51	2.91	2.23	1.08	0.86	2.86	3.5
*29	8-4-1959	428	8.34	7.08	3.08	2.34	1.20	1.08	3.25	4.0
*30	7-4-1959	425	8.39	7.02	3.48	2.57	1.37	1.08	3.31	4.1
31	25-2-1958	K.A.	8.45	7.31	3.37	2.56	1.31	1.14	3.43	4.2
32	25-2-1958	K.A.	8.47	7.48	3.48	2.57	1.42	1.20	3.54	4.6
33	25-2-1958	K.A.	8.61	7.94	3.71	2.68	1.48	1.26	3.82	4.6
34	25-2-1958	K.A.	8.85	7.63	3.54	2.63	1.48	1.20	3.65	4.5
35	25-2-1958	K.A.	9.54	7.99	3.65	2.74	1.43	1.22	3.83	4.9
‡36	23-2-1959	78° 20' E 8° 40' N	10.56	8.85	4.05	2.91	1.49	1.37	4.17	5.4

Off K. = 10 miles to the east of Kavarathy Island. K.A. = Kavarathy Anchorage outside the reef; T.L. = Total length; Max.W. = Maximum width; Sn. to D. = Snout to dorsal. Sn. to Vent. = Snout to Vent.

\* Collected by Dr. R. Raghuprasad.

† Collected by Mr. S. V. Sheik Koya Thangal.

‡ Collected by Mr. V. Balan.



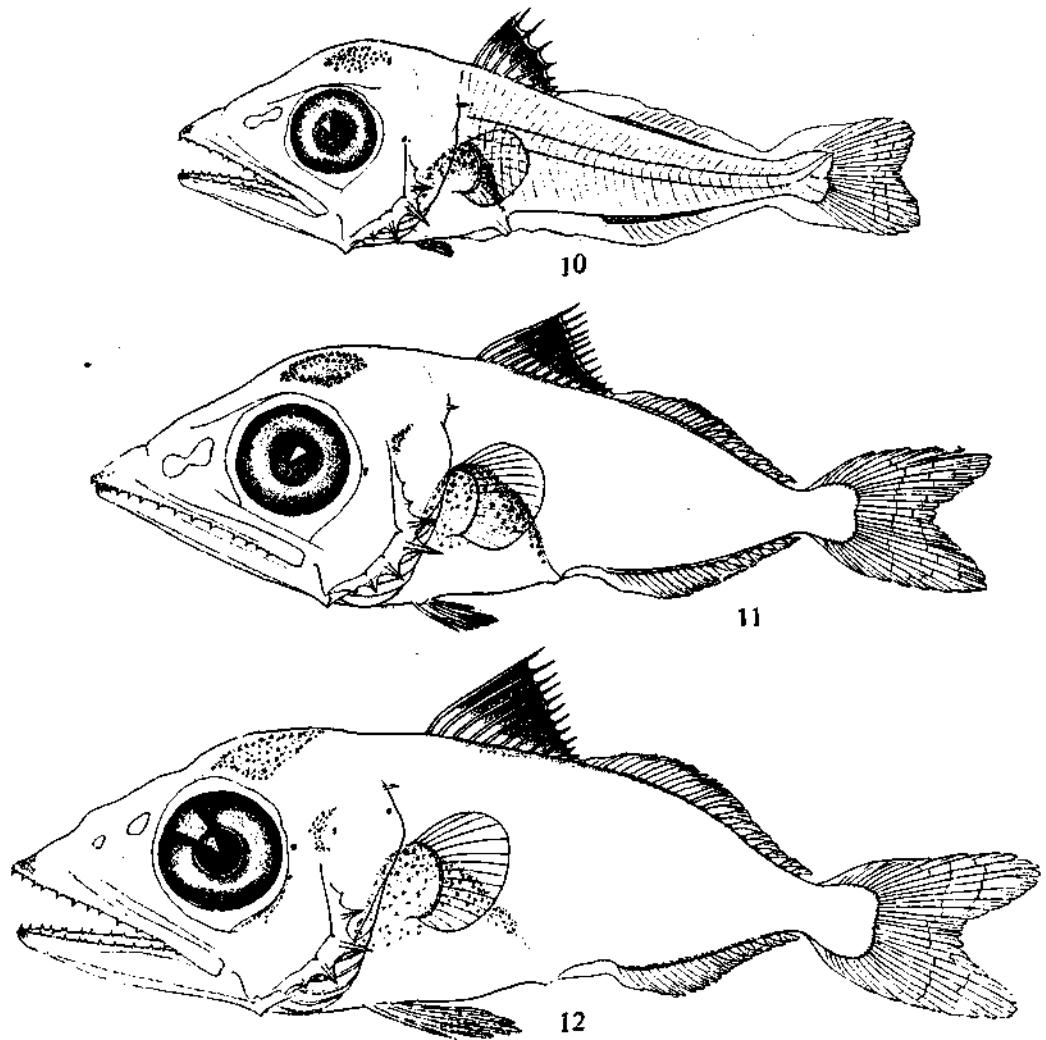
FIGS. 7-9. Larval *Neothunnus macropterus*. Fig. 7. 3.88 mm. stage. Fig. 8. 5.25 mm. stage. Fig. 9. 6.85 mm. stage.

A post-temporal spine is present immediately above the angle of the opercle. The first dorsal has 7 spines with dense chromatophores on the fin membrane between them which is very characteristic of the larvae of this species. There are two small chromatophores immediately behind the angle of the preoperculum in addition to those present in the previous stage.

7.42 mm. stage (Fig. 10).—This specimen was collected at the same time and place as the previous stage described.

The nasal opening on each side is elongated and shows a constriction in the middle. The first dorsal has 8 spines and is prominent with dense chromatophores along its upper half. The caudal fin is slightly forked and emarginate. The general pattern of distribution of chromatophores is similar to that of the previous stage.

8.85 mm. stage (Fig. 11).—This specimen was collected during the night of 25-2-1958 with a plankton net left under a drop light suspended.



FIGS. 10-12. Larval *Neothunnus macropterus*. Fig. 10. 7.42 mm. stage. Fig. 11. 8.85 mm. stage. Fig. 12. 10.56 mm. stage.

outboard just above the surface of the water while *R.V. Kalava* was anchored outside the reef at Kavarathy.

The specimen has the broad and chubby appearance generally seen in the early juveniles of tunas. There has been apparently a backward shifting of the vent and increase in depth of the body. The caudal is separate from the dorsal and anal fins. The first dorsal shows 13 spines and it is connected to the second dorsal by a narrow fin fold. The dorsal and anal finlets are dis-

tinct. The pelvic fins have grown conspicuously longer than in the previous stage. The preanal fin-fold has disappeared. There is a general increase in chromatophores. A narrow line of chromatophores is present on each side immediately below the dorsal fin, an isolated one behind the orbit and a small patch on the opercle. The chromatophore in the caudal fin is not present in this particular specimen though it is found in others of about the same length and in the older stage described below.

10.56 mm. stage (Fig. 12).—This specimen was collected in a plankton haul at 78° 20' E, 8° 40' N in the Gulf of Mannar on 23-2-1959 while *R.V. Kalava* was being taken to Mandapam for repairs.

The specimen has the general appearance of an early juvenile though the preopercular spines are still present and chromatophores have not invested the body. The nares are separate. The anus has shifted still backwards and the ventral fins have grown longer. The full complement of rays are present in all the fins except in the dorsal and anal. The finlets are connected to one another by a thin membrane. There is a slight increase in chromatophores as shown in the figure and an additional patch of chromatophores is present below the orbit.

Older stages than the one described above are not available in the collection. Regarding the identification of the larval stages, the remarks made under *K. pelamis* (*vide* page 366) hold good here also. The contributions by Schaeffer and Marr (1948), Mead (1951), Wade (1951) and Matsumoto (1958) have been helpful in the specific identity of these larvae from the Laccadive Sea.

In this connection it may be stated that the earliest stage of *N. macropterus* described by Wade (1951) from Philippine waters is 5.15 mm. while the earliest stage identified positively as that of the above species from the Hawaiian waters by Matsumoto (1958) is 3.9 mm. The 5.15 mm. stage figured and described by Wade (*op. cit.*) shows appreciable difference from specimens of about the same length collected from Indian waters and the 5.5 mm. stage described by Matsumoto (*op. cit.*). While difference in the presence of chromatophores could be attributed to the fact that the diagram of the former by Wade (*op. cit.*) has been made after clearing the specimens certain other differences such as the general body proportions, nature of the caudal fins and preopercular spines, absence of pelvics, position of the dorsal, etc., remain to be explained. As indicated in the description by Matsumoto (*op. cit.*) and evident from the specimens from the Laccadive Sea the pelvics appear even when the larva is about 4.75 mm. old at which stage the head is also proportionally larger, the body deeper, and the tail heterocercal.

There is no other information about the spawning of this species in Indian waters and the available data is too meagre for drawing any conclusions. According to Wade (1951) ripening adults were taken during trolling throughout the year from the Philippine Seas suggesting a protracted spawning period. Larval forms were collected by him almost throughout the year but March to December appear to be the period of intensive spawning with the maximum from May through September.

I am grateful to the Indo-Norwegian Project for making available *R.V. Kalaya* for the special cruises in the Laccadive Sea. I wish to place on record the interest taken and the courtesies shown during the cruises by the Norwegian Officers and Indian crew on board the Research Vessel. My thanks are due to Mr. M. Kumaran for the general assistance given to me in the laboratory and for the preparation of the diagrams and to my other colleagues who kindly collected some of the specimens described in the article.

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