

4.3 Bothid larvae – distinguishing features

Flat fish larvae differ greatly from adults except in some morphometrics and meristics after certain stage of growth.

The adult flat fishes are distinguished from other groups in having asymmetrical, strongly compressed body with short preanal region and with both eyes on one side ; dorsal fin fold and anal fin fold long and continuous; caudal fin with generally 17 or less principal rays, of which 15 are branched ; pelvic (ventral) fins generally with six or fewer number of rays, thoracic or jugular in position ; pelvic radials directly attached to the cleithra ; swim (air) bladder absent in adults ; mouth more or less protractile, bordered by premaxillaries ; parietals separated by superoccipitals ; interorbital bar mainly formed by the frontal of the ocular side ; pectoral arch attached to the skull by a forked post-temporal ; mesocoracoid absent ; vertebral column with solid centra co-ossified with arches ; posterior caudal vertebra with downwardly directed parapophyses (Norman, 1934).

The family Bothidae is discernible from other groups of flat fishes in the dorsal fin extending forward on to the head at least above the eye, none of the rays spinous, all rays articulated ; pelvic fins with asymmetrical base, that of the ocular side longer than that of the blind side and extending forward to the urohyal supported by a cartilaginous plate placed in advance of the cleithra, its anterior rays well in advance of the first ray of the blind side. Mouth terminal without supplemental bones ; no teeth on palate ; vertebrae never less than 30 ; caudal vertebrae with well developed apophyses ; preopercular margin free ; lower jaw generally prominent. Lower edge of the urohyal deeply emarginate so that the bone appears forked ; nasal organ of the blind side near edge of head ; optic chiasma monomorphic, the nerve of the right eye in sinistral forms always dorsal: pectoral radial present ; one or two postcleithra on each side ; ribs present ; eyes on left side (except in reversed specimens).. The first neural spine absent ; urostyle fused with hypural ; last neural and haemal spines fused with centrum (Amaoka, 1969).

Eggs of Bothidae have a single, small to moderate sized oil globule, are pelagic, round, have a narrow to moderate perivitelline space, and homogenous yolk. In late stage eggs and newly hatched larvae the single oil globule usually is in the rear of the yolk mass (Ahlstrom, *et al.*, 1984).

The larvae of flat fishes are symmetrical in early stages with thin, laterally compressed body ; continuous median fin folds without spinous rays ; the forward extension of the dorsal fin over the skull to the level of the eye ; all rays articulated through a system of pterygiophores and baseosts ; caudal fin with 17 rays, of which 15 are branched and borne on hypural plates ; pelvic fin with six rays ; left pelvic fin radial asymmetrical in advanced larval stages with its anterior rays in advance of the first ray of the right fin ; pelvic fin radials attached to the cleithra ; a urohyal (sciatic portion, Hensley, 1977) cartilaginous plate of Kyle (1913) and Norman (1934) placed in advance of cleithra ; presence of postcleithra on either side ; the pelvic fin complex consisting of a pair of 'Y' - shaped basipterygia attached to the posterior lower middle faces of the cleithra between cleithral tips and pectoral fins on either side ; to begin with the complex differentiates as a cluster of chondroblasts (cells) which transforms into the dorsal, posterior and anterior cartilaginous basipterygial processes as larvae grow. The dorsal basipterygial processes serve to attach the basipterygia to the cleithra, the anterior basipterygial processes differentiate into the pelvic fin radials and the fins and the posterior basipterygial processes (cartilaginous pubic bar, Kyle, 1913) continue as extension from the dorsal basipterygial processes posteriorwards along the midventral line of the body wall reaching up to the anal opening or before that. The terminal portion of the processes either end straight or get curved dorsalwards and may bear spines either in the proximal portion or full length ; the spines may or may not be present in cleithra, urohyal or posterior basipterygial processes or in any one them. All the aforesaid characters either singly or in combination with other characters help to distinguish larvae of bothids from other flat fishes.

Ahlstrom *et al.*, (1984) have reviewed the literature on pleuronectiform larvae and summarised the main characters belonging to several families and genera. According to them bothid larvae are thin bodied to diaphanous, sparsely pigmented, and possess an elongate second dorsal ray. Spines may appear on

urohyal, basipterygia, cleithra and epiotics. Bothid larvae reach relatively large size before metamorphosis. Early larval stages are often poorly represented in collections. They have recognised two subfamilies – Taeniopsettinae and Bothinae. All Taeniopsettinae genera have spines on epiotics urohyal, cleithra and basipterygials. The second dorsal ray is moderately or slightly elongate.

Larvae of Bothinae have ovate, round or elongate shape and lack epiotic spines. *Engyprosopon* has numerous urohyal and basipterygial spines and some species have spines on cleithra. *Psettina* and *Grammatobothus* have urohyal and basipterygial spines. Early larvae of *Psettina* have a hook-like projection on the lower jaw. *Crossorhombus* and *Lophonectes* have basipterygial spines only. Others do not have spines.

The present account is confined to the larval stages belonging to the subfamily Bothinae because, the other subfamily Taeniopsettinae representatives were not found in the collections taken during International Indian Ocean Expedition and Naga Expedition. Larvae belonging to the genera *Parabothus*, *Crossorhombus*, *Engyprosopon*, *Bothus*, *Asterorhombus*, *Psettina*, *Arnoglossus*, *Laeops* and *Chascanopsetta* are described and discussed in the present account.

4.4 Descriptions of larval stages and adults.

1. *Parabothus polylepis* (Alcock, 1889)

Larvae belonging to postflexion stages measuring 14.6 mm SL and 23.4 mm SL are available in the zooplankton collected during the International Indian Ocean Expedition (Figs. 1 A, B ; Tables 1 a, b).

Morphology :

Larval body thin, transparent, laterally compressed almost uniformly broad, leaf-like. Dorsal and ventral body wall runs almost parallel except towards the caudal region. In 14.6 mm SL larvae, eyes are symmetrical and black, the right one has started shifting and has reached the dorsal profile. Mouth small, less than the diameter of the eye, jaws almost equal with numerous teeth. Alimentary canal runs parallel to notochord to the level of seventh vertebral segment forms an elliptical coil placed at the posterior end of abdominal cavity, anus opens at the level of eighth vertebral segment. In 23.4 mm SL, rectal portion pushed forwards whereas the dorsal half remains undistributed, causing a characteristic bend in the intestinal loop towards its middle. Anus lies at the level of the sixth vertebral segment and swim bladder occupies posterior dorsal aspect of abdomen above intestinal loop.

Spines absent on the urohyal, cleithra and posterior basipterygial processes.

Fin and supporting structures :

Median fins continuous, dorsal fin extends over the skull reaching in front of the eye. First dorsal ray very small but the second is stout and long, supported by the first elongated dorsal pterygiophore. First anal pterygiophore long and stout articulated to the long, broad haemal spine of the first caudal vertebra, distal portion of pterygiophore is pushed forwards along with the rectal portion of intestinal coil in 23.4 mm SL. Median fin rays well developed and ossified. There are 92-94 dorsal and 72-73 anal fin rays.

Caudal rays well developed, of the 17 rays, three are borne on inferior hypural lower, four on inferior hypural middle, five on superior hypural middle,

three on superior hypural upper, and two rays borne directly by neural and haemal processes of penultimate vertebra on either side. Epural fused with superior hypural upper and does not bear any ray directly on it.

Pectoral fin retains the embryonic condition even in 23.4 mm SL larva. Arising from the posterior ventral face of the cleithra, a pair of juxtaposed cartilaginous rods (dorsal basipterygial processes) between pectoral fin and cleithral tips run obliquely down, which on reaching the level of cleithral tip continue as posterior basipterygial processes lying along the ventral body wall. At a little distance below the cleithra basipterygial processes give out a forward extension, the anterior basipterygial processes which in turn becomes the pelvic fin radial. In 14.6 mm SL the anterior basipterygial processes (pelvic fin radials) retain the cartilaginous nature. No rays are differentiated in the pelvic fin. In 23.4 mm SL pelvic fin rays are well differentiated. Three anterior rays of the left pelvic fin lie in advance of right fin, fourth ray lies opposite the cleithral tip, posterior basipterygial processes lying along the ventral body wall extend to the level of ascending loop of intestinal coil in 23.4 mm SL.

Axial skeleton :

Vertebral segments are well differentiated in the posterior caudal portion in 14.6 mm SL larva, neural and haemal processes of caudal region are well developed, in the precaudal portion only haemal arches are seen, vertebrae are clear in the anterior portion, in 23.4 mm and ossification is seen in most of them. In the caudal region the centra have assumed dumb-bell shape. Tiny spines discernible capping the posterior six haemal arches in 14.6 mm in the precaudal region are converted into six haemal processes in 23.4 mm SL. First neural arch is cartilaginous in 14.6 mm but ossification is visible in 23.4 mm ; There are 10 + 29-31 vertebrae including urostyle.

The adult :

Depth of body $2 \frac{1}{8}$ in the length of head $3 \frac{1}{5}$ to $3 \frac{1}{2}$. Upper profile of head a little notched in front of eyes. Diameter of eye 3 to 4 in length of head, and about 6 times interorbital width (mature o). A blunt knob on the snout above the maxillary. Maxillary extending to a little beyond anterior edge of eye, length $2 \frac{3}{4}$ to 3 in that of head. 8 or 9 gill-rakers on lower part of anterior arch. 82 to

85 scales in lateral line. Dorsal 83. Anal 63-66. Pectoral of ocular side with 11 rays, length $1 \frac{1}{2}$ to $1 \frac{2}{3}$ in that of head. Brownish ; a series of large dark rings at upper and lower edges of body, inconspicuous in the larger specimen ; two dark blotches or ocelli at junction of straight and curved parts of lateral line, and a larger blotch on middle of straight portion ; median fins with small brown spots ; pectoral with three indistinct brown cross-bars (Norman, 1934).

Remarks :

The larvae of *Parabothus* can be distinguished from others in the broad leaf-like body which is thin, in the presence of elongate dorsal fin ray at the anterior end of the dorsal fin, first tiny dorsal ray, urohyal in front of the cleithra, long asymmetrical left pelvic fin radial with anterior three rays in advance of the right fin, and in the posterior basipterygial processes extending to the ascending loop of the intestinal coil. These characters are shared by the larvae of *Parabothus* and *Arnoglossus* spp. Norman (1934) has reported that the adults of *Parabothus* are very close to *Arnoglossus* and *Bothus* from which *Parabothus* can be distinguished by the shape of the body and the meristics. In the larvae, parallel body profile is also met with in *A. elongatus* but not broad. The larvae of *Parabothus* can be distinguished by the broad leaf like body, the characteristic bend in the intestinal loop towards its middle, late differentiation of pelvic fin rays and the meristics from *A. elongatus* and also in the absence of extraordinarily elongate anterior dorsal fin ray at the anterior end.

The adults are reported from the Indian Ocean. The postflexion larvae of *Parabothus polylepis* are described and reported for the first time. The absence of preflexion and flexion stages in the present series limit the detailed description of the larval forms.

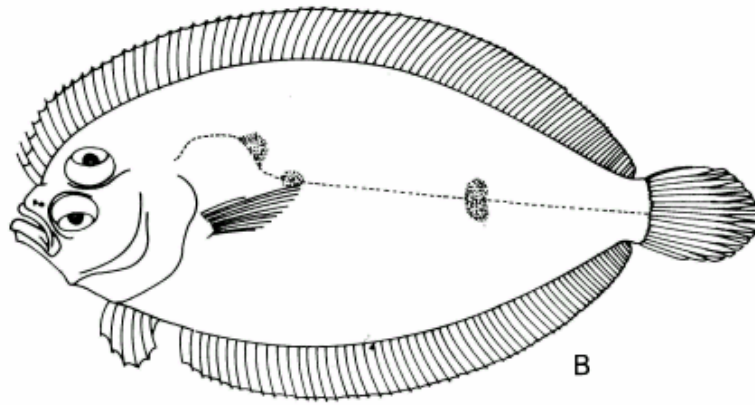
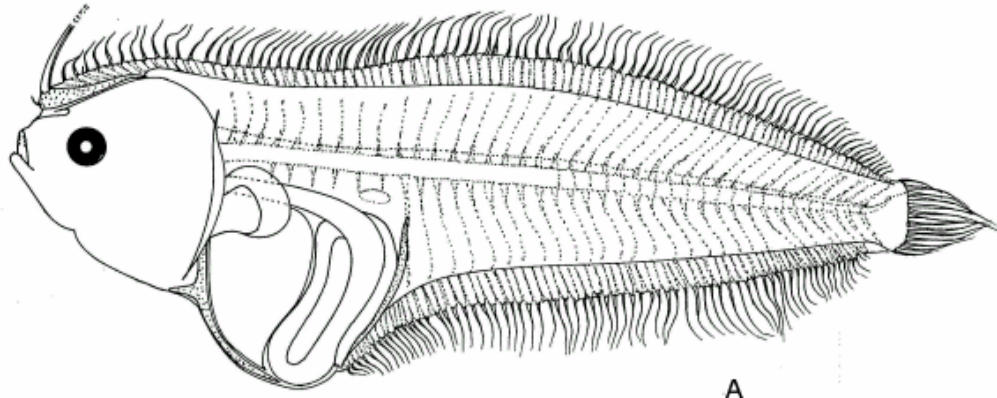


Fig. 1 - *Parabothus polylepis* A –14.6 mm SL (from Lalithambika Devi, 1986),
B – Adult (from Norman, 1934).

Table 1 a - *Parabothus polylepis* - morphometrics, in mm (Larval stages).

Stations	Body Length	Right Eye	Stage	Snout to Anus	Head Length	Snout Length	Eye		Body depth at Anus		Caudal Depth	Caudal Peduncle Length	Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Depth			
Ki 707	14.6 SL	Symmetrical	Post flexion	5.40	3.50	0.85	0.62	0.65	3.74	4.97	1.47	0.66	2.86
AB 22	23.4 "	Migrating	"	6.90	5.80	1.44	1.15	1.32	8.48	9.41	3.32	1.22	2.74

Table 1 b. *Parabothus polylepis* - meristics (Larval stages).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae		
					Dorsal	Anal	Caudal	Precaudal	Caudal	Total
Ki 707	14.6 SL	Post flexion	Flexed	Symmetrical	92	72	17	10	31	41
AB 22	23.4 "	"	"	Migrating	94	73	17	10	29	39

2. *Crossorhombus valde – rostratus* (Alcock, 1890)

Larval forms ranging from 6.0 mm SL to 12.9 mm SL are found in the IIOE and Naga Expedition zooplankton collections. Only postflexion stages are available in these collections (Figs. 2 A, B ; Tables 2 a, b).

Morphology :

Larval body thin, translucent, symmetrical and ovoid. Eyes black, remain symmetrical even in the largest specimen in the collections. Jaws carry small teeth, anterior portion of the alimentary canal runs almost parallel to the vertebral column up to the level of the 7th vertebral segment, thereafter runs down making a single elliptical coil. In the largest specimen available in the collection, anus opens at the level of the 5th vertebral segment, liver not massive as in *Engyprosopon*, *Bothus*, *Psettina* and *Arnoglossus* spp., its dorsoventral axis is twice the anteroposterior axis along the greatest width, ventral portion tapers and is placed below the intestinal coil. Swim bladder occupies the space between 8th and 10th vertebral segments, and does not appear to push the alimentary canal down as is seen in some species.

Spines are found only on the left ramus of the posterior basipterygial processes and are few in number, these get reduced in size towards distal end.

Fin and supporting structures :

Median fins continuous, forward extension of the dorsal fin fold has reached up to level of snout but is not fused with the cranium, tiny first dorsal ray is discernible in 6.0 mm SL in which the full complement of the median rays, characteristic of the species are found. Dorsal fin has 82-89 rays and the anal fin 62-68, second elongated dorsal ray so characteristic of bothids is hardly distinguishable even in the earliest larva available. Seventeen caudal fin rays occur and are distributed on hypural plates as follows: inferior hypural lower 3, inferior hypural middle 4, superior hypural middle 5, superior hypural upper 3 and one ray each on neural and haemal processes of the penultimate vertebra.

Pelvic fin radial, fin rays and posterior basipterygial processes are well differentiated in 6.0 mm SL, pelvic fin radial of the left side longer than that of the

right and three left pelvic fin rays occur in advance of the right fin. In 8.9 mm SL larvae, fourth pelvic fin ray lies opposite the tip of the cleithra. Posterior basipterygial processes lie along the ventral aspect of the abdominal wall, distal extremity of the left ramus tapers and reaches almost up to the middle of the intestinal loop, while that of the right ramus before reaching the level of the distal end of the left ramus curves dorsalwards and forwards and stops in front of the tip of the liver.

Axial skeleton :

In the absence of preflexion and flexion stages, it was not possible to study the progress of ossification in detail. In 6.0 mm larvae, vertebral segments are clearly marked, neural processes are bony, haemal processes of the caudal region are also bony, spines of the pre-caudal haemal arches are reduced in the last three, fairly well developed in the preceding three, absent in others. First neural arch remains cartilaginous even in the largest specimen of the present collection. The number of vertebrae ranges from 10+24-26 including urostyle.

The adult :

Depth of body $1 \frac{4}{5}$ to twice in the length, length of head $3 \frac{2}{3}$ to a little more than 4. Snout shorter than eye, diameter of which is $3 \frac{1}{3}$ to $3 \frac{3}{5}$ in length of head; each eye with a broad membranous flap in the male; interorbital width $1 \frac{1}{3}$ to $1 \frac{2}{5}$ times () or $\frac{3}{5}$ to $1 \frac{1}{6}$ times () diameter of eye; anterior edge of upper eye above middle or posterior part of lower. Male with a strong spine on the snout and some smaller spines on orbital margins. Maxillary extending to below anterior edge of eye, length $3 \frac{2}{3}$ to nearly 4 in that of head. 5 to 7 gill-rakers on lower part of anterior arch. 48 to 61 scales in lateral line. Dorsal 79-89. Anal (61) 63-74. Pectoral of ocular side with 10 or 11 rays, the upper ray prolonged and filamentous in the mature male; length $1 \frac{1}{4}$ to $1 \frac{3}{4}$ times () or $\frac{3}{4}$ to $\frac{7}{8}$ () that of head. Greyish brown, with darker spots and blotches, of which a row near upper and lower edges of body and 2 or 3 larger ones on lateral line are usually most prominent; male sometimes with small dark or bluish spots on head in front of interorbital space; median fins spotted with darker; hinder part of caudal with a broad blackish band (Norman, 1934).

Remarks :

It was not possible to study the sequence of formation of various systems because of the absence of preflexion and flexion stages in the collections. The post flexion stages of *Crossorhombus valde-rostratus* can be distinguished from other bothids in the presence of spines only on the left ramus of the posterior basipterygial processes and the absence on the cleithra and urohyal (Sciatic portion). The meristics and morphometrics agree with those of adults. The adults are reported from the Indian Ocean. Lalithambika Devi (1989 b) has described and reported for the first time the post larval stages of *Crossorhombus valde-rostratus*, from the Indian Ocean and adjacent waters.

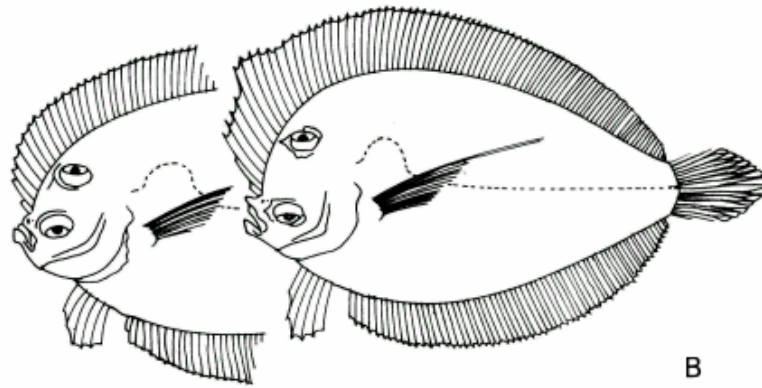
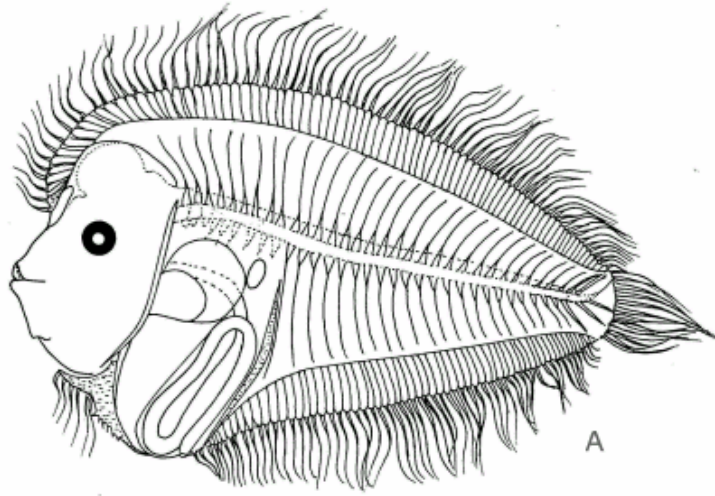


Fig. 2 - *Crossorhombus valde-rostratus*, A – 8.8 mm SL, B – Adult (from Lalithambika Devi, 1986).

Table 2 a - *Crossorhombus valde-rostratus* - morphometrics, in mm (Larval stages).

Stations	Body Length	Right Eye	Stage	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus	Depth	Length	
S8-23B	6.0 SL	Symm etrical	Post flexion	2.10	2.00	0.63	0.35	0.35	3.80	3.80	0.84	0.32	1.00
"	6.9 "	"	"	2.30	2.40	1.29	0.39	0.40	4.10	4.20	1.06	0.43	1.30
KI407	8.0 "	"	"	2.50	2.20	0.97	0.50	0.55	4.50	4.40	1.00	0.42	0.80
S10-7	8.9 "	"	"	2.40	2.40	1.09	0.45	0.48	5.90	5.90	1.70	0.68	0.80
S11C-100	9.8 "	"	"	2.50	2.50	1.16	0.45	0.48	6.20	6.20	2.00	0.64	0.80
DI5514	10.2 "	"	"	2.50	2.20	1.09	0.48	0.53	6.70	6.50	2.10	0.68	0.80
S11C-34	12.2 "	"	"	3.10	3.30	1.29	0.58	0.64	8.10	7.90	2.50	1.09	0.90
S11C-53	12.9 "	"	"	3.10	3.20	1.29	0.58	0.61	8.80	8.30	2.80	1.00	1.00

Table 2 b - *Crossorhombus valde-rostratus* - meristics (Larval stages).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			Spines		
					Dorsal	Anal	Caudal	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior basipterygial
S8-23B	6.0 SL	Post flexion	Flexed	Symm etrical	85	66	17	10	26	36	0	0	3
"	6.9 "	"	"	"	89	66	17	10	26	36	0	0	4
DI-5505	8.1 "	"	"	"	86	68	17	10	26	36	0	0	3
DI-5543	9.2 "	"	"	"	85	66	17	10	26	36	0	0	6
S11C-80	10.8 "	"	"	"	86	64	17	10	24	34	0	0	6
S11C-34	12.2 "	"	"	"	82	62	17	10	24	34	0	0	6
S11C-53	12.9 "	"	"	"	84	64	17	10	25	35	0	0	8

3. ***Crossorhombus azureus* (Alcock, 1889)**

Larval forms ranging from 7.5 mm SL to 18.8 mm SL are found in the plankton collections taken during the IIOE and Naga Expedition. The plankton samples contained only postflexion stages (Figs. 3 A, B ; Tables 3 a, b).

Morphology :

Larval body thin, symmetrical, ovoid and translucent in early post flexion stages. In advanced forms the body gets more elongated. Eyes black and symmetrical, no sign of migration even in largest specimens. Jaws equal and carry small teeth, anterior portion of the alimentary canal runs parallel to notochord only for a very short distance and then runs down obliquely, intestinal coil elliptical and placed at the posterior ventral aspect of abdominal cavity, rectal portion pushed forwards and anus opens at the level of fifth vertebral segment in largest specimens. Liver not massive as in *Engyprosopon*, *Bothus*, *Psettina* and *Arnoglossus* spp., its dorso-ventral axis more than twice the antero-posterior axis. Swim bladder occupies the space between eighth and tenth vertebral segments and does not seem to interfere with the orientation of intestinal loop.

Spines occur only on left ramus of posterior basipterygial processes, less in number when compared to many other species, they decrease in prominence and in size posteriorly. A small spinous process present on urohyal at its anterior end, near the notch up to which the left ventral fin radial extends.

Fin and supporting structures :

Forward extension of dorsal fin fold has reached up to the snout and is not fused with ethmoidal region of cranium. Elongated ray is shorter than in other species and can be distinguished only with difficulty from the remaining rays in postflexion stages beyond 11.2 mm SL. First ray is tiny and discernible even in the smallest larvae (7.5 mm SL). Full complement of median and caudal fin rays found in 7.5 mm SL larvae and above. 82-92 dorsal and 61-73 anal rays. Of the 17 caudal rays, three are borne on inferior hypural lower, four on inferior hypural middle, five on superior hypural middle, three on superior hypural

upper and one ray each on either side borne directly by neural and haemal processes of vertebrae just in front of urostyle.

Pelvic fin radials, rays and posterior basipterygial processes are well differentiated in 7.5 mm SL larvae, left pelvic fin radial longer than the right and three rays of left lie in advance of that of right fin. In 13.8 mm SL larvae, fourth pelvic fin ray lies opposite cleithral tip. Left ramus of posterior basipterygial processes extend up to middle level of intestinal loop where it tapers, right ramus before reaching terminal portion of left, curves like a tendril and stops in front of the liver.

Axial skeleton :

Since no preflexion and flexion stages are available, the stages at which the notochord gets segmented into vertebrae are not described. 10 precaudal and 26 caudal vertebrae present including urostyle, in 7.5 mm SL larva. Neural processes of precaudal and caudal region and the haemal processes of the caudal region are distinguishable in 7.5 mm SL larvae, haemal processes of precaudal region are small in last three vertebrae, fairly large in seventh, sixth and fifth, but in advanced stages haemal spines are of the same size, but not traceable in the first four, however, arches are found except in the first vertebrae. Centra of vertebrae are also distinguishable in 7.5 mm SL larvae and ossification though commenced in 11.0 mm SL, is not completed even in 18.8 mm SL. First neural arch remains cartilaginous even in the largest specimen (18.8 mm SL).

The adult :

Very close to the preceding species. Depth of body nearly twice in the length, length of head $3\frac{1}{2}$ to 4. Diameter of eye $3\frac{1}{5}$ to $3\frac{2}{3}$ in length of head; membranous flap in male much smaller; inter orbital width $\frac{2}{3}$ to $1\frac{1}{4}$ times () or $\frac{1}{6}$ to $\frac{4}{5}$ () diameter of eye; anterior edge of upper eye above middle or anterior part of lower. Maxillary extending to below anterior edge of eye or a little beyond, length $3\frac{3}{5}$ to $3\frac{4}{5}$ in that of head. 5 or 6 gill-rakers on lower part of anterior arch. 52 to 57 scales in lateral line. Dorsal 84-90. Anal 64-73. Pectoral of ocular side with 11 or 12 rays, the upper ray not prolonged in the male ; length $\frac{2}{3}$ to $\frac{3}{4}$ that of head. Greyish or brownish, variously spotted and blotched with paler, and darker; generally one, two or more dark blotches on

lateral line; male sometimes with two or more series of dark spots (blue in life) on head in front of interorbital space; median fins with dark brown or blackish spots and blotches, caudal often with a broad blackish band across its hinder part and a similar but less distinct band at its base (Norman, 1934).

Remarks :

As in the case of *C. valde-rostratus*, the sequence of development of various structures could not be studied because of the absence of preflexion and flexion stages. The larvae of *C. azureus* resemble very closely with those *C. valde-rostratus* in almost all aspects including the meristics and general shape. Nevertheless, that larvae of *C. azureus* can be distinguished from *C. valde-rostratus* in the presence of a tiny spinuous processes on the urohyal at its anterior end. The adults of the species are reported from Indian Ocean. The postlarval stages of *C. azureus* are described and reported for the first time from Indian Ocean and adjacent waters by Lalithambika Devi (1989 b).

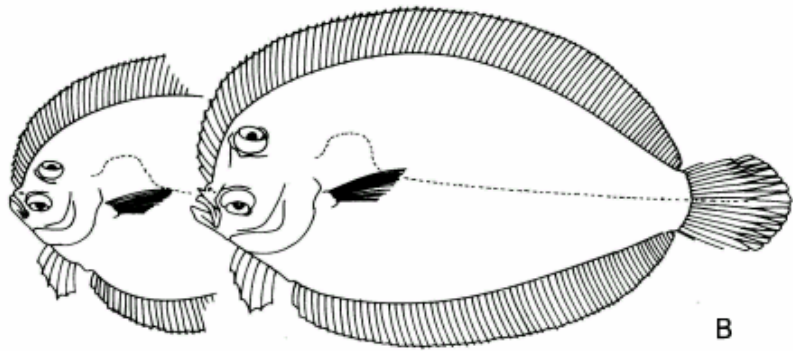
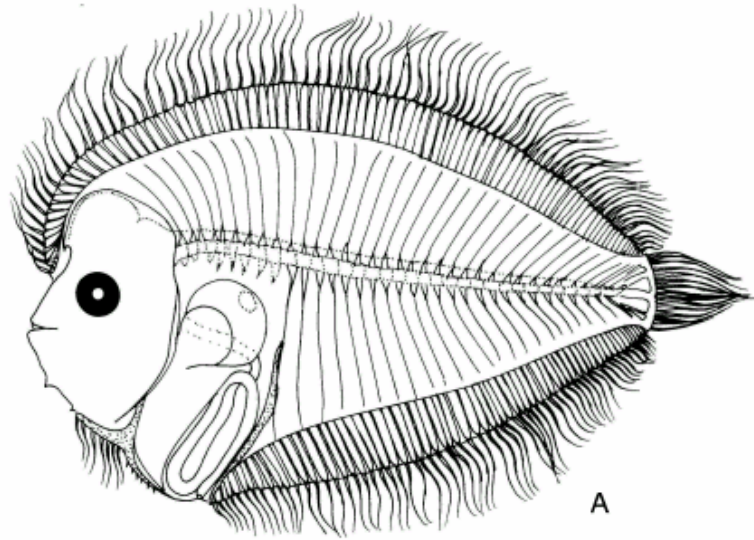


Fig. 3 - *Crossorhombus azureus*, A – 12.4 mm SL, B – Adult
(from Lalithambika Devi, 1986).

Table 3 a - *Crossorhombus azureus* - morphometrics, in mm (Larval stages).

Stations	Body Length	Right Eye	Stage	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus	Depth	Length	
S4 – 8	7.5 SL	Symmetrical	Post flexion	2.20	2.20	0.90	0.48	0.53	4.90	4.90	1.60	0.67	0.64
Ki 363	9.2 "	"	"	2.50	2.70	1.19	0.48	0.58	6.20	6.10	1.70	0.68	0.80
OS 4	10.4 "	"	"	2.70	2.90	1.14	0.55	0.61	6.90	6.70	2.20	0.81	1.00
S11C-46	11.2 "	"	"	2.60	2.90	1.24	0.52	0.55	7.80	7.40	2.50	0.93	1.10
S11C-80	12.3 "	"	"	2.80	2.90	1.19	0.55	0.55	8.30	8.10	2.50	0.97	1.10
S11C-53	13.5 "	"	"	2.70	2.80	1.13	0.58	0.61	8.80	8.90	2.80	1.01	0.80
NH – 40	14.8 "	"	"	3.60	3.40	1.40	0.58	0.62	11.10	11.10	3.40	1.32	0.90
DM1/57A/64	15.8 "	"	"	3.10	3.80	1.29	0.61	0.71	9.80	9.30	3.70	1.21	0.70
DI-5508	17.0 "	"	"	3.90	4.50	1.70	0.64	0.64	10.50	11.00	3.70	1.21	0.90
PI 20	18.0 "	"	"	4.70	4.30	1.60	0.87	0.87	9.80	9.90	3.50	1.33	1.30

Table 3 b- *Crossorhombus azureus* - meristics (Larval stages).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			Spines		
					Dorsal	Anal	Caudal	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior basipterygial
S4-8	7.5 SL	Post flexion	Flexed	86	63	17	10	26	36	1	0	6	
S4-6	8.9 "	"	"	87	68	17	10	27	37	1	0	6	
KI-363	9.2 "	"	"	85	67	17	10	26	36	1	0	5	
S11C-90	9.8 "	"	"	86	61	17	10	26	36	1	0	7	
S11C-53	11.0 "	"	"	82	63	17	10	25	35	1	0	10	
S4-6	12.6 "	"	"	90	70	17	10	26	36	1	0	9	
"	13.5 "	"	"	92	72	17	10	26	36	1	0	7	
Dm1/57A/64	15.8 "	"	"	86	68	17	10	25	35	1	0	6	
Di – 6608	17.0 "	"	"	92	73	17	10	26	36	1	0	4+	
PI – 20	18.0 "	"	"	90	67	17	10	26	36	1	0	7	
Na – 143	18.8 "	"	"	89	67	17	10	26	36	1	0	7	

Discussion

The larval forms contained in the IIOE and Naga Expedition plankton samples described herein possess the general characters shared by the bothid larvae. Absence of preflexion and flexion stages in the plankton collections limits details of characters useful in identifying early larval forms. However, the restriction of spines to the posterior basipterygial processes, and their absence on cleithra and urohyal, the short length of the elongated dorsal ray at the anterior end of the dorsal in, the meristics as well as general shape of the postlarval body help to place the larval stages described here under the genus *Crossorhombus*.

The presence of tiny spinous process at the anterior end of the urohyal (sciatic portion) near its notch in *C. azureus* together with the meristics provide some clue to distinguish them from *C. valde-rostratus*.

Ochiai and Amaoka (1963) described three postlarval forms of *C. valde-rostratus* ranging from 16.0 to 17.5 mm from Japanese waters. From their description it is seen that spines are present on the urohyal, cleithra and posterior basipterygial processes. Pertseva-Ostroumova (1965) has described larval stages ranging from 2.90 to 13.14 mm and placed them under *C. azureus*. The descriptions as well as figures published on these larval forms reveal that spines are present on urohyal, cleithra and posterior basipterygial processes. The present observations on the larval characteristics of *Crossorhombus* species from the Indian Ocean, South China Sea and Gulf of Thailand have been confirmed by Dr. Ahlstrom (personal discussions, 1977) who has examined the larval materials critically. The larval forms described by Ochiai and Amaoka (1963) as well as Pertseva-Ostroumova (1965) may therefore be referable to *Engyprosopon* spp. and not to *Crossorhombus* spp.

Amaoka (1969) has stated that even though *C. valde-rostratus* is synonymised with *C. kobensis* (*Engyprosopon kobensis*, Hubbs, 1915) by Norman (1934), the specimens of *C. kobensis* from Japanese waters differ from *C. valde-rostratus* collected from waters off Sri Lanka and East Africa. Amaoka (1969) has also reported that *C. azureus* obtained from Sri Lanka and South Eastern Indian waters resemble closely with *C. kanekonis* from Japan waters.

But he is of the view that these two species are separable from each other in adult characteristics. The adults of *C. valde-rostratus* and *C. azureus* are recorded from Indian waters. The larvae of these species are described and reported for the first time by Lalithambika Devi, (1989 b).

4. *Engyprosopon cocosensis* (Bleeker, 1855)

Larvae of *Engyprosopon cocosensis* are found in the plankton collections of IIOE, Naga Expedition and random samples from Laccadive Sea from preflexion to postflexion stages (3.5 mm NL to 13.7 mm SL (Figs. 4 A, B, C, D ; Tables 4 a, b, c & 25).

Morphology :

Larvae of *Engyprosopon cocosensis* have thin laterally compressed body, symmetrical in early stages, are mostly diaphanous. Eyes have black pigments and have more height (dorso-ventral diameter) than width (antero-posterior). Right eye shows signs of migration to left side in larvae measuring 11.1 mm SL and above, but not completed even in 13.7 mm SL larva in which right eye has moved a distance equal to half the diameter of the eye towards the dorsal side. Swim bladder is present, occupying space between eighth and ninth vertebral segment in the earliest stage and increases in size to occupy the space between eighth and tenth vertebral segments as the larvae grow. Liver massive, the dorso-ventral axis of which is greater than the anteroposterior axis. Alimentary canal is a single, more or less elliptical coil, placed vertically at posterior end of abdominal cavity in early stages becoming obliquely placed in 12.9 mm onwards. Anus opens at the 10th vertebral segment in early stages but pushed forwards later to open at the eighth vertebral segment, thus reducing the snout-anus length in post-larval stages (Table 4 a) .

Distinct spines occur on the urohyal (sciatic portion), cleithra and posterior basipterygial processes which increase both in number and size towards post flexion stages. Of the flat fish larvae so far examined, this species possesses maximum number of spines on the urohyal and posterior basipterygial processes (Lalithambika Devi, 1986). Spines on the urohyal are of even size whereas those of posterior basipterygial processes becomes small and feeble towards posterior end. Posterior basipterygial processes (Figs. 4 A, B, C) on reaching the ascending loop of alimentary canal curves dorsalwards but does not end in a spinous process as seen in *E. grandisquamis* and *E. xenandrus*. According to Ahlstrom (Personal discussions) this is the typical posterior basipterygial processes found in the larvae of *Engyprosopon* species.

Relative snout length, snout – anus length and snout - pelvic fin base length increase from preflexion to flexion stages and thereafter decreases (Table 25). Decrease is marginal in snout length, but considerable in the other two. Relative body depth at pectoral fin base and depth at anus decrease from preflexion to flexion stages, but increase in the subsequent stages. Relative head length, eye-height and eye width however, decrease gradually towards post-flexion stages.

Fin and supporting structures :

Dorsal and anal fin ray formations are seen in larvae 3.5 mm NL, the earliest stage available in the collections. In this stage, besides the anterior elongated dorsal ray, a few more rays are discernible in middle portion of median fin folds. Pterygiophores, however, are not differentiated in 3.5 mm NL. Full complement of median fin rays is seen in larvae of about 6.5 mm SL when first tiny dorsal ray is also differentiated. Tiny dorsal ray is articulated to a small forwardly directed anterior ramus of the first long, stout dorsal pterygiophore. This pterygiophore also supports the anterior half of baseost of third dorsal ray. First long, stout anal pterygiophore is seen in 4.7 mm NL articulated to anterior face of haemal arch of first caudal vertebrae. In many species the pterygiophores differentiate earlier to fin rays. But in *E. cocosensis* the rays along median fin folds differentiate earlier than pterygiophores. Thus, rays are found when larvae measure 3.5 mm NL whereas pterygiophores are not discernible even in 4.7 mm NL larvae. They appear at the anterior end of the anal fin fold but not to the same extent in dorsal fin fold of 5.0 mm NL larvae. 61 dorsal and 36 anal rays present in 4.7 mm NL larvae. Pterygiophores are articulated to neural and haemal processes. Baseosts are also differentiated in 5.0 mm NL. Last two vertebrae are peculiar in most of the flat fish larvae in that the neural and haemal arches (processes) are stout and long and reach up to the body wall and also in that they do not have any articulating pterygiophore. Median fin rays range from 74-88 in the dorsal and 57-65 in the anal (Table 5b).

Caudal fin rays start differentiating earlier than ural cartilages, a condition referred to as “early caudal formation” (ECF) which is characteristic of *E. cocosensis*. At this stage the terminal portion of notochord (urostyle) remains

straight. Three caudal rays occur in 4.7 mm NL larvae and one more is added in 5.0 mm NL (ECF). Ural cartilages start differentiating at this stage, inferior hypural middle is the first to differentiate. In 5.0 mm NL (early flexion, EFL) larvae even though the inferior hypural middle and superior hypural middle are seen, the former is more distinct and the four caudal rays differentiated by this time are articulated to the inferior hypural middle. Next three rays developed in 5.4 mm NL larvae are articulated to the superior hypural middle. In 5.6 mm SL larvae five rays are seen in the superior hypural middle, 3 rays on inferior hypural lower and three rays on superior hypural upper. Full complement of fin rays are seen in 6.0 mm SL formed by the addition of two more rays one on either side. These two rays are carried directly by the neural and haemal arches (Processes) of the penultimate vertebra (the vertebra just anterior to the urostyle). Dorsal most ray associated with neural arch is the last to develop.

Median fin rays are articulated through a system of baseosts and pterygiophores to the neural and haemal processes. Epural component discernible as a patch of cells in early flexion stages (5.0 mm NL) is differentiated during the midflexion stages (5.3 mm NL) but does not support any of the caudal rays. In postflexion stages, epural is seen fused distally to superior hypural upper. Terminal portion of the notochord projecting out beyond the periphery of the caudal fin to a short stem, the ural centrum in 5.6 mm SL. The caudal fin rays are brought to the terminal position by flexion of the notochord induced by the hypural cartilages which takes place between 5.0 mm NL and 5.6 mm SL.

Of the paired fins, pectoral fin bud gets differentiated earlier than pelvic fin. In most of the teleosts pectoral fin bud appears even before the eggs are hatched, but remains unrayed throughout the larval life. In flat fishes, pectoral fin rays wherever they are present differentiate only after metamorphosis. Pectoral girdle is the first supporting skeleton to get differentiated and ossified.

Pelvic fin rudiment is differentiated in 3.5 mm NL, its radial first appears as a pack of cells in the middle anterior portion of basipterygial processes in 4.7 mm NL which later becomes the anterior basipterygial processes. Posterior basipterygial processes extend posterior-wards as larval life advances and

border the ventral body wall and reach upto the level of the ascending loop of the intestinal coil and curve dorsalwards and stop just near the ventral tip of the liver. Pelvic fin proper is seen as a rudiment in 5.0 mm NL and in 5.6 mm SL it gets transformed into a cartilaginous rod – the anterior basipterygial process. At this stage, pelvic fin ray rudiments are also differentiated. In 6.5 mm SL larvae, the rays are differentiated, but they do not extend beyond the level of the body margin. Anterior portion of basipterygial process of the left side extends further forwards and in 8.1 mm SL, the pelvic fin of left side becomes asymmetrical and three of the rays of the left fin are in advance of the right fin. Distal end of left radial reaches upto the level of posterior-most spine of urohyal, the forward extension of left fin radial continues and in 13.7 mm SL, its distal end has reached up to level of the fifth spine of urohyal near its posterior end.

Axial skeleton

In the axial skeleton, notochord remains unsegmented and vacuolated in 3.5 mm NL, but neural and haemal spines are differentiated in anterior third of the body (the arches and spines together constitute the processes), first neural arch is differentiated only in 5.0 mm (early flexion) NL (Table 5c). The first dorsal pterygiophore is very well developed, grows forwards over the skull and supports the elongated dorsal ray, from very early stages. In the precaudal region, only haemal arches are differentiated but not the spines, but in the caudal region both arches and spines are differentiated in the anterior portion in 3.5 mm NL. Number of neural and haemal processes increases and full complement is formed in the flexion stages. Haemal arches of the first vertebra are lacking, those of next two to three have only arches, last two or three have only reduced spines and those in between, have significantly well developed spines. Reduction in size of haemal spines in the last few precaudal vertebrae may be to accommodate the swim bladder. Last two vertebrae have only arches and no spines even in the latest stages, of these the last one supports a ray each of the caudal fin complement directly.

Ossification was noticed in the neural and haemal spines from the very early stages, but centra and arches ossify only later. In 9.9 mm SL, the centra are dumb-bell shaped and bony, first neural arch remains cartilaginous in 12.2

mm SL, while the other arches have become ossified except at their bases. The number of vertebrae ranges from 10+23-26 including urosytle (Table 4b).

The adult :

Depth of body a little more than twice in the length, length of head $3 \frac{1}{2}$ to $3 \frac{3}{4}$. Snout shorter than eye, diameter of which is 3 to $3 \frac{1}{3}$ in length of head; interorbital space concave, width $\frac{1}{5}$ to $\frac{1}{3}$ () or $\frac{1}{8}$ to $\frac{1}{4}$ () diameter of eye; anterior margins of eyes level or lower a little in advance of upper. A short spine on the snout in the male. Maxillary extending to below middle of eye or not quite as far, length $2 \frac{1}{5}$ to $2 \frac{2}{5}$ in that of head. Teeth uniserial; some enlarged canines anteriorly. 5 to 7 short, pointed gill-rakers on lower part of anterior arch. About 45 scales in lateral line. Dorsal 77-84. Anal 56-63 (Fig. 4 D). Pectoral of ocular side with 11 or 12 rays, the upper ray prolonged in the male, length $\frac{3}{4}$ to $\frac{4}{5}$ that of head. Brownish, with traces of some paler areas, and with some black spots and blotches; median fins with small dark spots; pectoral with dusky cross-bars (Norman, 1934).

Remarks :

The larvae of *Engyprosopon cocosensis* possess spines on urohyal, cleithra and posterior basipterygial processes. The number of spines are more on the urohyal and posterior basipterygial processes than in any other species under the genus. In the larvae so far examined more than 20 spines were found in the posterior basipterygial processes. These processes reach up to the level of the ascending loop of the intestinal coil, then get curved dorsal-wards, beneath the loops and the tips lie embedded in the abdominal wall near to the ventral tip of the liver. Ahlstrom has suggested that this is the typical posterior basipterygial processes of the genus *Engyprosopon*. In this species, the median fin rays appear in 3.5 mm larvae but the pterygiophores are not well differentiated even in 4.7 mm NL except the first long pterygiophore situated along the roof of the skull carrying the elongated dorsal ray. In the caudal fin fold also the caudal rays are differentiated prior to the formation of the hypurals. Hence an "early caudal formation" stage prior to the flexion stage is characteristic of this species. The number of fin rays tally with those of the adults. The adults are reported from the Indian Ocean. But the larvae of this species are reported and described for the first time.

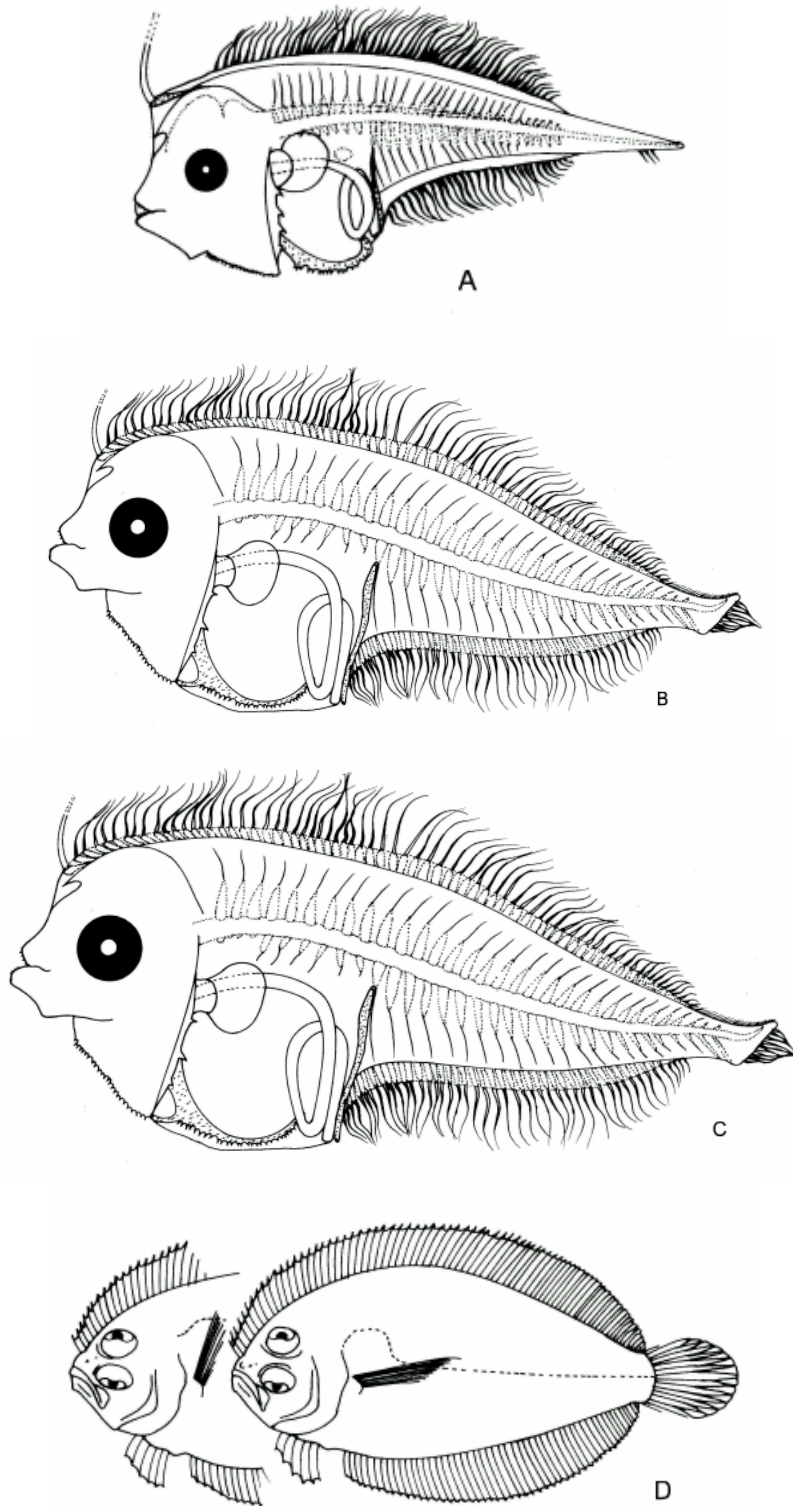


Fig. 4 - *Engyprosopon cocosensis*, A – 4.7 mm NL, B-5.4mm NL, C-12.9mm SL, D -Adult. (from Lalithambika Devi, 1986).

Table 4 a - *Engyprosopon cocosensis* - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Stage	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	anus	Depth	Length	
SIIB-91	4.5 NL	Symmetrical	Preflexion	2.0	1.3	0.45	0.35	0.42	2.0	-	-	1.0	
S6-34	4.7 "	"	Early caudal formation	2.4	1.4	0.45	0.39	0.42	2.0	-	-	1.1	
SIIB-91	4.9 "	"	Early flexion	2.4	1.4	0.52	0.31	0.37	1.9	-	-	1.3	
S6-39	5.0 "	"	"	2.5	1.4	0.47	0.39	0.45	2.0	-	-	1.3	
S6-15	5.3 "	"	Mid flexion	2.6	1.6	0.60	0.42	0.45	2.4	-	-	1.4	
S6-8	5.5 "	"	Late flexion	2.7	1.5	0.48	0.48	0.50	2.4	-	-	1.4	
S6-38	5.6 SL	"	Post flexion	2.6	1.7	0.61	0.52	0.58	3.2	0.68	0.42	1.2	
S6-15	5.8 "	"	flexion	2.6	1.7	0.68	0.45	0.52	3.4	0.84	0.47	1.4	
S6-5A	6.0 "	"	"	2.7	1.9	0.68	0.48	0.58	3.4	0.71	0.38	1.7	
S6-5A	6.5 "	"	"	2.9	2.0	0.60	0.53	0.64	3.7	0.84	0.39	1.6	
SIIB-91	6.9 "	"	"	3.2	2.0	0.71	0.42	0.48	3.1	0.64	0.35	1.6	
S8-20B	7.2 "	"	"	3.2	2.1	0.77	0.50	0.52	4.1	1.26	0.55	1.7	
S8-20B	8.1 "	"	"	3.1	2.3	0.87	0.55	0.58	4.4	1.42	0.58	1.7	
S6-38	8.6 "	"	"	3.4	2.6	0.90	0.61	0.68	4.5	1.42	0.61	2.0	
S4-19	9.5 "	"	"	3.0	2.4	1.00	0.64	0.68	5.9	1.50	0.81	1.8	
S8-41	9.9 "	"	"	3.6	2.6	0.90	0.61	0.74	5.0	1.60	0.64	1.8	
S4-6	10.3 "	"	"	3.8	2.8	0.81	0.84	0.90	4.7	1.60	0.64	1.9	
S3-16	10.6 "	"	"	4.0	2.7	0.84	0.81	0.81	5.1	1.80	0.68	2.1	
S4-6	11.1 "	Migrating	"	3.7	2.9	0.90	0.71	0.74	5.9	2.50	0.83	1.5	
S6-39	12.2 "	"	"	4.1	3.2	0.97	0.84	0.90	6.0	2.00	0.79	2.1	
S8-20B	12.6 "	"	"	4.3	3.3	1.00	0.72	0.81	6.9	2.60	0.90	2.0	
S6-38	13.3 "	"	"	4.1	3.3	1.10	0.82	0.81	6.5	2.30	0.90	1.9	
S4-6	13.7 "	"	"	3.7	3.3	1.10	0.93	0.87	8.6	3.50	1.13	1.3	

Table 4 b - *Engyproson cocoseris* –meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			Spines			
					Dorsal	Anal	Caudal	Left Pelvic	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior basipterygial processes
S6-34	4.7 NL	Early caudal formation	Straight	Symmetrical	61	36	3	0				24	4	25
BF26Cr.2	5.0 "	"	"	"	64	32	4	0				24	4	26
S6-39	5.0 "	Early flexion	Flexing	"	59	38	4	0				24	4	24
BF26Cr.2	5.4 "	"	"	"	68	49	7	0				25	4	24
S6-15	5.3 "	Mid flexion	"	"	68	50	8	0				20	4	20
S6-8	5.5 "	Late flexion	"	"	75	52	11	0				24	4	24
S6-38	5.6 SL	Post flexion	Flexed	"	69	52	15	0	10	23	33	33	3	34
S6-5A	6.0 "	"	"	"	78	54	17	0	10	26	36	33	5	23
BF27B Cr.2	6.5 "	"	"	"	75	57	17	Forming	10	24	34	33	6	30
BF25 Cr.2	7.3 "	"	"	"	81	61	17	"	10	24	34	28	5	33
S8-17	8.1 "	"	"	"	85	59	17	3+3	10	25	35	30	3	29
S6-38	8.6 "	"	"	"	83	61	17	3+3	10	24	34	42	4	38
BF-16	9.3 "	"	"	"	79	61	17	3+3	10	24	34	26	6	38
S4-19	9.5 "	"	"	"	74	61	17	3+3	10	23	33	31	6	34
S8-41	9.9 "	"	"	"	88	62	17	3+3	10	25	35	36	7	34
S6-38	10.4 "	"	"	"	85	65	17	3+3	10	24	34	36	6	26
KI397	11.2 "	"	"	"	86	65	17	3+3	10	24	34	40	9	39
S6-39	12.2 "	"	"	"	83	63	17	3+3	10	25	35	40	8	28
KI649	12.9 "	"	"	"	79	59	17	3+3	10	24	34	35	6	49
S6-38	13.3 "	"	"	"	87	65	17	3+3	10	26	36	38	5	16+
S4-6	13.7 "	"	"	"	80	59	17	3+3	10	25	35	32	6	26

Table 4 c - *E. coccosensis* - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Stations	Body Length	Stage	Noto-Chord	Right Eye	Precaudal vertebrae				Centra				Caudal vertebrae				Ural Centra	Total Vertebrae	Caudal Fin rays	Ural components				Epural
					Neural	Arch	Process	Haemal	Neural	Arch	Process	Haemal	Neural	Arch	Process	Haemal				Sup.	Mid.	Inf.	Hyp.	
S6-20B	3.5NL	Pre flexion	Straight	Symmetrical	9	0	0	0	8	0	18	5	18	5	0	0	0	0	0	0	0	0		
S6-34	4.7 "	Early caudal formation	"	"	9	0	0	8	0	18	5	18	5	0	0	0	0	0	0	0	0			
BF-26	5.0 "	Early flexion	Flexing	"	9	1	4	5	5	0	16	5	16	5	0	0	0	0	0	0	0			
S6-39	5.0 "	"	"	"	9	1	4	5	5	0	17	5	17	5	0	0	0	0	0	0	0			
BF-26	5.4 "	"	"	"	9	1	4	5	5	0	21	2	21	2	0	0	0	0	0	0	0			
S6-15	5.3 "	Mid flexion	"	"	9	1	4	5	5	0	23	2	23	2	0	0	0	0	0	0	0			
S6-8	5.5 "	Late flexion	"	"	9	1	4	5	5	0	20	2	20	2	0	0	0	0	0	0	0			
S6-38	5.6SL	Post flexion	Flexed	"	9	1	3	6	6	0	20	2	20	2	0	0	0	0	0	0	0			
S6-5A	6.0 "	"	"	"	9	1	3	6	6	10	23	2	23	2	25	1	1	1	1	1	1			
BF-27B	6.5 "	"	"	"	9	1	4	5	5	10	21	2	21	2	23	1	1	1	1	1	1			
BF-25	7.3 "	"	"	"	9	1	4	5	5	10	21	2	21	2	23	1	1	1	1	1	1			
S6-17	8.1 "	"	"	"	9	1	4	5	5	10	22	2	22	2	24	1	1	1	1	1	1			
S6-38	8.6 "	"	"	"	9	1	4	5	5	10	21	2	21	2	23	1	1	1	1	1	1			
BF-16	9.3 "	"	"	"	9	1	4	5	5	10	21	2	21	2	23	1	1	1	1	1	1			
S4-19	9.5 "	"	"	"	9	1	4	5	5	10	20	2	20	2	24	1	1	1	1	1	1			
S6-41	9.9 "	"	"	"	9	1	4	5	5	10	22	2	22	2	24	1	1	1	1	1	1			
S6-38	10.4 "	"	"	"	9	1	4	5	5	10	21	2	21	2	23	1	1	1	1	1	1			
KI-397	11.2 "	"	"	Migrating	9	1	4	5	5	10	21	2	22	1	23	1	1	1	1	1	1			
S6-39	12.2 "	"	"	"	9	1	6	3	3	10	22	2	22	2	24	1	1	1	1	1	1			
KI-649	12.9 "	"	"	"	9	1	4	5	5	10	21	2	21	2	23	1	1	1	1	1	1			
S6-38	13.3 "	"	"	"	9	1	6	3	3	10	23	2	23	2	25	1	1	1	1	1	1			
S-4-6	13.7 "	"	"	"	9	1	6	3	3	10	22	2	22	2	24	1	1	1	1	1	1			

5. *Engyprosopon latifrons* (Regan, 1908)

Larval stages ranging from 2.6 mm NL to 6.7 mm SL belonging to preflexion, flexion and postflexion stages were collected from the plankton samples of the IIOE, Naga Expedition and random collections from Laccadive Sea (Figs. 5 A,B, C, D, E ; Tables 5 a, b, c & 25).

Morphology :

Larvae have thin laterally compressed diaphanous body, symmetrical in early stages. Eyes are oval with black pigments and symmetrically placed in early stages. Teeth found on both jaws from 3.1 mm NL. Alimentary canal runs parallel to notochord upto the posterior end of the abdominal cavity where it forms a single circular coil, anus lies on the 10th myotome in early stages, intestinal loop becomes elliptical and the terminal portion runs down vertically in larvae of 3.1 mm NL. It is gradually pushed forwards and in 6.6 mm SL opens at the level of the eighth vertebral segment. Liver massive with its anteroposterior axis longer than the dorso-ventral axis in early stages. Occupying the space between the pectoral girdle and the intestinal coil, its posterior ventral end is drawn into a finger-like process lying ventrally to the intestinal loop. Antero-posterior axis of the liver becomes shorter from 4.2 mm SL and in advanced stages, dorso-ventral axis becomes longer than the other. Swim bladder is situated dorsal to the straight portion of the alimentary canal in early stages, its diameter is lesser than that of the eyes and it pushes the intestine ventralwards. Spines are well developed and are found distributed on the urohyal, cleithra and posterior basipterygial processes in all stages. The number of spines is however, less than that of *E. cocosensis*.

Relative snout length and snout - pelvic fin base length increases from preflexion to flexion stages and thereafter decreases. Snout - anus length gets gradually reduced unlike that in *E. cocosensis*. The relative body depth at pectoral base decreases, but unlike in *E. cocosensis* the depth at anus increases. Relative head length decreases from preflexion to flexion stages and then increases gradually unlike in *E. cocosensis*, and eye height and width gradually decreases (Table 25).

Fin and supporting structures :

Dorsal and anal fin folds are continuous and confluent with caudal in early stages. At the anterior end of the dorsal fin fold, an elongated ray supported by the first dorsal pterygiophore is seen in the earliest larvae (2.6 mm NL). Dorsal and anal pterygiophores are differentiated in 3.8 mm NL, except at the anterior and posterior ends of the fin folds. First anal pterygiophore is stout and long and is differentiated in 3.8 mm NL. In addition to the anterior elongated dorsal ray, rays are seen in the middle portion of the fin fold in 4.2 mm NL. Full complement of median rays are found in 5.7 mm SL, the first tiny ray in front of the dorsal elongated ray is seen supported by the anterior ramus of the forwardly curved first dorsal pterygiophore in 5.7 mm SL. In this species, the pterygiophores differentiate earlier than fin rays unlike those of *E. cocosensis*. There are 81-83 dorsal and 53-59 anal rays (Table 5 b).

Caudal fin complement is seen as a pack of cells on the under side of the body, a short distance anterior to the caudal extremity of the notochord in 4.7 mm NL. Flexion of the notochord is initiated in 4.8 mm NL and is completed in 5.7 mm SL larvae (Table 5c). Full complement of the caudal fin rays occurs in 5.7 mm SL larvae. The epural component is differentiated in larvae of 5.4 mm NL, the midflexion stage. It does not support any caudal ray but gets fused with the superior hypural upper and loses its identity in later stages.

Of the paired fins, pectorals are differentiated in early stages and remain unrayed even in 6.7 mm SL. Pelvic fin complex first appear as pack of cells along the posterior face of the lower middle portion of the cleithra in 4.7 mm NL larva. Pelvic fin radials (anterior basipterygial processes) appear as rudiments in 5.2 mm NL and fin rudiments are discernible in 6.6 mm SL larva. Pelvic fin rays are not differentiated even in 6.7 mm larva (Table 5b), the largest specimen recorded and described in the present series. Posterior basipterygial processes get differentiated in the earliest larvae and possess spines and they extend to the level of the ascending loop of the intestine and then curve dorsalwards and anteriorwards stopping short in front of the ventral tip of the liver and lie embedded in the abdominal wall ventrally.

Axial skeleton :

In the axial skeleton, notochord remains vacuolated and segmentation is indicated in 3.6 mm NL larva. Neural and haemal arches are faintly visible in 3.5 mm NL, but in 3.6 mm larvae small spines are seen, capping the neural and haemal arches. First neural arch is differentiated in 3.6 mm NL but its spine is not seen capping the arch, and remains cartilaginous in 6.7 mm SL larvae. Full complement of the neural and haemal processes appear in larvae of flexion stages. Segmentation of notochord into centra is found differentiating from 3.8 mm NL larvae, vertebral segments are discernible and not the process in 5.7 mm SL. There are 10 + 24 – 26 vertebrae including the urostyle. In this species, the haemal arches are only discernible in the precaudal region even in the largest specimens (6.7 mm SL) but not the haemal spines whereas in *E. cocosensis* these spines are differentiated in flexion stages.

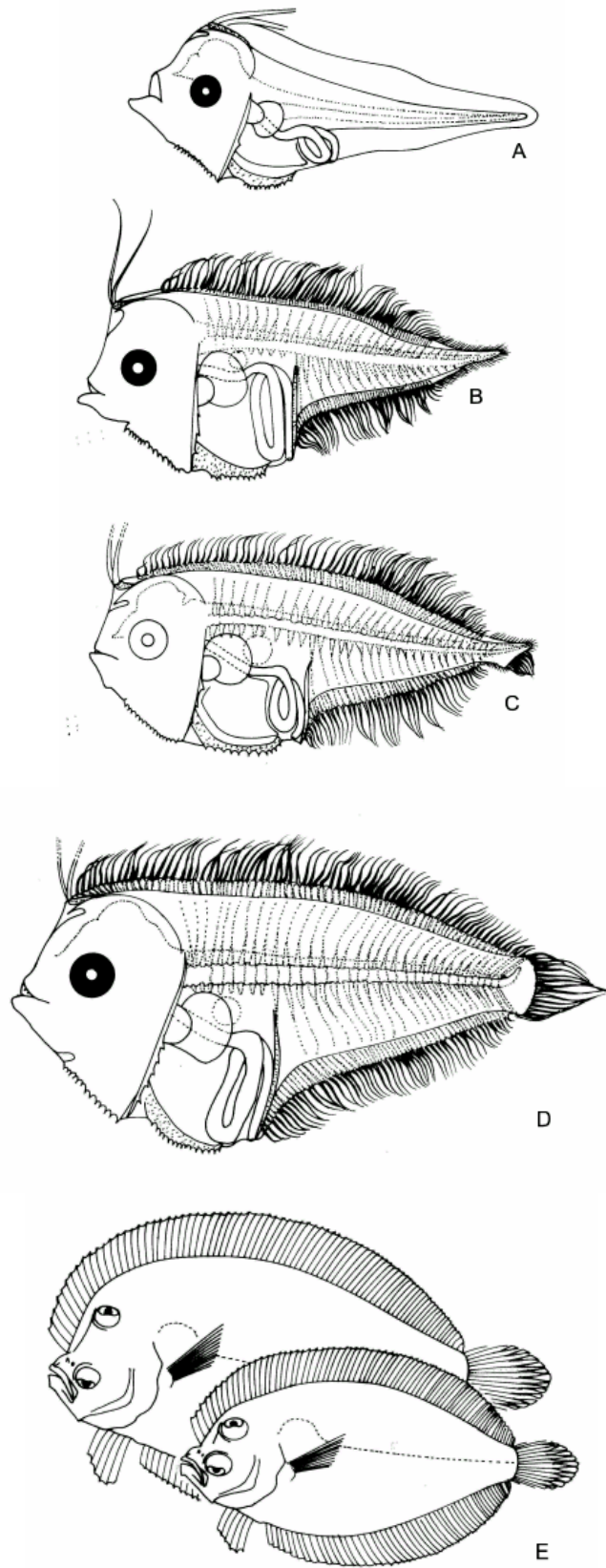
The Adult :

Depth of body $1 \frac{4}{5}$ to twice in the length, length of head $3 \frac{1}{2}$ to 4. Snout as long as or shorter than eye, diameter of which is 3 to 4 in length of head; interorbital space concave, width 1 to $1\frac{1}{2}$ times () or $\frac{1}{2}$ to $\frac{2}{3}$ (F) diameter of eye; anterior edge of upper eye above middle of lower. Rostral spine present in the male, but no orbital spines. Maxillary extending to below anterior $\frac{1}{4}$ of eye, length $2 \frac{2}{3}$ to $2 \frac{3}{4}$ in that of head. Teeth of upper jaw biserial anteriorly (at least in adults). 6 to 8 gill-rakers of moderate length on lower part of anterior arch. About 40 scales in lateral line. Dorsal 80-90. Anal 58-67 (Fig. 5 C). Pectoral of ocular side with 12 rays, length $\frac{2}{3}$ that of head; upper ray scarcely prolonged in male. Pale brownish, with traces of dark spots and markings on body and median fins (Norman, 1934).

Remarks :

The larvae of *E. latifrons* are distinguished from other species in the development of spines on urohyal, cleithra and posterior basipterygial processes even in the earliest specimens of the present series. The pterygiophores of the median fin folds differentiate earlier than the fin rays unlike those found in *E. cocosensis*, but the development of pelvic fin rays is late. The first neural arch appear earlier (3.6 mm NL). The full complement of the median fin rays are

differentiated when the larvae attains 5.7 mm SL whereas in *E. cocosensis* this occurs only when the larvae are around 6.5 mm SL. The spines on the urohyal, cleithra and posterior basipterygial processes are fewer in number than in *E. cocosensis*. The numerical counts agree with those of the adult *E. latifrons* (Norman, 1934). The adults are reported from the Indian Ocean. The larvae of this species are reported and described for the first time by Lalihtambika Devi, (1986).



Fi.g. 5 - *E. latifrons*, A-2.7 mmNL, B-4.8mm NL, C-5.2 mm NL, D-6.6.mmSL, E-Adult (from Lalithambika Devi, 1986).

Table 5 a - *Engyprosopon latifrons* - morphometrics, in mm (Larval stages within broken lines indicate notochoord flexion).

Stations	Body Length	Right Eye	Stage	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Depth	Peduncle Length	Snout to origin of pelvic fin
							Width	Height	Pectoral base	anus			
S6-15	2.6 NL	Symm etrical	Preflexion	1.6	0.7	0.21	0.29	0.27	0.90	0.72	-	-	-
S6-39	2.7 "	"	"	1.5	0.8	0.19	0.29	0.29	0.95	0.68	-	-	-
S6-39	3.0 "	"	"	1.9	0.9	0.29	0.29	0.31	1.16	0.81	-	-	0.80
S6-39	3.4 "	"	"	1.8	1.0	0.31	0.31	0.35	1.09	0.85	-	-	0.90
S6-34	3.6 "	"	"	2.0	1.0	0.32	0.35	0.35	1.40	1.10	-	-	1.00
S6-31	3.8 "	"	"	2.1	1.1	0.32	0.39	0.39	1.58	1.35	-	-	1.00
S6-31	4.3 "	"	"	2.4	1.4	0.45	0.42	0.45	2.30	2.00	-	-	1.00
S6-31	4.5 "	"	"	2.3	1.4	0.40	0.42	0.42	2.30	2.00	-	-	1.00
S5-5	4.6 "	"	"	2.5	1.5	0.52	0.41	0.45	2.60	2.10	-	-	1.10
S8-20B	4.8 "	"	Early flexion	2.2	1.5	0.60	0.39	0.45	2.40	2.10	-	-	1.40
S5-9B	5.5 "	"	Mid flexion	2.8	1.5	0.52	0.39	0.45	2.40	2.20	-	-	1.50
S5-4A	5.4 "	"	Late flexion	2.7	1.6	0.55	0.48	0.55	2.90	2.70	-	-	1.40
S6-35A	5.7 SL	"	Post flexion	2.5	1.6	0.58	0.43	0.48	2.90	2.80	0.53	0.35	1.40
S6-15	6.6 "	"	"	2.9	2.1	0.69	0.52	0.53	3.50	3.60	0.90	0.43	1.80
S6-29	6.7 "	"	"	3.2	2.1	0.61	0.52	0.58	3.00	2.80	0.71	0.38	1.60

Table 5 b - *Engyprosopon latifrons* –meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			Spines			
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior basipterygial processes
S6-39	2.6 NL	Pre flexion	Straight		1	0	0	0	-	-	-	10	1	13
"	2.7 "	"	"	Symmetrical	1	0	0	0	-	-	-	13	1	13
"	3.1 "	"	"	"	1	0	0	0	-	-	-	12	2	12
"	3.5 "	"	"	"	1	0	0	0	-	-	-	13	2	16
S6-31	3.6 "	"	"	"	1	0	0	0	-	-	-	17	2	18
"	3.8 "	"	"	"	1	0	0	0	-	-	-	18	3	27
S6-39	4.1 "	"	"	"	1	0	0	0	-	-	-	18	3	23
S6-31	4.2 "	"	"	"	1	Forming	0	0	-	-	-	19	4	22
S1-23	4.4 "	"	"	"	1	"	0	0	-	-	-	11	3	9
S5-5	4.6 "	"	"	"	Forming	"	0	0	-	-	-	14	3	19
S1-23	4.7 "	"	"	"	Ca.28	Ca.11	0	0	-	-	-	9	3	8
KI-518	4.9 "	"	"	"	30+	14+	0	0	-	-	-	12	3	9
S8-20B	4.8 "	Early flexion	Flexing	"	68	52	8	0	-	-	-	18	2	9
BF25Cr.2.	5.2 "	Mid flexion	"	"	73	50	9	0	-	-	-	15	3	12
S9A-18A	5.4 "	"	"	"	75	48	9	0	-	-	-	14	6	10
S5-4A	5.4 "	Late flexion	"	"	78	46	14	0	-	-	-	17	5	14
S6-35A	5.7 SL	Post flexion	Flexed	"	83	53	17	0	10	24	34	12	2	14
S6-15	6.6 "	"	"	"	81	56	17	Forming	10	26	36	13	5	15
S6-29	6.7 "	"	"	"	82*	59	17	"	10	25	35	18	6	10 +

6. *Engyprosopon mogkii* (Bleeker, 1854)

Larvae of *Engyprosopon mogkii* ranging from 2.8 mm NL to 10.7 mm SL belonging to preflexion, flexion and postflexion stages contained in the IIOE and Naga Expedition materials were studied in detail and reported (Figs. 6 A, B, C, D; Tables 6 a, b, c & 25).

Morphology:

Larvae of *E. mogkii* are thin, laterally compressed and symmetrical in early stages. Eyes spherical, without any black pigments in larvae measuring up to 2.9 mm NL, but they turn black in 3.4 mm NL, and remain symmetrical even in the largest larvae (10.7 mm SL) in the collection. Teeth which fall off easily present on both upper and lower jaws in all stages, in early larvae of 2.8 mm NL, one pair present in upper and two pairs in lower, but in 10.7 mm SL larva 9 pairs occur on upper jaw and four pairs on lower. Alimentary canal runs almost parallel to the notochord to the seventh myotome where it makes a simple circular loop and opens ventrally at the level of 10th myotome. Intestinal loop gets gradually converted into an elliptical coil placed obliquely at the posterior end of the abdominal cavity in advanced stages. Anus opens at the level of the ninth vertebral segment in the latest stage available. Liver is massive, the dorso-ventral axis of which is about twice the anteroposterior axis, its distal portion drawn into a diverticula which lies below the intestinal loop. Swim bladder occupies the space between 8th and 10th precaudal vertebra. Spines are found on the urohyal from very early stages but they appear on the cleithra and posterior basipterygial processes only from 1.4 mm NL larvae. Comparatively few in early stages the number of spines increases as larvae grow, but is less than that found in *E. cocosensis*.

Larval body covered by brownish black stellate pigments which fade in alcohol except a few blotches at the bases of the dorsal, anal and caudal fin rays, on the swim bladder and on the caudal portion of the vertebral column (Fig. 6A, B, C).

Relative head length increases from preflexion to flexion stages (Table 25.) but thereafter shows a decreasing tendency unlike in *E. latifrons*. The

relative snout length gradually decreases unlike in *E. cocosensis* and *E. latifrons*. Relative eye height and width decrease from preflexion stage upwards as in *E. cocosensis*. Relative body depth at pectoral fin base and at anus increases markedly as the larvae grew older, while relative length between snout and pelvic fin base gradually decreases.

Fin and supporting structures :

Median fins are continuous and confluent with the caudal in 2.8 mm NL, in the earliest larva of the collection. At the anterior end of the dorsal fin fold, an elongated dorsal ray is differentiated in 2.8 mm NL, supported by a long stout dorsal pterygiophore. First anal pterygiophore is also differentiated. Other pterygiophores are differentiated in dorsal and anal fin folds in 3.8 mm NL and are discernible from the anterior end. Rays are seen differentiated in larvae of 4.0 mm NL, full complement of the median rays are seen in the larvae of 7.0 mm SL when the first tiny ray of the dorsal fin is also distinguishable articulated to the anterior ramus of the 1st dorsal pterygiophore. There are (78) 80-87 dorsal and 58-62 anal rays (Table 6 b).

Caudal fin complex is differentiated as a pack of cells on the underside of the body, a short distance anterior to terminal portion of notochord in 3.8 mm NL larvae. When larval body attains a length of 4.0 mm NL inferior hypural lower and middle and superior hypural middle are discernible supporting caudal rays. Caudal fin development takes place between 3.8 and 5.8 mm NL, with full complement of rays appearing in 5.8 mm SL.

Pectoral fin remains in embryonic stage as in other species, the pelvic fin complex gets differentiated as cartilaginous processes attached to posterior face of cleithra at its lower middle portion in 2.8 mm NL larvae. This develops into dorsal basipterygial processes, proximal ends of which are attached to cleithra and distal portion continue as posterior basipterygial processes. Spination is developed latter in 3.4 mm NL. The anterior basipterygial processes remain in rudimentary condition in 5.3 mm NL larva. Pelvic fin radials get differentiated in postflexion larva of 7.0 mm SL with rudiments of fin rays, fin rays occur in 7.2 mm SL. Pelvic fin radials are asymmetrical as in other species but are comparatively shorter than in *E. cocosensis* and *E. latifrons*, left fin radial

longer than the right and the anterior three left in rays are in advance of the right, left fin radial reaching just up to the posterior margin of the urohyal. Distal ends of the posterior basipterygial processes extend to the midlevel of the intestinal loop and curves back as in other species.

Axial skeleton

Notochord remains vacuolated up to 3.8 mm larvae, centra are not differentiated, nine neural and three haemal arches are discernible in precaudal region of the earliest larvae collected. In caudal region 16 – 19 neural and 11 – 14 haemal arches in addition to five haemal processes are differentiated in the larvae measuring up to 2.9 mm NL. First dorsal pterygiophore long, bends over the skull and supports the elongated dorsal ray from the very early larva but is not connected with the first neural arch which is to be differentiated in 3.4 mm NL. Neural processes of the precaudal region and caudal region are distinguishable in larvae measuring 3.4 mm NL, but the haemal processes in precaudal region are seen only in larvae from 7.0 mm SL. Full complement of neural and haemal processes are seen from 8.8 mm SL larvae onwards. The centra are seen from 4.0 mm NL, ossification is evident in the first dorsal pterygiophore and pectoral girdle from very early stages, neural and haemal spines are next to ossify, centra show ossification from 8.8 mm SL. The arches get ossified in 9.8 mm SL, first neural arch is flimsy and remain cartilagenous even in 10.7 mm SL larvae. There are 10+24-25 vertebrae including urostyle.

The adult

Depth of body about twice in the length, length of head a little more than 4. Snout a little shorter than eye, diameter of which is $3 \frac{3}{5}$ to $3 \frac{2}{3}$ in length of head; interorbital space concave, width $\frac{1}{4}$ to $\frac{1}{2}$ diameter of eye; lower eye a little in advance of upper. No rostral or orbital spines. Maxillary extending to a little beyond anterior edge of eye, length $2 \frac{4}{5}$ to 3 in that of head. Upper jaw with an outer row of stronger teeth. 6 gill-rakers of moderate length on lower part of anterior arch. 51 to 53 scales in lateral line. Dorsal (78) 83-86. Anal (58) 61-62 (Fig. 6 D). Pectoral of ocular side with 11 rays, length $\frac{3}{4}$ that of head. Brownish, with numerous small dark spots on head, body and fins (Norman, 1934).

Remarks :

The larval body of *E. mogkii* is covered over by brownish black stellate pigments. These pigments fade away on clearing the specimens in alcohol except a few blotches along the base of the dorsal, anal and caudal fin rays as well as on the swim bladder and on the caudal portion of the vertebral column. The eyes become black at later stage than in *E. latifrons*. The relative length between snout and pelvic fin base gradually decreases unlike in *E. cocosensis* and *E. latifrons*. The spines on cleithra and posterior basipterygial processes are developed at a later stage. The caudal fins are differentiated earlier than *E. cocosensis* and *E. latifrons* but the pelvic fins are developed later. The number of median fin rays agree with those of the adults. The adults are reported from the Indian Ocean, but the larvae of this species are not reported and described so far.

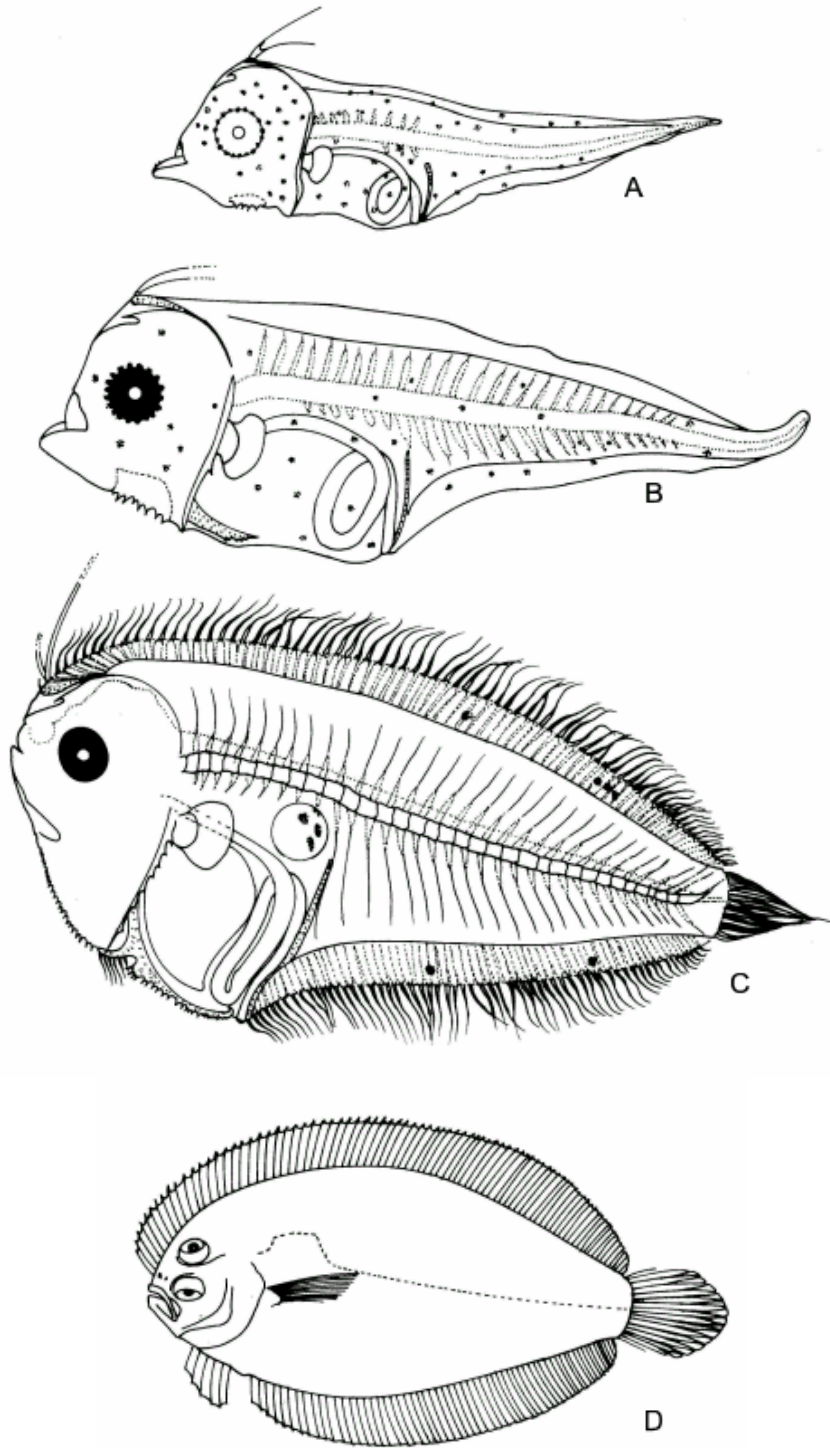


Fig. 6 - *E. mogkii*, A – 2.8mm NL, B-3.4 mm NL, C-9.4mm SL, D – Adult
(from Lalithambika Devi, 1986)

Table 6 a - *Engyprosopon mogkii*-morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Stage	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus	Depth	Length	
S11B-63	2.8 NL	Symmetrical	Pre flexion	1.60	0.80	0.26	0.27	0.26	1.13	0.84	--	--	0.80
"	2.9 "	"	"	1.60	0.80	0.26	0.26	0.29	1.13	0.93	--	--	0.77
"	3.4 "	"	"	1.70	1.00	0.35	0.26	0.32	1.44	1.14	--	--	0.80
"	3.7 "	"	Early flexion	2.00	1.20	0.35	0.26	0.29	1.90	1.70	--	--	0.90
"	4.0 "	"	Mid flexion	2.10	1.40	0.50	0.34	0.39	2.40	2.30	--	--	1.00
S9A-13A	5.3 "	"	Late flexion	2.30	1.60	0.50	0.43	0.48	2.70	2.50	--	--	1.40
"	5.8 SL	"	Post flexion	2.10	1.80	0.61	0.48	0.52	3.20	3.00	0.61	0.29	1.60
"	7.0 "	"	"	3.40	2.10	0.68	0.52	0.58	4.00	3.90	1.10	0.42	1.60
S9A-18A	7.2 "	"	"	3.50	2.10	0.61	0.48	0.55	3.50	3.50	0.71	0.43	1.70
S9A-13A	8.8 "	"	"	3.80	2.50	0.74	0.64	0.69	4.80	5.00	1.40	0.56	2.10
"	9.8 "	"	"	3.80	2.70	0.82	0.64	0.64	5.30	5.50	1.70	0.61	2.10

Table 6 b - *Engyprosopon mogkii* – meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin rays				Vertebrae			Spines		
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior besipterygial processes
S11B-63	2.8 NL	Pre flexion	Straight	1	0	0	0	0	6	0	0	0	0	
"	2.9 "	"	"	1	0	0	0	0	6	0	0	0	0	
"	3.4 "	"	"	1	0	0	0	0	9	1	5	5	5	
"	3.8 "	"	"	1	0	0	0	0	9	1	5	5	5	
S11B-63	4.0 "	Mid flexion	Flexing	70	44	10	0	0	13	3	11	11	11	
S9A-13A	5.3 "	Late flexion	"	77	52	12	0	0	19	6	19	19	19	
"	5.8 "	"	"	82	57	13	0	0	23	5	22	22	22	
S9A-13A	7.0 SL	Post flexion	Flexed	Ca. 81	Ca 59	17	Forming 3+3	10	20	9	20	20	20	
S9A-18A	7.2 "	"	"	87	61	17	"	10	26	6	26	26	26	
S9A-13A	8.8 "	"	"	85	59	17	"	10	29	10	23	23	23	
DI-5251	9.4 "	"	"	80	61	17	"	10	29	7	25	25	25	
S9A-13A	9.8 "	"	"	83	62	17	"	10	23	10	21	21	21	
VI-5227	10.7 "	"	"	80	60	17	2+4	10	29	7	24	24	24	

Table 6 c - *Engyprosopon mogkii* - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Stations	Body Length	Stage	Noto-chord	Right Eye	Precaudal vertebrae			Caudal vertebrae			Centra	Ural Centra	Total vertebrae	Caudal fin rays	Ural Bcomponents			Epural
					Neural	Process	Arch	Neural	Process	Arch					Sup	Hyp	Inf	
					Process	Arch	Process	Arch	Process	Arch	Centra	Ural Centra	Total vertebrae	Caudal fin rays	Sup	Hyp	Mid	Low
S11B-63	2.8 NL	Pre fl.	Straight	Symmetrical	0	9	0	0	16	5	11	0	25	0	0	0	0	0
"	2.9 "	"	"	"	0	9	0	0	19	5	14	0	28	0	0	0	0	0
"	3.4 "	"	"	"	9	1	0	0	10	10	9	0	29	0	0	0	0	0
"	3.8 "	"	"	"	9	1	0	0	7	14	7	0	31	0	0	0	0	0
"	4.0 "	Mid flexion	Flexing	"	9	1	0	10	22	22	2	22	34	10	0	X	X	X
S9A-13A	5.3 "	Late flexion	"	"	9	1	0	10	2	20	2	22	32	12	0	X	X	X
S9A-18A	6.8 "	"	"	"	9	1	0	10	21	21	2	23	33	13	0	X	X	X
S9A-13A	5.8 "	Post flexion	Flexed	"	9	1	0	10	22	22	2	24	35	17	X	X	X	X
"	7.0 "	"	"	"	9	1	3	10	22	22	2	24	35	17	X	X	X	X
S9A-18A	7.2 "	"	"	"	9	1	2	10	22	22	2	24	35	17	X	X	X	X
S9A-13A	8.8 "	"	"	"	9	1	6	10	21	21	2	23	34	17	X	X	X	X
"	9.8 "	"	"	"	9	1	6	10	21	21	2	23	34	17	X	X	X	X

7. *Engyprosopon grandisquamis* (Temminck and Schlegel, 1846)

Larvae ranging from 2.3 mm NL to 16.4 mm SL were present in the IIOE and Naga Expedition plankton collections. The larvae belonging to preflexion, flexion and postflexion stages were contained in the collections (Figs. 7 A, B, C, D, E, F ; Tables 7 a, b, c & 25).

Morphology :

Larval body diaphanous and symmetrical in early stages. Eyes symmetrical and prominent with black pigments sparsely distributed in 2.3 and 2.5 mm NL larvae and they turn black in 2.7 mm NL. Right eye has started shifting from its symmetrical position preparatory to migration to the left side in 11.9 mm SL, but shifting is not completed even in 16.4 mm SL, the largest larvae in the collections. At this stage right eye has migrated dorsalwards by about half the diameter of the eye. Anterior portion of the alimentary canal runs almost parallel to notochord and bends down at posterior end of the abdominal cavity, where it makes a single circular coil in 2.3 mm NL larva with anus opening on 10th myotome. The circular intestinal coil turns elliptical in 2.5 mm NL larvae and in advanced forms, this coil becomes compact, the anus moves forwards to the level of the eighth vertebral segment. Liver occupies the space between the cleithra and the intestinal loop, its antero-posterior axis is more than that of the dorso-ventral axis in preflexion and flexion stages, but in advanced forms dorso-ventral gains over the antero-posterior axis. A small but conspicuous swim bladder presses against the intestine downwards at its middle region in early stages, but later it occupies the space between seventh and ninth vertebral segments and lies obliquely downwards. A diverticulum is seen hanging from the urohyal region just in front of the sciatic portion of the larvae in early stages which may be designated as the urohyal appendage marked by a brownish black pigment blotch at its base. It shrivels up and the pigment is not traceable after 3.8 mm NL whereas a loose fold of skin is seen in the place of the appendage up to 5.5 mm NL. The pigments are not seen anywhere else on the body.

Spines are found on urohyal, cleithra and posterior basipterygial processes. In early stages (2.3 and 2.5 mm NL) they occur only on urohyal and

that too only two or three in number, those on the left ramus of the posterior basipterygial process do not juxtapose with those of the right ramus and hence are counted and represented separately.

Relative head length and snout length increases from preflexion to flexion stages but decreases towards post flexion stages (Table 25), a condition similar to that met with in *E. mogkii* as far as head length is concerned but not snout length in which respect it resembles *E. cocosensis* and *E. latifrons*. Relative snout – anus length as well as eye height and width decreases from preflexion to postflexion as in *E. latifrons* whereas *E. mogkii* resembles only with the former and *E. cocosensis* with the latter. Relative depth at pectoral base and the depth at anus increases as the larvae grow as in *E. mogkii* but not as in *E. cocosensis* and *E. latifrons*. Relative depth between snout and pelvic fin base decreases from preflexion to flexion stages gradually but thereafter suddenly. This feature is characteristic of the species.

Fin and supporting structures :

Elongated dorsal ray supported by the first elongated dorsal pterygiophore is seen at the anterior end of the dorsal fin fold in all stages of larvae. First long and stout anal pterygiophore gets differentiated in 3.6 mm NL, a few more pterygiophores are seen at anterior end of anal fin fold in 3.8 mm NL. Along the dorsal fin fold, however, the pterygiophores are not distinct at this stage. In 4.1 mm NL the median fin is differentiated from the anterior to the posterior end except above the head region and in the region of the anus, baseosts are discernible from 4.6 mm NL onwards. From the anterior end of the first dorsal pterygiophore a forward extension is differentiated in 5.8 mm SL larvae which supports the first tiny dorsal ray in later stages. First tiny dorsal ray is discernible only in 7.8 mm SL larvae when full complement of the dorsal fin and anal fin rays are found. There are 78 to 95 dorsal and 57 to 73 anal rays (Table 7 b).

Caudal fin complex is seen differentiating as a pack of cells at the ventral caudal extremity in 4.1 mm NL, inferior hypural middle and superior hypural middle are demarcated in 4.6 mm (early flexion) NL, inferior hypural lower and epural are differentiated in midflexion stages (5.0 mm NL). Flexion is initiated in

4.6 mm NL larvae and is completed in 5.8 mm SL. The full complement of the caudal fin rays (17) are seen in 5.8 mm SL. The epural does not support any ray as it becomes fused with the superior hypural upper from 5.8 mm SL. Of the 17 caudal rays, 15 are borne on hypural plates as follows: inferior hypural lower three, inferior hypural middle four, superior hypural middle five and superior hypural upper three. The two remaining ones are attached directly to the neural and haemal arches of the penultimate vertebra.

Pelvic fin complex consisting of the dorsal, posterior and anterior basipterygial components appear as pack of cells collected at the posterior ventral aspect of the cleithra near the lower middle portion in 2.3 mm NL. From this, cartilaginous bars, the basipterygials get differentiated, the proximal portion of which forms the dorsal basipterygial processes and remain attached to the cleithra. The processes then run obliquely downwards up to the tip of the cleithra from where they continue posteriorly along the ventral body wall as the posterior basipterygial processes in 3.3 mm NL larvae. Spines are well developed in the middle portion of the posterior basipterygial processes, the distal ends of the processes ending in spines, the processes reach up to the level of the ascending loop of the intestine in 5.0 mm NL larvae and remain like that even in 16.4 mm SL larvae. Anterior basipterygial processes representing the pelvic fin radials and pelvic fin proper are seen as pack of cells in 4.1 mm NL concentrated at the anterior face of the basipterygials where the dorsal and posterior portions meet.

A cartilaginous rod is differentiated with rudiments of fin rays from the pack of cells in 5.0 mm NL. When the larvae attain 5.8 mm SL, pelvic fin rays are differentiated and the fin radials have become asymmetrical, those of the left side being longer than those of right and two of the anterior rays of the left fin remaining in advance of those of the right fin. Forward extension of the anterior basipterygial processes on the left side continues and in 7.8 mm SL they have reached the level of the urohyal end in 15.3 mm between the last two spines of the urohyal and three rays of the left fin remain in advance of the right fin.

Axial skeleton :

Notochord remains vacuolated and unsegmented in early stages but in 4.1 mm NL segmentation has commenced from the anterior region but is less

marked posteriorly. First neural arch is differentiated in 4.1 mm NL and becomes ossified in 15.0 mm SL. In 2.3 and 2.5 mm NL larvae, only the first dorsal pterygiophore is present which is bony. Neural arches in the precaudal region and also in the anterior caudal region have started to differentiate in 3.3 mm NL so also the first haemal process as well as a few anterior haemal arches. But in the pre-caudal region, haemal arches have differentiated only from 3.8 mm NL. Development of neural and haemal processes are completed in 10.0 mm SL (Table 8c). Neural and haemal arches show ossification in 12.4 mm SL, except the first neural arch. Ossification of centra along its margin is also noticed in 12.4 mm SL. Vertebral centra are bony in 15.0 mm SL. There are 10+24 (25) vertebrae including urostyle.

The adult

Depth of body $1 \frac{2}{3}$ to $2 \frac{1}{8}$ in the length, length of head $3 \frac{3}{5}$ to $4 \frac{1}{5}$. Snout shorter than eye, diameter of which is $2 \frac{2}{3}$ to nearly 4 in length of head ; interorbital space concave, width $\frac{2}{3}$ to $1 \frac{3}{4}$ times (M) or $\frac{1}{3}$ to $\frac{7}{8}$ (F) diameter of eye ; anterior edge of upper eye above middle or posterior part of lower. Rostral and orbital spines present in the male, very small or absent in the female. Maxillary extending to, nearly to, or beyond anterior edge of eye, length 3 to $3 \frac{1}{2}$ in that of head. Teeth of upper jaw biserial anteriorly (at least in adults), uniserial laterally; those of lower jaw uniserial, sometimes in two rows posteriorly. 5 to 7 short gill- rakers on lower part of anterior arch. 36 to 45 scales in lateral line. Dorsal 79-89. Anal 59-68 (Fig. 7 F). Pectoral of ocular side with 10 to 12 rays, the upper ray some times a little prolonged in the male, length equal to or less than that of head, Brownish, generally with some darker spots and other markings; median fins usually with small brown spots ; a pair of large blackish spots in the middle of upper and lower margins of caudal (Norman, 1934).

Remarks :

The larvae of *E. grandisquamis* possess a small urohyal appendage in the early preflexion stages as in *Psettina brevirictis* and *P. iijimae* but disappears earlier than that of *Psettina* spp. The spines on the posterior basipterygial processes. The spines on the posterior basipterygial processes are peculiar in that the spines on either side do not juxtapose. The terminal portion instead of

turning back, a typical *Engyprosopon* characteristic according to Ahlstrom, ends straight in a spine. Ahlstrom suggests that such a character is helpful to assign a separate status to *E. grandisquamis* (personal communication). In *E. grandisquamis* the eyes become black earlier than in *E. mogkii*. The pelvic fin also gets differentiated much early.

Pertseva-Ostroumova (1965) has described larvae of this species from the plankton collections of Gulf of Tonkin ranging from 2.8-8.9 mm and a single specimen of 14.3 mm. The present description agrees with that of Pertseva-Ostroumova in many respects. However, she has not mentioned about the urohyal appendage or the peculiar character of the posterior basipterygial processes which is straight and ends in spine. The fin ray counts of the larvae tally with those of the adults. The adults are reported from the Indian Ocean.

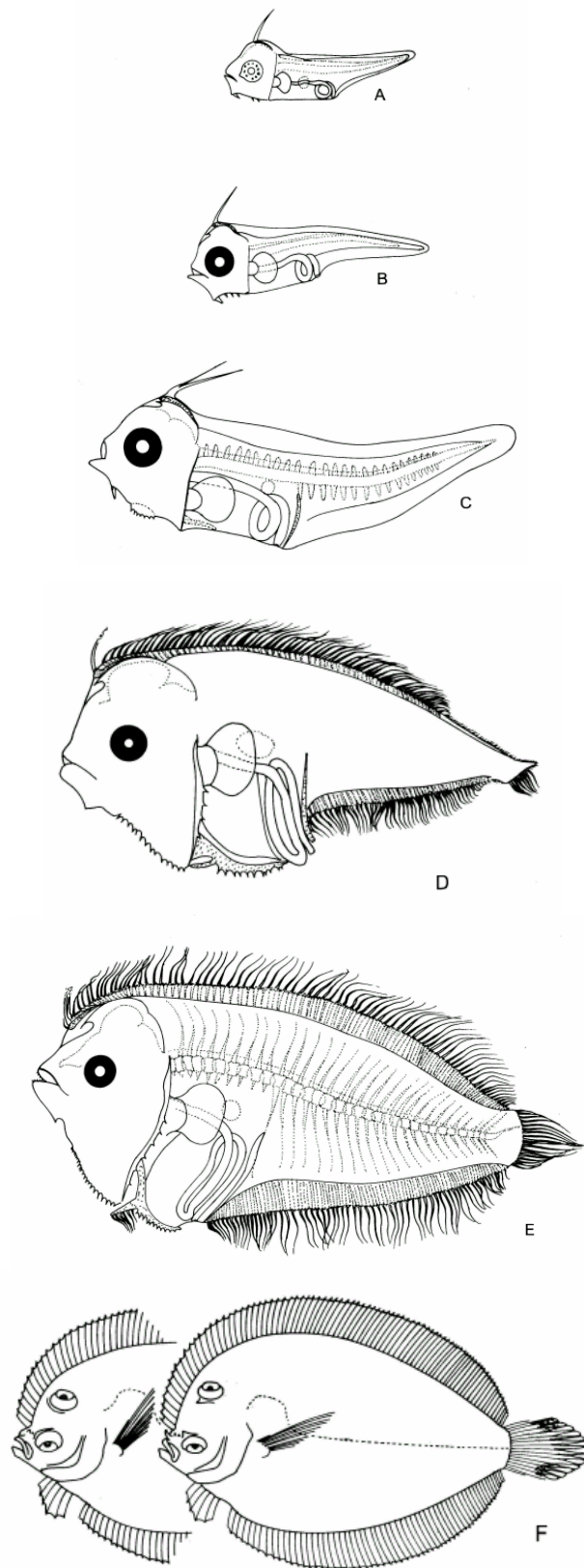


Fig. 7 - *E. grandisquama*, A-2.3 mm NL, B-2.5 mmNL, C-3.6 mm NL, D-5.1mm NL, E-8.8mm SL, F-Adult (from Lalithambika Devi, 1986).

Table 7 a - *Engyprosopon grandisquamis* - morphometrics, in mm
(Larval stages within broken lines indicate notochoord flexion).

Stations	Body Length	Right Eye	Stage	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus	Depth	Length	
S7-13	2.3 NL	Symmetrical	Pre flexion	1.60	0.71	0.16	0.24	0.26	0.68	-	-	-	-
S5-16	2.7 "	"	"	1.40	0.71	0.19	0.27	0.29	0.60	-	-	-	-
S7-18G	3.2 "	"	"	1.70	0.90	0.24	0.27	0.29	1.09	-	-	-	-
S6-30	3.8 "	"	"	1.90	1.00	0.29	0.32	0.39	1.24	-	-	-	-
S6-30	4.2 "	"	"	2.30	1.10	0.31	0.34	0.37	1.29	-	-	-	1.10
S10-U-1	4.5 "	"	"	2.30	1.30	0.39	0.30	0.35	1.70	-	-	-	1.20
S10-U-1	4.6 "	"	Early flexion	2.30	1.50	0.47	0.32	0.39	1.90	-	-	-	1.30
S5-5	5.0 "	"	Mid flexion	2.30	1.50	0.47	0.45	0.47	2.70	-	-	-	1.20
S9A-18A	5.5 "	"	Late flexion	2.50	1.70	0.43	0.43	0.45	2.60	-	-	-	1.40
"	5.6 "	"	"	2.50	1.70	0.56	0.40	0.40	2.30	-	-	-	1.50
S9A-18A	5.8 SL	"	Post flexion	2.70	1.80	0.58	0.42	0.45	2.80	0.62	0.34	0.34	1.60
"	6.4 "	"	"	3.30	1.90	0.58	0.45	0.53	3.00	0.64	0.35	0.35	1.70
S6-30	7.0 "	"	"	3.10	2.10	0.68	0.52	0.58	3.70	0.97	0.50	0.50	1.50
S9A-18A	7.6 "	"	"	3.10	2.10	0.60	0.46	0.46	3.90	1.03	0.48	0.48	1.50
"	8.2 "	"	"	3.20	2.20	0.60	0.58	0.58	4.20	1.06	0.47	0.47	1.70
"	9.2 "	"	"	3.70	2.60	0.81	0.64	0.68	5.40	1.70	0.61	0.61	1.60
"	10.1 "	"	"	3.80	2.90	0.84	0.69	0.69	5.90	2.00	0.71	0.71	1.70
S3-31	11.1 "	"	"	3.80	3.00	0.84	0.77	0.79	6.40	2.10	0.77	0.77	1.60
S8-41	12.4 "	Migrating	"	3.80	3.30	0.87	0.74	0.77	6.80	2.40	0.79	0.79	1.70
S9A-18A	13.7 "	"	"	4.00	3.90	0.84	0.97	0.99	6.60	2.40	0.97	0.97	2.00
S11A-34	14.5 "	"	"	4.60	3.90	0.81	0.94	0.99	7.20	2.50	1.01	1.01	2.30
S3-16	16.4 "	"	"	4.40	3.60	0.85	0.97	1.00	8.60	3.10	1.06	1.06	2.20

Table 7 b - *Engyproson grandisquamis* –meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays				Vertebrae			Spines		Posterior basipterygial processes	
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total	Urohyal	Cleithra		
Ki-527	2.3 NL	Pre flexion	Straight	Symmetrical	1	0	0	0					2	0	0
"	2.5 "	"	"	"	1	0	0	0					3	0	0
"	3.3 "	"	"	"	1	0	0	0					6	1	2/2
Me-53	3.6 "	"	"	"	1	0	0	0					7	1	2/2
S5-16	3.8 "	"	"	"	1	0	0	0					12	2	2/2
S10-U1	4.1 "	"	"	"	52	42	0	0					16	4	6/5
S6-31	4.5 "	Early caudal formation	"	"	48	39	4	0					14	4	6/5
S10-U1	4.6 "	Early flexion	Flexing	"	56	49	6	0					14	4	6/6
S5-5	5.0 "	Mid flexion	"	"	64	59	8	Forming					17	4	6/5
S9A-18A	5.5 "	Late flexion	"	"	58	49	11	"					15	4	6/6
S11A-85	5.8 SL	Post flexion	Flexed	"	81	60	17	2+4					20	5	7/7
S5-4A	6.1 "	"	"	"	78	58	17	"					21	6	7/7
"	6.5 "	"	"	"	85	61	17	"					20	6	7/6
S5-16	7.3 "	"	"	"	84	57	17	"					18	5	7/7
Ki-727	7.8 "	"	"	"	89	59	17	2+4					23	5	9/8
VA-1801	8.0 "	"	"	"	84	59	17	3+3	10				17	8	10/9
Ki-666	8.8 "	"	"	"	83	61	17	3+3	10				22	6	11/11
Ki-103	10.0 "	"	"	"	90	63	17	"	10				22	8	10/9
S3-20	12.4 "	"	"	Migrating	87	63	17	"	10				23	9	7/7
S11A-34	15.0 "	"	"	"	84	64	17	"	10				16	4	7/7
AB-16	15.3 "	"	"	"	79	56	17	"	10				24	7	8/8
S3-16	16.4 "	"	"	"	95	73	17	"	10				24	6	8/8

Table 7 c - *Engyprosopon grandisquamis* - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Stations	Body Length	Stage	Notochord	Right Eye	Precaudal vertebrae			Caudal vertebrae			Centra	Ural Centra	Total vertebrae	Caudal fin rays	Ural components			Epural
					Neural Process	Arch	Haemal Process	Neural Process	Arch	Haemal Process					Arch	Sup Upp	Hyp Mid	
KI-527	2.3 NL	Pre flexion	Straight	Symmetrical	0	0	0	0	0	0	0	0	0	0	0	0	0	
"	2.5 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	
"	3.3 "	"	"	"	0	9	0	0	16	0	0	0	0	0	0	0	0	
S5-16	3.8 "	"	"	"	9	0	0	7	11	8	10	0	0	0	0	0	0	
S10-U-1	4.1 "	"	"	"	9	1	0	7	11	21	0	0	0	0	0	0	0	
S6-31	4.5 "	"	"	"	9	1	0	8	4	19	4	0	0	0	0	0	0	
S10-U-1	4.6 "	Early flexion	Flexion	"	9	1	0	8	2	20	2	0	0	0	0	0	0	
S5-5	5.0 "	Mid flexion	"	"	9	1	0	8	2	21	2	0	0	0	0	0	0	
S9A-18A	5.1 "	Late flexion	"	"	9	1	0	8	2	22	2	0	0	0	0	0	0	
"	5.5 "	"	"	"	9	1	0	8	2	21	2	0	0	0	0	0	0	
S11A-85	5.8 SL	Post flexion	Flexed	"	9	1	3	5	2	21	2	0	0	0	0	0	0	
S5-4A	6.1 "	"	"	"	9	1	3	5	2	21	2	0	0	0	0	0	0	
"	6.5 "	"	"	"	9	1	3	6	2	21	2	0	0	0	0	0	0	
S5-16	7.3 "	"	"	"	9	1	3	6	2	21	2	0	0	0	0	0	0	
KI-727	7.8 "	"	"	"	9	1	3	6	2	21	2	0	0	0	0	0	0	
Va-1801	8.0 "	"	"	"	9	1	3	6	2	21	2	0	0	0	0	0	0	
KI-666	8.8 "	"	"	"	9	1	3	6	2	21	2	0	0	0	0	0	0	
KI-103	10.0 "	"	"	"	9	1	6	3	2	21	2	0	0	0	0	0	0	
S3-20	12.4 "	"	"	"	9	1	6	3	2	21	2	0	0	0	0	0	0	
S11A-34	15.0 "	"	"	"	9	1	6	3	2	21	2	0	0	0	0	0	0	
AB-16	15.3 "	"	"	"	9	1	6	3	2	22	2	0	0	0	0	0	0	
S3-16	16.4 "	"	"	"	9	1	6	3	2	21	2	0	0	0	0	0	0	

8. *Engyproson sechellensis* (Regan 1908)

Larvae ranging from 5.2 mm NL to 12.1 mm SL belonging to mid flexion and postflexion stages are described from the plankton collections of IIOE and Naga Expeditions (Fig. 8 A, B, C ; Table 8 a, b, c & 25)..

Morphology :

Larval body thin, transparent and asymmetrical in midflexion and early postflexion stages. Eyes symmetrical and black, the right one has started moving dorsalwards preparatory to its migration to the left side in 12.1 mm SL larvae. Intestine has a compact elliptical coil placed at the posterior end of the abdominal cavity. Rectal portion of the alimentary canal vertical in midflexion and in early postflexion stages, and the anus opens on the tenth vertebral segment in 5.2 mm NL. Ventral portion of the alimentary canal including the rectum and anus is pushed forwards and opens at the level of the eighth vertebral segment in 12.1 mm SL. Liver massive occupying the space between pectoral girdle and intestinal loop as in other spp. with the anteroposterior axis shorter than the dorso-ventral axis. Swim bladder present, spherical in midflexion stage, but in advanced stages becoming oval and lies above the intestinal loop in the space between seventh and tenth vertebral segments.

There is no spination on cleithra whereas they are present in the urohyal and posterior basipterygial processes. The number of spines increases as the larvae grow older. Because of the absence of preflexion stages in the collection as well as scarcity of the specimens belonging to flexion stages, the statistical analysis for morphometric data is not discussed.

Fin and supporting structures :

Fin rays are visible in the median fins except a small portion in the posterior caudal region in 5.2 mm NL larvae (the earliest in the collections). Full complement of the median fin rays is seen in 6.3 mm SL in which the tiny first dorsal ray in front of the elongated dorsal ray is also differentiated. There are 81-91 dorsal and 57-70 anal rays.

Caudal fin complement with six rays supported by the inferior hypural middle and superior hypural middle, both carrying three rays each in the earliest

larvae available in the collection (5.2 mm NL). Inferior hypural lower is differentiated but rays are found only in 5.5 mm SL, the superior hypural upper is also differentiated and bears three rays in 5.5 mm SL. Two rays borne on either side of the caudal fin by the processes of the penultimate vertebra are differentiated in 6.3 mm SL larvae.

Pelvic fin radial rudiment occurs in 5.2 mm NL and is differentiated in 5.5 mm SL. Left fin radial has grown past the right fin radial in 7.7 mm SL and grows forwards to the urohyal and reaches up to the level of the second spine from the posterior end in 12.1 mm SL. Fin ray rudiment is seen in 6.3 mm SL, in 7.7 mm SL the pelvic fin radial is asymmetrical, that of the left side being longer than the right. Fin rays are short and left two rays are seen in advance of the right fin. Posterior basipterygial processes beset with spines are present in the youngest larvae of the collection (5.2 mm NL). Distal end of the posterior basipterygial recurved on reaching the level of the ascending loop of the intestine but never reached the middle level of the intestinal loop.

Axial skeleton :

Segmentation of the notochord visible but centra are not discernible in 5.1 mm NL larva, the neural and haemal processes and arches are fairly well developed in caudal portion. In the precaudal region haemal arches are differentiated whereas neural processes are seen well developed.

First neural arch is also seen in 5.2 mm NL larva but remains in the cartilaginous condition even in 12.1 mm SL larvae. Neural and haemal processes are fully developed in 6.3 mm SL larva. Ossification of the processes commences in larvae 9.3 mm SL, centra are discernible in 6.9 mm SL. The ossification has commenced only from 9.3 mm SL but not completed even in the largest larvae (12.1 mm SL) available in the collection. There are 10 + 24 – 26 vertebrae including urostyle.

The adult

Depth of body $2 \frac{1}{5}$ in the length, length of head $3 \frac{3}{5}$ Snout shorter than eye, diameter of which is $3 \frac{1}{2}$ in length of head and equal to width of concave interorbital space ; anterior edge of upper eye above posterior part of lower. Male with a spine on the snout, one in front of and one above the lower eye, one

in front of and one below the upper eye.. Maxillary extending to below anterior 1/4 of eye, length about 2 2/3 in that of head. 6 gill-rakers of moderate length on lower part of anterior arch. 40 scales in lateral line. Dorsal 82. Anal 63 (Fig. 8 C). Pectoral of ocular side with 12 rays, upper ray produced and longer than head (in the male). Pale brownish ; dark spots or marking on body and fins (Norman, 1939).

Remarks :

The larvae of *E. sechellensis* are distinguished from other species in the absence of spines on the cleithra. The number of spines on urohyal and posterior basipterygial processes are more or less equal to those of *E. cocosensis*. The posterior basipterygial processes are typical of *Engyprosopon* species as in *E. cocosensis*, *E. latifrons* and *E. mogkii*. The numerical counts agree with those of the adult. The adults are reported from the Indian Ocean. The larvae is described and reported for the first time.

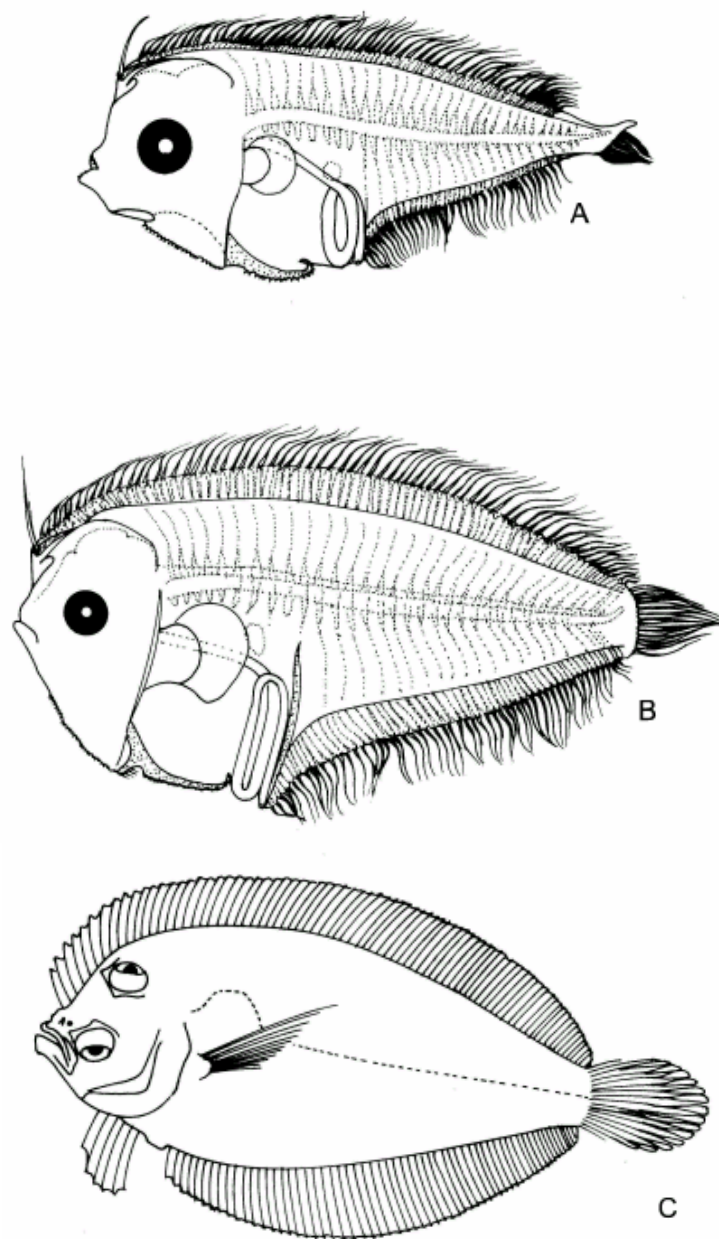


Fig. 8 - *E. sechellensis*, A-5.2 mm NL, B-9.3mm SL, C- Adult (from Lalithambika Devi, 1986).

Table 8 a - *Engyprosopon sechellensis* - morphometrics, in mm (larval stages).

Stations	Body Length	Right Eye	Stage	Snout to Anus	Head Length	Snout Length	Eye		Body depth at Pectoral fin base	Caudal Peduncle Length	Snout to origin of pelvic fin
							Width	Height			
S11B-91	5.2 NL	Symmetrical	Mid flexion	2.40	1.40	0.52	0.35	0.39	2.40	-	1.40
S8-26A	5.5 SL	"	Post flexion	2.40	1.60	0.58	0.45	0.56	2.90	0.61	1.50
"	6.3 "	"	"	2.80	1.80	0.68	0.52	0.48	3.20	0.79	1.80
S11B-81	6.9 "	"	"	3.50	2.00	0.71	0.45	0.52	4.00	0.97	1.50
S8-26A	7.7 "	"	"	3.30	2.40	0.81	0.53	0.63	4.10	1.38	2.20
"	7.9 "	"	"	3.30	2.20	0.71	0.58	0.68	4.00	1.32	1.60
S4-32	8.3 "	"	"	3.60	2.50	0.70	0.64	0.71	4.90	1.60	1.70
S6-34	8.7 "	"	"	3.50	2.50	0.90	0.58	0.64	4.80	1.55	1.70
S6-31	10.1 "	"	"	4.20	2.70	0.97	0.61	0.68	5.30	1.61	1.80
DI-52928	12.1 "	"	"	4.20	3.00	0.90	0.63	0.67	5.70	1.45	2.00

Table 8 b - *Engyprosopon sechellensis* – meristics (Larval stages).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			Spines			
					Dorsal	Anal	Caudal	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior basipterygial processes	
S11B-91	5.2 NL	Mid flexion	Flexing	Symmetrical	69	39	6					22	0	15
S8-26A	5.5 SL	Post flexion	Flexed	"	83	57	15	10		25	35	21	0	11+
"	6.3 "	"	"	"	89	60	17	10	26	26	36	20	0	14
S11B-81	6.9 "	"	"	"	84	58	17	10	24	34	34	27	0	22
S8-26A	7.7 "	"	"	"	89	70	17	10	26	36	36	23	0	14
"	7.8 "	"	"	"	88	66	17	10	26	36	36	22	0	17
S4-32	8.3 "	"	"	"	87	61	17	10	25	35	35	21	0	24
S6-34	8.7 "	"	"	"	87	62	17	10	25	35	35	23	0	19
OS-4	9.3 "	"	"	"	82	60	17	10	24	34	34	32	0	26
S6-31	10.1 "	"	"	"	88	68	17	10	26	36	36	21	0	15
S6-38	10.9 "	"	"	"	81	61	17	10	24	34	34	36	0	18
DI-5292B	12.1 "	"	"	Migrating	91	70	17	10	25	35	35	32	0	26

9. *Engyprosonon multisquama* Amaoka, 1963

Larvae ranging from 2.6 mm NL to 5.9 mm SL are described from plankton collected during IIOE and Naga Expeditions (Figs. 9 A, B, C, D ; Tables 9 a, b, c, 25).

Morphology :

Larval body diaphanous and symmetrical. Eyes symmetrical but not pigmented in 2.3 mm NL, turning black in 2.8 mm NL larvae. Alimentary canal runs parallel to the notochord, the intestinal coil is circular in early stages but in 3.7 mm NL becomes elliptical and placed at the posterior end of the abdominal cavity and the rectal portion dips vertically down, the anus at the level of the 10th myotome. Ventral portion of the intestinal loop gets pushed gradually forwards as the larvae grow and in 5.9 mm SL (the largest specimen in the collection) the anus opens on the ninth vertebral segment. Liver massive and occupies the space between the pectoral girdle and intestinal loop. Swim bladder small and occupies the space between eighth and tenth vertebral segment.

Spines which are comparatively small, are found on urohyal and posterior basipterygial processes from very early larval stages. Number of spines increases as the larvae grow. Spines are not seen on cleithra even in the largest (5.9 mm SL) specimens in the present collections.

Relative head length as well as length between snout and pelvic fin base increase from preflexion to postflexion stages unlike in other species so far studied. Relative snout length shows an increase from preflexion to flexion stages, thereafter decreases as in *E. cocosensis*, *E. latifrons* and *E. grandisquamis*. Relative snout to anus length decreases as in *E. latifrons*, *E. mogkii* and *E. grandisquamis*. Eye width increases from preflexion to flexion stages and then decreases in contrast to the species studied so far ; whereas the eye height decreases from preflexion to postflexion stages as in *E. cocosensis*, *E. latifrons*, *E. mogkii* and *E. grandisquamis*. Relative depth at pectoral base shows sudden increase from preflexion to flexion stages but the increment is gradual afterwards, as in *E. grandisquamis*. Depth at anus increases as in *E. latifrons*, *E. mogkii* and *E. grandisquamis*.

Fin and supporting structures :

Elongated dorsal ray at the anterior end of the dorsal fin fold is differentiated from early stages. First anal pterygiophore gets differentiated in 3.0 mm NL. In 3.7 mm NL larvae, median fin rays are differentiated from anterior to posteriorwards. However, dorsal rays are not differentiated over the skull region. First dorsal ray is not differentiated even in the largest larvae available in the collection (5.9 mm SL). Ramus of the supporting first dorsal ray grows out from the first elongated dorsal pterygiophore in 5.9 mm SL but the first ray is yet to develop. There are 84-85 dorsal and 52-53 anal rays.

Caudal fin complex is seen differentiating as pack of cells on the ventral side of the body a little anterior to the caudal extremity in 3.7 mm NL. Inferior hypural middle and superior hypural middle are differentiated in 4.2 mm NL with two caudal rays articulated to inferior hypural middle. Epural is differentiated from 5.1 mm NL (mid flexion stages). Flexion of the notochord is effected between 4.2 mm NL and 5.8 mm SL larvae. Full complement of caudal rays are seen in 5.8 mm SL.

Dorsal and posterior basipterygial processes of pelvic fin are differentiated in the earliest larvae (2.6 mm NL). Posterior basipterygial processes extend along the ventral aspect of the body wall and reach up to the intestinal loop, curve upwards and slightly forwards in advanced stages. Radial rudiment of pelvic fin is seen in 4.2 mm NL, radial is differentiated in late flexion (5.2 mm NL). Rays are not differentiated even in the largest specimens.

Axial skeleton :

Notochord vacuolated and unsegmented in larvae up to 4.8 mm NL. Neural and haemal arches begin to differentiate in 3.5 mm NL except the first neural arch, which is differentiated in 4.5 mm NL larva. Neural and haemal processes are differentiated in 3.7 mm NL, but in the precaudal region, only haemal arches are seen even in the largest specimen but not the haemal spines. There are 10 + 26 vertebrae including urostyle.

The adult :

Depth of body a little less than half its length of head 3.97-4.78. Snout short, about equal to the eye, diameter of which is 3.5 to 4.5 in length of head ; inter orbital space concave, width $\frac{1}{2}$ diameter of eye ; anterior edge of upper eye above middle of the lower. Rostral spine present and rather strong. Maxillary extending slightly beyond anterior edge of pupil of lower eye. Teeth on upper jaw biserial with largest teeth anteriorly. 5 to 8 gill – rakers on first arch similar in shape on both sides, rather long, developing on lower limb of arch. 45-50 scales in lateral line. Dorsal 83-96, anal 62-73 (Fig. 9 C). Pectoral of ocular side with 9-11 rays, length 0.5 to 0.9 in head ; produced and filamentous. Pale greyish green ; with irregularly scattered blackish spots paler than body on all fins. A pair of large jet-black blotches on caudal fin (Amaoka, 1969).

Remarks :

The larvae of *E. multisquama* resemble with those of *E. sechellensis* in the absence of spines on the cleithra. The number of spines on the urohyal and posterior basipterygial processes are fewer in number than those of *E. sechellensis* but is comparable to those of *E. latifrons*. The larval forms also possess the typical posterior basipterygial processes of the genus. The relative head length and snout to pelvic base increase from preflexion to postflexion stages unlike in other species studied so far. The depth across the anus is the least in *E. multisquama*. The number of dorsal and anal rays agree with those of the adult. The adults are reported from Japanese waters and not from the Indian Ocean. Ozawa and Fukui (1986), and Fukui, (1997) has reported the larvae of this species from South China Sea but is reported and described for the first time from Indian Ocean.

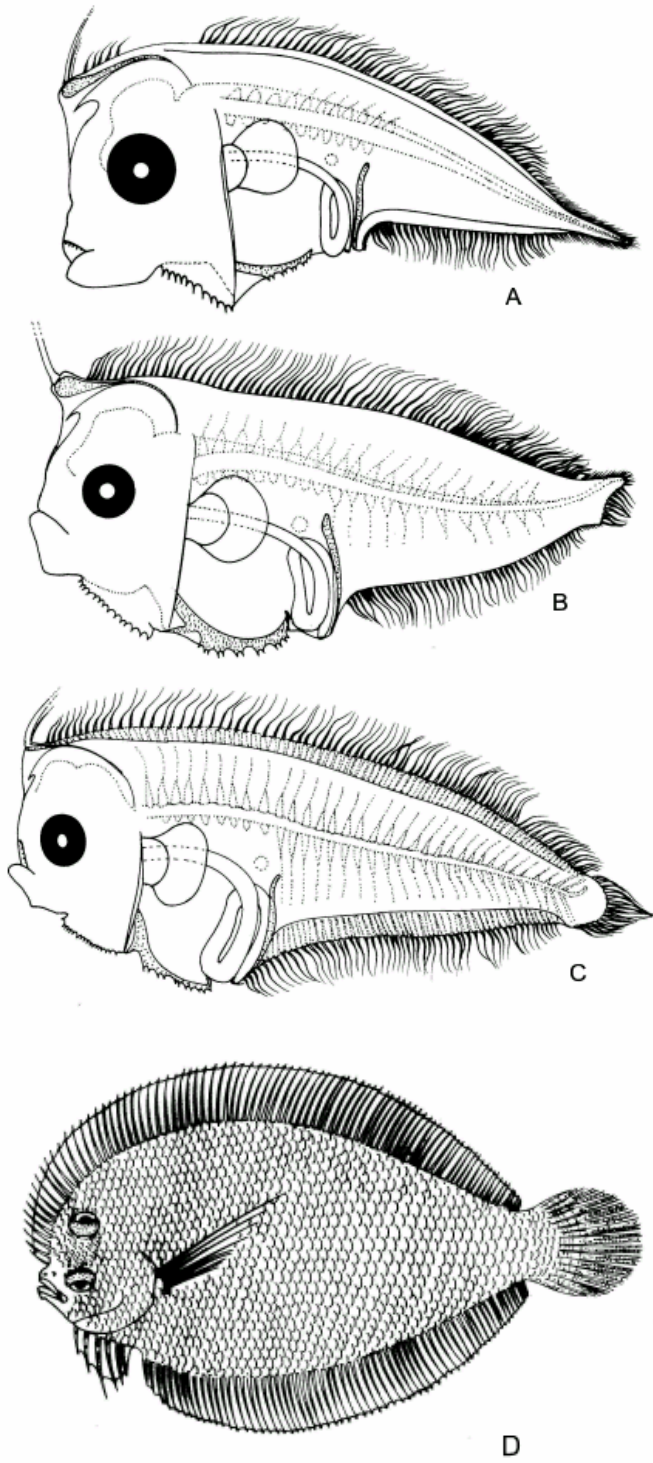


Fig. 9 - *E. multisquama*, A-3.7 mm NL, B-4.8 mm NL, C-5.9 mm SL, (from Lalithambika Devi, 1986), D- Adult (from Amaoka, 1969)

Table 9 a - *Engyprosopon multisquama* - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle Depth	Caudal Peduncle Length	Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus			
S6-34	2.6 NL	Symmetrical	Straight	1.40	0.70	0.16	0.23	0.23	0.71	0.64	-	-	-
S6-28	2.8 "	"	"	1.60	0.70	0.15	0.29	0.29	0.81	0.58	-	-	-
S5-9B	3.0 "	"	"	1.70	0.70	0.18	0.23	0.26	0.64	0.58	-	-	-
S6-39	3.1 "	"	"	1.50	0.80	0.21	0.24	0.29	0.90	0.72	-	-	0.80
S5-10	3.5 "	"	"	1.80	0.90	0.26	0.29	0.31	1.10	0.90	-	-	0.90
S8-20B	3.7 "	"	"	1.90	1.00	0.35	0.32	0.34	1.70	1.20	-	-	1.10
S8-20B	4.2 "	"	Early flexion	2.10	1.30	0.50	0.35	0.37	1.80	1.50	-	-	1.20
S8-20B	4.6 "	"	"	1.90	1.30	0.48	0.32	0.32	2.00	1.60	-	-	1.40
S8-26A	4.8 "	"	Mid flexion	2.30	1.30	0.45	0.39	0.42	2.20	2.10	-	-	1.20
S8-20B	5.2 "	"	Late flexion	2.40	1.60	0.50	0.35	0.43	2.40	2.30	-	-	1.70
S8-26A	5.6 "	"	"	2.40	1.60	0.58	0.45	0.56	2.90	2.70	-	-	1.50
S8-20B	5.8 SL	"	Flexed	2.60	1.80	0.60	0.45	0.40	2.70	2.40	0.55	0.29	1.90
S8-26A	5.9 "	"	"	2.60	1.80	0.58	0.45	0.41	2.70	2.80	0.64	0.37	1.70

Table 9 b - *Engyprosopon multisquama* - meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays				Vertebrae			Spines			
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior basipterygial processes	
S6-34	2.6 NL	Pre flexion	Straight	1	0	0	0						5	0	4
S6-28	2.8 "	"	"	1	0	0	0						8	0	4
S5-9B	3.0 "	"	"	1	1	0	0						9	0	4
S5-10	3.5 "	"	"	1	1	0	0						9	0	6
S8-20B	3.7 "	"	"	57	36	0	0						11	0	9
S8-20B	4.2 "	Early flexion	Flexing	65	43	2	0						9	0	10
S8-26A	4.5 "	"	"	67	42	7	0						16	0	11
S8-20B	4.6 "	"	"	64	49	5	0						14	0	14
S8-26A	4.8 "	Mid flexion	"	78	48	9	0						14	0	14
S8-20B	5.1 "	"	"	76	50	8	0						14	0	12
"	5.2 "	Late flexion	"	80	48	10	0						19	0	16
S8-26A	5.6 "	"	"	80	48	12	0						16	0	14
S8-20B	5.8 SL	Post flexion	Flexed	84	52	17	0	10	26	36	16	0	11	0	11
S8-26A	5.9 "	"	"	85	53	17	0	10	26	36	18	0	11	0	11

Table 9 c – *Engyprosopon multiquama* - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Station	Body Length	Stage	Notochord	Right Eye	Precaudal vertebrae						Caudal vertebrae						Total vertebrae	Caudal fin rays	Ural components						Epural			
					Neural			Haemal			Neural			Haemal					Upp	Mid	Inf	Mid	Hyp	Low				
					Process	Arch	Arch	Process	Arch	Arch	Process	Arch	Arch															
														Process	Arch	Arch										Process	Arch	Arch
S6-34	2.6 NL	Pre flexion	Straight	Symmetrical	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
S6-28	2.8 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S8-20B	3.7 "	"	"	"	9	0	8	0	19	5	19	5	19	5	19	5	19	5	19	5	19	5	19	5	19	5	19	5
"	4.2 "	Early flexion	Flexing	"	9	0	8	0	19	5	19	5	19	5	19	5	19	5	19	5	19	5	19	5	19	5	19	5
S8-26A	4.5 "	"	"	"	9	1	8	0	21	3	21	3	21	3	21	3	21	3	21	3	21	3	21	3	21	3	21	3
S8-20B	4.6 "	"	"	"	9	1	8	0	20	3	20	3	20	3	20	3	20	3	20	3	20	3	20	3	20	3	20	3
S8-26A	4.8 "	"	"	"	9	1	8	10	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2
S8-20B	5.1 "	"	"	"	9	1	8	10	21	3	21	3	21	3	21	3	21	3	21	3	21	3	21	3	21	3	21	3
"	5.2 "	"	"	"	9	1	8	10	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2
S8-26A	5.6 "	"	"	"	9	1	8	10	20	3	20	3	20	3	20	3	20	3	20	3	20	3	20	3	20	3	20	3
S8-20B	5.8 SL	Post flexion	Flexed	"	9	1	8	10	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2
S8-26A	5.9 "	"	"	"	9	1	8	10	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2	23	2

10. *Engyprosopon Xenandrus*, Gilbert, 1905

Larvae ranging from 4.8mm NL to 15.8 mm SL and belonging to preflexion and postflexion stages are found in the IIOE and Naga Expedition collections (Figs. 10 A, B, C, D ; Tables 10a, b).

Morphology :

Larval body diaphanous and symmetrical in early stages. Eyes black, right eye has started shifting from symmetrical position, preparatory to migration to left side in 12.6 mm SL larvae, but the shifting is not completed in 15.8 mm SL larvae, the largest specimen available in the collections. Jaws carry small teeth, alimentary canal runs parallel to notochord up to middle of the abdominal cavity where it makes a single coil-oval in shape, the antero-posterior diameter of the coil being more than dorso-ventral in earliest stages of larvae. At this stage rectal portion lies horizontally and is directed posteriorwards, but in 6.1 mm NL larvae, the dorso-ventral axis of the coil becomes more than the antero-posterior one and the coil is pushed to posterior end of abdominal cavity with the rectal portion lying vertically down and anus opening at the level of 10th vertebral segment. In later stages, intestinal coil gets gradually pushed forwards and in 15.8 mm SL anus comes to lie at the level of eighth vertebral segment. Liver is massive with antero-posterior axis more than dorso-ventral axis in early stages but becomes reversed in advanced stages. Swim bladder present lying below the space between eighth and tenth vertebral segments. Spines occur on the urohyal and posterior basipterygial processes but not on the cleithra.

Fin and supporting structures:

Median fins continuous, an elongated dorsal ray present at anterior end of dorsal fin fold and present in all remaining stages. In 6.1 mm NL larvae pterygiophores and fin rays are seen differentiated except at caudal extremity. The first tiny dorsal ray is discernible in 7.2 mm SL larvae in which full complement of median fin rays are seen. 79-94 dorsal and 62-70 anal rays.

In 6.1 mm NL larvae, hypural elements evident as pack of cells at caudal extremity of notochord along its ventral aspects. Flexion stages are not

available, so the sequence of formation of caudal rays is not described. Full complement of 17 caudal rays occur in 7.1 mm SL larvae.

Pelvic fin complex represented by cartilaginous bars (basipterygial processes) is seen in 4.8 mm NL larvae. Pelvic fin radial (anterior basipterygial processes) discernible in 6.1 mm larvae and rays are found in 7.2 mm SL larva. Pelvic fin radials are asymmetrical, those of left side longer than the right and three of the anterior rays of the left are in advance of those of right fin.

Posterior basipterygial processes lie along the ventral aspect of abdominal wall, the distal ends reach up to ascending loop of intestine and end up in spines as in *E. grandisquamis*.

Axial skeleton :

Notochord remains vacuolated and unsegmented in 4.8 mm NL larvae, vertebral segments clearly evident in anterior region in 7.1 mm SL larvae but only faintly visible posteriorly. First neural arch cartilaginous, very thin and blunt at its tip, second neural arch also cartilaginous but broad and spinous at its tip retaining the consistency even in the largest specimens measuring 15.8 mm SL larvae. In 11.7 mm SL larvae, vertebrae dumb bell-shaped and ossified. Six haemal processes and two arches occur in the precaudal region of which posterior three processes are smaller. Number of vertebrae range from 10+25-26 including urostyle.

The adult :

Depth of body about twice in the length, length of head $3 \frac{1}{5}$ to $3 \frac{2}{5}$. Snout shorter than eye, diameter of which is about $2 \frac{2}{3}$ in length of head ; interorbital space concave, width nearly equal to (M) or about $\frac{1}{4}$ (F) diameter of eye ; anterior edge of upper eye above middle of lower in the male ; each eye in the male with a broad semicircular fringed membrane. A strong spine on the snout in the male and one or more on each orbital margin. Maxillary nearly reaching middle of eye, length $2 \frac{1}{3}$ to $2 \frac{1}{2}$ in head. Teeth uniserial (?). 11 to 12 pointed gill-rakers of moderate length on lower part of anterior arch. 50 scales in lateral line. Dorsal 79-91. Anal 61-69 (Fig. 10 D).

Pectoral of ocular side with 12 rays, length $\frac{4}{5}$ that of head. Yellowish brown ; traces of small dark spots on median fins (Norman, 1934).

Remarks :

The larvae of *E. xenandrus* has posterior basipterygial processes ending in spine as seen in the case of *E. grandisquamis*. But the present larvae differ from those of *E. grandisquamis* in the absence of spines on the cleithra. The differentiation of fin rays are very late in *E. xenandrus*. The fin ray count agrees with the adults. The adults are reported from Hawaiian Islands. The larvae of this species are described and reported for the first time.

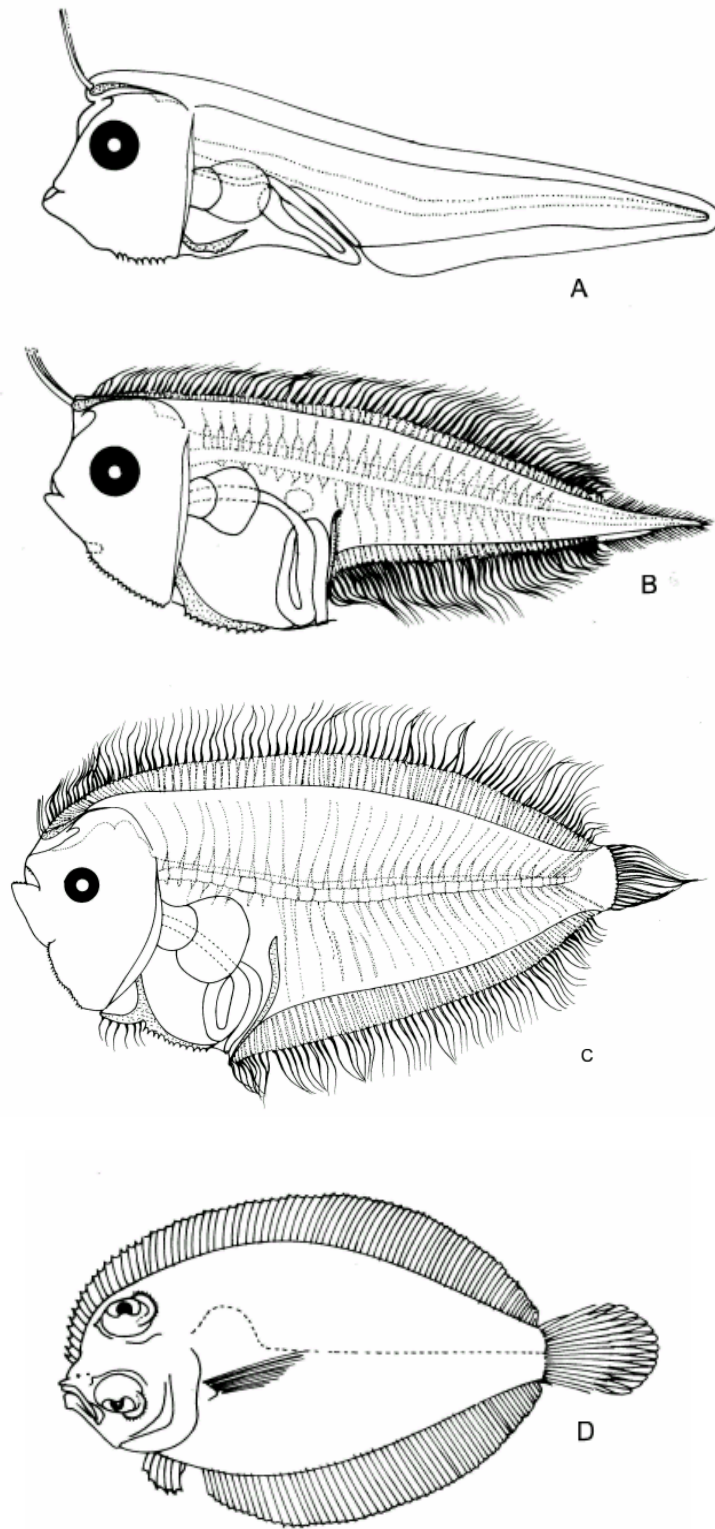


Fig. 10 - *E. xenandrus*, A-4.8 mm NL, B-6.1 mm NL, C-15.8 mm SL, D- Adult (from Lalithambika Devi, 1986)

Table 10 a - *Engyprosopon xenandrus* - morphometrics, in mm (Larval stages).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus	Depth	Length	
Ar Dodo 25	4.8 NL	Symmetrical	Straight	2.00	1.20	0.34	0.31	0.34	1.16	0.81	-	-	-
Dm 132	6.1 "	"	"	3.00	1.70	0.52	0.46	0.41	2.40	2.30	-	-	-
S8 - 20 B	7.1 SL	"	Flexed	3.20	1.80	0.55	0.48	0.45	3.00	3.00	0.77	0.39	1.80
S8 - 26 A	7.2 "	"	"	3.30	1.90	0.71	0.61	0.61	3.80	3.60	1.30	0.58	1.30
S4 - 32	9.0 "	"	"	3.70	2.60	1.00	0.64	0.66	5.20	5.20	1.80	0.68	1.70
"	10.1 "	"	"	3.70	2.80	1.00	0.68	0.68	5.30	5.30	1.80	0.74	1.60
"	11.1 "	"	"	4.40	3.10	0.98	0.74	0.71	5.60	6.10	2.20	0.81	2.10
"	12.5 "	"	"	4.40	3.20	1.00	0.74	0.64	6.60	6.80	2.20	0.81	1.80
"	12.8 "	Migrating	"	4.30	3.50	0.87	0.84	0.87	6.10	6.10	2.20	0.90	2.60
"	13.6 "	"	"	3.90	3.80	0.90	0.90	0.80	6.30	6.30	2.40	1.00	2.10
"	14.0 "	"	"	4.20	3.90	1.30	0.93	0.90	6.90	7.00	2.70	1.01	2.00

Table 10 b - *Engyprosopon xenandrus* – meristics (Larval stages).

Stations	Size (mm)	Stage	Noto-chord	Right Eye	Fin Rays			Vertebrae			Spines			
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior bespipterygial processes
Ar Dodo 25	4.8 NL	Pre flexion	Straight	Symmetrical	1	0	0	0				9	0	6
Dm 132	6.1 "	"	"	"	Ca74	ca49	0	0				19	0	12
S8 – 20 B	6.1 SL	Post flexion	Flexed	"	Ca75	ca54	17	Forming	10	26	36	19	0	15
S8 – 26 A	7.2 "	"	"	"	81	62	17	3+3	10	25	35	25	0	16
S4 – 32	9.0 "	"	"	"	78	62	17	"	10	25	35	24	0	18
"	9.5 "	"	"	"	90	65	17	"	10	26	36	18	0	16
"	10.1 "	"	"	"	91	64	17	"	10	25	35	25	0	16
"	10.6 "	"	"	"	86	66	17	"	10	26	36	23	0	20
"	11.1 "	"	"	"	88	70	17	"	10	26	36	26	0	16
"	11.3 "	"	"	"	89	65	17	"	10	25	35	23	0	15
"	12.5 "	"	"	"	93	66	17	"	10	26	36	28	0	14
"	12.8 "	"	"	"	94	68	17	"	10	26	36	17	0	10+
"	13.0 "	"	"	"	93	69	17	"	10	26	36	19	0	18
S4-32	13.6 "	"	"	"	86	66	17	"	10	26	36	10+	0	10+
"	14.0 "	"	"	"	79	67	17	"	10	26	36	17	0	10+
KI-322	15.8 "	"	"	"	93	66	17	"	10	25	35	28	0	13

Discussion

The number, size and pattern of distribution of spines (serrations) on the urohyal, basipterygial processes and cleithra together with the meristics and morphometrics help in identifying the larvae of different species, of *Engyprosopon*.

The differences in standard length, snout to anus length, depth of body across anus, length at which differentiation of median, caudal and pelvic fin rays and supporting structures, first neural arch, first tiny dorsal ray as well as the commencement of migration of eye show variations among different species of *Engyprosopon* larvae studied so far (Table 10). Among the different species of larvae examined so far, those of *Engyprosopon xenandrus* appear to be the largest. It has the maximum length at postflexion stage, maximum snout to anus length, late in the development and differentiation of first neural arch, median pterygiophores, median rays and hypural elements and also late in the commencement of migration of the eye (Table 11). But in the maximum depth at anus and late development and differentiation of first dorsal ray and pelvic fin radials, the position occupied by *E. xenandrus* is shared by *E. cocosensis*, *E. grandisquamis* and *E. mogkii* respectively. Nevertheless, it is difficult to recognise the shortest species among the genus. *E. sechellensis* has the minimum length at postflexion stage, *E. mogkii* has the shortest snout to anus length and early differentiation and development of first neural arch and hypurals while *E. multisquama* has the minimum depth at anus and early differentiation of median pterygiophores. *E. latifrons* come first in the early differentiation of first dorsal ray.

Larval forms belonging to *E. cocosensis*, *E. latifrons*, *E. mogkii* and *E. grandisquamis* can be distinguished from *E. sechellensis*, *E. multisquama* and *E. xenandrus* in the presence of spines on the cleithra and their absence in the latter. In the former group, the spines are more in number in *E. cocosensis* than in others. Larvae of *E. latifrons* differ from *E. mogkii* in that the former has spines on the urohyal, cleithra and posterior basipterygial processes from the very early stages (2.6 mm NL larvae) but not differentiated in the cleithra and posterior basipterygial processes in the latter even in 2.8 mm NL larvae. They

are seen in the larvae of 3.4 mm NL and above. In *E. mogkii* even the posterior basipterygial processes develop only in 3.4 mm NL. In *E. grandisquama* also the spines are absent in 2.3 mm NL. larvae on the cleithra and posterior basipterygial processes which get differentiated only in 3.3 mm NL. However, the early larvae of *E. grandisquamis* can be distinguished from those of *E. mogkii* in having a urohyal appendage in the former and the larval body of *E. mogkii* is covered over by brownish black stellate pigments. The spines on the posterior basipterygial processes in *E. grandisquamis* is also peculiar in that their positions on the right and left rami do not juxtapose and can be counted separately.

Among *E. sechellensis*, *E. multisquama* and *E. xenandrus* the spines are more in the first species than in others a character comparable to *E. cocosensis*. The posterior basipterygial processes in *E. xenandrus* end in spine as in *E. grandisquamis*, while in *E. multisquama* the distal end of the posterior basipterygial processes get reflected backwards and ends curved. A similar condition of the posterior basipterygial processes is found in *E. cocosensis*, *E. latifrons*, *E. mogkii* and *E. sechellensis*. In the absence of earlier stages it is difficult to assess the length of the larvae at which median fins are differentiated in *E. cocosensis* and *E. sechellensis*. (Tables 4b, 8b & 11). From the tables it is seen that the differentiation of median fin is comparatively late in *E. xenandrus* and early in *E. cocosensis*. The caudal fin ray differentiates earlier in *E. mogkii*, but apparently late in *E. xenandrus* (between 6.1 and 7.1 mm) even though the larvae of the latter species belonging to flexion stages are not available in the collections. The pelvic fin gets differentiated much earlier in *E. grandisquamis* but very late in *E. mogkii* whereas the first neural arch is differentiated early in *E. mogkii* and late in *E. sechellensis*. In general, it could be assumed that *E. xenandrus* apparently takes more time for differentiation of various organ systems. The depth across anus is more pronounced in *E. cocosensis* and least in *E. multisquama*.

Of the seven species described in the present report *E. grandisquamis* has been described by Pertseva-Ostroumova (1965), Ozawa and Fukii (1986) and Fukii (1997). Ozawa and Fukii (1986) have reported larvae of *E. grandisquama* (3.6-15 mm SL) and *E. multisquama* (12.7-14.8 mm SL). They

agree with the present forms. The specimens reported by Pertseva-Ostroumova have been collected from Gulf of Tonkin ranging in length from 2.8 to 8.9 mm and a larva of 14.3 mm. They seem to include two kinds of larvae as the difference in vertebral counts, pigmentation and median fin rays. The present forms agree with those described by Pertseva-Ostroumova as *Crossorhombus azureus* and *Crossorhombus* sp. in the presence of spines on the urohyal cleithra and posterior basipterygial processes. But they have not mentioned the presence of urohyal appendage which is characteristic in the early stages of the materials of the present description and also not mentioned about the peculiar disposition of the basipterygial processes which end in spinous processes in *E. grandisquamis*. Ahlstrom et al. (1984) in reviewing characters of different pleuronectiform larvae have included a figure of *E. xenandrus* measuring about 20 mm.

The larvae of *Engyprosopon* species resembles with those of *Engyophrys senta* (Hensley, 1977) and *Trichopsetta ventralis* (Futch, 1977) in the general shape, meristic characters and in the presence of spines on urohyal, cleithra and posterior basipterygial processes. But differ in the possession of short based pelvic fin girdle. Though some asymmetry prevail in the pelvic fin of *Engyophrys* and *Trichopsetta* spp., it is only in respect of position of the right and left fin radials and origin of first left fin ray just in front of the right fin. In *Engyprosopon* the left ventral fin radial is strongly asymmetrical being longer than that of the right and two to three rays of the left fin are placed well in advance of the right. The presence of spines on the otic bones in the head in the larvae of *Engyophrys senta* also help to distinguish them from those of *Engyprosopon* spp. Further, *Engyophrys senta* and *Trichopsetta ventralis* belong to Paralichthidae of Amaoka which can be distinguished from Bothidae in having short based pelvic fin radial in the former among other characters (Norman, 1934). Further Norman has reported that the adults of *Engyprosopon* belongs to Indo-Pacific region, whereas *Engyophrys senta* and *Trichopsetta ventralis* belong to tropical waters of America. The larvae of the above are reported from Gulf of Mexico.

It may be noted that larvae of *E. grandisquamis* and *E. xenandrus* possess characters which are similar to other *Engyprosopon* species, they could be placed separately from *Engyprosopon* in the presence of straight posterior

basipterygial processes ending in spine. Ahlstrom has also suggested to provide a separate status to these two species on the above ground which is worth considering.

The larvae of *E. cocosensis*, *E. latifrons*, *E. mogkii*, *E. sechellensis*, and *E. xenandrus* are described and reported for the first time.

Table 11. Difference in morphometrics at the commencement of postflexion and length of larvae when meristic characters differentiate in Engyprosoon species (in mm).

pecies	Standard length	Snout to anus length	Body depth across anus	Median fin rays	Pelvic fin rays	First neural arch	First tiny dorsal ray	Hypural	Commencement of eye migration
<i>E. cocosensis</i>	5.6	2.6	3.2	3.5	5.0	5.0	6.5	5.0	11.1
<i>E. latifrons</i>	5.7	2.5	2.8	4.7	6.6	3.6	5.7	4.8	-
<i>E. mogkii</i>	5.8	2.1	3.0	4.0	7.2	3.4	7.0	4.0	-
<i>E. grandisquamis</i>	5.8	2.7	2.8	4.1	5.0	4.1	7.8	4.6	12.4
<i>E. sechellensis</i>	5.5	2.4	2.7	5.2	6.3	5.2	6.3	5.2	12.1
<i>E. multisquama</i>	5.8	2.6	2.4	3.7	-	4.5	-	4.2	-
<i>E. xenandrus</i>	7.1	3.2	3.0	6.1	7.1	6.1	7.2	6.1	12.8

11. *Bothus myriaster* (Temminck and Schlegel, 1846)

Larvae ranging from 4.1 mm NL to 33.5 mm SL are found in the collections of IIOE and Naga Expedition samples. The larvae belonging to preflexion, flexion and postflexion stages are present (Figs. 11 A, B, C; Tables 12 a, b, c & 25).

Morphology :

Larval body thin, symmetrical, laterally compressed more deeply ovate than in most other species, transparent in early stages, snout prominent and cerebral hemispheres have truncate anterior margin. Eyes black, symmetrical and squarish in early stages, becoming spherical later. Right eye has not started shifting to the left side, even in 33.5 mm SL larva, largest specimen in the collection. Jaws carry small teeth, alimentary canal runs parallel to the notochord for a short distance, then runs obliquely downwards, makes an elliptical coil at the posterior end of the abdominal cavity in 4.1 mm NL larva, anus opening at the level of ninth vertebral segment. In later stages, ventral portion of intestinal loop pushed obliquely forwards and the anus comes to lie at the level of sixth vertebral segment in 33.5 mm SL larva. A pair of caecal outgrowths appear at the anterior end of the intestine and another pair a little below, directed into the space between the loops. Intestinal loop not compact its ventral portion with a smooth curvature the space between ascending and descending loops being filled with glandular material. Liver not massive, narrow, its dorso-ventral axis more than twice its antero-posterior axis even in preflexion stages, the distal end drawn out into a finger-like process lying beneath the intestinal loop. Swim bladder small, placed between seventh and ninth vertebral segments but in advanced stages it gets reduced. Spines totally absent.

Relative head length increases from preflexion to flexion stages, thereafter decreases (Table 25), but relative snout length decreases from preflexion to flexion and later increasing from flexion to post flexion stages. Relative snout - anus length and length from snout to pelvic fin base, as well as eye width and height decrease from preflexion to postflexion. Body depth at

pectoral fin base and across anus increases from preflexion to postflexion stages.

Fin and supporting structures :

Elongated dorsal ray at anterior end of the dorsal fin fold comparatively short. Distinction of elongated dorsal ray becomes difficult as the larvae reaches 14.4 mm SL and thereafter it is not discernible from rest of the rays. Forward extension of the first dorsal pterygiophore noticeable in 4.1 mm NL larva. First tiny ray is discernible in 4.2 mm NL, but median fin rays not differentiated in the posterior caudal portion. Full complement of median fin rays occurs in 7.9 mm SL in which 87 dorsal and 62 anal rays can be counted. Median fin ray vary from 86 to 92 in the dorsal and 62 to 70 in the anal. Forward extension of dorsal fin fold grows beyond the tip of the first dorsal pterygiophore and fifth dorsal ray lies opposite the tip of pterygiophore in largest specimen of the collection.

In 4.1 mm NL larva hypural elements occur as pack of cells, in 4.2 mm inferior hypural lower and epural are differentiated with no rays, the inferior hypural middle and superior hypural middle are differentiated with four rays each, in 4.5 mm, a ray is seen on inferior hypural lower. Flexion of the notochord evident in larvae ranging between 4.1 and 5.2 mm NL. Full complement of caudal fin rays is noticed in 5.2 mm larvae when flexion of the notochord is completed.

Pectoral fins remain without rays even in the largest specimen, in the pelvic fin complex, posterior basipterygial processes visible in earliest larvae running down to the midlevel of intestinal loop where it curves. Anterior basipterygial processes is evident in 4.1 mm NL larvae. Left pelvic fin radial long, asymmetrical and reaches the level of cleithral tip. Anterior two rays of left fin appear in advance of right fin. In the largest specimen 33.5 mm SL, left pelvic fin radial has reached the level of posterior third of urohyal with three rays of the left fin lying in advance of right fin.

Axial skeleton :

Notochord remains vacuolated in the posterior caudal region but segmentation discernible in 4.1 mm NL. In 4.8 mm NL segmentation is

completed, ossification initiated along the periphery of centra in 7.9 mm SL but not completed even in 33.5 mm larva. In 4.1 mm NL larva neural and haemal processes in caudal region are differentiated so also neural processes in precaudal region. Haemal processes seen only in late postflexion stages. Haemal process of first caudal vertebra broad, leaf like reaching the base of the anal fin. First anal pterygiophore arises from middle of this large haemal process. Long stout and cartilaginous, it extends obliquely downwards and forwards, the cartilaginous part sculptured with minute tubercle – like outgrowths on the surface.

The adult

Depth of body $1\frac{3}{4}$ to $1\frac{4}{5}$ in the length, length of head $4\frac{1}{6}$ to $4\frac{1}{4}$. Profile of head distinctly convex in front of upper eye, concave in front and just above lower eye; diameter of eye $3\frac{3}{4}$ in length of head; interorbital width more than twice diameter of eye; anterior edge of upper eye above posterior part of lower; each eye with a large membranous flap on its hinder part in the male. Male with a strong spine on the snout and another at symphysis of lower jaw; some smaller spines around round orbits. Axillary extending to below anterior edge of eye, length $3\frac{4}{5}$ in that of head. Teeth more strongly developed on blind side of jaws. 6 short gill-rakers on lower part of anterior arch. Scales all cycloid on ocular side, except at extreme upper and lower edges of body, where they are ctenoid; those of blind side cycloid; 104 scales in lateral line. Dorsal 93-95. Anal 67-71 (Fig. 11 C). Pectoral of ocular side with 8 or 9 rays, upper rays prolonged and filamentous in the male, longest more than twice as long as head. Caudal obtusely pointed. Pale brownish; head and body with numerous small brown spots ringed with pale brown paler than the ground-colour, and pale blue spots ringed with dark brown; a diffuse dark blotch at junction of straight and curved parts of lateral line and another more distinct blotch at the middle of its straight portion; dorsal and anal fins with small brown dots, and each with a row of larger dusky spots; caudal dark at base and at tip of rays, a pale band across the middle; pectoral with traces of faint cross-bars; blind side of fish yellowish-white anteriorly becoming dark brown posteriorly; a number of narrow, wavy, dark transverse bars (blue in life) just in front of the posterior dark portion (Norman, 1934).

Remarks :

The larval body is deeply ovate, diaphanous and symmetrical. The anterior elongated dorsal ray is not prominent and does not persist in the postflexion stages. Spines are totally absent on the cleithra, urohyal and posterior basipterygial processes. The intestinal coil is not compact. The interspace between the ascending and descending loops are filled with glandular material. The posterior basipterygial processes extend beyond the level of the descending loop of the alimentary canal. The first tiny dorsal ray is differentiated in flexion stages but full complement of median fin rays are seen only in postflexion stages. The elongated anterior dorsal ray shrivels up in the early postflexion stages. This species appears to have protracted larval life because the eye migration has not yet started in 33.5 mm SL larva even though flexion to postflexion stage has attained when the larvae were 5.2 mm SL. The larval forms can be placed under the genus *Bothus* in the presence of an elongated and asymmetrical left pelvic fin radial, with elongated rays, the anterior three of which are placed in advance of the right fin ; in the posterior basipterygial processes extending beyond the level of the descending loop of the intestinal coil, in the absence of spination anywhere on the body as well as in the possession of deeply ovate body. The meristics and morphometrics of the larval forms tally with the adults of *B. myriaster*. The adult fishes belonging to *B. myriaster* have been reported from the Indian Ocean. The larval forms are described and reported for the first time, since the larval forms designated as *B. myriaster* from Japanese waters and Porto Novo coast do not belong to this species.

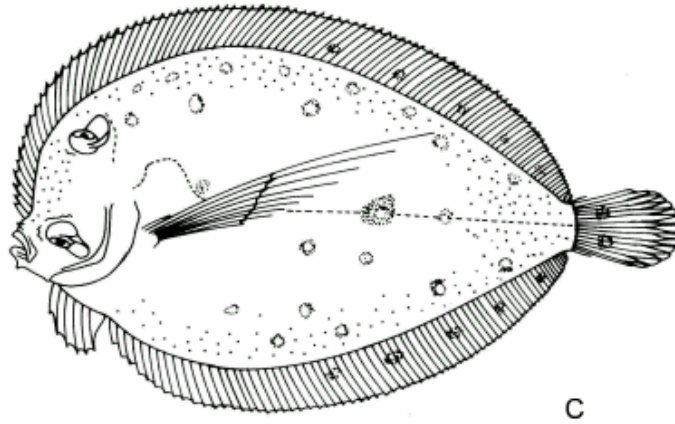
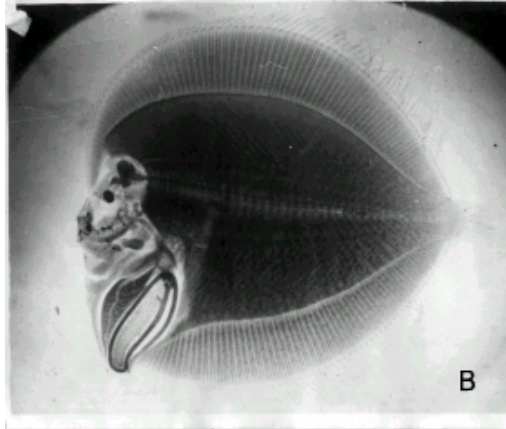
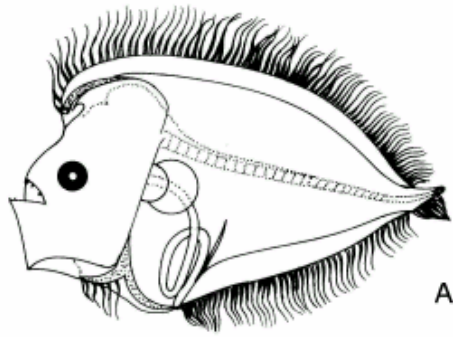


Fig. 11 - *Bothus myriaster*, A-4.2 mm NL, B-33.5 mm SL, C-Adult
(from Lalithambika Devi, 1986)

Table 12 a - *Bothus myriaster* - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle Depth	Caudal Peduncle Length	Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus			
S8 – 20B	4.1 NL	Symmetrical	Straight	1.60	1.10	0.52	Missing	2.00	1.90	-	-	0.90	
"	4.2 "	"	Mid flexion	1.50	1.30	0.60	0.32	0.35	2.60	-	-	0.50	
"	4.5 "	"	"	1.70	1.50	0.64	0.32	0.35	2.70	-	-	0.70	
S8 – 23B	4.8 "	"	Late flexion	1.80	1.60	0.70	Missing	2.80	2.70	-	-	1.20	
S8 – 20B	5.2 SL	"	Post flexion	1.90	1.60	0.87	0.35	0.37	3.10	0.61	0.29	0.64	
S8 – 23 B	5.7 "	"	"	2.40	2.00	1.30	0.33	0.35	2.90	0.53	0.24	1.40	
"	7.9 "	"	"	2.80	2.50	1.30	0.48	0.48	5.10	1.00	0.32	1.10	
"	8.5 "	"	"	3.10	2.50	1.50	0.37	0.39	6.30	1.60	0.60	1.50	
DI – 5010	9.5 "	"	"	2.80	2.60	1.00	0.42	0.52	6.40	1.00	0.32	1.10	
S8 – 20B	10.4 "	"	"	3.40	3.40	1.40	0.40	0.50	8.30	2.30	0.59	1.20	
S4 – 17	10.9 "	"	"	2.70	3.00	1.09	0.48	0.55	8.00	2.20	0.64	0.90	
DI – 5508	11.4 "	"	"	2.60	3.00	1.10	0.39	0.47	7.70	2.30	0.77	0.50	
S8 – 20B	12.1 SL	"	"	3.00	3.10	1.40	0.45	0.48	11.00	4.20	0.98	0.80	
DI – 5355	12.3 "	"	"	3.00	3.10	1.50	0.52	0.52	9.00	2.70	0.92	0.90	
DI – 5010	14.4 "	"	"	4.00	4.10	1.50	0.55	0.61	10.90	3.30	0.90	1.00	
Me – 178	17.0 "	"	"	4.40	4.50	1.60	0.56	0.61	13.70	4.30	1.20	0.80	
NH – 40	20.6 "	"	"	4.90	4.90	2.30	Missing	17.60	17.60	7.60	1.80	0.60	
"	21.5 "	"	"	4.00	5.00	2.00	"	17.80	16.90	7.40	1.90	0.60	
Dm1/29/65	33.5 "	"	"	5.00	5.50	2.50	0.77	0.85	28.3	10.60	2.30	0.30	

Table 12 b - *Bothus myriaster* – meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total
S8 – 20B	4.1 NL	Pre flexion	Straight	Symmetrical	ca64	ca44	0	2+4			
"	4.2 "	Mid flexion	Flexing	"	ca74	ca54	8	2+4			
S8 – 23B	4.8 "	Late flexion	"	"	ca84	ca54	11	2+4			
S8 – 20B	5.2 SL	Post flexion	Flexed	"	88	65	17	3+3	10	26	36
S8 – 23B	7.9 "	"	"	"	87	62	17	3+3	10	29	39
DI – 5010	9.5 "	"	"	"	89	67	17	3+3	10	28	38
DI – 5508	11.4 "	"	"	"	92	70	17	3+3	10	28	38
DI – 5010	14.4 "	"	"	"	86	65	17	3+3	10	28	38
Me – 178	17.0 "	"	"	"	89	65	17	3+3	10	28	38
Dm1/29/65	33.5 "	"	"	"	91	67	17	3+3	10	28	38

Table 12 c – *Bothus myriaster* - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Stations	Body Length	Stage	Noto-chord	Right Eye	Precaudal vertebrae				Caudal vertebrae				Centra	Ural Centra	Total vertebrae	Caudal fin rays	Ural components				Epural	
					Neural		Haemal		Neural		Haemal						Sup	Mid	Inf	Hyp		Low
					Process	Arch	Process	Arch	Process	Arch												
S8-20B	4.1 NL	Pre flexion	Straight	Symmetrical	9	1	0	0	20	6	20	6	+	0	36	0	0	0	0	0	0	
"	4.2 "	Mid flexion	Flexing	"	9	1	0	0	23	2	23	2	+	0	35	8	0	X	X	X	X	
"	4.5 "	"	"	"	9	1	0	0	23	2	23	2	+	0	35	9	0	X	X	X	X	X
S8-23B	4.8 "	Late flexion	"	"	9	1	0	0	23	2	23	2	25	0	35	11	0	X	X	X	X	X
S8-20B	5.2 SL	Post flexion	Flexed	"	9	1	0	0	23	2	23	2	25	1	36	17	X	X	X	X	X	X
S8-23B	5.7 "	"	"	"	9	1	0	0	24	2	24	2	26	1	37	17	X	X	X	X	X	X
"	7.9 "	"	"	"	9	1	0	0	26	2	26	2	28	1	39	17	X	X	X	X	X	X
DI-5010	9.5 "	"	"	"	9	1	0	0	25	2	25	2	27	1	38	17	X	X	X	X	X	X
S4-17	10.9 "	"	"	"	9	1	0	0	25	2	25	2	27	1	38	17	X	X	X	X	X	X
DI-5508	11.4 "	"	"	"	9	1	0	0	25	2	25	2	27	1	38	17	X	X	X	X	X	X
DI-5355	12.3 "	"	"	"	9	1	0	0	25	2	25	2	27	1	38	17	X	X	X	X	X	X
AB-198	14.2 "	"	"	"	9	1	0	0	25	2	25	2	27	1	38	17	X	X	X	X	X	X
DI-5010	14.4 "	"	"	"	9	1	0	0	25	2	25	2	27	1	38	17	X	X	X	X	X	X
Me-178	17.0 "	"	"	"	9	1	0	0	25	2	25	2	27	1	38	17	X	X	X	X	X	X
Dm1/29/65	33.5 "	"	"	"	9	1	0	0	25	2	25	2	27	1	38	17	X	X	X	X	X	X

* Rudiments

from flexion to postflexion but decrease considerably towards juvenile. Relative body depth at pectoral fin base increases from preflexion to flexion, then decreases slightly to postflexion and thereafter increases significantly, body depth across the anus increases gradually from preflexion to juvenile, while relative length from snout to the pelvic fin base increases from preflexion to flexion stages and decreases thereafter.

Fin and supporting structures :

Median fin folds are continuous, at the anterior end of the dorsal fin fold there is an elongated dorsal ray which is not as long as that found in the larvae of the *Arnoglossus*, *Engyprosopon*, *Psettina* and other related genera. Short and not reaching beyond the level of the pectoral girdle. This ray is found to shrivel up in 5.6 mm. First anal pterygiophore gets differentiated in 3.3 mm NL larvae. At the anterior end of dorsal fin fold two more rays are differentiated, forward extension of the first dorsal pterygiophore is seen differentiating in 4.3 mm NL larvae to support the first tiny dorsal ray in front of the elongated dorsal ray. The tiny first dorsal ray which is the last to differentiate is discernible in 4.6 mm NL larvae. Full complement of 85 dorsal and 67 anal rays are found from 9.3 mm SL, by differentiation of rays at the caudal region. Median fin rays range from 85 to 92 in the dorsal and 66 to 77 in the anal.

In 4.3 mm NL larvae, inferior hypural middle with three rays has differentiated but flexion of the notochord has not yet taken place. In 6.4 mm NL, superior hypural middle elements are differentiated but without rays. However, in 6.8 mm larvae three rays are seen on the inferior hypural lower, four on inferior hypural middle and five on superior hypural middle. The flexion of the notochord takes place between 5.6 and 7.4 mm. Epural complement is developed in 6.8 mm larva which fuses with superior hypural upper in postflexion stages. Full complement of caudal fin rays are seen in 7.4 mm SL.

Pectoral fins remain unrayed. No trace of pelvic fin is seen in 3.3 mm NL larvae, but in larvae 4.3 mm NL, posterior basipterygial processes extending to the middle level of intestinal loop and rudiments of pelvic fin radials are seen. Pelvic rays are developed in 4.6 mm NL larvae, pelvic fin radial is asymmetrical and the anterior rays of left fin lie in advance of right fin. Growth of pelvic fin

appears to be slower than that noticed in *Bothus myriaster*. In 34.9 mm SL specimens, pelvic fin has reached only a little below the middle level of urohyal and third ray of the left in lies opposite the cleithral tip and the right fin extends only up to this point.

The cartilaginous structures have pitted appearance or possess minute tubercle –like processes.

Axial skeleton :

Segmentation of the notochord is seen in the precaudal region in 3.3mmNL larvae but it remains vacuolated in the caudal region, a condition which prevailed in the early postflexion stages. First neural arch discernible in 4.3 mm NL which is cartilaginous, neural processes of the remaining precaudal vertebral segments are seen well differentiated in 3.3 mm NL but only haemal arches are seen in the precaudal portion. Neural and haemal processes of the anterior caudal region get differentiated in 3.3 mm NL. Haemal spine of first caudal vertebrae long, broad, leaf like and extends to base of anal fin fold. First anal pterygiophore long and stout, placed vertically down reaching the level of anus. Neural and haemal arches show ossification in 16.0 mm SL, ossification of centra along the margins is also noticed in 16.0 mm SL, ossification appears to be completed in postflexion stages ranging between 16.0 mm and 29.3 mm SL. Absence of larval stages between 16.0 and 29.3 mm SL makes it difficult to follow the sequence of ossification in detail.

The adult :

Depth of body $1\frac{2}{3}$ to twice in the length, length of head $3\frac{1}{3}$ to 4. Upper profile of head convex, or with a slight notch in front of lower eye. Diameter of eye $3\frac{1}{2}$ to nearly 5 in length of head ; interorbital width equal to or a little less than diameter of eye in the male, rather narrower in the female ; anterior edge of upper eye above, or a little behind middle of lower; male generally with a dermal tentacle on hinder part of each eye. Mature male with one or more irregular bony tubercles on snout in front of lower eye, and often one or two in front of upper eye ; except for a blunt knob on the snout, these are wanting in female. Maxillary extending to below anterior edge or anterior $\frac{1}{2}$ of eye, length about 3 in that of head. About 6 to 8 very short gill-rakers on lower

part of anterior arch. Scales ctenoid on ocular side, cycloid on blind side ; 80 to 92 in lateral line. Dorsal 85-95. Anal 64-71 (Fig. 12 E). Pectoral of ocular side with 9 to 11 rays, upper rays greatly prolonged in the mature male, sometimes reaching base of caudal. Caudal obtusely pointed. Vertebrae 10 + 29. Brownish, covered with paler and darker spots, blotches, rings or ocelli ; generally a large dark blotch on middle of straight portion of lateral line ; median fins similarly coloured and marked ; pectoral spotted with brown, with or without irregular dark cross bars (Norman, 1934).

Remarks :

The larvae of *B. pantherinus* resemble very much with those of *B. myriaster*. It may be noted that the differentiation of characters such as development of fin rays, pelvic fin, flexion of notochord take place late in *B. pantherinus* than in *B. myriaster* except the migration of the right eye. The meristics agree with those of adult. The adults are reported from the Indian Ocean. The larvae are described and reported for the first time.

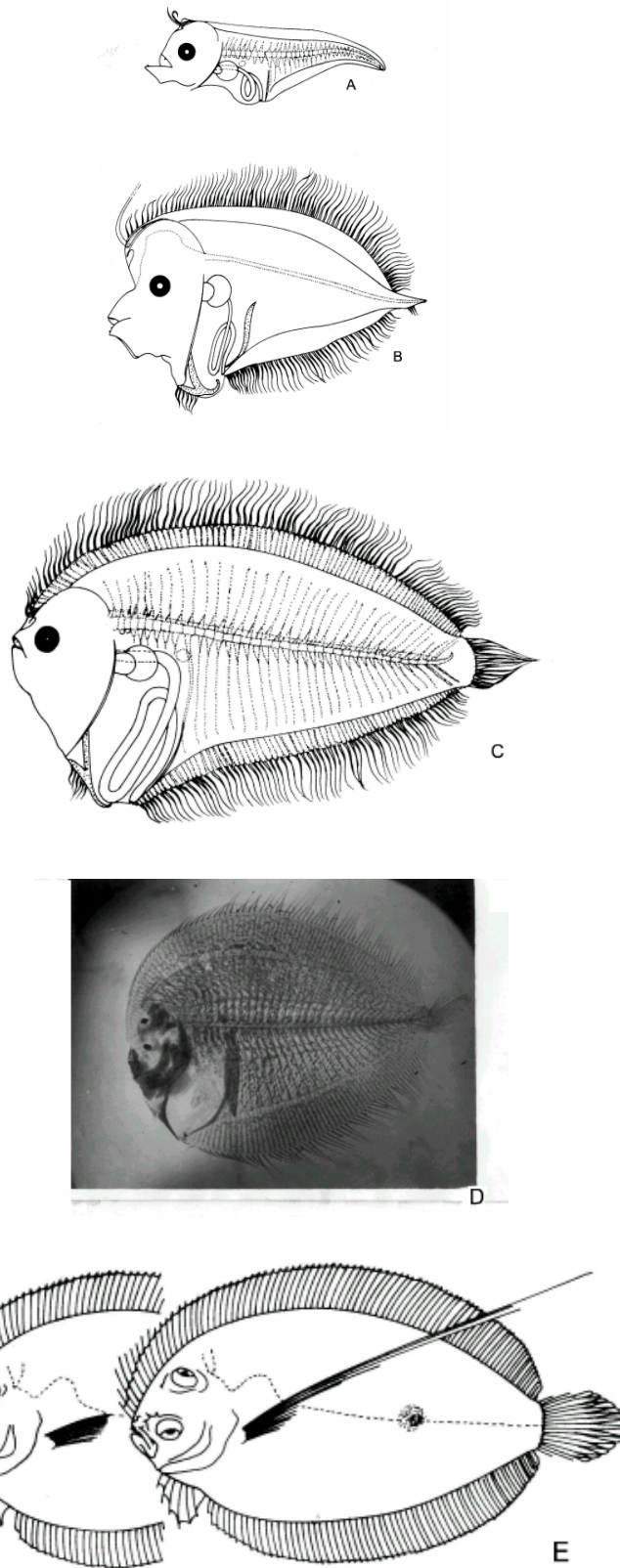


Fig. 12 - *Bothus pantherinus*, A-3.3 mm NL, B-6.4 mm NL, C-15.6 mm SL, D-34.9 mm SL, E-Adult (from Lalithambika Devi, 1986)

Table 13 a - *Bothus pantherinus* - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus	Depth	Length	
S6 – 15	3.3 NIL	Symmetrical	Pre flexion	1.70	0.80	0.26	0.31	0.26	0.81	0.71	-	-	-
"	4.3 "	"	Early caudal formation	2.40	1.30	0.47	0.31	0.39	2.00	1.80	-	-	1.20
S8 – 23 B	4.6 "	"	"	1.70	1.30	0.40	0.32	0.32	2.60	2.40	-	-	0.80
S8 – 23 B	5.6 "	"	Early flexion	2.10	1.80	0.89	0.34	0.37	3.10	3.10	-	-	1.20
S8 – 20 B	6.4 "	"	"	2.40	2.10	0.79	0.39	0.35	3.90	3.40	-	-	1.30
S6 – 15	6.8 "	"	Late flexion	2.70	2.20	1.09	0.42	0.48	3.40	3.20	-	-	1.30
"	7.4 SL	"	Post flexion	3.00	2.00	0.68	0.52	0.48	3.70	3.60	0.84	0.48	1.70
"	9.3 "	"	"	2.70	2.40	0.81	0.53	0.58	4.50	4.50	1.26	0.52	1.00
S6 – 28	11.0 "	Migrating	"	4.00	3.30	1.01	0.58	0.68	6.00	6.10	1.60	0.58	1.50
S6 – 15	11.3 "	"	"	3.90	3.00	0.81	0.64	0.68	6.70	6.40	1.80	0.71	1.00
"	11.6 "	"	"	4.00	3.00	1.03	0.64	0.68	6.30	6.20	2.00	0.81	1.00
S6 – 28	12.4 "	"	"	4.50	3.70	1.00	0.61	0.68	6.70	7.00	2.00	0.74	1.40
S4 – 32	16.0 "	"	"	4.70	4.00	1.10	0.64	0.68	9.00	9.20	3.50	1.00	2.10
S10- U31	29.3 "	Migrated	Metamorphosed	3.30	7.00	1.80	1.06	0.87	21.50	16.10	6.00	2.00	1.20
UM1 – 3	34.9 "	"	"	4.50	7.10	2.00	1.06	0.90	25.20	22.80	8.40	1.90	1.10

Table 13 b - *Bothus pantherinus* – meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total
S6 – 15	3.3 NL	Pre flexion	Straight	Symmetrical	1	0	0	0			
S6 – 15	4.3 "	Early caudal formation	"	"	Ca.59	Ca.35	3	+			
S8 – 23B	4.6 "	"	"	"	Ca.81	Ca.59	3	1+5			
SB – 23B	5.6 "	Early flexion	Flexing	"	79	51	6	2+4			
S6 – 15	6.8 "	Late flexion	"	"	81	61	12	2+4			
"	7.4 SL	Post flexion	Flexed	"	88	67	17	2+4	10	29	39
"	9.3 "	"	"	"	85	67	17	2+4	10	27	37
S6 – 28	11.0 "	"	"	Migrating	92	72	17	2+4	10	29	39
S6 – 15	11.6 "	"	"	"	85	69	17	2+4	10	29	39
S6 – 28	12.4 "	"	"	"	86	68	17	2+4	10	27	37
NH – 40	16.0 "	"	"	"	98	77	17	2+4	10	29	39
S10 – U31	29.3 "	Metamorphosed	"	Migrated	92	70	17	2+4	10	28	38
UM – 1-3	34.9 "	"	"	"	92	66	17	2+4	10	28	38

Table 13 c. *Bothus pantherinus* - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Stations	Body Length	Stage	Notochord	Right Eye	Precaudal vertebrae			Caudal vertebrae			Centra	Ural Centra	Total vertebrae	Caudal fin rays	Ural components			Epural				
					Neural		Haemal		Neural						Haemal		Sup		Mid	Inf	Hyp	Low
					Process	Arch	Process	Arch	Process	Arch					Upp	Mid						
S6 - 15	3.3 NL	Pre fl.	Straight	Symm etrical	9	0	0	2+6*	15	7	15	7	0	0	0	0	0					
S6 - 15	4.3 "	Early caudal formation	"	"	9	1	Not clear	26	2	2	26	2	0	0	0	0	0					
S8 - 23B	4.6 "	Early flexion	Flexing	"	9	1	"	24	2	2	24	2	0	0	0	0	0					
S8 - 20B	6.4 "	Early flexion	"	"	9	1	6+2*	24	2	2	24	2	0	0	0	0	0					
S8 - 23B	5.6 "	Late flexion	"	"	9	1	6+2*	23	2	2	23	2	0	0	0	0	0					
S6 - 15	6.8 "	Post flexion	"	"	9	1	6+2*	26	2	2	26	2	0	0	0	0	0					
"	7.4 SL	Post flexion	Flexed	"	9	1	Not clear	26	2	2	26	2	0	0	0	0	0					
"	9.3 "	"	"	"	9	1	"	24	2	2	24	2	0	0	0	0	0					
S6 - 28	11.0 "	"	"	Migrating	9	1	6	26	2	2	26	2	0	0	0	0	0					
S6 - 15	11.3 "	"	"	"	9	1	6	26	2	2	26	2	0	0	0	0	0					
S6 - 15	11.6 "	"	"	"	9	1	6	26	2	2	26	2	0	0	0	0	0					
S6 - 28	12.4 "	"	"	"	9	1	6	24	2	2	25	1	0	0	0	0	0					
S4 - 32	16.0 "	"	"	"	9	1	6	26	2	2	26	2	0	0	0	0	0					
S10 - U31	29.3 "	Membrane orphosed	"	Migrated	9	1	6	25	2	2	25	2	0	0	0	0	0					
NE - 1	34.9 "	"	"	"	9	1	6	25	2	2	25	2	0	0	0	0	0					
UM 1-3	34.9 "	"	"	"	9	1	6	25	2	2	25	2	0	0	0	0	0					

* Rudiments

13. *Bothus mancus* (Broussonet, 1782)

One post larva measuring 18.9 mm SL was found in the zooplankton samples collected during IIOE (Figs.13 A, B ;Tables 14 a, b).

Morphology :

Larval body thin, laterally compressed, diaphanous and strongly ovate ; eyes black and symmetrical, more oval than circular, snout is prominent, mouth small and terminal, jaws devoid of teeth. Alimentary canal runs parallel for a short distance, then runs obliquely down, intestinal coil elliptical, not compact, leaving space in between ascending and descending portions, glandular cells filling the intervening spaces, rectal portion lies vertically down, anus directed posteriorwards opens at the level of ninth vertebral segment. Antero-posterior axis of liver short unlike that in *Engyprosopon*, *Psettina* and others, its dorsoventral axis more than four times the antero-posterior axis and the distal end drawn out into a finger-like diverticulum which lies below the intestinal loop up to the level of the descending portion of intestine.

Spines absent on the body particularly on urohyal, cleithra or posterior basipterygial processes.

Fin and supporting structures :

Median fins continuous, dorsal fin extends beyond the level of the eye and rays commence from the very tip of it, the elongated dorsal ray at the anterior end of dorsal fin fold, characteristic of bothid larvae is absent, the anterior-most dorsal pterygiophore long and comparatively stout, bends over the skull and extends up to the tip of the dorsal fin fold. In other bothid larvae this pterygiophore supports the elongated anterior dorsal ray, suggesting that early larvae of this species might also had the elongated dorsal ray which might have shriveled up in advanced forms, as in other species of *Bothus*. Forward extension of dorsal fin remains separate from ethmoid region of cranium. All pterygiophore are well differentiated, so also the fin rays. 103 dorsal and 77 anal rays. Caudal fin rays well developed and articulated to hypural plates and also to neural and haemal processes of penultimate vertebra.

Pectoral fin developed but rays are not differentiated, pelvic fin radials (anterior basipterygial processes) well developed, elongated and asymmetrical, that of left side extending beyond tip of cleithra over to urohyal. Fin rays are also well developed. Anterior three left pelvic rays lie in advance of that of right fin. Posterior basipterygial processes extend up to level of anus and bear no spines.

Axial skeleton :

Vertebrae well differentiated and ossified, no haemal spines in precaudal region, whereas neural and other haemal spines are well differentiated. There are 10+30 vertebrae including the urostyle.

The adult :

Depth of body $1 \frac{3}{4}$ to a little more than twice in the length ; length of head $3 \frac{2}{5}$ to $3 \frac{3}{5}$. Anterior profile of head a little concave in front of eyes. Diameter of eye $4 \frac{2}{3}$ to $6 \frac{1}{2}$ in length of head ; interorbital width 2 to $2 \frac{4}{5}$ times (M) or a little more than once to $2 \frac{1}{6}$ times (F) diameter of eye ; anterior edge of upper eye above posterior edge of lower (young) or farther back ; eyes in the male each with some dermal appendages. Male with a strong spine on the snout, and another in front of lower orbital ridge; 3 or 4 small spines anteriorly on upper orbital ridge. Maxillary extending to below anterior edge or anterior part of eye, length $2 \frac{4}{5}$ to 3 in head. Teeth mostly uniserial in both jaws, but with traces of a second row anteriorly. Gill-rakers rather slender and of moderate length, 9 to 11 on lower part of anterior arch. Scales feebly ctenoid or cycloid on ocular side, all cycloid on blind side ; 85 to 90 in lateral line. Dorsal 98-103. Anal 76-80 (Fig. 13 B). Pectoral of ocular side with 10 or 11 rays, upper rays greatly prolonged in the mature male, moderately produced in the female. Caudal pointed. Pale brownish, everywhere mottled with grey and brown ; head and body with rounded bluish spots edged with darker ; a diffuse dark blotch at junction of straight and curved parts of lateral line, another on middle of straight portion, and a smaller and less distinct blotch near base of caudal fin ; other faint dusky blotches on head, and a series near upper and lower edges of body ; median fins variegated with bluish grey spots and ocelli and with some dark blotches ; pectoral with irregular dark brown cross-bars; lower surface sometimes sprinkled with numerous small brown spots (Norman, 1934).

Remarks :

The post larva can be placed under the genus *Bothus* in the presence of an elongated and asymmetrical left pelvic fin radial with elongated rays, the anterior three of which are placed in advance of that of the right fin ; in the presence of well developed posterior basipterygial processes extending to the level of the anus and in the absence of spines anywhere on the body, particularly on the cleithra, urohyal and posterior basipterygial processes. The deeply ovate body, which is thin, symmetrical and diaphanous as well as the less pronounced anterior second dorsal ray are also characteristic of the genus *Bothus*. The number of fin rays tally with those of the adult *Bothus mancus*. The adult of *Bothus mancus* are reported from the Indian Ocean. But the larval stages belonging to *Bothus mancus* are not described and reported so far except an unpublished figure of metamorphosed specimen measuring about 30.0 mm of P.struhsaker, which is included in the review work published by Ahlstrom *et al.* (1984) on Pleuronectiformes: Development.

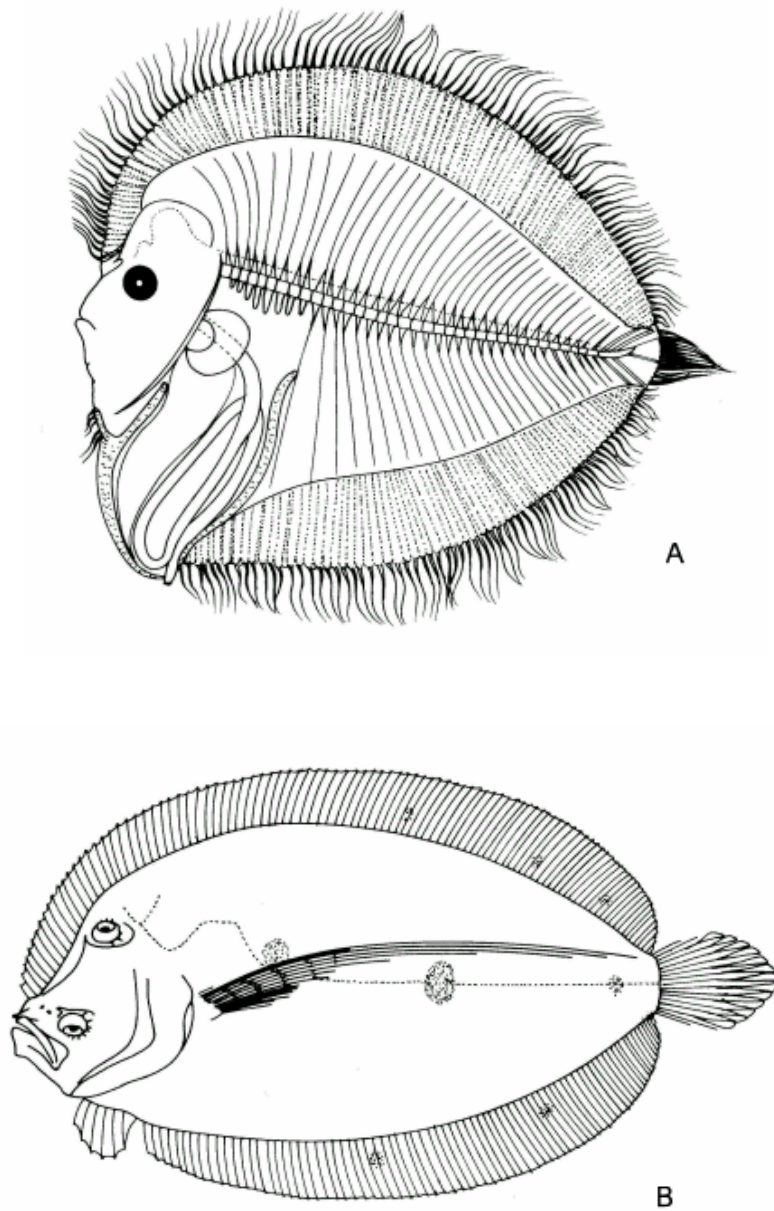


Fig. 13 - *Bothus mancus*, A-18.9 mmSL, B-Adult (from Lalithambika Devi, 1986)

Table 14 a - Morphometrics, in mm, of isolated stages of bothid larvae.

Station	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus	Depth	Length	
<i>Bothus mancus</i>													
Ar - 40	18.9 SL	Symmetrical	Flexed	3.70	3.50	1.60	0.71	0.81	15.70	15.90	5.80	1.27	0.70
<i>Bothus species</i>													
Ki - 354	21.8 SL	Migrated	Flexed	5.00	5.00	1.22	1.05	1.03	10.10	10.10	3.10	1.35	2.30
<i>Asterorhombus intermedius</i>													
Ki - 680	7.8 SL	Symmetrical	Flexed	2.70	2.50	0.74	0.45	0.43	4.30	4.30	0.81	0.45	1.30
<i>Laeops macrophthalmus</i>													
Di - 5548	4.3 NIL	Symmetrical	Straight	2.20	1.00	0.13	0.29	0.35	0.92	0.77	-	-	-
S4 - None	19.0 SL	Migrating	Flexed	6.10	4.20	0.80	0.74	0.77	7.40	6.30	1.70	0.85	2.80
<i>Chascanopsetta lugubris</i>													
AB - 66	37.0 SL	Symmetrical	Flexed	13.80	5.90	2.20	1.00	1.03	9.07	9.86	2.09	0.69	5.72

Table 14 b - Meristics of isolated stages of bothid larvae.

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total
Bothus mancus											
Ar - 40	18.9 SL	Post Flexion	Flexed	Symmetrical	103	77	17	3+3	10	30	40
Bothus species											
Ki - 354	21.8 SL	Metamorphosed	Flexed	Migrated	98	76	17	3+3	10	not clear	10+
Asterorhombus intermedius											
Ki - 680	7.8 SL	Post flexion	Flexed	Symmetrical	90	61	17	2+4	10	26	36
Laeops macrophthalmus											
DI - 5548	4.3 NL	Pre flexion	Straight	Symmetrical Migrating	1	0	0	0			
S4 - None	19.0 SL	Post flexion	Flexed	Migrating	98	75	17	3+3	11	35	46
Chascanopsetta lugubris											
AB - 66	37.0 SL	Post Flexed	Flexed	Symmetrical	115	82	17	2+4	16	37	53

14. *Bothus* sp.

A metamorphosed specimen measuring 21.8 mm SL is contained in the collection taken from the Indian Ocean during IIOE. (Fig. 14 ; Tables 14 a, b).

Morphology :

Body thin, flat, leaf-like and translucent ; eyes on the left side, right one being positioned over the left one near the dorsal profile. Mouth terminal, small being less than the diameter of the left eye, lower jaw with 4 pairs of teeth, one pair on premaxilla and another pair on maxilla are visible. Teeth fall out easily and hence not possible to count accurately. Snout in front of the eye, comparatively small and a little larger than diameter of the eye. Alimentary canal runs obliquely down, intestinal coil elliptical and placed at posterior half of abdominal cavity, ventral half of the intestinal coil is pushed forwards to a level behind the pelvic fin radial, anus lies at the level of the sixth vertebral segment, its opening directed posteriorwards. Liver not massive, its dorso-ventral axis about twice its antero-posterior axis. Swim bladder placed postero-dorsally in the abdominal cavity.

Spinacion is absent on the body.

Fin and supporting structures :

Median fins continuous, but not confluent with the caudal, rays well developed, 98 along the dorsal and 76 along the anal, the first dorsal ray small and tiny. Pterygiophores well developed and bony, the first one long, extends forwards over the skull roof to the anterior end of dorsal fin and articulate with the first tiny dorsal ray on an anterior projection while second ray is supported on the main body of the pterygiophore.

Caudal fin rays are well differentiated and are carried by the inferior hypural lower, inferior hypural middle, superior hypural middle, superior hypural upper as well as on the neural and haemal processes of penultimate vertebra. 17 caudal rays. No rays are borne on epural.

Among paired fins, the pectorals retain their embryonic condition, pelvic fins well developed and strongly asymmetrical. Left fin radial longer and extends to urohyal, fourth pelvic fin ray lies opposite the tip of the cleithra, anterior three rays of left pelvic fin lie in advance of the right fin.

Axial skeleton :

Vertebral segments well differentiated, centra dumb-bell shaped, ossification advanced considerably, arches are ossified including the first small and thin arch, which has no spine. In precaudal region, haemal processes are found only on the last six vertebrae, only arches are seen in the remaining anterior ones except the first.

Remarks:

Thin, flat, leaf like body, both eyes on left side, asymmetrical pelvic fin with anterior three rays of the left fin in advance of the right fin, absence of spination on any part of the body, extension of the posterior basipterygial processes beyond the level of the descending loop of the intestinal coil are all characters helpful to place the metamorphosed larva described here among bothids particularly to the genus *Bothus* sp. In the absence of preflexion and flexion stages in the collection, it is difficult to assign specific status to the metamorphosed larva. In the fin ray count the present form agrees with the adults of *Bothus mellissi*, *B. lunatus*, *B. mancus* and *B. bleekeri*. Of these *B. bleekeri* does not conform to the shape of the body, the mouth is also slightly bigger than the diameter of the eye. The same also holds good for *B. mancus*. There is some resemblance to *B. mellissi* and *B. lunatus*. In *B. lunatus* the mouth is more than twice the diameter of the eye. Even though the metamorphosed form is in agreement with *B. mellissi*, it is difficult to consider the present larva as *B. mellissi* for the reason that *B. mellissi* is reported from Mediterranean and Atlantic waters.

In all the probability the present form may be a counter part of *B. mellissi* from Indo-Pacific region.

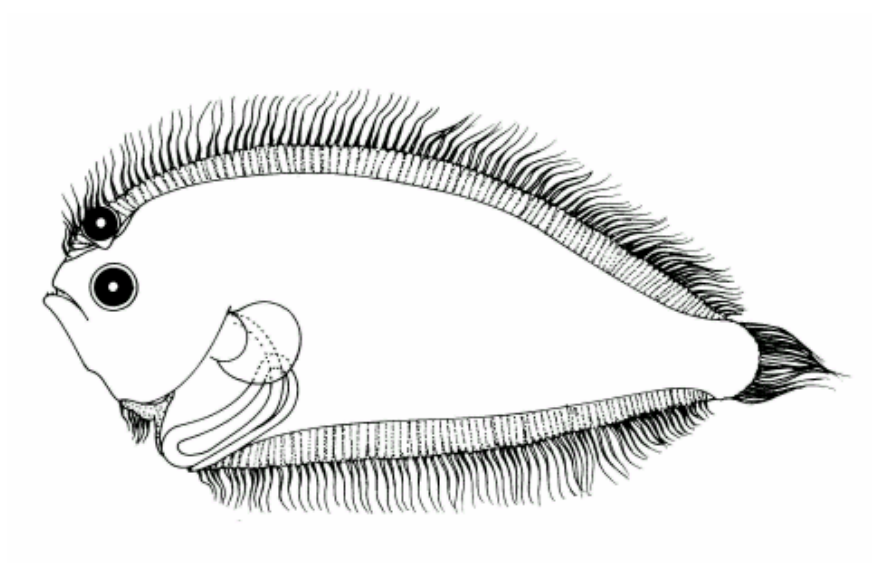


Fig. 14 - *Bothus* sp. 21.8 mm SL (metamorphosed) (from Lalithambika Devi, 1986)

Discussion

The larvae belonging to the genus *Bothus* can be distinguished from others in the presence of asymmetrical pelvic fin radials, that of the left side being much longer than the right and the anterior 2 to 3 rays of the left fin placed in advance of that of the right fin, the posterior basipterygial processes extending to the level beyond the middle of the intestinal loop, absence of spines on cleithra, urohyal and posterior basipterygial processes, the shriveling of the anterior elongated dorsal ray in early postflexion stages, as well as the meristics.

Larval stages belonging to *Bothus myriaster* and *B. pantherinus* occur in the plankton collected from the Indian Ocean, South China Sea and Gulf of Thailand. Preflexion, flexion and postflexion stages were contained in the plankton collections. In the case of *B. pantherinus* metamorphosed stages were also present in the collections.

The larvae of *B. myriaster* transforms into postflexion stages when they attain a standard length of 5.2 mm whereas *B. pantherinus* it takes place only when the larvae attain a length of 7.4 mm SL (Table 15). However, postflexion stages of *B. myriaster* appears to have protracted larval life when compared with *B. pantherinus*, because in the case of *B. myriaster*, it remains in the postlarval condition even after attaining 33.5 mm SL without any sign of metamorphosis while in the case of *B. pantherinus* commencement of eye migration, a prelude to metamorphosis is seen when the larvae attain a length of 11.0 mm SL and get metamorphosed when the larvae reach a length of 29.3 mm SL. The median, caudal and pelvic fin rays as well as posterior basipterygial processes are differentiated earlier in *B. myriaster* than in *B. pantherinus*.

In *B. myriaster* the relative snout length decreases from preflexion to flexion and increases from flexion to postflexion stages (Table 15). In *B. pantherinus* the relative snout length decreases from preflexion to metamorphosed stages. No increase was noticed at any stages. The body depth at pectoral fin base increases from preflexion to postflexion in *B. myriaster* but in *B. pantherinus* it increases from preflexion to flexion and then show a decrease followed by a significant increase from postflexion to metamorphosed

stages. The relative length from snout to pelvic fin base increases from preflexion to flexion and decreases thereafter in *B. pantherinus* whereas in *B. myriaster* the decrease is found throughout the larval stages.

Kuronuma (1942) has given the photograph of a metamorphosed specimen measuring 40 mm and referred it as belonging to *B. ovalis*. *B. ovalis* has been synonymised as *B. myriaster* (Amaoka, 1964, though Kamohara, 1958 recognised *B. myriaster* and *B. ovalis* as one and the same but gave no reason). The fin ray counts agree with those of the present series, but no metamorphosed stage is available in the present material. Ochiai and Amaoka (1963) have reported a larval form and referred it to as the larva of *B. myriaster*. For want of details it is difficult to compare the present materials with that of Ochiai and Amaoka. Amaoka (1964) has described larval stages ranging from 25 mm SL to 43 mm belonging to *B. myriaster* from waters around Sumatra. Out of the 86 specimens investigated by Amaoka only one specimen of 25.0 mm SL larva the pelvic fins are symmetrically placed below the eyes. In 32.2 mm and 35.0 mm SL larvae (metamorphosed stages) he describes that the pelvic fin on the ocular side has broad base and first ray of the fin of the blind side stands opposite the fourth one on the ocular side. The present larval materials differ from those of Amaoka in that the pelvic fins are strongly asymmetrical even from preflexion stages and also in the symmetrical position of the eye even in 33.5 mm SL larva. Ramanathan, (1977 - Ph.D. Thesis) and Ramanathan and Natarajan (1979) have described three larval forms ranging from 1.6 to 15.6 mm length and placed them under *B. myriaster*. The descriptions and figures reveal that the larvae possess spines on urohyal. It is not clear whether serrations are found on the cleithra and posterior basipterygial processes. The present observations show that larvae of *Bothus* species do not possess spines on urohyal, cleithra or posterior basipterygial processes. Hence the larval forms described by Ramanathan may not come under *B. myriaster*. Gopinath (1946) has reported a few stages of bothid larvae and placed them under *B. pantherinus*. But these larval forms do not come under the *Bothus* species as they possess spines on the cleithra, urohyal and posterior basipterygial process. In all the probability they may be referable to *Engyprosopon* spp. Ochiai and Amaoka (1963) have reported a larval form referable to *Bothus* but did not confirm whether it belonged

to *B. myriaster* of *B. pantherinus*. The larval characters reported in the present series agree with the adults in the meristic counts.

The larvae of *B. pantherinus* is described and reported for the first time.

A post larva measuring 18.9 mm SL belonging to *B. mancus* and a metamorphosed specimen belonging to *Bothus* sp. were contained in the plankton collected during IIOE. The general character of the genus *Bothus* are found in the larvae referred to as *B. mancus*. The number of fin rays also agrees with the adult. Ahlstrom (1984) in reviewing the Pleuronectiformes development has included the figure of a metamorphosed stage of *B. mancus* measuring 30.0 mm from an unpublished work of Struhsaker. Larval stages of *B. mancus* are not described.

The metamorphosed stage of *Bothus* sp. resemble *B.* in fin ray count and general shape. Since *B. mellissi* is found only in the Mediterranean and Atlantic waters, the present larva may be regarded as the counterpart of *B. mellissi* from the Indo-Pacific region.

Table 15 - Difference in morphometrics at the commencement of postflexion and length of larvae when meristic characters differentiate in *Bothus* species (in mm).

Species	Standard length	Snout to anus	Body depth across to anus	Median fin rays	Pelvic fin rays	First neural arch	First tiny dorsal ray	Hypural	Commencement of eye migration
<u>B. myriaster</u>	5.2	1.9	3.1	4.1	4.1		4.2	4.2	33.5
<u>B. pantherinus</u>	7.4	3.0	3.6	4.3	4.3	4.3	4.6	4.3	11.0

15. *Asterorhombus intermedius* (Bleeker, 1866)

A post larva measuring 7.8 mm SL is contained in the zooplankton collection taken during IIOE (Figs. 15 A, B ; Tables 14 a, b).

Morphology :

Larval body thin, flat, symmetrical and lancet-shaped, eyes black and symmetrical, snout more tapering than truncate, depth across the anus is maximum. Snout about one and a half times the diameter of eye. Mouth small and terminal, less than the diameter of eye. Lower jaw projects a little beyond the upper, jaws carry villiform teeth, six pairs on the upper and five pairs on the lower. Alimentary canal runs parallel to notochord up to level of the eight vertebral segment, forms an elliptical coil, posterior half of which is pushed forwards, but does form a bend as in *Parabothus*. Front face of the loop comes near the cleithra. The anus together with the anal fin and the first anal pterygiophore got pushed forwards and anus come to lie at the level of fourth vertebral segment. Liver broad at its dorsal aspect, but ventrally tapers and lies below the intestinal loop as a finger-like diverticulum, dorso-ventral axis more than antero-posterior. Swim bladder present occupying the space between sixth to eighth vertebral segments.

Spines absent, brown pigment spots area present on the abdomen over the swim bladder.

Fin and supporting structures :

Forward extension of dorsal fin reaches the middle level of eye and remains free from ethmoid region of cranium. First tiny dorsal ray developed, second dorsal ray very long and stout. Dorsal fin rays over the skull are separated fairly widely when compared with remaining rays. First dorsal pterygiophore extends over skull to tip of the snout. First anal pterygiophore long, stout and bent forwards. Median pterygiophores and fin rays well developed. There are 90 dorsal and 61 anal rays.

Caudal fin and hypural plates are well developed, supporting 15 caudal rays as in other *Bothid* larvae. Neural and haemal arches of the penultimate

vertebra support one ray each directly to arches and contributed to the caudal fin complement.

Pectoral fin developed and remains unrayed, pelvic fin rays well developed, anterior two rays of the left fin lie in advance of the right, left pelvic fin radial, longer than right, distal end of which has reached a little in front of cleithra and second ray lies opposite the tips of cleithra. Normal basipterygial processes attached to lower third of cleithra and run down obliquely along the ventral body wall as posterior basipterygial processes which reach as far as middle level of intestinal coil and distal portions bend slightly upwards. The basipterygial processes are comparatively shorter than in other species. No spines over the urohyal, cleithra and posterior basipterygial processes.

Axial skeleton :

Vertebrae are differentiated but not ossified, neural processes in the precaudal and caudal portions are well developed except first dorsal one, haemal processes of caudal region are also well developed, first one is stout and broad, but haemal processes in the precaudal region are only faintly marked in posterior part and are six in number, anterior ones are not marked, first neural arch is developed but has no process and remains cartilaginous. Ten precaudal and 26 caudal vertebrae including urostyle are differentiated, distal end of urostyle has sunk in between the hypural plates.

The adult :

Depth of body about 1.6 length of head, length of head 3.47 - 3.59. Snout rather long about 1.5 diameter of lower eye, diameter of which is 3.47-4.05 is length of head. Inter orbital space width 1.6 - 1.67; anterior edge of upper eye about at the same level to anterior margin of lower eye or a little behind. Maxillary extend to below anterior edge of lower eye or a little beyond it, a little more than two diameter of lower eye. Teeth uniserial on both jaws enlarged anteriorly on upper jaw ; 8-9 gill – rakers on first arch, palmate, with five to eight strong spinules on its margin ; none on upper limb. 53-54 scales in lateral line. Dorsal 82-85, anal 63 (Fig. 14 B). Pectoral of ocular side with 11 rays unequal, ocular side feeble and short, a little more than half length of head; brownish with a series of dark brown blotches along upper and lower edges of body less

defined blotches on lateral line; head with irregularly scattered blackish spots. All fins with numerous dark brown spots; a row of larger spots along basal parts of the dorsal and anal (Amaoka, 1969).

Remarks:

The lancet shape of the larval body is characteristic of the species. The absence of spines on the urohyal, cleithra and posterior basipterygial processes are characters shared by the present larvae and the larvae of *Bothus* spp. and *Arnoglossus* spp. The small number of vertebrae, the short length of the posterior basipterygial processes consequent on the forward growth of the intestinal coil help in distinguishing the species. Further the processes not extending to the level of the anus and short length of the pelvic fin radial distinguish the larva from the *Bothus* spp. The fact that the processes extend beyond the ascending loop of the intestine and shape of the body differentiate the present larva from *Arnoglossus* spp. The number of fin rays and the vertebral count agree with the adults of *Asterorhombus intermedius*.

The adult fishes of this species are not reported from Indian waters. The larval stages of the species are not yet described and reported. The absence of preflexion and flexion stages in the present collection limit the detailed description.

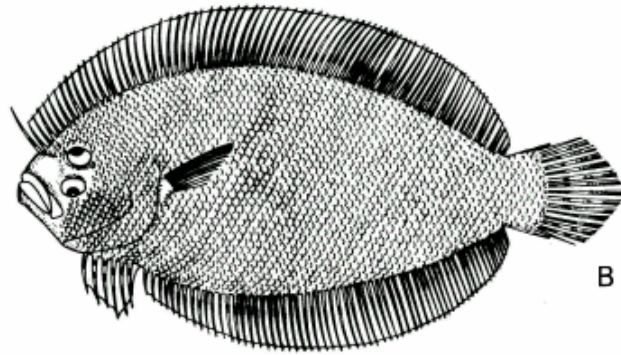
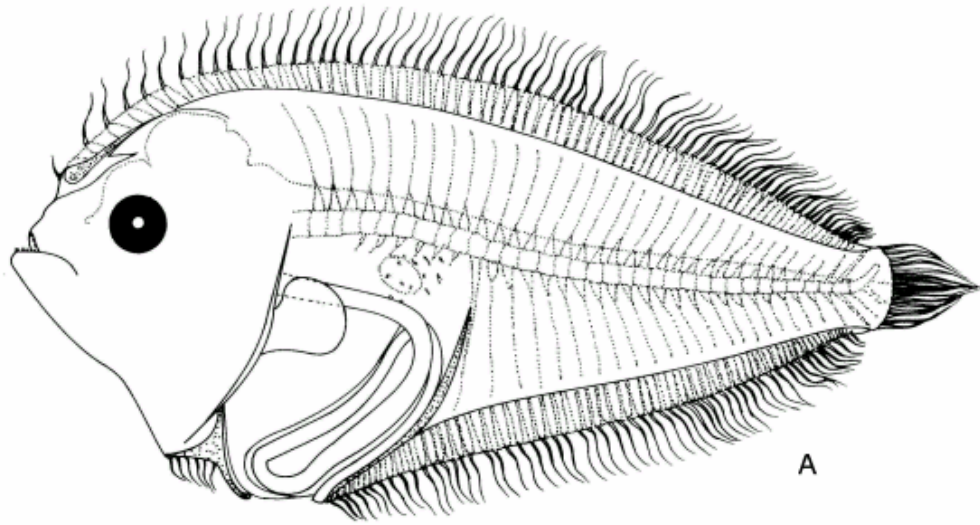


Fig. 15 - *Asterorhombus intermedius*, A-7.8 mm SL (from Lalithambika Devi, 1986), B- Adult (from Amaoka, 1969).

16. *Psettina brevirectis* (Alcock, 1890)

Larvae ranging from 2.1 mm NL to 17.5 mm SL occur in the collections of the Naga expedition belonging to preflexion, flexion, postflexion as well as metamorphosed stages (Figs. 16 A, B, C, D, E Tables 16 a, b, c & 25).

Morphology :

Larval body thin, transparent and symmetrical in early stages, eyes symmetrical and pigments have started differentiating in 2.2 mm NL larvae, right eye has started shifting from its symmetrical position preparatory to migration to left side in 12.7 mm SL, which is completed in 16.1 mm SL. Teeth not visible up to 2.6 mm NL. Anterior portion of the alimentary canal runs obliquely downwards and makes an elliptical coil at posterior end of abdominal cavity, the terminal portion of intestine lies vertically down and in early stages opens at the level of the 10th myotome. In advanced stages, elliptical coil becomes more compact leaving very little space between intestinal loops. Anus pushed forwards simultaneously to the level of seventh vertebral segment in the later stages. Liver has a longer antero-posterior axis than dorso-ventral axis in early stages but after flexion of notochord, the condition is reversed. Swim bladder located posteriorly occupying space between seventh and tenth vertebral segments.

A pigmented diverticulum hangs down from urohyal region, that is in front of urohyal (sciatic portion) just above the first spine of the urohyal in 2.1 mm NL the earliest larva. This appendage shrivels up from 8.8 mm SL onwards and is traceable up to 10.1 mm SL larvae.

Spines are late to appear on urohyal and posterior basipterygial processes unlike in other species so far examined, these get differentiated from larvae of 5.4 mm NL and in posterior basipterygial processes from 7.0 mm SL. Spines are not found on cleithra even in 14.5 mm SL larva. Spines on posterior basipterygial processes are confined only to the middle, distal half being devoid of any such spines, they tend to reduce in size and sharpness when the larvae gets metamorphosed.

Relative head length, snout to anus length as well as eye width and height decrease from preflexion to metamorphosed stages but the eye width shows

slight increase from postflexion to metamorphosed stages. However, the values are less than those of preflexion. Depth at pectoral fin base and across anus increases till postflexion stages and thereafter decreases suddenly in metamorphosed stages to values less than those of preflexion. The length between snout and pelvic fin base decreases till postflexion, then increases to metamorphosed, the values being less than preflexion figures.

Fin and supporting structures :

Elongated dorsal ray at anterior end of dorsal fin fold is identifiable though reduced in size up to 12.7 mm SL and is absent in larvae of 14.5 mm SL onwards. Pterygiophores are differentiated in 3.2 mm NL and the rays begin to differentiate from 3.4 mm NL from the anterior end. First anal pterygiophore stout and long and differentiated in 3.2 mm. First dorsal pterygiophore extend forwards beyond the articulation of elongated dorsal ray in 4.9 mm NL larvae but the first tiny dorsal ray is differentiated only in 7.0 mm SL when full complement of 78 dorsal and 61 anal rays are found. Number of fin rays range from 76 to 82 dorsals and 58 to 64 anals.

Rudiments of the hypural elements are seen differentiating as pack of cells at the ventral caudal extremity in 4.3 mm NL larvae. Caudal fin rays are differentiated from 5.2 mm NL. Inferior hypural middle and superior hypural middle are differentiated carrying four and three rays respectively in 5.2 mm NL larvae. In 5.6 mm NL larvae inferior hypural lower and epural are differentiated. Superior hypural upper, however, is differentiated only in postflexion larvae. Flexion of notochord takes place between 5.2 mm NL and 7.0 mm SL and full complement of fin rays are seen in 7.0 mm SL.

The pelvic fin complex appear as pack of cells at ventral posterior aspect of the cleithra in 2.7 mm NL. Posterior basipterygial processes are differentiated in 3.2 mm NL, which run along ventral border of body wall and reach the level of ascending loop of intestine in 5.6 mm NL. Pelvic fin rudiments are seen as pack of cells in 4.3 mm NL from which the radial rudiment is differentiated in 4.6 mm NL. Pelvic fin radial (anterior basipterygial processes) is differentiated in 6.6 mm NL with rudiments of rays. Left pelvic fin radial becomes asymmetrical and rays are found in 7.7 mm SL, left fin radial reaches level of

cleithra in 8.0 mm SL and in 14.5 mm SL it reaches the level of posterior most spine on the urohyal, anterior three rays of left pelvic fin are in advance of those of right side. In 16.1 mm SL the anterior rays super-impose the urohyal and extends far forwards reaching in front of first spine on the urohyal. Even though urohyal is discernible in 4.4 mm NL, spines appear only in 5.4 mm NL.

Axial skeleton :

Notochord remains vacuolated and unsegmented, in 4.4 mm NL larvae, segmentation has started differentiating from anterior to posterior, first neural arch is differentiated as a cartilaginous loop-like structure in front of the second neural arch in 4.4 mm NL, bearing no spinous process, gets ossified only very late in 11.2 mm SL, whereas arches of the remaining neural and haemal as well as neural processes start ossification in 8.0 mm. Precaudal centra start differentiating from 4.9 mm NL when the caudal centra are only faintly marked, and are differentiated from 5.2 mm NL. The dumb-bell shaped vertebrae are seen in 11.7 mm SL, the first vertebra has no neural process but the arch is drawn out into a lancet-shaped portion which is short and never reaches the dorsal body wall like other neural spines. First dorsal pterygiophore supporting the elongated dorsal ray is seen in earliest larvae of 2.1 mm NL, is bony and grows forwards over the skull. Precaudal neural arches are differentiated in 2.3 mm NL and neural processes in 2.7 mm with very small spines on second, third and fourth arches. In caudal region the haemal processes are differentiated in 2.7 mm NL and neural processes in 3.2 mm in anterior half and are completed in 5.2 mm NL. But haemal arches started differentiating in 2.3 mm NL in the last two vertebrae. Tiny haemal processes are discernible in 5.6 mm NL which are completed in 8.0 mm SL when six processes are visible. These spines are long and equal from fifth to eight vertebra and short in ninth and tenth. There are 10 + 25-27 vertebrae including urostyle.

The adults :

Depth of body about twice in the length, length of head about $3 \frac{1}{2}$. Upper profile of head with a slight notch in front of eyes. Snout shorter than eye, diameter of which is 3 to $3 \frac{1}{4}$ in length of head ; eyes separated by a narrow ridge, the lower a little in advance of upper. Maxillary extending to below anterior edge of eye or a little beyond, length $3 \frac{2}{5}$ to $3 \frac{4}{5}$ in that of head ;

lower jaw $2 \frac{2}{5}$ to $2 \frac{3}{5}$ in head. 7 or 8 gill-rakers on lower part of anterior arch. 47 to 52 scales in lateral line. Dorsal (76) 78-82. Anal 60-66 (Fig. 16 E). Pectoral of ocular side with 11 rays, length $\frac{3}{5}$ to $\frac{2}{3}$ that of head. Longest rays of left pelvic about $2 \frac{2}{3}$ in length of head. Caudal rounded. Brownish, a series of rather indistinct dark blotches along upper and lower edges of body, continued on bases of dorsal and anal fins: two or three blotches on lateral line ; a dark patch on distal part of pectoral hinder part of caudal fin with a broad blackish band (Norman, 1934).

Remarks :

Larvae of *P. brevirectis* have spines on urohyal, and posterior basipterygial processes, but not on cleithra. The number of spines are few and restricted to proximal half of the posterior basipterygial processes. The urohyal appendage is clearly visible in early larval stages but shrivels up in postflexion stages. The number of fin rays and vertebrae tally with adults but differ from *P. iijimae*.

Larvae of *P. brevirectis* have been reported by Lalithambika Devi (1981) with brief description. The adults are reported from Indian Ocean. But all the larval material of the present account have been from Gulf of Thailand and South China Sea.

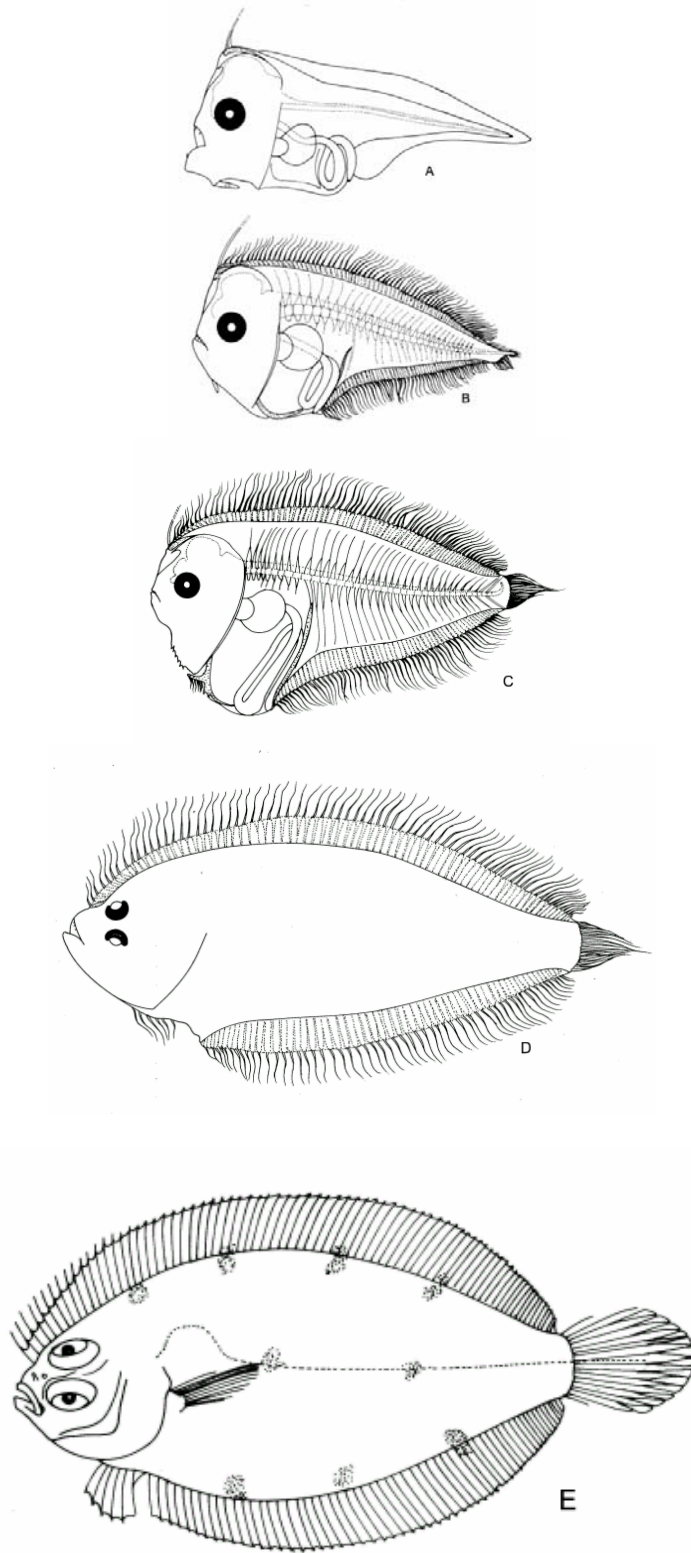


Fig. 16 - *Psettina brevirectis*, A-3.0 mm NL, B-5.2mm NL, C-9.5 mm SL, D-16.1 mm SL (metamorphosed) , E- Adult (from Lalithambika Devi, 1986).

Table 16. Difference in morphometrics at the commencement of postflexion and length of larvae when meristic characters differentiate in *Psettina* species (in mm).

Species	Standard length	Snout to anus	Body depth across to anus	Median fin rays	Pelvic fin rays	First neural arch	First tiny dorsal ray	Hypural	Commencement of eye migration
<i>P. brevirostris</i>	6.3	2.8	3.8	3.4	6.6	4.4	7.0	5.2	12.7
<i>P. ijimai</i>	6.5	2.8	3.4	4.3	6.3	4.3	6.5	4.6	13.5

17. *Psettina iijimae* (Jordan and Starks, 1904)

Larvae ranging from 1.8 mm NL to 44.6 mm SL occur in the collections of the IIOE and Naga Expedition. The larvae belonging to preflexion, flexion and postflexion and metamorphosed stages are available for study (Figs. 17 A, B, C, D ; Tables 17 a, b, c & 25).

Morphology :

Larval body thin, transparent and symmetrical in early stages ; eyes symmetrical, black pigments are seen from 2.6 mm NL larvae, right eye starts shifting from its symmetrical position to the left side in 13.5 mm SL larvae and migration is completed in larvae ranging in length from 20.2 and 22.5 mm SL. Teeth not visible in the larvae up to 2.3 mm NL, anterior portion of the alimentary canal runs slightly slanting downwards towards ventral aspect and makes an elliptical coil at posterior end of the abdominal cavity, terminal portion lies vertically down and anus opens at the level of tenth myotome in early stages. In advanced stages, the alimentary canal becomes compactly packed with the ventral portion being pushed forwards and the anus opens at the level of seventh vertebral segment. The antero-posterior axis of liver is longer than the dorso-ventral axis in early stages but after metamorphosis the latter is more. Swim bladder is present in the posterior part of the abdominal cavity occupying space between seventh and tenth vertebral segments.

A pigmented diverticulum hangs down just in front of the first spine on the urohyal in the earliest larva of 1.8 mm NL, which shrivels up as growth progresses and is traceable up to 12.7 mm SL in cleared specimens. Brownish black pigment is present at the base of the appendage which disappears along with the appendage. Pigments are not noticeable anywhere else on the body of the larva.

Spines appear late on urohyal and posterior basipterygial processes unlike in *Engyrosopon* spp. This species also differs from others in that spinules are distributed near to the baseosts along dorsal and ventral body wall even before the formation of the fin rays and these are found distributed along the fin rays when the larva attains 4.6 mm NL onwards and continue to exist

even in the metamorphosed stage. Spines on urohyal get differentiated from larva of 5.1 mm NL and posterior basipterygial processes are confined to its proximal half, the distal half being devoid of any such spines. The spines are not found on the cleithra. The spines on the posterior basipterygial processes and urohyal reduce in size and disappear as soon as metamorphosis has taken place.

Relative head length and length between snout and pelvic fin base increase from preflexion to flexion stages, decrease from flexion to postflexion stages and then show increase from postflexion to metamorphosed stages but the increment is less than the preflexion values. Relative snout - anus length, depth at pectoral fin base as well as the eye width and height gradually decrease but the eye width shows a slight increase in the metamorphosed stages. However, increment is less than the preflexion values. Relative depth across anus decreases from preflexion to flexion stages and increases slightly during postflexion stages but decreases again. Relative snout length shows slight increase during flexion stages to decrease thereafter.

Fin and supporting structures :

Elongated dorsal ray at anterior end of the dorsal fin fold is seen in the larvae from very early stages up to 20.2 mm SL. Pterygiophores and baseosts are differentiated in 3.8 mm NL but rays are not differentiated. First anal pterygiophore is long and stout and differentiated in 3.7 mm NL. Fin rays and pterygiophores differentiate from anterior to posterior. First dorsal pterygiophore extends forwards beyond the articulation of the elongated dorsal ray in 5.8 mm NL larvae which is indicated in 4.9 mm. First dorsal ray is very small and differentiated in 6.5 mm SL larva when full complements of 85 dorsal and 68 anal rays are seen. The dorsal and anal rays ranged from 82-93 and 68-70 respectively.

Rudiments of the hypural elements are seen differentiating as a pack of cells at the ventral caudal extremity in 4.3 mm NL. Caudal rays become distinct, inferior hypural middle and superior hypural middle get differentiated and carry four and two rays respectively in 4.6 mm NL larva. In 5.5 mm NL larva, inferior hypural lower is differentiated and the hypural upper in 6.5 mm SL. Flexion of

the notochord takes place between 4.6 mm NL and 6.5 mm SL larvae. Epural component is distinguishable in 4.9 mm NL larva. Full complement of the caudal fin rays are seen in 6.5 mm SL. Of the 17 caudal rays, 15 are borne by the hypural plates. The inferior hypural lower three, middle four, superior hypural middle five and upper three.

Pelvic fin complex appears as pack of cells at ventral posterior face of the cleithra in 3.7 mm NL larva. Pelvic (anterior basipterygial processes) fin radial rudiment is indicated in 4.3 mm NL larva when the posterior basipterygial processes are also differentiated. Pelvic fin ray rudiments are seen in 6.3 mm NL and the rays are discernible in 6.5 mm SL. At this stage, two of the left pelvic fin rays are seen in advance of the right fin rays. The left fin radial continues to grow in advance of the right and reaches the level of the cleithral tip in 6.5 mm SL and in 10.8 mm SL it reaches the level of the posterior most spine on the urohyal. In 20.2 mm SL larva, anterior rays of pelvic fin super impose the urohyal and tip of the cleithra is seen between third and fourth rays. The urohyal is differentiated in 4.3 mm NL.

Axial skeleton :

Notochord remains vacuolated and segmented in larvae up to 4.9 mm NL, segmentation commences from the anterior end. The first neural arch is differentiated as a cartilaginous loop-like structure in front of the second neural arch in 4.3 mm NL larva, has no neural process but a lancet-shaped portion is present which is short and never reaches the body wall like other neural spines. It gets ossified in 10.8 mm SL, while the other processes get ossified much earlier (in 6.5 mm SL). First dorsal pterygiophore carries the elongated dorsal ray and is seen in the earliest larvae 1.8 mm NL. The first dorsal pterygiophore remains ossified from the earliest larvae and grows over the skull. Precaudal neural processes are seen in 3.7 mm NL except the first. In caudal region, the neural and haemal processes are also differentiated in 3.7 mm NL and are completed in 5.8 NL. Haemal arches of the precaudal region have started differentiating in 3.7 mm NL and the tiny processes have started differentiating from 5.8 mm NL but completed only in 8.6 mm SL when six processes are discernible. Precaudal centra start differentiating from 5.5 mm NL and the caudal centra are only faintly marked which are clearly seen from 6.5 mm SL.

Vertebrae initiate ossification from 10.8 mm SL. There are 10+28-30 vertebrae including urostyle.

The adult :

Depth of body $2 \frac{3}{5}$ in the length, length of head nearly 4. Upper profile of head distinctly notched in front of eyes. Snout shorter than eye, diameter of which is 3 in length of head ; eyes separated by a narrow bony ridge (), the lower very little in advance of upper. Maxillary extending to below anterior part of eye, length about 3 in that of head ; lower jaw a little more than twice in head. 6 or 7 gill-rakers on lower part of the anterior arch. 55 scales in lateral line. Dorsal (80-89) 95. Anal (69-73) 75 (Fig. 17 E). Pectoral of ocular side with 11 rays, length about $1 \frac{3}{4}$ in that of head. Longest ray of left pelvic $2 \frac{1}{2}$ to $2 \frac{4}{5}$ in length of head. Caudal rounded Brownish, with a number of darker spots and rings, of which rows at upper and lower edges of body are most prominent ; median fins spotted with darker (Norman, 1934).

Remarks :

Larvae of *p. iijimae* can be distinguished from *P. brevirectis* by the presence of spinules on the fin rays. The number of spines on urohyal and posterior basipterygial processes are more than in *P. brevirectis*. The meristics are also on a higher side in *P. iijimae*. The number of fin rays tally with adults. The larval forms described by Pertseva-Ostroumova (1965) agree with the characters reported in the present account, except in the spination on fin rays.

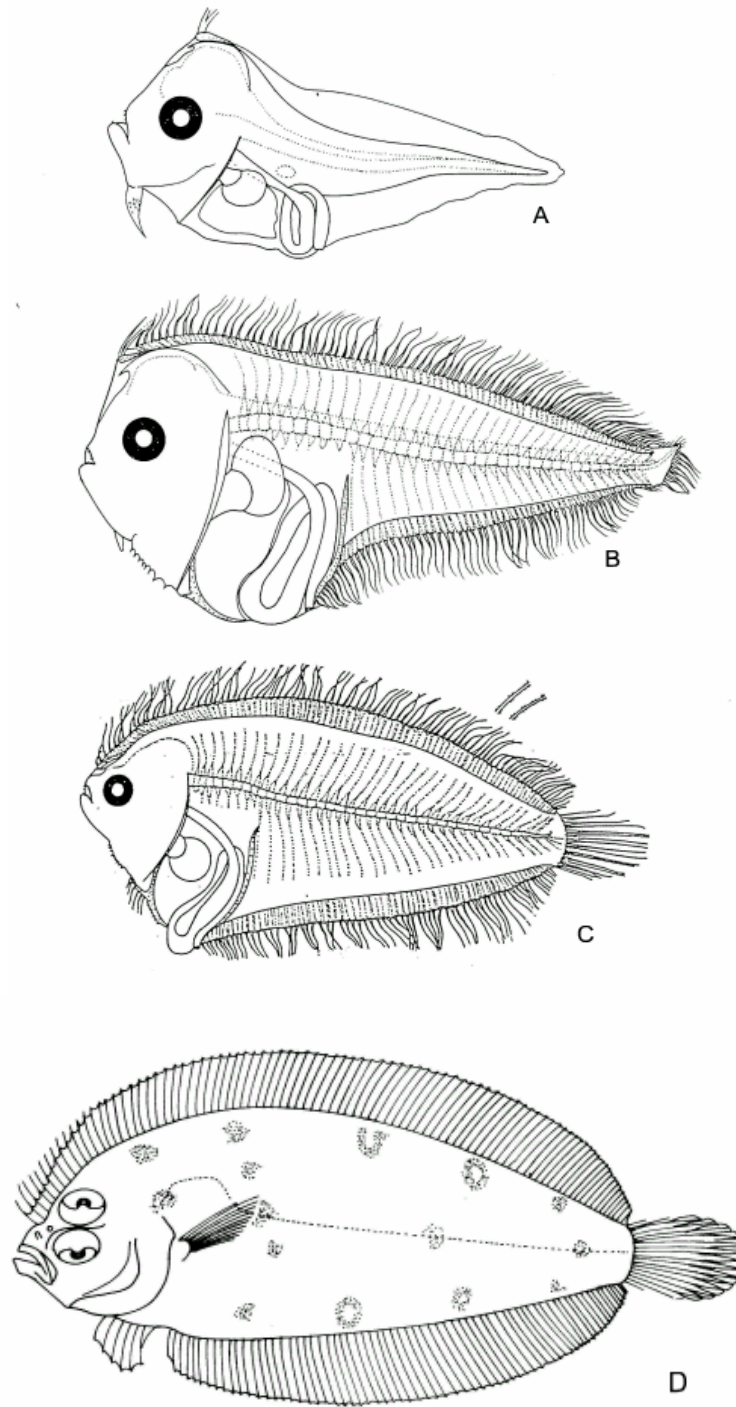


Fig. 17 - *Psettina iijimae*, A-3.0 mm NL, B-5.7 mm NL, C-19.7 mm SL (Enlarged view of spinules on rays drawn), D-Adult (from Lalithambika Devi, 1986).

Table 17 a - *Psettina brevirostris* - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus	Depth	Length	
S7-18G	2.1 NL	Symmetrical	Straight	1.14	0.47	0.10	0.16	0.18	0.58	0.45	-	-	-
S7-18A	2.4 "	"	"	1.40	0.64	0.12	0.23	0.24	0.77	0.45	-	-	-
S5-28A	3.0 "	"	"	1.55	0.77	0.24	0.26	0.31	1.09	0.90	-	-	-
S6-42	3.4 "	"	"	1.80	1.00	0.26	0.29	0.35	1.38	1.13	-	-	0.90
S5-10	3.8 "	"	"	1.80	1.15	0.31	0.29	0.34	1.60	1.35	-	-	0.90
S3-11	4.1 "	"	"	2.00	1.32	0.31	0.35	0.40	2.00	1.90	-	-	0.90
S7-8B	4.3 "	"	"	2.10	1.30	0.38	0.37	0.40	2.30	2.30	-	-	0.90
S7-8B	4.6 "	"	"	2.00	1.40	0.45	0.35	0.42	2.30	2.30	-	-	0.91
S7-8B	4.9 "	"	"	2.10	1.40	0.39	0.39	0.43	2.60	2.60	-	-	0.93
S5-15	5.2 "	"	Early flexion	2.10	1.40	0.37	0.40	0.45	2.50	2.30	-	-	1.10
S7-8B	5.4 "	"	"	2.50	1.50	0.55	0.42	0.48	2.70	2.60	-	-	1.40
S7-8B	5.6 "	"	Mid flexion	2.50	1.60	0.42	0.42	0.48	3.10	3.00	-	-	1.30
S3-19	6.6 "	"	Late flexion	2.60	1.70	0.52	0.42	0.48	3.40	3.40	-	-	1.20
S7-8B	6.3 SL	"	Flexed	2.80	1.90	0.45	0.47	0.52	3.60	3.80	0.68	0.35	1.30
S7-8B	6.8 "	"	"	2.90	2.00	0.61	0.45	0.50	3.80	3.70	0.68	0.42	1.30
S7-8B	7.0 "	"	"	2.80	2.00	0.42	0.45	0.52	4.00	4.30	0.97	0.39	1.30
S7-17B	8.0 "	"	"	3.00	2.30	0.56	0.52	0.56	4.60	4.60	0.97	0.52	1.30
S3-19	8.7 "	"	"	3.40	2.30	0.60	0.53	0.60	5.00	5.00	1.03	0.52	1.40
S3-12	10.1 "	"	"	3.50	2.70	0.70	0.50	0.71	5.00	5.40	1.55	0.60	1.40
S5-28B	11.2 "	"	"	3.50	2.80	0.70	0.56	0.68	5.80	6.00	1.90	0.76	1.40
S3-23	12.7 "	Migrating	"	3.90	3.20	0.93	0.60	0.68	6.90	7.10	2.20	0.77	1.80
S5-27	14.5 "	"	"	4.50	3.70	1.00	0.74	0.77	7.70	8.00	2.70	0.90	1.90
S11A-34	16.1 "	Migrated	Metamorphosed	4.20	4.00	1.10	0.74	0.53	6.50	7.00	2.60	1.03	2.20
S9-10	17.5 "	"	"	5.30	4.90	1.22	1.26	0.81	5.71	5.60	1.90	0.97	3.20

Table 17 b - *Psettina brevirostris* – meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			Spines			
					Dorsal	Anal	Caudal	Left Pelvic	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior basipterygial processes
S5-28A	2.3 NL	Pre flexion	Straight	Symmetrical	1	0	0	0				0	0	0
"	2.7 "	"	"	"	1	0	0	0				0	0	0
"	3.0 "	"	"	"	1	0	0	0				0	0	0
"	3.2 "	"	"	"	1	0	0	0				0	0	0
S6-42	3.4 "	"	"	"	1+	Forming	0	0				0	0	0
S5-10	3.8 "	"	"	"	"	"	0	0				0	0	0
S7-8B	4.3 "	"	"	"	ca.48	ca.40	0	0				0	0	0
"	4.6 "	"	"	"	68	61	0	0				0	0	0
"	4.9 "	"	"	"	75	56	0	0				0	0	0
S7-8B	5.2 "	Early flexion	Flexing	"	74	56	7	0				0	0	0
"	5.4 "	"	"	"	72	50	11	0				0	0	0
"	5.6 "	Mid flexion	"	"	75	55	11	0				0	0	0
S3-19	6.6 "	Late flexion	"	"	79	59	12	Forming				0	0	0
S7-19A	7.0 SL	Post flexion	Flexed	"	78	61	17	"	10	26	36	4	0	2
S7-42	7.7 "	"	"	"	77	59	17	2+4	10	26	36	6	0	2
S7-17B	8.0 "	"	"	"	78	58	17	2+4	10	27	37	5	0	2
S3-19	9.6 "	"	"	"	78	59	17	2+4	10	27	37	6	0	2
S7-42	10.1 "	"	"	"	80	62	17	3+3	10	26	36	6	0	2
S7-8B	11.4 "	"	"	"	82	62	17	3+3	10	26	36	4	0	3
"	12.1 "	"	"	"	79	64	17	3+3	10	26	36	6	0	2
S3-23	12.7 "	"	"	"	79	63	17	3+3	10	26	36	6	0	4
S5-27	14.5 "	"	"	"	78	60	17	3+3	10	25	35	6	0	4
S11A-34	16.1	Metamorphosed	"	"	76	58	17	3+3	10	26	36	0	0	0
S9-10	17.5	"	"	"	77	59	17	3+3	10	27	37	0	0	0

Table 17 c – Development of vertebral column, caudal fin rays and caudal fin supporting bones in larvae of *Psettina brevictis*.

Station	Body Length	Stage	Notochord	Right Eye	Preactinal vertebrae			Caudal vertebrae			Centra	Ural Centra	Total Vertebrae	Caudal fin rays	Ural components			Epural				
					Neural		Haemal		Neural						Haemal		Sup		Mid	Inf	Hyp	Low
					Process	Arch	Process	Arch	Process	Arch					Upp	Mid						
S5-28A	2.3	Post flexion	Straight	Symmetrical	0	9	0	0	0	0	0	11	0	0	0	0	0					
"	2.7	"	"	"	3	6	0	3	15	0	0	24	0	0	0	0	0					
"	3.2	"	"	"	9	0	0	4	7	13	0	29	0	0	0	0	0					
S7-8B	4.4	"	"	"	9	1	0	6	3	20	0	32	0	0	0	0	0					
"	4.9	"	"	"	9	1	0	6	3	23	0	36	0	0	0	0	0					
"	5.6	Mid flexion	Flexing	"	9	1	2	6	2	24	24	36	11	0	X	X	X					
"	5.2	Early flexion	"	"	9	1	0	6	2	24	2	36	7	0	X	X	0					
S3-19	6.6	Late flexion	"	"	9	1	3	5	2	23	2	35	12	0	X	X	X					
S7-19A	7.0	Post flexion	Flexed	"	9	1	4	4	2	23	2	36	17	X	X	X	X					
S7-17B	8.0	"	"	"	9	1	6	3	2	24	2	37	17	X	X	X	X					
S3-19	9.6	"	"	"	9	1	6	3	2	24	2	37	17	X	X	X	X					
S3-12	10.1	"	"	"	9	1	6	3	2	23	2	36	17	X	X	X	X					
S5-28B	11.2	"	"	"	9	1	6	3	2	23	2	36	17	X	X	X	X					
S3-23	12.7	"	"	Migrating	9	1	6	3	2	23	2	36	17	X	X	X	X					
S5-27	14.5	"	"	"	9	1	6	3	1	22	2	35	17	X	X	X	X					
S11-34	16.1	Metamorphosed	"	Migrated	9	1	6	3	2	23	2	36	17	X	X	X	X					
S9-10	17.5	"	"	"	9	1	6	3	2	23	2	36	17	X	X	X	X					

Discussion

Larval stages belonging to two species *Psettimana* are collected from the Indian Ocean, Gulf of Thailand and South China Sea.

The larvae of *P. brevirectis* in the presence of spines on the median fin rays in the latter which differentiates as soon as the fin rays are formed. It may be noted that the spines are present near to the baseosts along the dorsal and ventral body even before the fin rays are differentiated. The differentiation of first neural arch, tiny dorsal ray, caudal rays, pelvic fin rays and spines on urohyal take place in *P. iijimae* earlier than in *P. brevirectis*. But differentiation of median fin, commencement of eye migration and metamorphosis take place later than in *P. brevirectis*. The larvae at postflexion stage also are comparatively longer in *P. iijimae* than in *P. brevirectis* (Table 18). The range in meristic counts of the larval forms agree with those of the adults.

Uchida (1936) has described postlarval stages with a greatly elongated branched dorsal ray and identified them as *P. iijimae*. The diagnostic features such as urohyal appendage, spines on urohyal and posterior basipterygial processes present in the larval forms of *P. iijimae*, being absent in the larval forms described by Uchida (1936) they cannot be placed under *P. iijimae*. The presence of elongated and branched dorsal ray together with the slender body of the larval forms described Uchida resemble closely with the larval forms described as *Arnoglossus japonicus* by Amaoka (1973). The larvae described by Amaoka (1976) as *P. iijimae* from waters around Japan differ from the larvae of *P. iijimae* reported in detail by Pertseva-Ostroumova (1965) from Gulf of Tomkin as well as the present series from the Indian Ocean, Gulf of Thailand and South China Sea in the absence of urohyal appendage and spines on urohyal and posterior basipterygial processes, structures characteristic of *P. iijimae*. Hence in all probability, the specimens described by Amaoka as *P. iijimae* may be referable to *Bothus* species.

Larval characteristics of *P. iijimae* reported and described by Pertseva-Ostroumova (1965) from Gulf of Tomkin agree with those from the Indian Ocean, Gulf of Thailand and South China Sea. The presence of larvae ranging from

early stages to metamorphosing, and metamorphosed stages in the present series confirm the identification of Pertseva-Ostroumova (1965). The meristic counts agree with those of the adults. However, it is not clear whether the spines on fin rays, a characteristic feature of *P. ijimae* have been noted by Pertseva-Ostroumova (1965).

It may be noted that the urohyal appendage is also present in the larval forms of *Engyprosopon grandisquamis*, but is very small and is found only in the preflexion stages in *E. grandisquamis*. The presence of spines on cleithra of *E. grandisquama* clearly distinguishes them from *Psettina*. The absence of spines on cleithra is also a character shared in common by *E. sechellensis*, *E. multisquama* and *E. xenandrus* but larval forms of these *Engyprosopon* species can be distinguished from those of *Psettina* species by the differentiation of spines on posterior basipterygial processes at a later stage and also by the restriction of the spines only to its proximal part in *Psettina* spp.

The larval forms of *P. brevirectis* is described for the first time.

Table 18 a - Psettina ijijmae - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus	Depth	Length	
S5-23A	1.8 NL	Symmetrical	Straight	1.00	0.41	0.13	0.18	0.21	0.61	0.45	-	-	-
S7-13	2.1 "	"	"	1.30	0.55	0.16	0.23	0.23	0.71	0.50	-	-	-
S7-18G	2.6 "	"	"	1.50	0.74	0.16	0.23	0.26	0.97	0.61	-	-	-
S5-22A	3.2 "	"	"	1.80	1.00	0.21	0.29	0.34	1.48	1.26	-	-	-
S7-18G	3.7 "	"	"	1.70	1.00	0.31	0.29	0.32	1.50	1.30	-	-	0.70
S5-10	3.9 "	"	"	1.80	1.10	0.39	0.31	0.32	1.90	1.50	-	-	0.90
S7-8B	4.3 "	"	"	1.90	1.20	0.35	0.34	0.35	2.30	2.20	-	-	0.90
S7-18G	4.6 "	"	Early flexion	2.30	1.40	0.42	0.34	0.36	2.10	2.00	-	-	0.90
S7-18G	4.9 "	"	"	2.40	1.55	0.50	0.34	0.35	2.40	2.00	-	-	1.30
S7-8B	5.1 "	"	Mid flexion	2.40	1.60	0.55	0.38	0.43	2.70	2.40	-	-	1.30
S5-22E	5.2 "	"	"	2.30	1.60	0.58	0.39	0.42	2.70	2.70	-	-	1.30
S7-8B	5.8 "	"	Late flexion	2.40	1.80	0.55	0.42	0.48	3.00	2.80	-	-	1.30
S9-21	6.3 "	"	"	2.70	1.80	0.53	0.45	0.48	3.10	2.80	-	-	1.50
KI-527	6.6 "	"	"	2.70	1.90	0.53	0.45	0.48	3.10	3.10	-	-	1.30
S9-13A	6.5 SL	"	Flexed	2.50	1.80	0.53	0.48	0.53	3.40	3.20	0.58	0.32	1.10
S9-13A	7.0 "	"	"	2.80	2.00	0.61	0.53	0.56	3.50	3.40	0.66	0.39	1.30
S9A-13A	8.6 "	"	"	3.30	2.20	0.63	0.53	0.60	4.40	4.30	0.90	0.42	1.50
S7-8B	9.1 "	"	"	3.50	2.20	0.69	0.52	0.58	5.40	5.30	1.13	0.52	1.30
S9A-13A	10.3 "	"	"	3.60	2.40	0.64	0.52	0.58	5.50	5.40	1.32	0.64	1.70
S9A-13A	11.7 "	"	"	3.70	2.80	0.74	0.58	0.61	5.70	5.80	1.61	0.66	1.60
S9A-13A	12.7 "	"	"	4.40	3.00	0.77	0.61	0.68	5.60	6.70	1.80	0.71	2.00
S9A-13A	13.5 "	Migrating	"	4.40	3.00	0.74	0.60	0.64	5.90	6.60	2.00	0.79	1.90
S3-29	14.7 "	"	"	4.40	3.10	0.81	0.60	0.68	6.40	7.10	2.40	0.89	1.90
S11A-12	16.2 "	"	"	4.80	3.70	1.03	0.60	0.63	7.90	8.30	2.50	0.85	1.80
S4-U24	18.5 "	"	"	4.80	4.10	1.03	0.84	0.84	8.80	8.90	2.80	1.13	1.90
S5-28A	19.7 "	"	"	5.00	4.00	1.00	0.87	0.97	9.70	9.60	2.90	1.13	2.00
S5-28A	20.2 "	"	"	5.20	4.20	1.10	0.89	0.97	8.70	9.30	2.80	1.22	2.10
S9A-10	22.5 "	Migrated	Metamorphosed	5.40	6.10	1.50	1.29	0.90	8.60	8.40	2.60	1.38	3.10
S9A-4A	26.4 "	"	"	7.00	7.10	1.70	1.80	1.20	8.70	8.70	3.00	1.58	4.00
S9A-4A	36.4 "	"	"	9.50	9.10	1.90	2.60	1.90	10.90	11.30	3.70	2.20	6.10
S9A-5	44.6 "	"	"	11.00	11.70	2.50	2.70	1.90	14.20	13.20	5.60	3.00	7.60

Table 18 b. *Psettina ijijmae* - meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			Spines				
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior basipterygial processes	
S5 – 23A	1.8 NL	Pre flexion	Straight	1	0	0	0						0	0	0
S7 – 18G	2.1 "	"	"	1	0	0	0						0	0	0
S7 – 8B	3.7 "	"	"	1	0	0	0						0	0	0
	4.3 "	"	"	1+	Form ing	0	0						0	0	0
S9A – 13 A	*4.9 "	Early flexion	Flexion	"	"	0	0						*0	0	0
S7 – 8B	5.1 "	Mid flexion	"	"	"	0	0						6	0	0
S9A – 13 A	5.5 "	Late flexion	"	"	ca.78	0	0						8	0	0
S7 – 8B	5.8 "	"	"	"	ca.82	0	0						9	0	0
S9A – 13A	6.5 SL	Post flexion	Flexed	85	68	17	2+4	10	29	39	10	0	10	0	0
"	7.0 "	"	"	87	68	17	2+4	10	29	39	10	0	8	0	2
"	8.6 "	"	"	93	70	17	2+4	10	29	39	10	0	9	0	5
"	10.8 "	"	"	88	68	17	3+3	10	28	38	10	0	8	0	4
S6 – 30	11.5 "	"	"	86	69	17	3+3	10	29	39	10	0	8	0	7
S7 – 8B	13.5 "	"	"	86	69	17	3+3	10	28	38	10	0	9	0	10
S5 – 10	15.5 "	"	"	88	70	17	3+3	10	29	39	10	0	10	0	10
S3 – 32	16.9 "	"	"	84	68	17	3+3	10	28	38	10	0	9	0	9
S5 – 28A	20.2 "	"	"	91	70	17	3+3	10	30	40	10	5	5	0	11
S9A – 10	22.5 "	Metamorphosed	"	82	68	17	3+3	10	29	39	10	0	0	0	0
S9A – 4A	26.4 "	"	"	84	70	17	3+3	10	29	39	10	0	0	0	0
S9A - 5	44.6 "	"	"	82	68	17	3+3	10	28	38	10	0	0	0	0

* Spinules along the base of median fins.

Table 18 c – Psettina iijimae - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Stations	Body Length	Stage	Noto-Chord	Right Eye	Precaudal vertebrae						Caudal vertebrae						Ural Centra	Total vertebrae	Caudal fin rays	Ural components				Epural
					Neural		Haemal		Centra		Neural		Haemal		Centra					Sup	Hyp	Mid	Inf	
				Process		Arch		Process		Arch		Process		Arch		Process		Upp	Mid	Mid	Low			
S5 – 23A	1.8 NL	Pre flexion	Straight		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S7 – 18G	2.1 "	"	"	Symmetrical	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
"	2.3 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
"	2.6 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
"	3.0 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S5 – 22A	3.2 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
S7 – 18G	3.7 "	"	"	"	9	0	3	0	7	10	11	10	10	10	10	10	11	11	10	3	0	0	0	0
S7 – 8B	4.3 "	"	"	"	9	1	6	0	24	3	25	3	3	3	25	3	25	3	0	0	0	0	0	0
S7 – 18G	4.6 "	"	Flexion	"	9	1	8	0	24	3	24	3	3	3	24	3	24	3	0	0	0	0	0	0
S9A – 13A	4.9 "	"	"	"	9	1	8	0	24	3	24	3	3	3	24	3	24	3	0	0	0	0	0	0
"	5.5 "	"	"	"	9	1	8	0	26	3	26	3	3	26	3	26	3	0	0	0	0	0	0	0
S7-8B	5.8 "	"	Mid flexion	"	9	1	4	0	26	2	26	2	2	26	2	26	2	0	0	0	0	0	0	0
S9A – 13A	6.5 SL	"	Flexed	"	9	1	4	0	26	2	26	2	2	26	2	26	2	0	0	0	0	0	0	0
"	7.6 "	"	"	"	9	1	4	0	26	2	26	2	2	26	2	26	2	0	0	0	0	0	0	0
"	8.6 "	"	"	"	9	1	6	0	26	2	26	2	2	26	2	26	2	0	0	0	0	0	0	0
"	10.8 "	"	"	"	9	1	6	0	25	2	25	2	2	25	2	25	2	0	0	0	0	0	0	0
"	11.7 "	"	"	"	9	1	6	0	26	2	26	2	2	26	2	26	2	0	0	0	0	0	0	0
"	12.7 "	"	"	"	9	1	6	0	26	2	26	2	2	26	2	26	2	0	0	0	0	0	0	0
"	13.5 "	"	"	Migration	9	1	6	0	25	2	25	2	2	25	2	25	2	0	0	0	0	0	0	0
S5 – 5.10	15.5 "	"	"	ling	9	1	6	0	26	2	26	2	2	26	2	26	2	0	0	0	0	0	0	0
S3 – 32	16.9 "	"	"	"	9	1	6	0	25	2	25	2	2	25	2	25	2	0	0	0	0	0	0	0
S4 – U24	18.3 "	"	"	"	9	1	6	0	26	2	26	2	2	26	2	26	2	0	0	0	0	0	0	0
S5 – 28A	20.2 "	"	Juvenile	"	9	1	6	0	27	2	27	2	2	27	2	27	2	0	0	0	0	0	0	0
S9A – 10	22.5 "	"	"	"	9	1	6	0	26	2	26	2	2	26	2	26	2	0	0	0	0	0	0	0
S9A – 4A	26.4 "	"	"	"	9	1	6	0	26	2	26	2	2	26	2	26	2	0	0	0	0	0	0	0
S9A – 5s	44.6 "	"	"	"	9	1	6	0	25	2	25	2	2	25	2	25	2	0	0	0	0	0	0	0

18. *Arnoglossus tapeinosoma* (Bleeker, 1904)

Larvae ranging from 2.8 mm NL to 24.6 mm SL are found in the collections taken during IIOE, Naga Expedition as well as random samples from the Laccadive Sea. Larvae belonging to preflexion, flexion and postflexion stages are available in the samples (Figs. 18 A, B, C, D, E ; Tables 19 a, b, c & 25).

Morphology :

Larval body is thin, flat, transparent, long and symmetrical in early stages, body is more elongated than in *Engyprosopon* and *Psettina* spp. Eyes are symmetrical and prominent, black pigmentation not completed in larvae up to 3.8 mm NL, right eye has started shifting from its symmetrical position preparatory to its migration to the left side in 13.0 mm SL. Shifting of the eye is not completed even in the largest specimen available in the collections.

Anterior portion of alimentary canal runs almost parallel to the notochord and bends down at the posterior end of abdominal cavity where it describes a single, circular coil in early stages. Copepod remnants occur in the lumen of the gut. Anus opens on right side of the 10th myotome in early larval stages. The circular nature of the alimentary canal gets gradually changed into an elliptical coil, in advanced forms intestinal coil becomes compact and anus gets pushed forwards to the level of the eighth vertebral segment. Liver occupies the space between cleithra and intestinal loop, its antero-posterior axis is more than that of the dorso-ventral axis, but in advanced stages, the dorso ventral gains over antero-posterior axis. Swim bladder is seen above intestinal loop occupying the space between eighth and ninth vertebral segments, pushing the intestinal loop ventralwards.

Spines are not found anywhere on the body. Relative head length, and relative length between snout and pelvic fin base increase from preflexion to flexion stages and thereafter decreases (Table 25) .Relative snout length, relative snout to anus length and relative eye width and height decrease from preflexion to postflexion stages. Relative body depth at pectoral fin base and relative body depth across anus increase as the larva grows.

Fin and supporting structures :

Elongated dorsal ray at anterior end of the dorsal fin fold is present in all stages of the larvae. First anal pterygiophore gets differentiated in 5.5 mm NL larva, in 5.9 mm NL larva, the pterygiophores and median fin rays are differentiated from anterior to posterior, but rays are not found above the head region and in anal region and beyond 17th caudal vertebrae. However, following seven caudal vertebrae have neural processes but rays and pterygiophores are not discernible. In 6.2 mm NL rays on anterior region of dorsal and anal fin fold develop, forward extension of the first dorsal pterygiophore is differentiating to support the first tiny dorsal ray in 7.8 mm SL larva, but this tiny dorsal ray is discernible only in 13.0 mm SL larva when full complement of median rays are formed. There are 93-97 dorsal and 66-74 anal rays (Table 19 b).

In 6.3 mm NL larva, two caudal rays are discernible, even though hypural elements are not differentiated. In 6.5 mm NL larva, inferior hypural middle bearing two rays and superior hypural middle supporting three rays develop. Inferior hypural lower has not yet differentiated but one of the rays which is to be supported by the inferior hypural lower is also present, causing notochord to deflect dorsalwards. Epural is differentiated in 8.0 mm NL larva. In midflexion stage, even though the superior hypural is not developed, two rays are discernible which are to be support by it. Flexion is initiated in larvae of 6.5 mm NL and is completed before 9.3 mm SL. Full complement of 17 caudal rays are seen in 9.3 mm SL larva. The distribution of caudal rays on hypural plates are as in other bothid species.

Pectoral fin remains unrayed throughout the larval life. Pelvic fin complex appears as pack of cells at posterior ventral margin of the cleithra midway between pectoral fin attachment and cleithral tip in 4.0 mm NL. From this basipterygial processes differentiate paired cartilaginous rods, the proximal ends of which are attached to cleithra from where they run down obliquely up to a little distance above cleithral tips to form the dorsal basipterygial processes which continue as the posterior basipterygial processes along the ventral border of the body wall in 4.5 mm NL larva. Primordium of the pelvic fin is seen as a cluster of cells at the junction where dorsal and posterior basipterygial processes meet in

6.2 mm NL. Anterior basipterygial processes differentiate as cartilaginous rods from the cluster of cells which support the rudiment of the fin rays in 8.4 mm NL larva. When the larva attains 9.3 mm SL pelvic fin rays are differentiated. Pelvic fin radial of the left side becomes asymmetrical by growing longer than the right and the anterior two rays of the left fin lie in advance of those of the right in 9.3 mm SL. Forward extension of the left fin radial continues and in 23.5 mm SL, it reaches the middle level of urohyal. From 18.6 mm SL larva the anterior three rays of the left fin lie in advance of those of the right. Posterior basipterygial processes reach up to the ascending loop of intestine, the distal ends bending dorsalwards. Urohyal is differentiated as a cartilaginous plate in 5.9 mm NL.

Axial Skeleton :

Notochord remains vacuolated and unsegmented in early stages but in 8.4 mm SL larva segmentation has commenced from anterior region and is distinctly visible whereas in the posterior region the segments are only faintly demarcated. First neural arch is differentiated in 5.6 mm NL, and ossification starts at its tip in 8.4 mm NL which gets completed in 16.6 mm SL. Neural arches of the precaudal and caudal regions are differentiated except the last few in 3.8 mm NL. Haemal arch of the first caudal vertebrae and a few following arches are also differentiated in 3.8 mm NL. But in the precaudal region, haemal arches have commenced differentiation only from 4.0 mm NL. Development of neural and haemal processes is completed in 9.3 mm SL. Ossification of arches starts in 11.8 mm SL except the first neural arch, that of the centra along their margins are also noticed in 14.9 mm SL. Vertebral centra are bony in 23.5 mm SL. There are 10+31 vertebrae including the urostyle.

The Adult :

Depth of body $2\frac{1}{2}$ to 3 in the length, length of head 3 to nearly 4. Snout shorter than eye, diameter of which is 3 to $3\frac{3}{4}$ in length of head ; eyes separated by a narrow bony ridge, their anterior margins level of lower a little in advance of upper. Maxillary extending to below anterior edge or anterior $\frac{1}{3}$ of eye, length $2\frac{3}{5}$ to $2\frac{4}{5}$ in that of head ; lower jaw nearly twice in head. Teeth all small and close-set, not enlarged anteriorly. 8 to 12 slender gill-rakers on lower part of anterior arch. Scales feebly ctenoid on ocular side, cycloid on blind side ; 48 to 55 in lateral line. Dorsal (83) 89-98 ; anterior rays greatly

prolonged in the mature male, a little longer than those which follow in the female. Anal (65) 67-72 (Fig. 18 E). Pectoral of ocular side with 11 or 12 rays, length about 2/3 that of head. Caudal pointed or double truncate. Brownish ; a series of indistinct darker blotches along upper and lower edges of body ; a dark blotch at junction of straight and curved parts of lateral line, and generally one or two smaller blotches on straight portion ; median fins with numerous small brown spots ; a large dark spot at base of posterior parts of dorsal and anal ; a dark spot on distal part of pectoral ; distal ends of pelvics blackish (Norman, 1934).

Remarks :

The larval body is thin, long, flat and transparent. The anterior elongated dorsal fin ray is prominent and persists throughout the larval life. The median fin rays are differentiated from anterior to posterior in 5.2 mm NL but over the head region and anal region the differentiation of pterygiophores and rays are delayed till 6.2 mm NL. In the caudal fin the rays are differentiated earlier than the hypural plates. The length of the larvae at postflexion stages is more than that of *Engyproson*, *Bothus* and *Psettina* species. Spines are absent on the cleithra, urohyal and posterior basipterygial processes. The distal ends of the posterior basipterygial processes extend only upto the level of the ascending loop of the intestinal coil, in which case they differ from *Bothus* spp. The fin ray count tallies with the adult *A. tapeinosoma*. Jones and Pantulu (1958) have wrongly identified *Psettina* sp. to *A. tapeinosoma*. The identification of larval forms by Balakrishnan (1963) and referring them to *A. tapeinosoma* is wrong because of the presence of spines on cleithra, urohyal and posterior basipterygial processes. The adult fishes belonging to *A. tapeinosoma* are reported from Indian Ocean. But the larval forms have not been described and reported so far.

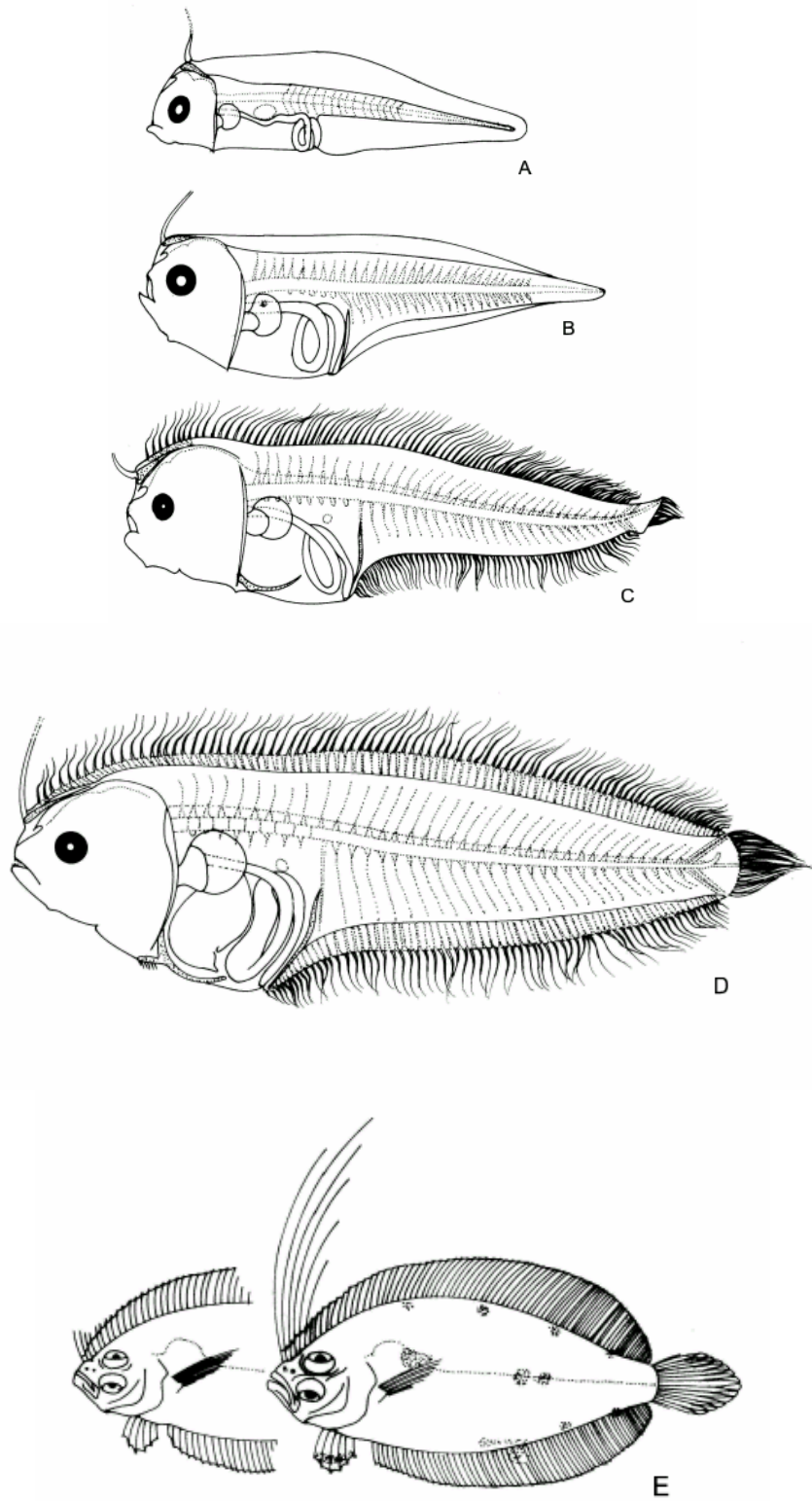


Fig. 18 - *Arnoglossus tapeinosoma*, A-2.8 mm NL, B-5.6 mm NL, C-8.0 mm NL, D-16.5 mm SL, E- Adult. (from Lalithambika Devi, 1986)

Table 19a - *Arnoglossus tapeinosoma* - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus	Depth	Length	
S11A-85	2.8 NL	Symmetrical	Straight	1.60	0.70	0.19	0.21	0.21	0.60	0.45	-	-	-
S6-31	3.7 "	"	"	2.00	0.90	0.21	0.29	0.29	1.00	0.60	-	-	-
S6-39	3.8 "	"	"	2.00	0.90	0.19	0.27	0.27	0.95	0.76	-	-	-
S6-31	4.5 "	"	"	2.20	1.20	0.22	0.32	0.35	1.20	1.06	-	-	-
S6-28	5.3 "	"	"	2.50	1.40	0.40	0.32	0.39	1.55	1.60	-	-	-
S9-15	5.9 "	"	"	2.60	1.60	0.39	0.39	0.45	1.80	1.70	-	-	-
S6-3	6.2 "	"	"	2.40	1.50	0.45	0.40	0.45	2.10	2.20	-	-	1.30
S6-28	6.3 "	"	Early caudal formation.	3.10	1.60	0.42	0.39	0.42	1.90	2.10	-	-	-

S6-28	6.5 "	"	Early flexion	3.30	1.90	0.40	0.40	0.43	2.30	2.40	-	-	1.70
S3-10	7.8 "	"	Mid flexion	3.50	2.00	0.48	0.45	0.48	2.50	2.50	-	-	1.90
S3-19	8.0 "	"	"	3.50	1.90	0.42	0.45	0.48	2.40	2.50	-	-	1.90
S5-24	8.4 "	"	Late flexion.	3.80	2.40	0.55	0.48	0.60	3.20	3.20	-	-	2.00

S7-8B	9.3 SL	"	Flexed	3.80	2.40	0.50	0.42	0.40	3.00	3.00	1.03	0.45	2.00
S8-41	11.8 "	"	"	4.40	3.00	0.70	0.56	0.64	4.20	4.40	1.60	0.64	2.70
S8-41	13.0 "	Migrating	"	5.30	3.30	0.90	0.55	0.61	4.30	4.80	1.70	0.77	3.00

S11C-2	14.9 "	"	"	5.60	4.20	1.01	0.64	0.77	5.90	6.50	2.50	1.14	3.20
S11a-34	15.6 "	"	"	5.30	3.80	0.84	0.61	0.64	5.10	5.60	2.30	0.92	3.00
S11a-34	18.6 "	"	"	6.00	4.50	0.90	0.68	0.71	6.60	7.00	2.60	1.13	3.30
S5-19	22.6 "	"	"	7.00	4.90	0.97	0.87	0.93	7.80	8.50	3.20	1.26	3.10
S3-16	23.5 "	"	"	7.80	5.50	1.13	1.00	1.13	8.50	9.70	3.70	1.38	3.60
S3-13	24.6 "	"	"	7.10	5.10	1.22	1.10	1.08	9.56	10.40	3.70	1.42	2.90

Table 19 b - *Arnoglossus tapeinosoma* - meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			Spines				
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total	Urohyal	Cleithra	Posterior basipterygial processes	
BF-24 Cr:2	2.8 NL	Pre flexion	Straight	1											
S6-31	3.7 "	"	"	Symmetrical	1										
S6-31	4.5 "	"	"	"	1										
S6-28	5.3 "	"	"	"	1										
S9-15	5.9 "	"	"	"	ca.62	ca.34									
S6-3	6.2 "	"	"	"	ca.72	ca.42									
S6-28	6.3 "	Early caudal formation.	"	"	ca.67	ca.38	2								
S6-28	6.5 "	Early flexion	Flexing	"	ca.74	ca.45	6								
S3-10	7.8 "	Mid flexion	"	"	ca.86	ca.63	11								
S5-24	8.4 "	Late flexion	"	"	93	65	12	Forming							
S7-8B	9.3 SL	Post flexion	Flexed	"	94	66	17		10	31	41				
S8-41	11.8 "	"	"	"	96	66	17		10	31	41				
"	13.0 "	"	"	Migrating	95	69	17		10	31	41				
S11C-2	14.9 "	"	"	"	94	70	17		10	31	41				
S11A-34	15.6 "	"	"	"	96	74	17		10	31	41				
"	18.6 "	"	"	"	97	68	17		10	31	41				
S3-16	23.5 "	"	"	"	93	73	17		10	31	41				
S3-13	24.6 "	"	"	"	94	73	17		10	31	41				

Table 19 c – *Arnoglossus tapeinosoma* - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Station	Body Length (mm)	Stage	Notochord	Right Eye	Precaudal vertebrae			Caudal vertebrae			Centra	Ural Centra	Total Vertebrae	Caudal fin rays	Ural components			Epural
					Process	Arch	Haemal	Process	Arch	Haemal					Sup	Mid	Inf	
S11A-85	2.8 NL	Pre flexion	Straight	Symmetrical	0	0	0	0	0	0	0	0	0	0	0	0	0	
S6-31	3.7 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	
S6-39	3.8 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	
S6-30	4.0 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	
S6-31	4.5 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	
S6-28	5.3 "	"	"	"	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ar Lu 31	5.6 "	"	"	"	9	1	0	12	6	12	0	0	0	0	0	0	0	
S9-15	5.9 "	"	"	"	9	1	0	14	12	14	0	0	0	0	0	0	0	
S6-5	6.2 "	"	"	"	9	1	0	24	4	24	0	0	0	0	0	0	0	
S6-28	6.3 "	Early caudal formation	"	"	9	1	0	23	5	23	0	0	0	0	0	0	0	
"	6.5 "	Early flexion	Flexing	"	9	1	0	26	2	26	0	0	0	0	0	0	0	
S3-10	7.8 "	Mid flexion	"	"	9	1	0	28	2	28	0	0	0	0	0	0	0	
S3-19	8.0 "	Late flexion	"	"	9	1	0	27	2	27	0	0	0	0	0	0	0	
S5-24	8.4 "	Post flexion	"	"	9	1	0	29	2	29	0	0	0	0	0	0	0	
S7-8B	9.3 SL	Post flexion	Flexed	"	9	1	6	28	2	28	0	0	0	0	0	0	0	
S8-41	11.8 "	"	"	"	9	1	6	28	2	28	0	0	0	0	0	0	0	
"	13.0 "	"	"	Migrating	9	1	6	28	2	28	0	0	0	0	0	0	0	
S11C-2	14.9 "	"	"	"	9	1	6	28	2	28	0	0	0	0	0	0	0	
S11A-34	15.6 "	"	"	"	9	1	6	28	2	28	0	0	0	0	0	0	0	
"	18.6 "	"	"	"	9	1	6	28	2	28	0	0	0	0	0	0	0	
S5-19	22.6 "	"	"	"	9	1	6	28	2	28	0	0	0	0	0	0	0	
S3-16	23.5 "	"	"	"	9	1	6	28	2	28	0	0	0	0	0	0	0	
S3-13	24.6 "	"	"	"	9	1	6	28	2	28	0	0	0	0	0	0	0	

19. *Arnoglossus aspilos* (Bleeker, 1851)

Larvae ranging from 3.3 mm NL to 7.5 mm SL are present in the IIOE and Naga Expedition collections. The larvae belonging to preflexion, flexion and postflexion stages are available in the samples (Figs. 19 A, B, C; Tables 20 a, b, c & 25).

Morphology :

Larval body is thin transparent, symmetrical, laterally compressed and comparatively short. Eyes symmetrical, black and continues to be in the symmetrical condition even in 7.5 mm SL. Lower jaw very prominent and projects beyond the upper, angle of lower jaw is far in advance of the level of eye. Teeth are present on jaws only up to larvae measuring 3.6 mm NL. Anterior portion of the alimentary canal runs obliquely downwards and makes an elliptical coil which occupies posterior ventral half of the abdominal cavity, anus opening at the level of ninth myotome. In advanced stages the elliptical coil becomes more compact and the ventral portion is pushed forwards so that anus opens at the level of seventh vertebral segment in 7.5 mm SL larva. Liver is comparatively small, its dorso-ventral axis is more than twice the antero-posterior axis in early stages, but the dorso-ventral axis is more than thrice the antero-posterior axis in advanced stages. Swim bladder occupies the posterior dorsal half of abdominal cavity between seventh and ninth vertebral segment.

Spines are not found anywhere on the body. Relative head length does not show much variation in different stages of growth (Table 25), the relative snout length increases in preflexion to flexion stages but there after decreases slightly. Relative snout to anus length increases as the larva grows. Eye width increases from preflexion to flexion stages and then decreases. Eye height on the other hand decreases from preflexion to postflexion stages. Relative depth at pectoral fin base and relative depth across the anus increase up to flexion stages and thereafter decrease. Relative length between snout and pelvic fin base decreases up to flexion stages and then increases.

Fin and supporting structures :

Elongated dorsal fin ray at the anterior end is seen in all stages available, in the collection. Fin folds are continuous. Anal pterygiophore is differentiated in earliest specimen, median pterygiophores and rays are differentiated from anterior to posterior end and are well developed except a few posterior ones in very early stages (3.3 mm NL larvae). First tiny dorsal ray is differentiated in 5.7 mm larva when the full complement of 80 dorsal and 63 anal rays of median fins are found. Dorsal fin rays and anal fin rays vary from 72-81 and 52-67 respectively.

In 3.5 mm NL larva, seven caudal rays are discernible distributed as follows: inferior hypural lower one ray, inferior hypural middle and superior hypural middle three each. In 5.7 mm larva flexion of the notochord is completed and full complement of 17 caudal rays are seen.

Pectoral fins are fleshy and remain embryonic in all stages of the larvae. Pelvic fin radial and rays are found even in earliest larvae available in the collections. Two of left pelvic fin rays are found well in advance of those of right fin. This early differentiation of pelvic fin appears to be one of the salient features of the larvae of this species. Posterior basipterygial processes run along the ventral body wall up to the level of the ascending loop of intestinal coil where the terminal portion curve dorsalwards and forwards and ends before tip of the liver in advanced stages. No spines are found on urohyal, cleithra and posterior basipterygial processes.

Axial skeleton :

Notochord is vacuolated and unsegmented in early stages, vertebral segments are not clearly defined even in 7.5 mm SL larva particularly in the posterior caudal region. Neural processes in the precaudal and neural and haemal processes in the caudal region are discernible even in earliest larvae 3.3 mm NL. In precaudal region, haemal processes are found in the posterior four vertebral segments preceded by four arches. Processes are very small and can be distinguished only with difficulty even in 7.5 mm SL larva, the largest specimens available in the collection. First neural arch is cartilaginous in 7.5 mm SL larva. There are 10+26-29 vertebral segments including the urostyle.

The adult :

Depth of body $2 \frac{1}{4}$ in the length, length of head 4. Diameter of eye $3 \frac{1}{5}$ to nearly 4 in length of head ; eyes separated by a narrow interspace, the lower a little in advance of upper. Maxillary extending to below anterior part of eye, length $2 \frac{2}{5}$ in that of head ; lower jaw about twice in head. Teeth minute, rather close-set, not enlarged anteriorly. 7 rather slender gill-rakers on lower part of anterior arch. Scales ctenoid on ocular side, cycloid on blind side ; 46 to 48 in lateral line. Dorsal 80 (84) ; all the rays scaled, at least on ocular side, none prolonged. Anal 61-62 (64) (Fig. 19 C). Pectoral of ocular side with 11 or 12 rays, length about $\frac{2}{3}$ that of head. Uniformly brownish (Norman, 1934).

Remarks :

The larvae of *A. aspilos* can be distinguished from other species in the presence of median dorsal and anal rays and also pelvic fin rays from the very early stages. The spines are absent on cleithra, urohyal and posterior basipterygial processes. The larvae of *A. aspilos* has the smallest number of dorsal and anal rays among the genus so far examined. But the number of vertebrae almost equal to that of *A. tapeinosoma*. The larval body is, however, shorter than *A. tapeinosoma*. The number of fin rays agree with those of adults. The adults are reported from Indian Ocean. The larvae of *A. aspilos* have not been described and reported so far.

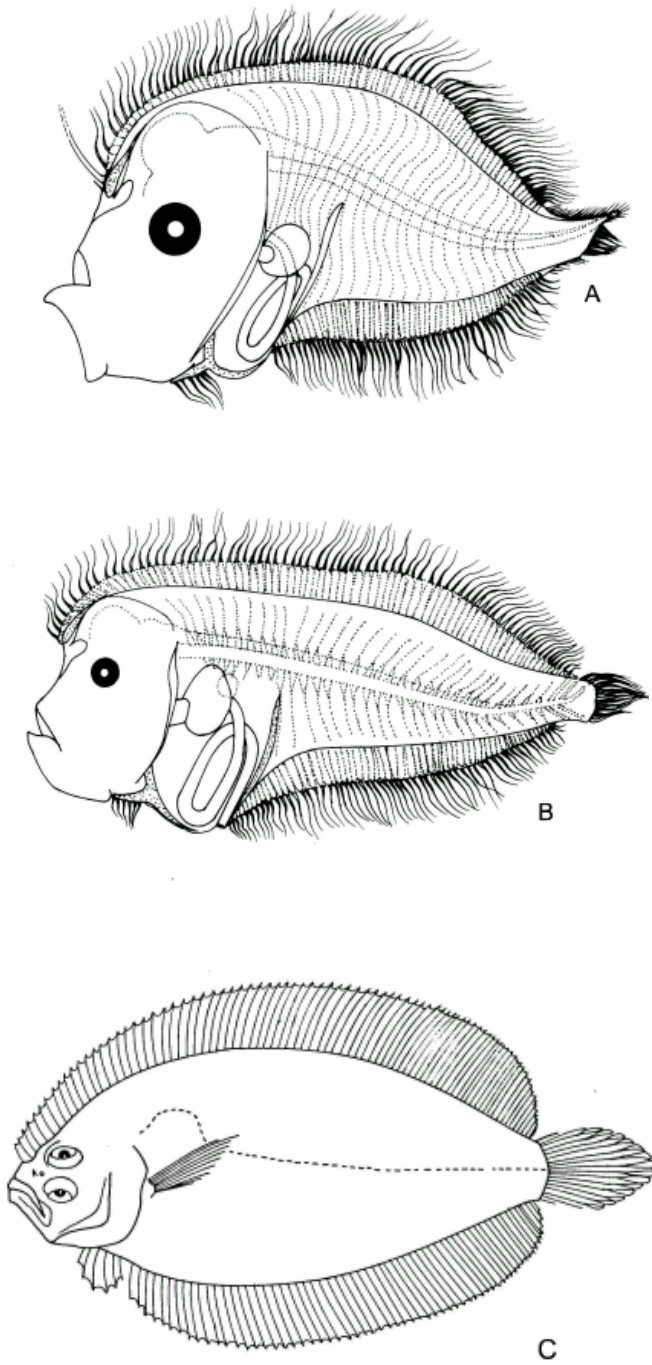


Fig. 19 - *Arnoglossus aspilos*, A-3.5 mm NL, B-7.5 mm SL, C- Adult
(from Lalithambika Devi, 1986).

Table 20 a - *Arnoglossus aspilos* - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at Pectoral fin base	Anus	Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height			Depth	Length	
S8-26A	3.3 NL	Symmetrical	Straight	1.10	1.00	0.45	0.29	0.27	1.70	1.70	-	-	0.60
"	3.4 "	"	"	1.30	1.00	0.50	0.27	0.27	1.70	1.70	-	-	0.80
"	3.6 "	"	"	1.20	1.00	0.40	0.29	0.39	2.00	1.70	-	-	0.40
"	3.5 "	"	Mid flexion	1.20	1.00	0.50	0.29	0.29	2.00	1.90	-	-	0.50
S6-29	5.7 SL	"	Flexed	2.20	1.70	0.88	0.51	0.37	2.30	2.20	0.60	0.30	1.50
S6-3	6.2 "	"	"	2.40	1.80	0.90	0.40	0.45	2.40	2.30	0.80	0.45	1.30
AB-54	7.5 "	"	"	2.60	2.00	0.93	0.42	0.52	4.50	4.30	1.00	0.55	0.90

Table 20 b - *Bothus myriaster* – meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae		Total
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	
S8 – 26A	3.3 NL	Pre flexion	Straight	Symmetrical	ca.58	ca.50	0	2+4		
"	3.4 "	"	"	"	59	52	0	2+4		
"	3.6 "	"	"	"	64	52	0	2+4		
"	3.5 "	Mid flexion.	Flexing	"	ca.74	ca.52	7	2+4		
S6 – 29	5.7 SL	Post flexion	Flexed	"	80	63	17	2+4	10	29
S6 – 3	6.2 "	"	"	"	72	52	17	2+4	10	26
AB – 54	7.5 "	"	"	"	81	67	17	2+4	10	26

Table 20 c --*Arnoglossus aspidos* - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Stations	Body Length	Stage	Noto-chord	Right Eye	Precaudal vertebrae			Caudal vertebrae			Centra	Ural Centra	Total vertebrae	Caudal fin rays	Ural components				Epural				
					Neural		Haemal		Neural						Haemal		Sup	Upp		Mid	Inf	Hyp	Low
					Process	Arch	Process	Arch	Process	Arch					Process	Arch							
S8 - 26 A	3.3 NL	Pre flexion.	Straight	Symmetrical	9	1	0	8	0	0	0	0	0	0	0	0	0	0					
"	3.4 "	"	"	"	9	1	0	8	0	0	0	0	0	0	0	0	0	0					
"	3.6 "	"	"	"	9	1	0	8	0	0	0	0	0	0	0	0	0	0					
"	3.5 "	Mid flexion	Flexing	"	9	1	0	8	0	0	0	0	0	0	0	0	0	0					
S6 - 29	5.7 SL	Post flexion	Flexed	"	9	1	+	8	10	26	2	26	2	28	1	39	17	17	X				
S6 - 3	6.2 "	"	"	"	9	1	+	8	10	23	2	23	2	25	1	36	17	17	X				
AB - 54	7.5 "	"	"	"	9	1	4	4	10	23	2	26	2	28	1	39	17	17	X				

20. *Arnoglossus elongatus* Weber, 1913

Larvae ranging from 4.3 mm NL to 19.7 mm SL are found in the collections of IIOE and Naga Expeditions. The larvae belonging to preflexion, flexion and postflexion stages are contained in the samples (Figs. 20 A, B, C, D ; Tables 21 a, b, c).

Morphology

Larval body thin, transparent and symmetrical in early stages. Eyes symmetrical and black pigments are seen from the earliest stage available 4.3 mm NL, right eye has started shifting from its symmetrical position preparatory to migration to left side in 16.7 mm SL, but not completed even in 19.7 mm SL larva. Teeth not visible even in the postflexion stage. Anterior portion of alimentary canal runs almost parallel to notochord and makes an elliptical coil placed at the posterior end of abdominal cavity. Terminal portion of the intestine runs vertically down and anus opens at the level of the 11th myotome. Intestinal coil has a peculiar comma shape when viewed ventrally. In advanced stages, this elliptical coil becomes more compact, the ventral portion being pushing forwards. Anus opens at the level of ninth vertebral segment. Anterio-posterior axis of the liver is longer than dorso-ventral axis. Swim bladder occupies the space between ninth and 11th vertebral segments.

Spines are not found any where on the body. Relative head length and snout length decrease from preflexion to postflexion stages. Eye width and height as well as depth across anus and snout to anus length increase from preflexion to flexion stage and thereafter decreases. Body depth at pectoral fin base decreases during flexion stages but increases afterwards. Length between snout and pelvic fin base increases from flexion to postflexion stages.

Fin and supporting structures :

The elongated dorsal ray at anterior end of dorsal fin fold is seen from very early stages to the largest specimen available. This ray is longer than in all other species so far studied. It has a length almost one and half times the body length and ends bifurcated. First anal pterygiophore is differentiated in the earliest larvae. Fin and pterygiophores differentiate from anterior to posterior

end from 5.4 mm NL. First dorsal pterygiophore extends forwards beyond the articulation of the elongated dorsal ray in larvae of 7.8 mm SL. First tiny dorsal ray gets differentiated in larvae ranging between 8.8 and 15.2 mm SL, when full complement of the median fin rays are differentiated. 102 to 103 dorsal and 78 to 81 anal rays are seen in advanced stages.

Rudiments of the hypural elements are differentiated as a pack of cells at the ventral caudal extremity of the notochord in 5.4 mm NL larvae. Caudal rays are seen differentiating from 7.8 mm NL larvae and is completed in 8.8 mm SL.

Pectoral fins remain in embryonic stage. Basipterygial processes are differentiated in 5.4 mm NL larva, posterior basipterygial portion of which runs down along the ventral body wall and reaches the level of ascending loop of intestine in later stages. Urohyal is also differentiated in 5.4 mm NL larva. Pelvic fin radial rudiment is seen as pack of cells in 7.8 mm NL, radials (anterior basipterygial processes) are differentiated with ray rudiments in 8.8 mm SL. Left pelvic fin radial becomes asymmetrical and reaches beyond the level of cleithral tip in 15.2 mm SL. Three rays of the left pelvic fin are seen in advance of those of the right fin in 19.7 mm SL. Left pelvic fin radial continues to grow forwards and its second ray lies opposite to the cleithral tip in the largest specimen.

Axial skeleton :

First neural arch is differentiated as a cartilaginous loop-like structure in front of second neural arch in 5.4 mm NL, without any spinous processes, but there is a lancet-shaped portion which is short and does not reach the body wall, like other neural spines in advanced stages. Even in 19.7 mm SL, the largest specimen available in the collection, it is not ossified. Arches of the neural and haemal processes as well as centra start ossification in 15.2 mm SL. Precaudal and caudal centra start differentiation from 7.8 mm NL, vertebrae are dumb-bell shaped in 19.7 mm SL, and are ossified. Precaudal neural processes are seen in 4.3 mm NL larvae, in the caudal region, neural and haemal processes are also differentiated in 4.3 mm NL and completed in 15.2 mm SL. Haemal processes of the precaudal region starts differentiating in 7.8 mm NL. There are 11+34 vertebrae including urostyle.

The adult :

Depth of body 3 or nearly 3 in the length, length of head $3 \frac{1}{2}$ to $3 \frac{2}{3}$. Snout shorter than eye, diameter of which is about 3 in length of head ; eyes separated by a bony ridge, the lower a little in advance of upper. Maxillary extending to below anterior $\frac{1}{2}$ of eye, length $2 \frac{1}{4}$ to $2 \frac{1}{3}$ in that of head ; lower jaw $1 \frac{2}{3}$ to 2 in head. Teeth minute, those of upper jaw somewhat larger and wider apart anteriorly. 8 or 9 slender gill-rakers on lower part of anterior arch. Scales feebly ctenoid on ocular side, cycloid on blind side ; 64 to 66 in lateral line. Dorsal 100-102 ; all the rays scaled, at least on ocular side, second to fourth rays somewhat prolonged (male ?). Anal 78-79 (Fig. 20 D). Pectoral of ocular side with 12 or 13 rays, length $1 \frac{1}{2}$ to $1 \frac{3}{4}$ that of head. Caudal rounded. Yellowish brown, with some indistinct darker markings, including a blotch just behind curve of lateral line ; a series of dark spots on dorsal and anal fins (Norman, 1934).

Remarks :

Larvae of *A. elongatus* possess bothid characters enumerated elsewhere in the present report. They can be distinguished from *Crossorhombus*, *Engyprosopon* and *Psettina* in the absence of spine on cleithra, urohyal and posterior basipterygial processes in which respect they resemble larvae of *Bothus* spp. The elongate anterior dorsal fin ray which continues to exist through larval life, and in the posterior basipterygial processes not extending to the anus as well as the larger number of vertebrae and fin rays help to identify larval forms belonging to *A. elongatus* from *Bothus* spp.

Possession of a very long anterior dorsal ray extending more than one and a half times body length with bifurcated distal end ; eleven precaudal myotome / vertebrae ; very large number of vertebrae and fin rays ; late differentiation of pelvic fin rays separate larvae of *A. elongatus* from other species of the genus.

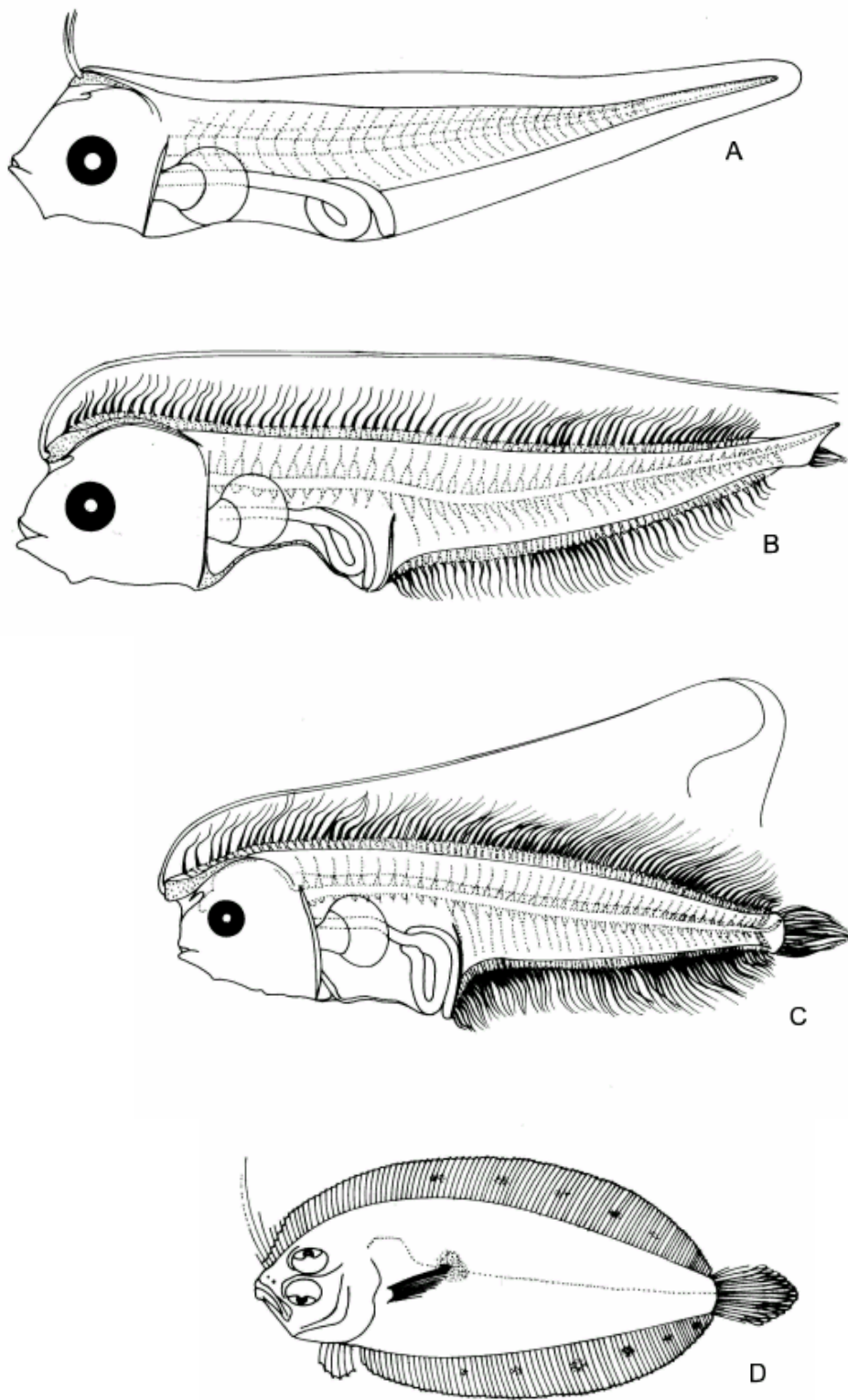


Fig. 20 - *Arnoglossus elongatus*, A-4.5 mm NL, B-7.8 mm NL, C-8.8 mm SL, D-Adult (from Lalithambika Devi, 1986)

Table 21 a - *Arnoglossus elongatus* - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at Pectoral fin base	Anus	Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height			Depth	Length	
S11A - 34	4.3	Symmetrical	Straight	2.00	1.10	0.21	0.26	0.24	1.06	0.85	-	-	-
S7 - 15	5.4	"	"	2.30	1.40	0.48	0.35	0.39	1.61	1.13	-	-	-
S6 - 3	7.8	"	Early flexion	4.50	2.00	0.52	0.52	0.55	2.10	2.40	-	-	1.10
KI - 677	8.8	"	Flexed	4.70	2.50	0.67	0.52	0.54	2.50	2.60	0.80	0.70	1.70
S4 - 8	15.2	"	"	5.30	3.60	0.70	0.74	0.81	4.90	4.70	1.51	0.72	3.50
S4 - 24B	16.7	Migrating	"	5.90	3.90	0.90	0.71	0.77	5.00	5.00	1.60	0.87	3.80
S6 - 15	17.6	"	"	5.80	4.20	1.12	0.71	0.74	5.20	5.30	1.80	0.84	3.70
S4 - 24 B	19.7	"	"	6.80	4.40	1.14	0.77	0.77	5.50	5.80	1.80	0.93	4.10

Table 21 b - *Arnoglossus elongatus* – meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae				
					Dorsal	Anal	Caudal	Left pelvic	Precaudal	Caudal	Total	
S11 – 34	4.3 NL	Pre flexion	Straight	Symmetrical	1	0	0	0				
S7 – 15	5.4 "	"	"	"	ca.70	ca.36	0	0				
S6 – 3	7.8 "	Early flexion	Flexion	"	ca.74	ca.54	5	0				
Ki – 677	8.8 SL	Flexed	Flexed	"	ca.96	ca.75	17	FR	11	34	45	
S4 – 8	15.2 "	"	"	"	103	81	17	2+4	11	34	45	
S4 – 24B	16.7 "	"	"	Migrating	102	78	17	2+4	11	34	45	
S6 – 15	17.6 "	"	"	"	102	81	17	2+4	11	34	45	
S4 – 24B	19.7 "	"	"	"	103	79	17	3+4	11	34	45	

Table 21 c – *Arnoglossus elongatus* - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Stations	Body Length	Stage	Notochord	Right Eye	Precaudal vertebrae						Caudal vertebrae						Ural Centra	Total vertebrae	Caudal fin rays	Ural components				Epural					
					Neural			Haemal			Neural			Haemal						Sup	Upp	Hyp	Inf		Mid	Low			
					Process	Arch	Arch	Process	Arch	Arch	Process	Arch	Arch	Process	Arch	Arch													
S11A-34	4.3 NL	Pre flexion	Straight	Symmetrical	10	0	0	0	0	0	0	27	5	5	27	5	5	0	0	0	0	0	0	0	0	0	0		
S7-15	5.4 "	"	"	"	10	1	0	8	0	23	5	23	5	5	23	5	5	0	0	0	0	0	0	0	0	0	0	0	
S6-3	7.8 "	Early flexion	Flexion	"	10	1	7	3	3	28	5	28	5	5	28	5	5	0	X	X	0	0	0	0	0	0	0	0	
KI-677	8.8 SL	Post flexion	Flexed	"	10	1	7	3	3	31	2	31	2	2	31	2	2	X	X	X	X	X	X	X	X	X	X	X	
S4-8	15.2 "	"	"	"	10	1	7	3	3	31	2	31	2	2	31	2	2	X	X	X	X	X	X	X	X	X	X	X	
S4-24B	16.7 "	"	"	Migrating	10	1	7	3	3	31	2	31	2	2	31	2	2	X	X	X	X	X	X	X	X	X	X	X	X
S6-15	17.6 "	"	"	"	10	1	7	3	3	31	2	31	2	2	31	2	2	X	X	X	X	X	X	X	X	X	X	X	X
S4-24B	19.7 "	"	"	"	10	1	7	3	3	31	2	31	2	2	31	2	2	X	X	X	X	X	X	X	X	X	X	X	X

21. *Arnoglossus intermedius* (Bleeker, 1866)

Larvae ranging from 4.0 mm NL to 7.4 mm NL are present in the collections taken from the Indian Ocean during IIOE but not in Naga Expedition collections (Figs. 21 A, B ; Tables 22 a, b, c).

Morphology :

Larval body thin, transparent, laterally compressed and leaf like. Eyes black and symmetrical. Lower jaw prominent projecting beyond the upper ; angle of the lower jaw is in advance of the level of eye. Teeth present but few in number. Alimentary canal runs parallel to the notochord up to fourth myotome, then gets pushed ventralwards by the swim bladder, it then makes an elliptical coil at the level of the eighth myotome, anus opens at the level of the 10th myotome. In 7.4 mm anus is pushed forwards and opens at the level of eighth myotome. Swim bladder very conspicuous and occupies the space between fifth and eighth myotomes. Liver more or less rectangular in shape, anterior-posterior axis being almost equal to dorso-ventral axis in early stages but the former gains over the latter as grow the proceeds. 34 myotomes can be deciphered in the caudal region.

Spines are not found anywhere on the body.

Fin and supporting structures :

Median fin folds are continuous and confluent with caudal in early stages. At the anterior end of dorsal fin fold, there are two elongated dorsal rays, in 4.0 mm NL larva three more rays are seen in 4.7 mm. In the largest specimen available 7.4 mm NL dorsal and anal rays are well differentiated in the anterior region than in posterior part. 70 dorsal and 48 anal rays are differentiated.

Caudal portion remains straight even though inferior hypural lower, middle and superior hypural middle are discernible in 7.4 mm NL. Flexion of the notochord is not effected, caudal rays are also not differentiated. In this respect, the larvae of this species differ from several other species reported so far. Pectoral fins remain in embryonic condition, rudiment of the pelvic fin complex are seen as a pack of cells at the distal ventral aspect of the cleithra in 4.1 mm

NL. Posterior basipterygial processes, pelvic fin radial and rays are discernible in 5.0 mm NL, but radials do not extend to the level of the tip of cleithra. In the largest specimen 7.4 mm NL, three rays are seen well in advance of the right fin and first rays of left fin lies opposite the cleithral tip.

Axial skeleton :

Notochord remains vacuolated, segmentation into vertebral centra is seen in 7.4 mm NL, nine segments in the precaudal and 23-24 segments in the caudal are seen in 7.4 mm NL. Segmentation is not clear in the posterior third of caudal portion, but 9-10 myotomes can be clearly marked out. Last myotome is very long and narrow. Urostyle segment is differentiated in this. It may be noted that each myotome corresponds to a vertebral segment. Neural processes begin to differentiate in the last three precaudal and first caudal myotome six neural arches in the precaudal and 12 in the caudal region are also visible. They have not become processes, but there are no haemal processes in the precaudal region. However, haemal arches are seen in precaudal region. In the caudal region, three processes and eleven arches are also discernible in 4.0 mm NL. In 7.4 mm NL larvae very small haemal spines are seen in the precaudal region. The first neural arch is discernible in 6.0 mm NL, thus marking the 10 precaudal vertebral segment.

The adult:

Depth of body $2 \frac{1}{5}$ to $2 \frac{2}{5}$ in the length, length of head about $3 \frac{1}{2}$. Snout longer than eye, diameter of which is $4 \frac{1}{2}$ to 5 in length of head ; eyes separated by a concave space, its width $\frac{1}{4}$ to $\frac{1}{3}$ diameter of eye ; lower eye a little in advance of upper. Maxillary extending to below anterior edge of eye or a little beyond, length about $2 \frac{1}{2}$ in head ; lower jaw $1 \frac{3}{4}$ to $1 \frac{4}{5}$ in head. Teeth of upper jaw very small and close-set laterally, becoming stronger and wider apart anteriorly ; lateral teeth of lower jaw somewhat stronger and wider apart than those of upper. Gill-rakers "Palmate" (short, broad, the margins strongly spinulate) ; 8 or 9 on lower part of anterior arch. Scales feebly ctenoid on ocular side, cycloid on blind side ; 45 to 50 in lateral line. Dorsal 77-83 ; first ray somewhat prolonged and expanded distally. Anal 56-62 (Fig. 21 B). Pectoral of ocular side with 9 to 11 rays, length about $\frac{1}{2}$ head. Caudal rounded or obtusely pointed. Brownish ; a number of dark brown blotches and annular

markings on body, of which a series near upper and lower edges of body, a pair above and below commencement of straight part of lateral line, and another pair on the straight portion, are usually most conspicuous ; all the fins with numerous dark brown spots; a row of larger spots along basal parts of dorsal and anal (Norman, 1934).

Remarks :

The larval forms of *A. intermedius* can be distinguished from the remaining species of the genus in the presence of two elongated dorsal rays at the anterior end of the dorsal fin fold from the very early stages. Spines are not found on the urohyal, cleithra and posterior basipterygial processes. The caudal portion remains straight even after the differentiation of hypural plates in 7.4 mm NL larvae. The caudal rays are also wanting. The median fin rays are not developed in the posterior third of the caudal portion. The pelvic fin is well developed and three rays of the left fin lie in advance of the right fin. There is space for a few more dorsal and anal rays to be developed in the posterior caudal portion. With this the fin ray count of the larvae will tally with the adult. The adults of this species are reported from Indian Ocean. The larval forms of this species are not described and reported so far.

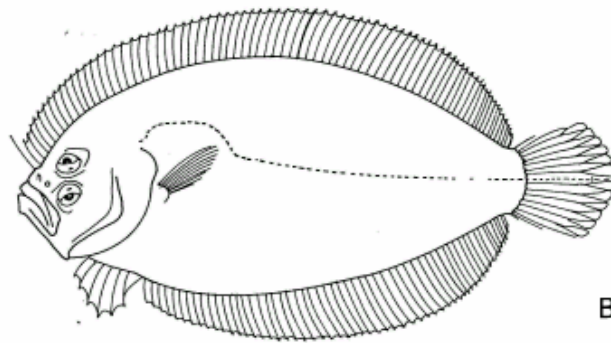
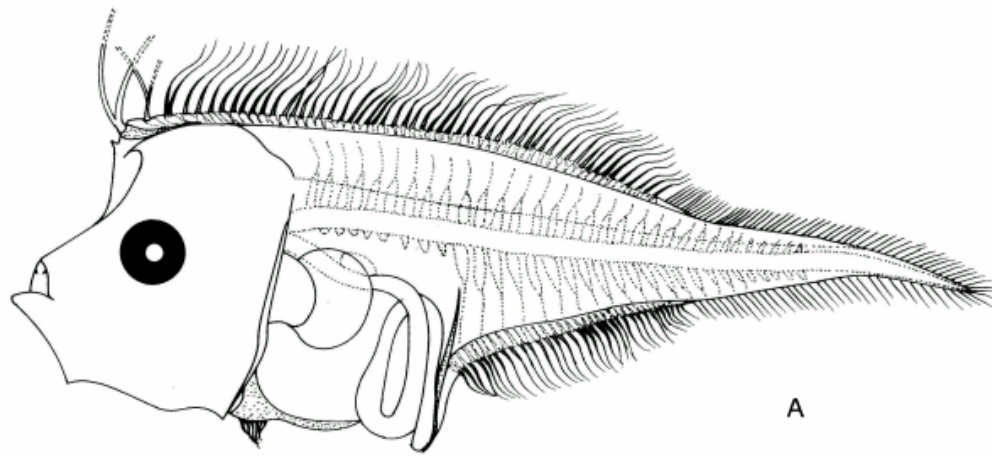


Fig. 21 - *Arnoglossus intermedius*, A-5.0 mm, B-Adult (from Lalithambika Devi, 1986)

Table 22 a - *Arnoglossus intermedius* - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle		Snout to origin of pelvic fin
							Width	Height	Depth	Length	Depth	Length	
PI - 16	4.0 NL	Symmetrical	Straight	1.70	0.90	0.35	0.24	0.24	1.09	-	-	-	-
"	4.1 "	"	"	1.90	1.00	0.60	0.24	0.26	1.09	-	-	-	-
DI - 5014	4.7 "	"	"	2.10	1.30	0.70	0.26	0.29	1.40	-	-	-	-
PI - 16	5.0 "	"	"	2.00	1.30	0.68	0.29	0.26	1.80	-	-	-	1.00
DI - 5014	5.7 "	"	"	2.20	1.70	0.68	0.31	0.37	2.20	-	-	-	1.50
"	6.0 "	"	"	2.20	1.60	0.77	0.35	0.30	2.80	-	-	-	1.10
OS - 30	7.4 "	"	"	2.80	2.00	0.81	0.39	0.41	3.90	-	-	-	1.50

Table 22 b - *Arnoglossus intermedius* - meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Left pelvic
					Dorsal	Anal	Caudal	
PI - 16	4.0 NL	Post flexion	Straight	Symmetrical	5	0	0	0
PI - 16	4.1 "	"	"	"	5	0	0	0
DI - 5014	4.7 "	"	"	"	5	FR	0	0
PI - 16	5.0 "	"	"	"	47	17	0	FR
DI - 5014	6.0 "	"	"	"	64	34	0	2+4
Ds - 30	7.4 "	"	"	"	70	48	0	3+3

Table 22 c – *Arnoglossus intermedius* - development of vertebral column, caudal fin rays and caudal fin supporting structures.

Stations	Body Length	Stage	Noto-chord	Right Eye	Precaudal vertebrae			Caudal vertebrae			Centra	Ural Centra	Total vertebrae	Caudal fin rays	Ural components				Epural
					Neural	Arch	Haemal	Neural	Arch	Haemal					Upp	Mid	Inf	Hyp	
PI - 16	4.0 NL	Post flexion	Straight	Symmetrical	3	6	0	3	1	12	3	0	0	0	0	0	0	0	0
"	4.1 "	"	"	"	3	6	0	6	4	13	4	0	0	0	0	0	0	0	0
DI - 50/14	4.7 "	"	"	"	9	0	0	7	18	5	18	0	0	0	0	0	0	0	0
PI - 16	5.0 "	"	"	"	9	0	0	8	18	5	18	0	0	0	0	0	0	0	0
DI - 50/14	6.0 "	"	"	"	9	1	0	8	19	3	19	0	0	0	0	0	0	0	0
OS - 30	7.4 "	"	"	"	9	1	4	3	21	2	22	0	0	0	0	X	X	X	0

22. *Arnoglossus imperialis* (Rafinesque, 1810)

Larvae ranging from 7.7 mm NL to 12.2 mm SL are present in the collection taken from the Agulhas Bank on board R.S. AFRICANA during IIOE. Preflexion, flexion and postflexion stages are contained in the collections (Figs. 22 A, B, C. : Tables 23 a, b &25).

Morphology :

Larval body thin, transparent, laterally compressed, long and leaf-like. Eyes black and symmetrical. Mouth small, lower jaw prominent and project beyond the upper with five and three pairs of teeth on upper and lower jaws respectively in early stages. Alimentary canal runs parallel to the notochord up to the level of sixth myotome and then runs down obliquely describing a single elliptical coil ending in a straight rectal portion lying vertically down, the anus opening on the 10th myotome in 7.7 mm NL. In 12.2 mm SL larvae, rectal portion is seen pushed forwards so that the anus opens at the level of eighth vertebral segment. Swim bladder present lying below the sixth and eighth myotome in early stages but pushed backward to lie between eighth and ninth vertebral segments in 12.2 mm SL. Liver well developed and its dorsoventral axis is about twice the antero-posterior axis.

Spines are not found on the urohyal, cleithra or on posterior basipterygial processes. But discoid scutes with a circlet of 9 spines are seen in between the distal ends of the pterygiophores and in different parts of the body. These spiny scutes are concentrated more on ventral aspect of the abdomen, along the posterior basipterygial processes, pelvic fin radial, cleithra and sides of the abdomen as well as a few on rays. These scutes with spines are different from spines on the cleithra, urohyal or on basipterygial processes of *Engyprosopon* and related groups and wherever present margins of the structure are drawn out into spines.

In 8.5 mm NL larva pigments are seen on the swim bladder as dark blotch with a central white dot. Brownish black spots are also found beneath the intestine and along the dorsal body wall in patches, dorsal aspect of the

notochord beneath the spinal cord and also on the median fins at posterior caudal portion. In some larval forms pigments are not clearly seen.

Relative head length, depth at pectoral fin base, and depth across the anus increase from preflexion to postflexion stages. Relative snout length on the other hand decreases. Snout to anus length, eye width, eye height and length between snout and pelvic fin base increase from preflexion to flexion stages and thereafter decreases, to values less than those of preflexion stage.

Fin and supporting structure :

Median fin folds are continuous and confluent with the caudal in 7.7 mm larvae. An elongated dorsal ray followed by 6 to 7 short rays are seen in the anterior end of dorsal fin fold. In the middle caudal portion of dorsal and anal fin folds, fin rays are also well differentiated but not in the remaining anterior and posterior portions in 7.7 mm NL. In 8.5 mm NL rays are developed in the remaining anterior portion and in 10.3 mm SL all rays are found except the tiny first dorsal ray, the differentiation of which is indicated in 12.2 mm SL, the largest specimen in the collections. There are 101 dorsal and 79 anal rays. Forward extension of the first dorsal pterygiophore which is to support the first tiny dorsal ray is differentiated in 7.7 mm NL larvae.

In 7.7 mm NL larva, the inferior hypural lower, middle, superior hypural middle as well as epural plates are differentiated, but caudal rays are not traceable. Notochord remains straight at this stage, its flexion however, is seen in 8.5 mm NL larva in which two rays are seen articulated to inferior hypural middle. Full complement of 17 rays are seen in 10.3 mm SL larva along with flexion of the notochord.

Among the paired fins, the pectoral remains in the embryonic stage. In 7.7 mm NL the pelvic fin radial rudiment is seen. Posterior basipterygial processes do not reach up to the level of the intestinal loop, the pelvic fin radials (anterior basipterygial processes) are differentiated in 8.5 mm NL and in 10.3 mm SL two rays of the left pelvic fin are seen lying in advance of the right. The pelvic fin radial of the left side grows forwards and reaches a little front of the tip of the cleithra in 122 mm SL.

Axial skeleton :

Notochord remains vacuolated and straight in 7.7 mm NL larva. Nine neural processes, one arch and six haemal processes preceded by two arches are clearly differentiated in precaudal region in 10.3 mm SL. First neural arch is cartilaginous. In the caudal region 29 neural and haemal processes and two arches at the posterior end are seen in 10.3 mm SL. Segmentation of the notochord is also complete in 10.3 mm SL. There are 10 precaudal and 32 caudal vertebrae including the urostyle.

The adults :

Depth of body $2 \frac{1}{3}$ to $2 \frac{3}{4}$ in the length, length of head $3 \frac{4}{5}$ to $4 \frac{1}{4}$. Snouts shorter than eye diameter of which is $2 \frac{5}{6}$ to 4 in length of head ; eye separated by a bony ridge, the lower a little in advance of the upper. Maxillary extending to below anterior part of eye, length $2 \frac{5}{6}$ to $3 \frac{1}{8}$ in that of head ; lower jaw $2 \frac{1}{10}$ to $2 \frac{1}{5}$ in head. Teeth all small, not enlarged anteriorly. 8 to 10 gill-rakers on lower part of anterior arch. Scales feebly ctenoid on ocular side, cycloid on blind side ; 58 to 63 in lateral line. Dorsal (94) 95-106 ; second to fifth or sixth rays thickened, prolonged, and free for most of their length in the mature male, the highest ray nearly as long as head ; in the mature female the second to fifth rays are somewhat thickened, a little longer than those which follow. Anal 74-82 (Fig. 22 C). Pectoral of ocular side with 9 to 11 rays, length $1 \frac{1}{4}$ to $1 \frac{2}{5}$ in that of head. Rays of pelvic fin of ocular side rather longer in the male. Caudal rounded. Vertebrae 10 + 32-35. Greyish or brownish, generally with irregular darker patches ; fins with some small dark spots ; male with a conspicuous black blotch on hinder end of pelvic fin of ocular side ; in the female this is greyish in colour and very indistinct (Norman, 1934).

Remarks :

The larvae possesses bothid characters. In the absence of spines on cleithra, urohyal and posterior basipterygial processes, these larvae can be placed under the genus *Arnoglossus* or *Bothus*. The long leaf-like larval body, the posterior basipterygial processes not extending to the anus are characters helpful in placing the present larval forms along with *Arnoglossus* spp. The presence of spiny discoid scutes distributed along the bases of the median fin

rays, cleithra, urohyal, posterior basipterygial processes and also in other parts of the body are characteristic feature of the species. Kyle (1913) has observed these spiny discs in *A. imperialis* from 7.0 mm to 29.0 mm and not afterwards. He has stated that “ with one exception all known genera of the family Rhombidae have spines in one form or another in the postlarval stages, but none have such a well developed system of spines as we find in *Arnoglossus*”. This statement might have led many workers to confuse between the spines on the urohyal, cleithra and posterior basipterygial processes and the spiny discoid scutes and guided them to place such larvae under *Arnoglossus* spp. Another peculiarity of the present larvae is that the caudal rays are differentiated much after the differentiation of hypural plates and that the urostyle remains straight even after the development of hypural plates. The number of fin rays and vertebrae tally with the adults of *Arnoglossus imperialis*. The adults are reported from the Atlantic coasts of Europe and Africa, northern Scotland and western part of Mediterranean (Norman, 1934). Larvae from Atlantic waters have been described and reported by Kyle (1913). Larval forms described in the present report have been collected only from stations around Agulhas Bank. Decker (1973) has reported that copepod species of Atlantic origin flourish in Agulhas Bank. The larvae of *A. imperialis* are described from the Indian Ocean for the first time by Lalithambika Devi, (1986) and reported by Lalithambika Devi & Rosamma Stephen, (1998). Adults are not yet reported from Indian waters.

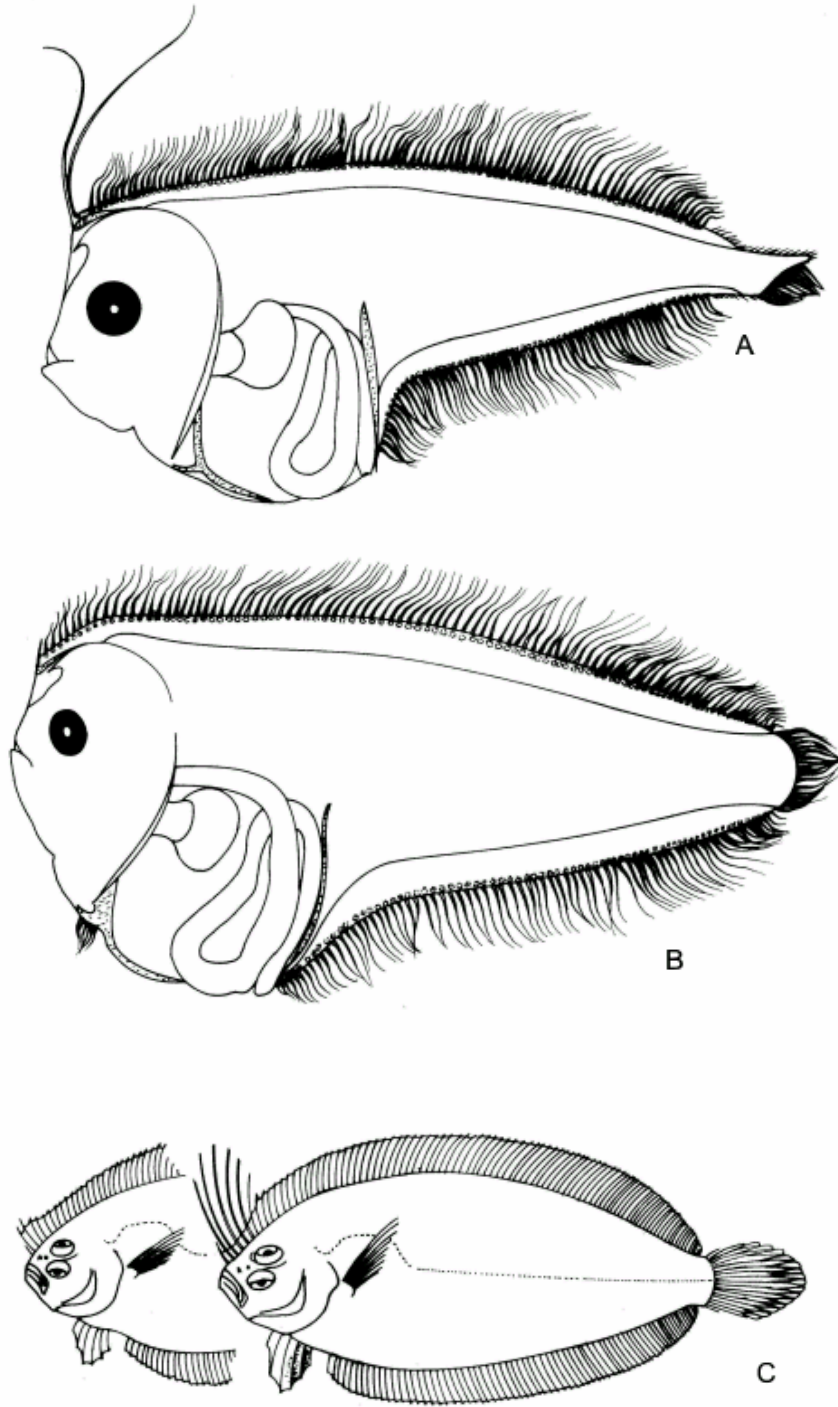


Fig. 22 – *A. imperialis* , A-8.5 mm NL, B-12.2 mm SL, C-Adult.
(from Lalithambika Devi, 1986)

Table 23 a - *Arnoglossus imperialis* - morphometrics, in mm (Larval stages within broken lines indicate notochord flexion).

Stations	Body Length	Right Eye	Notochord	Snout to Anus	Head Length	Snout Length	Eye		Body depth at		Caudal Peduncle Length	Snout to origin of pelvic fin
							Width	Height	Pectoral fin base	Anus		
A – 2877	7.7	Symmetrical	Straight	3.00	1.70	0.56	0.37	0.40	2.80	2.60	-	1.20
A – 3497	8.5	"	Mid flexion	3.40	1.90	0.55	0.47	0.55	3.50	3.40	-	1.50
A – 3546	10.3	"	Post flexion	3.80	2.50	0.66	0.55	0.58	4.70	4.70	0.87	1.30
A – 2866	12.2	"	"	4.20	2.90	0.84	0.52	0.55	5.80	5.90	1.42	1.50

Table 23 b - *Arnoglossus imperialis* – meristics (Larval stages within broken lines indicate notochord flexion).

Stations	Size (mm)	Stage	Notochord	Right Eye	Fin Rays			Vertebrae			
					Dorsal	Anal	Caudal	Precaudal	Caudal	Total	
A- 2877	7.7 NL	Pre flexion	Straight	Symmetrical	Ca.87	Ca.59	0	0			
A – 3497	8.5 "	Mid flexion	Flexing	"	Ca. 92	Ca.67	11	0			
A – 3546	10.3 SL	Post flexion	Flexed	"	98	76	17	2+4	10	32	42
A – 2866	12.2 "	"	"	"	101	79	17	2+4	10	32	42

Discussion

Larvae of *Arnoglossus tapeinosoma*, *A. aspilos*, *A. elongatus*, *A. intermedius*, and *A. imperialis* are reported and discussed. The larvae of *Arnoglossus* spp. can be differentiated from those of *Bothus* spp. from the shape of the larvae (elongated in *Arnoglossus* and oval in *Bothus*), the posterior basipterygial processes not extending to the level of the anus, in the retention of the anterior elongated dorsal ray in all stages of the larvae and in the comparatively short length of the left pelvic fin radial.

The maximum length at postflexion stage and the maximum depth at anus are met with in larvae of *A. imperialis* (Table 24). The snout to anus length is maximum in *A. elongatus* whereas *A. aspilos* has the minimum in all the three. The length at which commencement of median and pelvic fin rays, first neural arch, first tiny dorsal ray, hypurals and eye migration is minimum in *A. aspilos*. It is maximum in *A. imperialis* except in the case of tiny dorsal in which *A. tapeinosoma* has the maximum. As the eye migration has not commenced in the largest specimen of *A. imperialis* and *A. intermedius*, it is difficult to assess the length at which eye migration is commenced. In the differentiation of the pelvic fin and posterior basipterygial processes during the preflexion stages, larvae of *A. aspilos* and *A. intermedius* can be distinguished from others. But in *A. intermedius* except the anterior two elongated and two ordinary rays (which is also characteristic of this species) other median fin rays are developed later. The larvae of *A. intermedius* and *A. imperialis* can be distinguished from those of other species in the urostyle remaining straight even after the hypural plates are differentiated and also in the late development of caudal rays. The larvae of *A. imperialis* differs from

other species in the presence of spiny discoid scutes distributed in several parts of the body. *A. elongatus* can be separated from others in the possession of an extra ordinarily elongated anterior dorsal ray almost one and half times the length of the larva and also in the presence of 11 precaudal vertebrae.

Balakrishnan (1963) had described larval form with spines on urohyal, cleithra and posterior basipterygial processes and identified them as belonging to *A. tapeinosoma*. But the present observations indicate that larvae of

Arnoglossus spp. do not possess any spine on the above structures. In all the probability the larvae described by Balakrishnan may be referable to *Engyprosopon* spp. Pertseva-Ostroumova (1965) has reported a larval form measuring 8.3 mm Gulf of Tomkin belonging to *A. elongatus* which resemble the larval stage of the present account. Kyle (1913) has described larvae of *A. imperialis* 7.0 to 29.0 mm collected from Atlantic waters. The larval forms reported in the present series resemble very much with those reported by Kyle. But the adults and larvae of *A. imperialis* are not reported from Indian waters. The fact that the larvae of *A. imperialis* of the present report have been collected from Agulhas Bank only give strength to the statement made by Decker (1973) to the effect that the waters in the Agulhas Bank can support Atlantic species of copepods successfully.

The meristic counts of the different larval forms described and reported here agree with those of respective adults.

Table 24. Difference in morphometrics at the commencement of postflexion and length of larvae when meristic characters differentiate in *Arnoglossus* species (in mm).

Species	Standard Length	Snout to anus	Body depth across to anus	Median fin rays	Pelvic fin rays	First neural arch	First tiny dorsal ray	Hypural	Commencement of eye migration
<i>A. tapeinosoma</i>	9.3	3.8	3.0	5.9	8.4	5.6	13.0	6.5	13.0
<i>A. aspidos</i>	5.7	2.2	2.2	3.3	3.3	3.3	5.7	3.5	7.5
<i>A. elongatus</i>	8.8	4.7	2.6	5.4	8.8	5.4	6.8-15.2	7.8	16.7
<i>A. intermedius</i>	Only preflexion stages			4.0-4.7	5.0	6.0	-	7.4	-
<i>A. imperialis</i>	10.3	3.8	4.7	7.7	8.5-10.3	10.3	12.2	7.7-8.5	-

23. *Laeops macrophthalmus* (Alcock, 1889)

Larvae belonging to one preflexion and another post flexion stages measuring 4.3 mm NL and 19.0 mm SL respectively are present in the IIOE and Naga Expedition collection (Figs. 23 A, B, C ; Tables 14 a, b).

Morphology :

The larval body is thin, flat, symmetrical and translucent. Ventral profile of the abdomen remains straight and parallel to the dorsal body wall, caudal portion tapers in preflexion stage but in postflexion stage tapers gradually giving the characteristic shape. Eyes black and symmetrical, in postflexion stage they have a conical muscular outer ring. The snout is about one and half times the diameter of the eye in front of it in preflexion stage. Mouth terminal and small being less than the diameter of the eye in early stage, jaws are almost equal, teeth absent in preflexion stage, but 11 pairs in the upper and 6 pairs in lower appear in postflexion stage. Alimentary canal runs almost parallel to the notochord up to seventh myotome where it forms an elliptical coil which is directed backwards and occupies the posterior end of the abdominal cavity, rectal portion is distinctly marked, directed backwards and anus opens at the level of the 11th myotome. In postflexion stage, the intestinal coil gets considerably elongated and pushes the abdomen which hangs down as a trailing appendage. The trailing abdomen equals the length between first and seventh caudal vertebral segments and the rectal portion extends further down. If the trailing abdomen is superimposed on the body, the intestinal loop reaches the level of seventh caudal vertebra and the anus opens at the level of the tenth. An oval swim bladder is placed at the space between fourth and sixth myotomes, which presses the alimentary canal down in preflexion stage. Liver is not massive as in other bothids, its antero-posterior axis measuring more than two and a half times the dorso-ventral axis.

Spines are not seen anywhere on the body particularly on the urohyal, cleithra and posterior basipterygial processes.

Fin and supporting structures :

The medium fin folds are continuous and confluent in the preflexion stage. The anterior end of the dorsal fin fold extends over the skull but has not reached the snout with a well differentiated, elongated dorsal ray supported by the first dorsal pterygiophore arising from the level of the base of the occipital. No other rays or pterygiophores occur in the fin folds, except the dermatrichia. In 19.0 mm SL larva, the dorsal fin has not grown much over to the snout from the condition met within preflexion stage. But rays are differentiated in dorsal and anal fin fold along with pterygiophores. The elongated dorsal ray is retained, the tiny first dorsal is seen articulated to the small forward extension of the first dorsal pterygiophore. Median rays are comparatively long and most of the rays have a length equal to the depth of the body without pterygiophores. There are 93 dorsal and 70 anal rays. Small brownish pigment patches are seen distributed along the dorsal and ventral body wall at the bases of the dorsal and anal fin rays and also at the posterior dorsal corner of the abdominal cavity beneath the vertebral column.

In the preflexion stages there is no trace of the caudal fin, but in postflexion stage the caudal rays and supporting hypurals are well differentiated. There are 17 caudal rays distributed as in other bothids.

Of the paired fins, the pectoral remains fleshy and no rays are developed even in the postflexion larva. In the preflexion stage, there is no trace of pelvic fin. However, dorsal and posterior basipterygial cartilages are discernible, the latter extending to the level of the anus. In postflexion stage, the pelvic fin rays are well differentiated, the left pelvic fin radial is asymmetrical being longer than the right and the anterior three rays lie in advance of that of the right fin. The posterior basipterygial processes are very long and follow the trailing intestinal loop up to the level of the anus. No spines are found on the urohyal, cleithra and posterior basipterygial processes.

Axial skeleton :

Notochord remains vacuolated and unsegmented in the preflexion stage, the caudal end remaining straight, myotomes are well differentiated 11 in the precaudal region and 35 in caudal region. In 19.0 mm vertebrae are clearly visible. In the caudal region they are dumb-bell shaped and ossification has commenced, neural and haemal processes are also well developed. The first neural arch is cartilaginous and has no spines in 19.0 mm SL larva. There are 11 precaudal and 35 caudal vertebrae including urostyle.

The adults :

Depth of body $2 \frac{1}{3}$ to $2 \frac{2}{3}$ in the length, length of head 3 to $3 \frac{2}{3}$. Upper profile of head and body more or less convex above and behind eyes. Diameter of eye $3 \frac{3}{4}$ to a little more than 4 ($5 \frac{1}{5}$ in young) in length of head ; lower eye a little in advance of upper, which is very close to edge of head ; Maxillary extending to beyond anterior edge of eye, length $3 \frac{3}{4}$ to $4 \frac{1}{4}$ ($3 \frac{3}{5}$ in young) in that of head ; teeth uniserial, almost entirely confined to blind side of jaws. 6 to 8 gill-rakers on lower part of anterior arch. About 93 scales in lateral line. Dorsal 85-90 ; origin above posterior nostril of blind side; first two rays detached from remainder of fin; none of the rays prolonged, longest shorter than head (except in young). Anal 67-70 (Fig. 23 C). Pectoral of ocular side with 13 to 15 rays, length $1 \frac{1}{6}$ to $1 \frac{3}{5}$ in that of head. Caudal obtusely pointed. Brownish ; dorsal and anal fins darker towards their margins; middle rays of caudal and distal part of left pectoral dark brown or blackish (Norman, 1934).

Remarks :

The preflexion larva can be distinguished from other bothid larvae in the straight abdominal portion which remains parallel to the dorsal profile, in the backwardly directed intestinal loop and rectal portion. In the possession of long narrow leaf like posterior caudal portion, the trailing abdomen, the posterior basipterygial processes following the trailing abdomen up to the anus, the number of fin rays and vertebrae the larvae of *Laeops macrophthalmus* differ from *Arnoglossus* spp. and *Bothus* spp. to which they resemble in the presence of spineless urohyal, cleithra and basipterygial processes and asymmetrical pelvic fin radial with three of the anterior rays lying

in advance of that of the right fin. The adults are reported from the Indian Ocean. The larvae of this species are described and reported for the first time. The scarcity of larval material in the plankton collections has limited the detailed description.

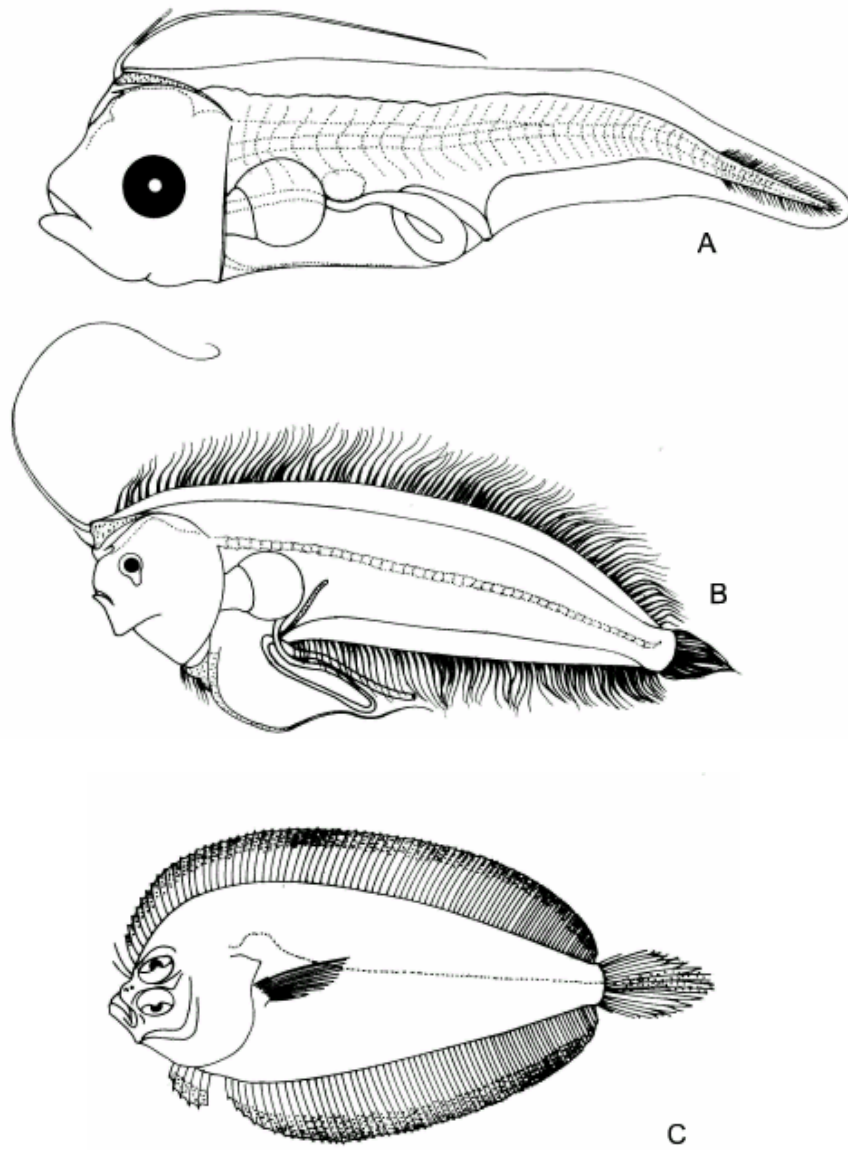


Fig. 23 - *Laeops macrophthalmus*, A- 4.3 mm NL, B-19.0 mm SL, C-Adult
(from Lalithambika Devi, 1986).

24. *Chascanopsetta lugubris* Alcock, 1894

A single postflexion stage specimen measuring 37.0 mm SL and two damaged specimens are available in IIOE collections. These are not included in the systematic portion (Figs. 24 A, B ; Tables 14 a, b).

Morphology :

Larval body extremely long, thin, laterally compressed, symmetrical and leaf-like. Body length six times head length, head length about six times eye diameter. Eyes are comparatively small and symmetrically placed. Mouth small and lower jaw projects slightly beyond the upper, snout more than twice the diameter of eye in front of it. Viscera lost due to damage and rupture of the abdominal wall.

Spines absent on urohyal, cleithra and posterior basipterygial processes.

Fin and supporting structure :

Dorsal fin extends forwards over skull and reaches above the level of eye, rays start from extremity of the fin, tiny first dorsal ray well developed, supported by the forward extension of the first long, stout dorsal pterygiophore, which originates from base of occipital region, second dorsal ray long and the following 12-13 rays are smaller than the rest of the median rays. There are 115 dorsal rays. In the anal fin first caudal pterygiophore is long but not stout and leaf-like as in *Bothus* and *Arnoglossus*. It runs slantingly down to the edge of the ventral body wall. Seventy eight small rays occur in anal fin, all dorsal and anal pterygiophores and baseosts are well developed.

Caudal fin has 17 rays. Hypural plates are well differentiated, inferior hypural lower supports three, middle four, superior hypural middle five, superior hypural upper three and one ray on either side supported by neural and haemal processes of penultimate vertebra. Urostyle shrunk below the margin of caudal fin.

Pectoral fins remain in embryonic condition, pelvic fins have six rays which are smaller than median fin rays. Pelvic fin radial of left side are comparatively short, distal extremity of radial reaches only a

little in front of cleithral tip and one ray of left fin is in advance of the right. The posterior basipterygial processes displaced due to the rupture of abdominal wall, when kept in position along the ventral margin, it can reach a little distance in front of the anal fin.

Axial skeleton :

Vertebrae well differentiated and centra dumb-well shaped, first neural arch not clear. In precaudal region 15 neural and 13 haemal processes developed, neural and haemal processes of caudal region well developed, last two vertebrae in front of urostyle have no pterygiophores. There are 16 + 37 vertebrae including urostyle.

The adult :

Depth of body $3 \frac{1}{4}$ to nearly 4 in the length, length of head 4 to $5 \frac{1}{4}$. Diameter of upper eye $3 \frac{2}{3}$ to 4 in length of head, 3 to 5 times interorbital width. Cleft of mouth generally oblique, but sometimes nearly vertical or horizontal ; maxillary extending to well beyond eye, length $1 \frac{1}{4}$ to $1 \frac{2}{5}$ in that of head. Width of curve of lateral line 5 to $5 \frac{3}{4}$ in straight part. Dorsal 114-122. Anal 77-85 (Fig. 25 B). Pectoral of ocular side with 14 to 17 rays, length $1 \frac{3}{4}$ to $2 \frac{1}{5}$ in that of head. Caudal obtusely pointed ; caudal peduncle deeper than long. Greyish or yellowish brown, with or without numerous small dark spots ; fins dusky (Norman, 1934).

Remarks :

The larva of *Chascanopsetta lugubris* has long leaf like body strongly compressed with subterminal mouth. It is similar to the larvae of *Bothus* spp. and *Arnoglossus* spp. in the spinules urohyal, cleithra and posterior basipterygial processes, in the asymmetrical nature of the left pelvic fin, elongated dorsal ray at the anterior end of the dorsal fin and continuous median fins. The larva can be distinguished from the *Bothus* spp. in the shape of the body, well developed anterior elongated dorsal ray and in the short but asymmetrical left pelvic fin radial with one ray in advance of the right fin and also in the meristics. The larva also differs from those of *Arnoglossus* spp. in the extension of the posterior basipterygial processes beyond the ascending loop of the intestine (the viscera being lost it is difficult to assess the exactness

of the last mentioned character. However, from the length of the posterior basipterygial processes retained in the specimen it may be seen that the processes can reach the level of the anus if it was present), in the short asymmetrical pelvic fin and in the meristics.

The larval stages of *Chascanopsetta lugubris* have been reported by Kyle (1913), Brunn (1937 a) and Amaoka (1971 a). The adults are reported from the Indian Ocean but not the larvae.

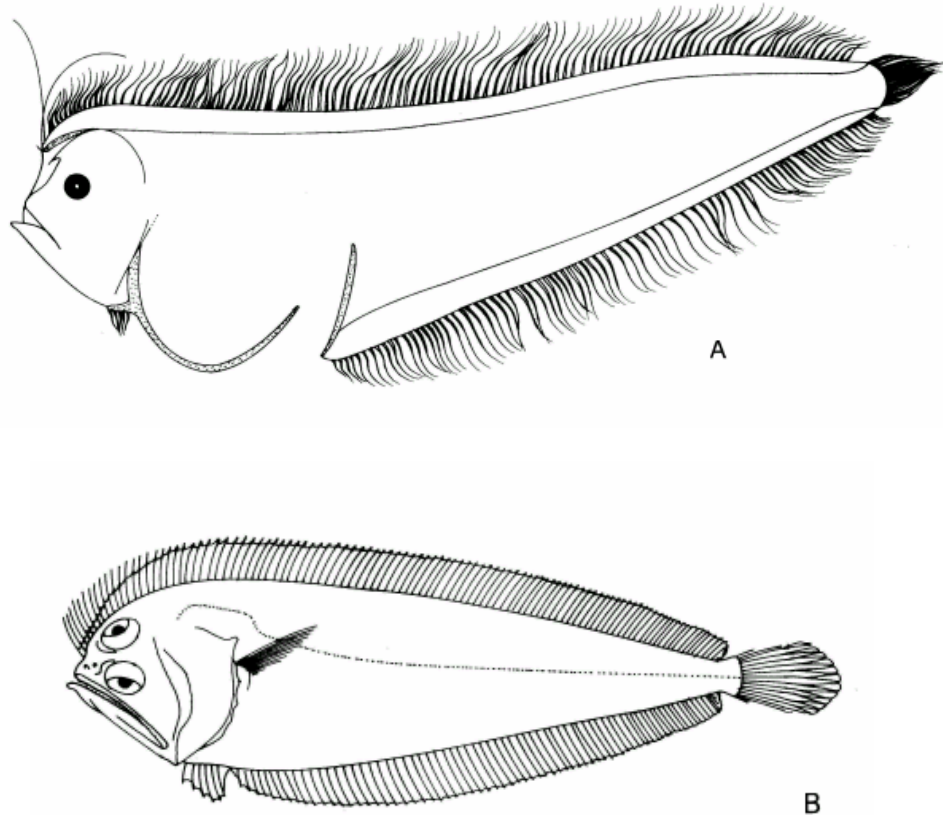


Fig. 24 - *Chascanthopsetta lugubris*, A- 37.0 mm SL, B-Adult
(from Lalithambika Devi, 1986)

Table 25 - Body proportions of larval and metamorphosed stages of bothid fishes, "Body proportion expressed as 10⁻² of body length or head length : Mean Standard deviation and Range).

Body proportion	<i>E. coccosensis</i>	<i>E. latifrons</i>	<i>E. mogkii</i>	<i>E. grandisquamis</i>
<u>SA/BL</u>				
Pre flexion	47.50 ± 4.95 (44-51)	56.22 ± 3.93 (51-63)	54.00 ± 3.61 (50-57)	55.17 ± 7.47 (50-70)
Flexion	49.25 ± 0.50 (49-50)	49.00 ± 2.65 (46-51)	50.00 ± 6.08 (43-54)	45.50 ± 2.38 (45-50)
Post flexion	38.29 ± 6.03 (27-46)	45.33 ± 2.31 (44-48)	43.20 ± 5.85 (36-49)	37.83 ± 7.57 (27-52)
Metamorphosed	--	--	--	--
<u>HL/BL</u>				
Pre flexion	29.50 ± 0.71 (29-30)	30.00 ± 2.06 (27-33)	28.67 ± 0.58 (28-29)	27.67 ± 2.07 (26-31)
Flexion	28.50 ± 1.29 (27-30)	29.33 ± 2.08 (27-31)	32.33 ± 2.52 (30-35)	31.00 ± 1.41 (30-33)
Post flexion	27.53 ± 2.40 (24-32)	30.33 ± 2.08 (28-32)	29.20 ± 1.30 (28-31)	27.83 ± 2.29 (22-31)
Metamorphosed	--	--	--	--
<u>SL/HL</u>				
Pre flexion	33.50 ± 2.12 (32-35)	30.44 ± 3.05 (24-35)	33.67 ± 1.15 (33-35)	27.33 ± 2.42 (23-30)
Flexion	35.25 ± 2.75 (32-38)	36.33 ± 3.21 (34-40)	32.00 ± 3.61 (29-36)	30.00 ± 3.46 (25-33)
Post flexion	34.24 ± 3.80 (29-40)	32.67 ± 3.51 (29-36)	31.00 ± 2.00 (29-34)	27.67 ± 3.77 (21-32)
Metamorphosed	--	--	--	--
<u>EW/HL</u>				
Pre flexion	27.50 ± 0.71 (27-28)	33.00 ± 4.18 (27-41)	31.00 ± 4.36 (26-34)	31.33 ± 4.97 (23-38)
Flexion	27.00 ± 4.16 (22-32)	27.33 ± 2.31 (26-30)	24.33 ± 2.52 (22-27)	25.00 ± 3.74 (21-30)
Post flexion	25.65 ± 2.89 (21-31)	25.67 ± 1.15 (25-27)	25.00 ± 1.58 (23-27)	24.33 ± 1.56 (22-27)
Metamorphosed	--	--	--	--

Contd..

Table 25. (Contd.)

Body proportion	<i>E. coccosensis</i>	<i>E. latifrons</i>	<i>E. mogkii</i>	<i>E. grandisquamis</i>
<u>EH/HL</u>				
Pre flexion	31.00 + 1.41 (30-32)	34.00 + 2.92 (30-39)	33.67 + 2.08 (32-36)	35.00 + 5.10 (27-41)
Flexion	28.75 + 3.30 (26-33)	31.33 + 2.31 (30-34)	27.33 + 3.06 (24-30)	26.75 + 2.99 (24-31)
Post flexion	29.00 + 3.10 (24-34)	27.67 + 2.52 (25-30)	27.00 + 2.00 (24-29)	25.50 + 1.85 (22-28)
Metamorphosed	--	--	--	--
<u>BP-/BL</u>				
Pre flexion	--	36.00 + 3.00 (35-39)	39.50 + 0.71 (39-40)	38.00 + 6.16 (29-43)
Flexion	--	--	--	--
<u>BP+/BL</u>				
Pre flexion	48.00 + 4.24 (45-51)	50.75 + 6.34 (42-57)	42.00	39.50 + 6.36 (35-44)
Flexion	44.75 + 4.03 (40-49)	49.33 + 5.03 (44-54)	54.00 + 5.20 (51-60)	50.50 + 5.45 (45-58)
Post flexion	53.88 + 5.29 (46-63)	49.67 + 4.16 (45-53)	54.00 + 3.00 (49-57)	50.67 + 3.45 (46-54)
Metamorphosed	--	--	--	--
<u>BA-/BL</u>				
Pre flexion	--	27.20 + 2.49 (25-31)	17.50 + 20.51 (30-32)	29.75 + 5.44 (22-34)
Flexion	--	--	--	--
<u>BA+/BL</u>				
Pre flexion	43.50 + 0.71 (43-44)	43.25 + 4.99 (36-47)	34.00	34.50 + 4.95 (31-38)
Flexion	42.00 + 2.94 (39-45)	44.67 + 5.03 (40-50)	50.33 + 6.66 (46-58)	45.75 + 6.18 (41-54)
Post flexion	54.53 + 4.81 (45-66)	48.67 + 6.51 (42-55)	54.00 + 3.39 (49-57)	52.50 + 4.17 (47-59)
Metamorphosed	--	--	--	--

Contd..

Table 25. (Contd.)

Body proportion	<i>E. coccosensis</i>	<i>E. latifrons</i>	<i>E. mogkii</i>	<i>E. grandisquamis</i>
<u>CD/BL</u>				
Post flexion	16.53 + 4.14 (9-26)	11.33 + 2.52 (9-14)	14.00 + 3.24 (10-17)	16.00 + 3.44 (10-20)
Metamorphosed	--	--	--	--
<u>CL/BL</u>				
Pre flexion	6.88 + 1.05 (5-9)	6.33 + 0.58 (6-7)	5.80 + 0.45 (5-6)	6.42 + 0.67 (5-7)
Metamorphosed	--	--	--	--
<u>SP/BP</u>				
Pre flexion	22.50 + 0.71 (22-23)	25.14 + 2.19 (22-28)	26.67 + 2.52 (24-29)	26.50 + 0.71 (26-27)
Flexion	26.00 + 0.82 (25-27)	27.33 + 1.53 (26-29)	25.00 + 1.00 (24-26)	26.00 + 1.83 (24-28)
Post flexion	19.65 + 4.78 (9-28)	26.33 + 1.53 (24-27)	24.00 + 2.55 (21-28)	18.58 + 4.96 (13-28)
Metamorphosed	--	--	--	--

Contd..

Table 25. (Contd.)

Body proportion	<i>E. sechellensis</i>	<i>E. multiquama</i>	<i>B. myriaster</i>	<i>B. pantherinus</i>
<u>SA/BL</u>				
Pre flexion	--	53.00 ± 3.63 (48-57)	39.00	48.33 ± 10.02 (37-56)
Flexion	46.00	45.60 ± 3.65 (41-50)	37.33 ± 1.15 (36-38)	28.67 ± 1.15 (38-40)
Post flexion	42.67 ± 4.18 (35-51)	44.50 ± 0.71 (44-45)	27.66 ± 7.58 (15-42)	34.29 ± 4.23 (29-41)
Metamorphosed	--	--		12.00 ± 1.41 (11-13)
<u>HL/BL</u>				
Pre flexion	--	25.67 ± 1.51 (23-27)	27.00	27.33 ± 3.06 (24-30)
Flexion	27.00	29.20 ± 1.79 (27-31)	32.33 ± 1.15 (31-33)	32.33 ± 0.58 (32-33)
Post flexion	28.56 ± 1.74 (25-31)	31.00 ± 0.00 (31)	26.86 ± 4.94 (17-35)	27.29 ± 1.98 (25-30)
Metamorphosed	--	--		22.00 ± 2.83 (20-24)
<u>SL/HL</u>				
Pre flexion	--	26.67 ± 4.93 (23-35)	47.00	33.33 ± 2.52 (31-36)
Flexion	37.00	35.40 ± 2.70 (31-38)	44.33 ± 1.53 (43-46)	45.67 ± 6.66 (38-50)
Post flexion	34.00 ± 3.32 (28-38)	32.50 ± 0.71 (32-33)	46.07 ± 8.66 (36-65)	30.71 ± 3.35 (27-30)
Metamorphosed	--	--		27.00 ± 1.41 (26-28)
<u>EW/HL</u>				
Pre flexion	--	33.50 ± 3.83 (30-41)	--	29.33 ± 8.39 (24-39)
Flexion	25.00	35.40 ± 2.70 (22-30)	23.00 ± 2.83 (21-25)	19.00 ± 0.00 (19)
Post flexion	24.56 ± 2.79 (21-29)	25.00 ± 0.00 (25)	16.07 ± 2.93 (12-22)	20.00 ± 3.61 (16-26)
Metamorphosed	--	--		15.00 ± 0.00 (15)

Contd..

Table 25. (Contd.)

Body proportion	<i>E. sechellensis</i>	<i>E. multisquama</i>	<i>B. myriaster</i>	<i>B. pantherinus</i>
<u>EH/HL</u>				
Pre flexion	--	35.83 + 2.93 (33-41)	--	29.33 + 4.04 (25-33)
Flexion	28.00	29.40 + 4.04 (25-35)	25.60 + 2.83 (23-27)	20.00 + 2.65 (17-22)
Post flexion	27.33 + 3.74 (22-35)	22.50 + 0.71 (22-23)	17.69 + 2.87 (15-23)	21.42 + 2.88 (17-24)
Metamorphosed	--	--	--	12.50 + 0.71 (12-13)
<u>BP-/BL</u>				
Pre flexion	--	26.50 + 3.79 (21-29)		
Flexion	--			
<u>BP+/BL</u>				
Pre flexion	--	38.50 + 10.61(31-46)	49.00	43.00 + 16.37 (25-57)
Flexion	46.00	46.00 + 3.67 (43-52)	60.66 + 3.06 (58-64)	55.33 + 5.51 (50-61)
Post flexion	53.22 + 3.70 (47-59)	46.50 + 0.71 (46-47)	74.87 + 10.28 (51-91)	53.71 + 3.68 (48-59)
Metamorphosed	--			72.50 + 0.71 (72-73)
<u>BA-/BL</u>				
Pre flexion	--	22.00 + 2.58 (19-25)	--	22.00
Flexion	--			
<u>BA+/BL</u>				
Pre flexion	--	29.00 + 4.24 (26-32)	46.00	47.00 + 7.07 (42-52)
Flexion	40.00	41.40 + 5.64 (35-48)	59.33 + 3.06 (56-62)	51.67 + 4.16 (47-55)
Post flexion	53.11 + 3.59 (49-59)	44.00 - 4.24 (41-47)	74.07 + 10.58 (51-91)	53.71 + 3.90 (48-58)
Metamorphosed	--	--		60.00 + 7.07 (55-65)

Contd..

Table 25. (Contd.)

Body proportion	<i>E. sechellensis</i>	<i>E. multisquama</i>	<i>B. myriaster</i>	<i>B. pantherinus</i>
<u>CD/BL</u>				
Post flexion	15.33 ± 2.92 (11-19)	10.00 ± 1.41 (9-11)	22.66 ± 9.26 (9-37)	15.86 ± 3.34 (11-22)
Metamorphosed	--			22.00 ± 2.83 (20-24)
<u>CL/BL</u>				
Post flexion	6.78 ± 0.67 (6-8)	5.50 ± 0.71 (5-6)	6.40 ± 1.72 (3-9)	6.00 ± 0.58 (5-7)
Metamorphosed	--			6.00 ± 1.41 (5-7)
<u>SP/BP</u>				
Pre flexion	--	27.00 ± 1.71 (26-29)	22.00	17.00
Flexion	27.00	28.80 ± 3.03 (25-33)	17.67 ± 6.66 (12-25)	20.00 ± 0.01 (19-21)
Post flexion	22.44 ± 4.66 (17-29)	31.00 ± 2.83 (29-33)	9.13 ± 6.48 (1-25)	12.86 ± 4.85 (9-23)
Metamorphosed	--			3.50 ± 0.71 (3-4)

Contd..

Table 25. (Contd.)

Body proportion	<i>P. brevirictis</i>	<i>P. ijimai</i>	<i>A. tapeinosoma</i>	<i>A. aspiros</i>
<u>SA/BL</u>				
Pre flexion	49.78 ± 5.02 (43-58)	52.57 ± 7.09 (44-62)	49.00 ± 5.78 (39-57)	34.67 ± 2.89(33-38)
Flexion	42.50 ± 3.51 (39-46)	45.00 ± 3.70 (41-50)	46.25 ± 3.20 (44-51)	34.00
Post flexion	36.89 ± 5.13 (31-44)	32.33 ± 5.07 (25-40)	35.00 ± 4.34 (29-41)	37.00 ± 2.83(35-39)
Metamorphosed	29.00 ± 2.65 (26-31)	25.91 ± 4.11 (22-36)		
<u>HL/BL</u>				
Pre flexion	28.33 ± 2.96 (22-32)	27.14 ± 2.73 (22-31)	25.25 ± 1.28 (24-27)	29.00 ± 1.00(28-30)
Flexion	27.50 ± 1.29 (26-29)	30.43 ± 1.13 (29-32)	27.00 ± 2.45 (24-29)	29.00
Post flexion	27.33 ± 1.94 (25-30)	23.25 ± 2.45 (20-29)	24.20 ± 2.11 (21-28)	28.50 ± 2.12(27-30)
Metamorphosed	26.67 ± 2.53 (25-28)	26.27 ± 3.44 (23-35)		
<u>SL/HL</u>				
Pre flexion	26.22 ± 4.44 (19-32)	28.43 ± 5.16 (21-35)	25.38 ± 3.16 (21-30)	45.00 ± 5.00(40-50)
Flexion	30.00 ± 5.23 (26-37)	30.57 ± 3.46 (26-36)	23.50 ± 1.29 (22-25)	50.00
Post flexion	25.89 ± 2.93 (21-31)	27.08 ± 2.19 (25-31)	22.40 ± 2.30 (20-27)	49.50 ± 3.53 (47-52)
Metamorphosed	26.00 ± 1.73 (15-28)	24.00 ± 2.28 (21-27)		
<u>EW/HL</u>				
Pre flexion	29.56 ± 4.10 (25-36)	33.00 ± 6.93 (28-44)	27.13 ± 3.31 (23-27)	28.30 ± 1.15 (27-29)
Flexion	27.00 ± 1.83 (25-29)	23.71 ± 0.95 (22-25)	22.00 ± 1.83 (20-24)	29.00
Post flexion	21.67 ± 2.18 (19-25)	21.33 ± 2.81 (16-27)	17.33 ± 1.75 (15-20)	19.50 ± 2.12 (18-21)
Metamorphosed	22.33 ± 3.51 (19-26)	26.55 ± 4.41 (19-33)		

Table 25. (Contd.)

Body proportion	<i>P. brevirictis</i>	<i>P. ijimae</i>	<i>A. tapeinosoma</i>	<i>A. aspilos</i>
<u>EH/HL</u>				
Pre flexion	33.67 ± 4.09 (30-40)	36.00 ± 7.96 (29-51)	29.13 ± 1.81 (26-32)	31.00 ± 6.92 (27-39)
Flexion	30.50 ± 1.91 (28-32)	25.71 ± 1.80 (22-27)	24.00 ± 9.57 (23-25)	29.00
Post flexion	24.44 ± 2.18 (21-27)	23.08 ± 3.06 (17-28)	18.66 ± 1.94 (16-21)	24.00 ± 2.82
Metamorphosed	14.33 ± 2.31 (13-17)	17.36 ± 3.14 (11-21)		
<u>BP-/BL</u>				
Pre flexion			25.80 ± 3.03	
Flexion	32.00 ± 4.00 (28-36)	40.17 ± 6.31 (34-49)		
<u>BP+/BL</u>				
Pre flexion	48.83 ± 6.49 (41-58)	53.00	31.66 ± 2.08 (30-34)	52.60 ± 3.06 (50-56)
Flexion	51.25 ± 2.99 (48-55)	49.71 ± 2.69 (46-52)	33.80 ± 3.50 (30-38)	57.00
Post flexion	55.00 ± 2.85 (51-58)	48.58 ± 4.58 (43-59)	35.44 ± 2.70 (32-40)	50.00 ± 14.14 (40-60)
Metamorphosed	37.00 ± 3.61 (33-40)	33.36 ± 4.20 (30.43)		
<u>BA-/BL</u>				
Pre flexion	23.33 ± 5.86 (19-30)	30.67 ± 7.45 (23-39)	21.20 ± 5.93 (16-30)	
Flexion				
<u>BA+/BL</u>				
Pre flexion	45.17 ± 8.70 (33-53)	5.10	32.33 ± 3.06 (29-35)	49.66 ± 2.52 (47-52)
Flexion	49.50 ± 4.43 (44-54)	46.00 ± 3.65 (41-52)	34.50 ± 3.51 (31-38)	54.00
Post flexion	56.44 ± 2.86 (53-61)	50.25 ± 3.08 (46-58)	38.33 ± 3.57 (32-44)	48.00 ± 12.73 (39-57)
Metamorphosed	37.67 ± 5.51 (32-43)	33.73 ± 4.67 (29-45)		

Contd..

Table 25. (Contd.)

Body proportion	<i>P. brevirictis</i>	<i>P. ijimae</i>	<i>A. tapeinosoma</i>	<i>A. aspidos</i>
<u>CD/BL</u>				
Post flexion	14.11 ± 3.10 (10-19)	13.50 ± 2.15 (9-16)	14.33 ± 1.73 (11-17)	4.00
Metamorphosed	13.33 ± 2.52 (11-16)	11.73 ± 1.27 (10-14)		
<u>CL/BL</u>				
Post flexion	6.22 ± 4.41 (6-7)	5.83 ± 0.39 (5-6)	6.00 ± 0.87 (5-8)	
Metamorphosed	6.67 ± 1.15 (6-8)	6.18 ± 0.60 (5-7)		
<u>SP/BP</u>				
Pre flexion	22.00 ± 2.61 (19-26)	21.00 ± 2.00 (19-23)	21.00	17.66 ± 6.51 (11-24)
Flexion	22.00 ± 3.37 (18-26)	25.00 ± 4.76 (20-34)	24.50 ± 1.00 (24-26)	14.00
Post flexion	16.11 ± 2.93 (13-21)	13.75 ± 3.08 (10-19)	18.56 ± 4.10 (12-23)	19.00 ± 9.90 (12-26)
Metamorphosed	18.00 ± 0.04 (14-20)	14.64 ± 5.18 (10-29)		

Contd..

Table 25. (Contd.)

Body proportion	<i>A. elongatus</i>	<i>A. Imperialis</i>
<u>SA/BL</u>		
Pre flexion	45.00 ± 2.83 (43-47)	38.96
Flexion	58.00	40.00
Post flexion	38.20 ± 8.32 (33-35)	35.66 ± 1.74 (34-37)
Metamorphosed		
<u>HL/BL</u>		
Pre flexion	26.00 – 0.00 (26)	22.08
Flexion	26.00	22.35
Post flexion	24.20 ± 2.80 (22-24)	24.02 ± 3.54 (23-24)
Metamorphosed		
<u>SL/HL</u>		
Pre flexion	26.50 ± 10.61 (19-34)	32.94
Flexion	26.00	28.95
Post flexion	24.40 ± 3.44 (19-27)	27.69 ± 1.82 (26-29)
Metamorphosed		
<u>EW/HL</u>		
Pre flexion	24.50 ± 0.71 (24-25)	21.76
Flexion	26.00	24.74
Post flexion	19.00 ± 1.87 (17-21)	19.97 ± 2.88 (18-22)
Metamorphosed		

Contd..

Table 25. (Contd.)

Body proportion	<i>A. elongatus</i>	<i>A. imperialis</i>
<u>EH/HL</u>		
Pre flexion	25.00 + 4.24 (22-28)	23.52
Flexion	28.00	28.95
Post flexion	22.20 + 3.68 (18-28)	21.09 + 2.99 (19-23)
Metamorphosed		
<u>BP-/BL</u>		
Pre flexion	25.00	
Flexion		
<u>BP+/BL</u>		
Pre flexion	30.00	36.36
Flexion	29.00	41.18
Post flexion	29.60 + 1.67 (28-32)	46.59 + 1.35 (46-48)
Metamorphosed		
<u>BA-/BL</u>		
Pre flexion	20.00	
Flexion		
<u>BA+/BL</u>		
Pre flexion	21.00	33.77
Flexion	31.00	40.00
Post flexion	30.00 + 0.71 (29-31)	47.00 + 1.93 (46-48)
Metamorphosed		

Contd..

Table 25. (Contd.)

Body proportion	<i>A. elongatus</i>	<i>A. imperialis</i>
<u>CD/BL</u>		
Post flexion	9.60 + 0.55 (9-0)	10.05 + 2.26 (8-12)
Metamorphosed		
<u>CL/BL</u>		
Post flexion	5.60 + 1.34 (5-8)	5.05 + 0.39 (4-5)
Metamorphosed		
SP/BL		
Pre flexion		
Flexion	14.00	
Post flexion	21.40 + 1.67 (19-23)	12.46 + 0.23 (12-13)
Metamorphosed		

BP = Body proportion ; HL = Head length ; BL = Body length ; AN = Snout to anus ; SA = Snout to anus ; SL = Snout length ; EW = Eye width ; EH = Eye height ; BP- = Body depth at pectoral fin base before development of dorsal base ; BP+ = Body depth at pectoral fin base after development of dorsal base ; BA- = Body depth at anus before development of dorsal and anal bases ; BA+ = Body depth at anus after development of dorsal and anal bases ; CD = Caudal peduncle depth ; CL = Caudal peduncle length ; SP = snout to pelvic fin base.

4.5 Key for the identification of the bothid larvae

The larvae of Pleuronectiformes (Heterosomata --- flat fishes) have very little morphological resemblance with their adults. In early larval stages meristics are also not clearly differentiated to the extent that they could be regarded as characters of diagnostic value. The scarcity of larval forms in the zooplankton collections and the difficulty experienced in rearing of planktonic eggs up to identifiable larval stages in tropical waters have on several occasions, prevented larval taxonomists to prepare a suitable key for identification. Even the collaborative venture of more than 9 nations to study the Indian Ocean ichthyoplankton (International Indian Ocean Expedition 1960-65) could not yield sufficient material both in number and in stages of growth, particularly of bothid group to prepare a comprehensive key for identification. The key presented here provides distinct, diagnostic features of the larval forms studied so far, prepared mostly on the basis of the work on bothid larval fishes by the author as well as from published papers on bothid larvae of the Indo-Pacific region.

Pigmentation and the nature of its distribution is one of the several diagnostic characters of fish larvae when the material is fresh. But most of the classical works have been based on preserved material where pigmentation is lost. The Indian Ocean and Naga Expedition materials are preserved in formalin with very little pigmentation left behind. The present study is based on morphometric and meristic characters.

The current hypothesis on the interrelationships of pleuronectiform fishes Based on Norman (1934, 1966), Hubbs (1945) and Amaoka (1969), is given as Fig. 25. The sub families and genera of the family Bothidae of the Indo-Pacific region are as follows:

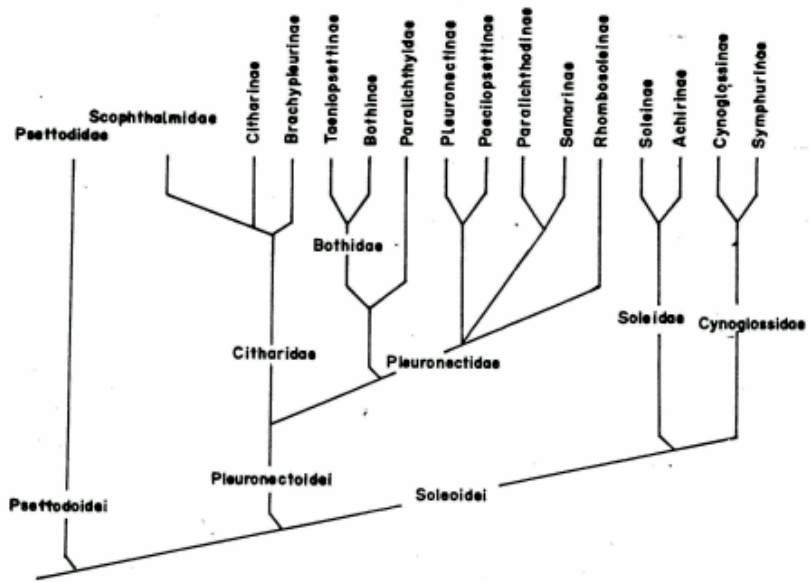


Fig. 25 – Current hypothesis for interrelationships of pleuronectiform fishes, from Hensley and Ahlstrom, 1984.

Family BOTHIDAE

TAENIOPSETTINAE

BOTHINAE

TAENIOPSETTA

ARNOGLOSSUS

PSETTINA

LOPHONECTES

ENGYPROSOPON

CROSSORHOMBUS

BOTHUS

PARABOTHUS

TOSARHOMBUS

GRAMMATOBOTHUS

KAMOHARAIA

MANCOPSETTA

ACHIROPSETTA

CHASCANOPSETTA

PELECANICHTHYS

LAEOPS

JAPONOLAEOPS

NEOLAEOPS

ASTERORHOMBUS

Family BOTHIDAE

As stated elsewhere flat fish larvae have no resemblance with the adults. The meristic and morphometric characters of adults observable only in advanced stages of post-larvae provide marginal but significant tips to identify the larvae.

The adult flat fishes can be distinguished from other teleosts (Norman, 1934) in having asymmetrical, strongly compressed body, short pre-anal region, both eyes on one side ; dorsal and anal fins long and continuous; all rays are simple and not spinous, caudal fin generally with 17 or less principal rays, of which 15 are branched; pelvic (ventral) fin usually with 6 or fewer number of rays, thoracic or jugular in position; pelvic radials directly attached to the cleithra; swim (air) bladder absent in adults; mouth more or less protractile, bordered by pre-maxillaries; parietals separated by supraoccipitals, interorbital bar mainly formed by the frontal of the ocular side, pectoral arch attached to the skull by a forked post-temporal; mesocoracoid absent; vertebral column with solid centra co-ossified with arches; posterior caudal vertebrate with downwardly directed parapophyses.

Norman (1934) has distinguished adult Bothidae in having the dorsal fin extending forward on the head atleast to the level above the eye, none of the rays spinous; all rays articulated; pelvic fins with asymmetrical base, that of the ocular side longer than that of the blind side and extending to the urohyal supported by a cartilaginous plate placed in advance of the cleithra, its anterior ray well in advance of the first ray of the blind side, mouth terminal without supplemental bones, no teeth on palate; vertebrae never less than 30, caudal vertebrae with well developed apophyses; preopercular margin free, lower jaw generally prominent, lower edge of the urohyal deeply emarginate so that the bones appear forked; nasal organ of the blind side near the edge of head, optic chiasma monomorphic, the nerve of the right eye in sinistral forms always dorsal, pectoral radial present; one or two post cleithra on each side; ribs present; eyes on left side (except in reversed specimens) the first neural spine absent; urostyle fused with hypural; last neural and haemal spines fused with centrum (Amaoka, 1969).

The larvae of flat fishes are symmetrical in early stages with thin laterally compressed body; continuous median fin folds without spinous rays; the forward extension of the dorsal fin over the skull to the level of the eye; rays are invariably articulated through a system of pterygiophores and baseosts; caudal fin with 17 rays, of which 15 are branched and are borne on hypural plates, pelvic fin with six rays, left pelvic- fin radial asymmetrical in advanced larval stages with its anterior 2 to 3 rays in advance of the first ray of the right fin; pelvic fin radials attached to the cleithra; a urohyal (Ahlstrom *et al.*, 1984; sciatic portion – Hensley, 1977; cartilaginous plate – Kyle, 1913 and Norman, 1934) placed in advance of the cleithra; presence of post-cleithra on either side; basipterygia attached to the posterior lower middle faces of the cleithra between cleithral tips and pectoral fins on either side; the pelvic fin complex differentiates as a cluster of chondrioblasts (cells) which transform into Y -shaped processes attached to the posterior lower middle faces of the cleithra between cleithral tips and pectoral fin on either side as larvae grow ; right arm of Y attached to the cleithra, while left arm differentiates into the pelvic fin radial and fin and the distal portion along the midventral line of the body extending up to the anus or near to it, the terminal portion of the processes end straight or get curved dorsalwards ; the processes may bear spines either in the proximal portion or along its full length, Kyle (1913) has recognised this as the cartilaginous pubic bar while Ahlstrom *et al.*, (1984) termed it as basipterygial process ; the spines may or may not be present on cleithra, urohyal or posterior basipterygial processes or in any one of them (Fig. 26). The aforesaid characters either in combination with other characters or alone help to distinguish the larvae of bothids from other Pleuronectiformes.

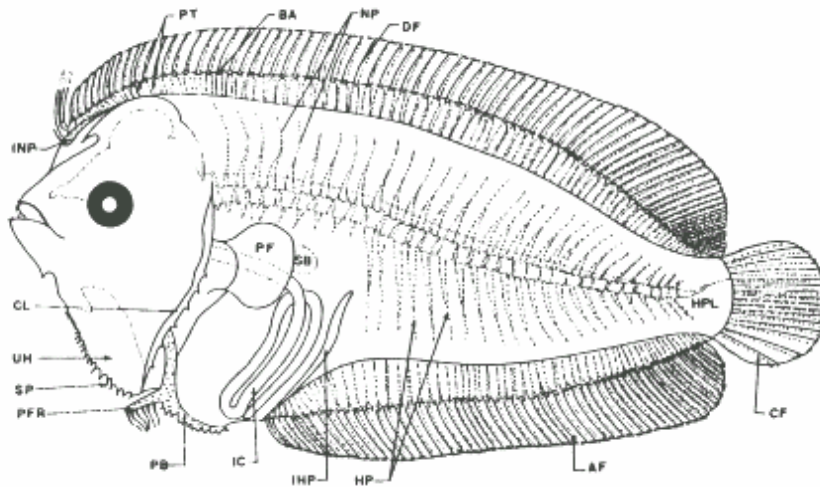


Fig. 25 - A larva of Bothid flat fish showing characters of diagnostic value. INP - 1st neural pterygiophore, PT - Pterygiophores, BA - Baseosts, NP - Neural processes, DF - Dorsal fin rays, HPL - Hypural plates, CF - Caudal fin rays, AF - Anal fin rays, HP - Haemal processes, IHP - 1st haemal pterygiophore, IC - Intestinal coil, PB - Posterior basipterygial processes, SB - Swim bladder, PF - Pectoral fin, PFR - Pelvic fin radial with fin rays, SP - Spines, UH - Urohyal, CL - Cleithra.

Fig. 25 - A larva of Bothid flat fish showing characters of diagnostic value. 1NP-1st neural pterygiophore, PT-Pterygiophores, BA-Baseosts, NP-Neural processes, DF-Dorsal fin rays, HPL-Hypural plates, CF-Caudal fin rays, AF-Anal fin rays, HP-Haemal processes, 1HP1st haemal pterygiophore, IC-Intestinal coil, PB-Posterior basipterygial processes, SB-Swim bladder, PF-Pectoral fin, PFR-Pelvic fin radial with fin rays, SP-Spines, UH-Urohyal, CL-Cleithra.

Ahlstrom *et al.*, (1984) have reviewed the literature on larvae of Pleuronectiformes and summarised the main characters of different families and genera. According to them, larvae of bothid range from thin bodied to diaphanous condition sparsely pigmented, and possess an elongated second dorsal ray. Spines may appear on urohyal, basipterygial processes, cleithra and epiotics. They have reported that bothid larvae attain relatively large size before metamorphosis and that early larval stages are often poorly represented in collections. They have recognised two subfamilies/ Taeniopsettinae and Bothinae.

Sub Family 1 Taeniopsettinae

Spines on epiotic bones of the head, minute short spines on urohyal, cleithra and posterior basipterygial processes. The 2nd dorsal ray is moderately or slightly elongated (Amaoka, 1970).

Only one genus has hitherto been reported from the Indo-Pacific region.

Genus *Taeniopsetta* Gilbert

Large body having 2nd dorsal ray slightly elongated with large serrated urohyal ; the posterior process of pelvic bone (posterior basipterygial process, pubic bar) short, plate - like and serrated, three spines on head ; 1st ray of the right ventral fin opposite the 2nd ray of the left (Amaoka, 1970) ; lacks melanophores, but have four reddish orange spots in live larvae along the bases of the dorsal and anal fins and orange, reddish and yellow blotches and bands on the body and head (Ahlstrom *et al.*, 1984).

The spines arranged subvertically along the margin of head, well developed, though the lowermost one is rudimentary.

Dorsal fin rays 85-95, anal fin rays 71-81; vertebrae 10+30-32 *Taeniopsetta ocellata* (Gunther) Fig. 27 (from Amaoka, 1970).

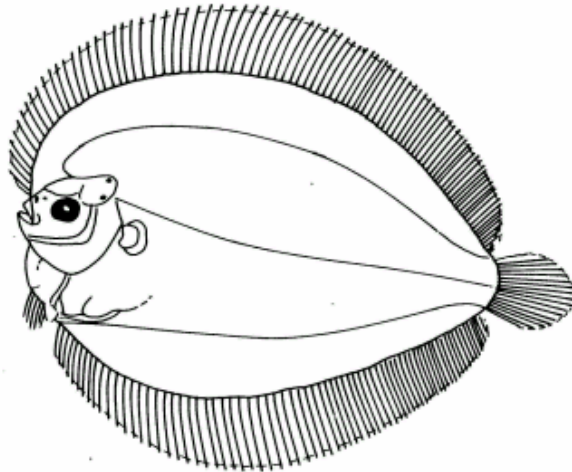


Fig. 27 – Larva of *Tapeionopsetta ocellata*, 59.0 mm SL, from Amaoka, 1970.

Sub family 2 Bothinae

Body ovate, round or elongate, epiotic spines absent ; spines on urohyal, cleithra and basipterygials may or may not be present. The second dorsal ray invariably long ; the pelvic fin radials are asymmetrical and in many cases that of the left side elongated and the anterior ray or rays in advance of the right side.

Pigmentation sparse in most larvae of bothinae and lacking in some species, exceptions found in some cases (Ahlstrom *et al.*, 1984).

17 genera of adults are reported from the Indo-Pacific region (Norman,1934, Amaoka, 1969).

1. Spines
 - 1.1. Present
 - 1.1.1. On urohyal, cleithra and posterior basipterygial processes 6.1.4
 - 1.1.2. On urohyal and posterior basipterygial processes 1.2.2&2.4
 - 1.1.3. On posterior basipterygial processes 1.2.3
 - 1.1.4. On median fin rays 6.1.5
 - 1.1.5. On discoid scutes in different parts of the body 1.2.1
 - 1.2. Absent 6
 - 1.2.1. On urohyal, cleithra and posterior basipterygial processes 2.3
 - 1.2.2. On cleithra 6.1.4&5
 - 1.2.3. On urohyal and cleithra 2.5
2. Elongated dorsal rays
 - 2.1. 2nd 6
 - 2.2. Very long about 1 ½ times the body length 6.1.6&6.3.2
 - 2.3. 2nd, 3rd elongated 6.1.6
 - 2.4. 2nd, 3rd and 4th 6.1.4
 - 2.5. Not very long 6.1.3
3. Left pelvic fin radial asymmetrical
 - 3.1. Short based 6.1.4&6.3.2&3
 - 3.2. Long based 6 other than above
4. Caudal pterygiophore
 - 4.1. Short stout leaf-like 6.1.6&6.3.1
 - 4.2. Thin, long and leaf-like 5.3
5. Pre-caudal vertebrae
 - 5.1. 15-17 6.3.3
 - 5.2. 10-12 6.1.6&6.3.2
 - 5.3. 10 6 other than above
6. Posterior basipterygial processes extending to
 - 6.1. Ascending level of intestinal loop
 - 6.1.1. Body broad leaf-like, vertebrae 10+(29-36)including urostyle *Parabothus*
 - 6.1.2. Body oval in metamorphising stage; vertebra 10+(28-30) *Tosarhombus*
 - 6.1.3. Body thin ovoid to elongate ; vertebrae 10(24-27) *Crossorhombus*

- | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| 6.1.4. Body laterally compressed ; mostly diaphanus urohyal appendage in early stages in one species, vertebrae 10+(23-27) | <i>Engyprosopon</i> |
| 6.1.5. Body slender, moderately elongated or oval; urohyal appendage in early stages in one species, vertebrae 10+(24-30) | <i>Psettina</i> |
| 6.1.6. Body long, elongated dorsal ray very prominent, vertebrae 10-12 + (26-36) | <i>Arnoglossus</i> |
| 6.1.7. Body oval in post flexion stages; at least two or four anterior dorsal fin rays elongated. In early stages, only second ray elongated, vertebrae 10+(27-28) | <i>Grammatobothus</i> |
| 6.2. Middle level of the intestinal loop | |
| 6.2.1. Body lancet – shaped, vertebrae 10+(25-27) | <i>Asterorhombus</i> |
| 6.3. Anus | |
| 6.3.1. Body deeply ovate, vertebrae 10+(25-32) | <i>Bothus</i> |
| 6.3.2. Body with parallel caudal portion, abdomen trailing, vertebrae 10-12+(35-42) | <i>Laeops</i> |
| 6.3.3. Body elongate and leaf-like, vertebrae 15-18+(37-44) | <i>Chascanopsetta</i> |

Genus *Parabothus* Norman

Post larval body elongate gradually tapering near the caudal end., first dorsal ray tiny 2nd dorsal ray elongated, urohyal in front of the cleithra, long asymmetrical left pelvic fin radial with anterior three rays in advance of the right fin; the posterior basipterygial process extending to the ascending loop of the intestinal coil; a bend in the intestinal loop near its middle and the late differentiation of pelvic fin rays seem to be characteristic.

Five species of adults reported from the Indo-Pacific region (Norman, 1934) and 2 species from the Japanese waters (Amaoka, 1969), but only post larvae of one species available from the Indo-Pacific region.

Dorsal fin rays 92-94, anal fin rays 72-73; Fig. 28

vertebrae 10+29-31 including -- urostyle (from Lalithambika Devi,1986)

Parabothus polylepis (Alcock)

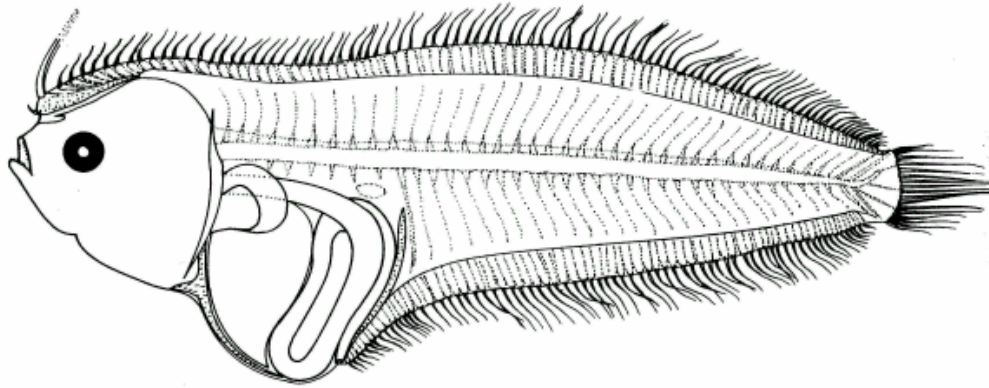


Fig. 28 – Larva of *Parabothus polylepis*, 14.6 mm SL, from Lalithambika Devi, 1986.

Genus *Tosarhombus* Amaoka

Spines absent, body oval in shape in metamorphosing stage; punctuate melanophores present along the entire pterygiophore base of dorsal fin; elongated 2nd ray filamentous; 3rd ray on left pelvic fin opposite to 1st ray on right side; posterior basipterygial processes short and thin.

It is endemic to the Pacific coast of Japan and is comprised of only one species.

Dorsal fin rays more than 95, anal fin rays more than 76, vertebrae 10+(28-30) – Fig. 29 from Fukui, 1997.

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Tosarhombus octoculatus, Amaoka.

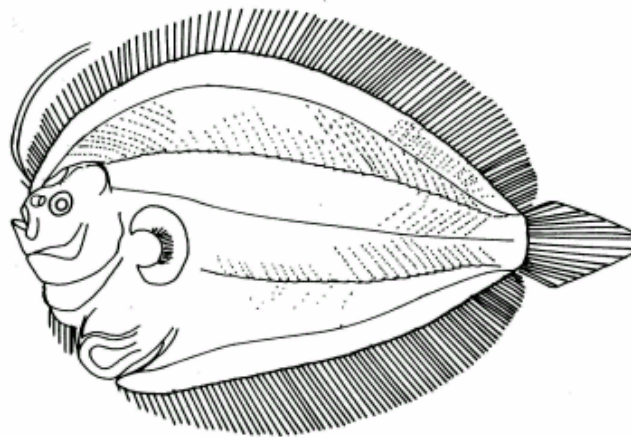


Fig. 29 – Larva of *Tosarhombus octoculatus*, 26.7 mm SL, from Fukui, 1997.

Genus *Crossorhombus* Regan

Body thin, translucent, ovoid to elongate, jaws carry smaller teeth, larvae possess spines on posterior basipterygial process and that too only on the left ramus, ctenoid scales along the bases of the dorsal and anal fins, one scale per ray; 2nd dorsal fin ray not distinctly longer than the other rays; three left pelvic fin rays in advance of the right fin; liver not massive and its dorso-ventral axis more than twice the anterior posterior axis; swim bladder does not displace the contour of the alimentary canal.

Two species of adults are reported from the Indo-Pacific region (Norman, 1934) and two species from the Japanese waters (Amaoka, 1969).

Synopsis to species

1. Spines on posterior basipterygial process 3-8.
Dorsal fin rays 79-89; Anal fin rays 62-74.
Vertebrae 10+24-26 -- *Crossorhombus valde-rostratus* (Alcock). Fig. 30 (from LalithambikaDevi, 1989b).
2. Spines on posterior basipterygial processes 5-10. A small spinous process on the urohyal at its anterior end near the notch up to which the left ventral fin radial extends. Dorsal fin rays 82-92, anal fin rays 61-73; vertebrae 10+25-27 -- *C. azureus* (Alcock) Fig. 31 (from Lalithambika Devi, 1989b).
3. Spines on posterior basipterygial processes 4 to 8. Dorsal fin rays 79-88; Anal fin rays 59-69. Vertebrae 10+24-26 -- *C. kobensis* Fig. 32 (from Fukui, 1997) (Jordan *et* Starks)
4. Spines on posterior basipterygial process 6-9.
Dorsal fin rays 84-92, Anal fin rays 63-73. Fig. 33 (from Fukui, 1997)
Vertebrae 10+25-27 -- *C. kanekonis* (Tanaka)

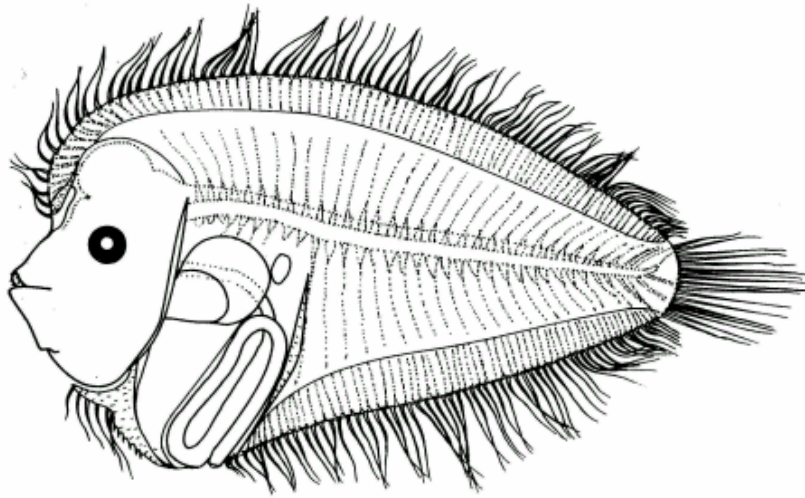


Fig. 30 – Larva of *Crossorhombus valde-rostratus*, 8.8 mm SL, from Lalithambika Devi, 1989.

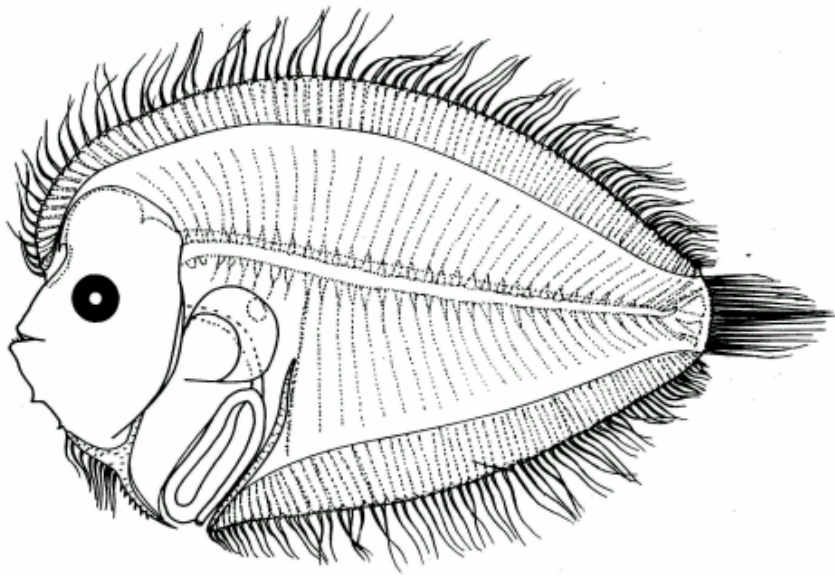


Fig. 31 – Lava of *C. azureus*, 12.4 mm SL, from Lalithambika Devi, 1989.

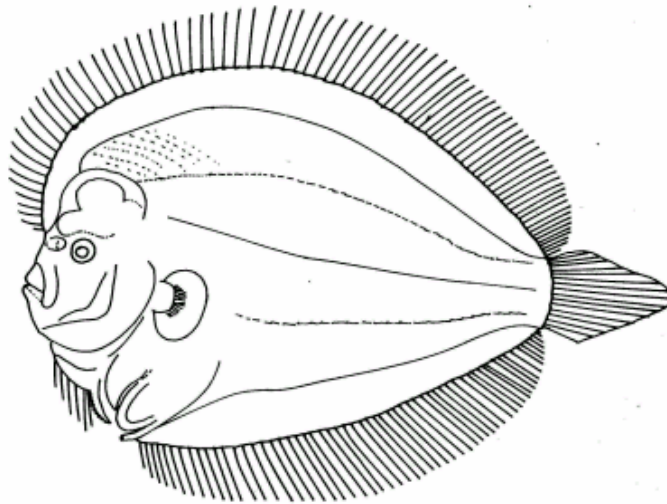


Fig. 32 – Larva of *C. kobensis*, 15.4 mm SL, Fukui, 1997.

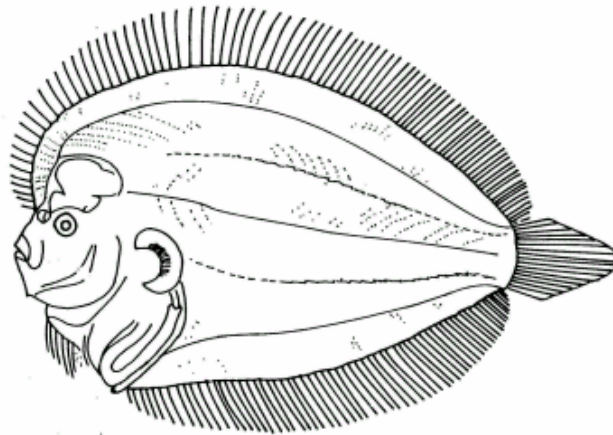


Fig. 33 – Larva of *C. kobensis*, 13.8 mm SL, Fukui, 1997.

Genus *Engyprosopon* Gunther

The genus *Engyprosopon* is the most enigmatic group among bothids as far as larval taxonomy is concerned. The description of larvae and their assignment to different species by different authors have created confusion. The scarcity of the specimens both in number as well as in different stages of development in the plankton collections might have generated such confusion.

The number, size and pattern of distribution of spines on urohyal, cleithra and posterior basipterygial processes together with the meristics and morphometrics help in identifying the larvae belonging to different species. The spines on cleithra may be

absent in some species. Posterior basipterygial process reach upto the level of ascending loop of the intestinal coil and curves dorsalwards which is the typical *Engyprosopon* character or ends straight in a spine.

15 species of adults are reported from the Indo-Pacific (Norman, 1934) and five species from Japan (Amaoka, 1969), of which two species are common.

Synopsis to species

1. Spines present
 - 1.1. On urohyal, cleithra and posterior basipterygial Processes4
 - 1.2. On urohyal and posterior basipterygial process5
2. Spines absent
 - 2.1. On cleithra5
- 3.1. The distal end of the posterior basipterygial process ends in spine 4.4&6.3
- 3.2. The distal end of the posterior basipterygial process curves dorsalwards and anteriorwards below the intestinal loop Except above
- 3.3. The spines on the right and left ramus do not juxtapose 4.4
- 4.1. Spines on urohyal 20-42, cleithra 3-9 and posterior basipterygial processes 20-49 6.1. Fig. 34a
- 4.2. Spines on urohyal 9-19, cleithra 1-6 and posterior basipterygial processes 8-27 6.2. Fig. 35a
- 4.3. Spines on urohyal 6-29, cleithra 1-10 and posterior basipterygial processes 5-26 7.1. Fig. 36a
- 4.4. Spines on urohyal 2-24, cleithra 2-9 and posterior basipterygial processes 2/2- 11/11 which end in spine 7.2. Fig. 37a
- 5.1 Spines on urohyal 20-36, cleithra - o - and posterior basipterygia processes 14-26 8.5. Fig. 38a
- 5.2. Spines on urohyal 5-19, cleithra absent and posterior basipterygial processes 4-16 8.6. Fig. 39a
- 5.3. Spines on urohyal 9-28, cleithra absent and posterior

	basipterygial processes 6-20 and ends in spine.	6.3. Fig. 40a
6.1.	Caudal formation stage prior to flexion stage	8.1
6.2.	Pterygiophores of the median fin rays differentiate early.....	8.2
6.3.	Fin rays differentiate very late	8.7
7.1.	Brownish black stellate pigments over the whole body	8.3
7.2.	A diverticulum hanging down from the urohyal region (urohyal appendage) with pigments at its base in early stages	8.4
8.1.	Dorsal fin rays (69)74-88, anal fin rays (52)57-65; vertebrae from 10+(23-26) _ <i>E. cocosensis</i> (Bleeker)	Fig.34 (from Lalithambika Devi, 1986)
8.2.	Dorsal fin rays 81-83 (90), anal fin rays 53-59(67) ; vertebrae 10+(24-26) <i>E. latifrons</i> (Regan)	Fig. 35 (from Lalithambika Devi, 1986)
8.3.	Dorsal fin rays (78)80-87, anal fin rays 58-62; vertebrae 10+(24-25) <i>E. mogkii</i> (Bleeker)	Fig. 36 (from Lalithambika Devi, 1986)
8.4	Dorsal fin rays 78-95, anal fin rays 56-73 ; vertebrae 10+(23-25) <i>E. grandisquamis</i> (Temminck and Schlegel)	Fig. 37 (from Lalithambika Devi, 1986)
8.5	Dorsal fin rays 81-91, anal fin rays 57-70 ; vertebrae 10+(24-26) <i>E. sechellensis</i> (Regan)	Fig. 38 (from Lalithambika Devi, 1986)
8.6	Dorsal fin rays 83-96, anal fin rays 52-74 ; vertebrae 10+(25-27) <i>E. multisquama</i> (Amaoka)	Fig. 39 (from Lalithambika Devi, 1986)
8.7	Dorsal fin rays 78-94, anal fin rays 62-70 ; vertebrae 10+(25-26) <i>E. xenandrus</i> (Gilbert)	Fig. 40 (from Lalithambika Devi, 1986)

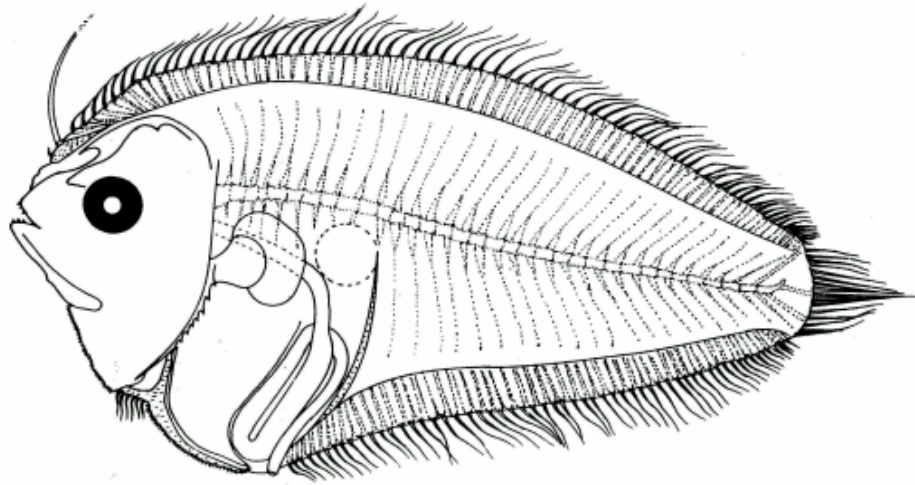


Fig. 34 – Larva of *Engyprosopon cocosensis*, 12.9 mm SL,
from Lalithambika Devi, 1986.

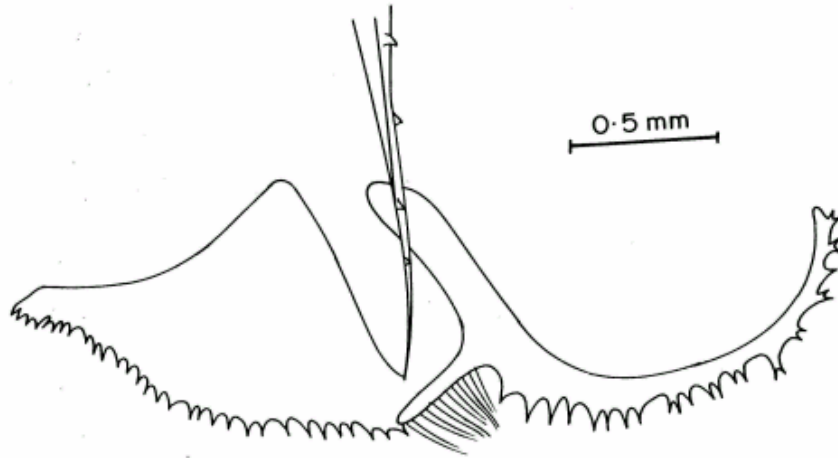


Fig. 34 A – Pattern of distribution of spines on urohyal, cleithra and posterior
basipterygial processes of larvae of *E. cocosensis*, 8.1 mm SL.

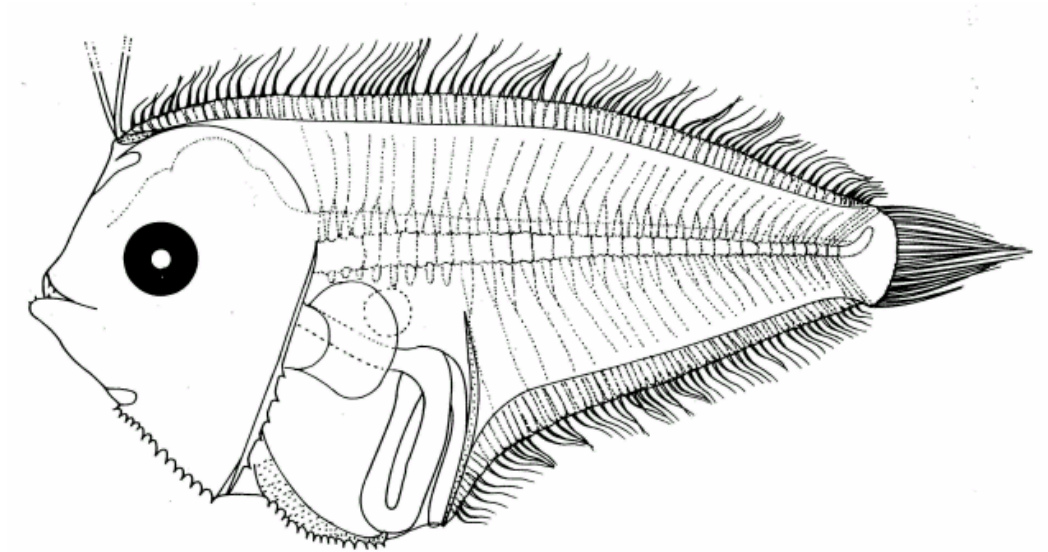


Fig. 35 – Larva of *E. latifrons*, 6.6 mm SL, Lalithambika Devi, 1986.

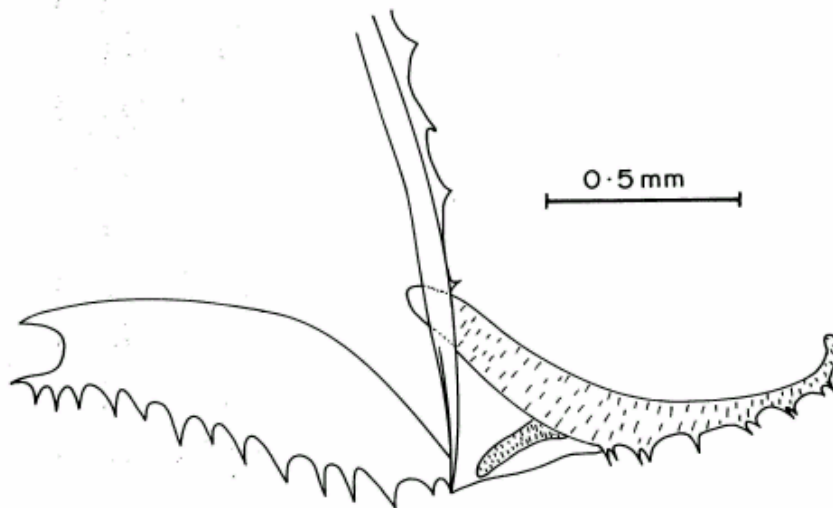


Fig. 35 A - Pattern of distribution of spines on urohyal, cleithra and posterior basypterygial processes of larvae of *E. latifrons*, 6.7 mm SL.

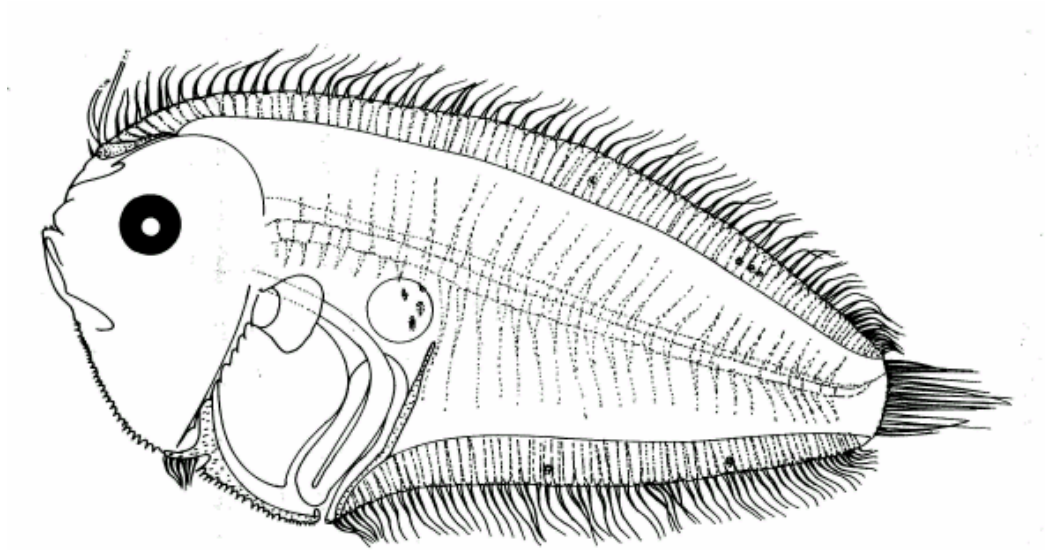


Fig. 36 – Larva of *E. mogkii*, 9.4 mm SL, from Lalithambika Devi, 1986.

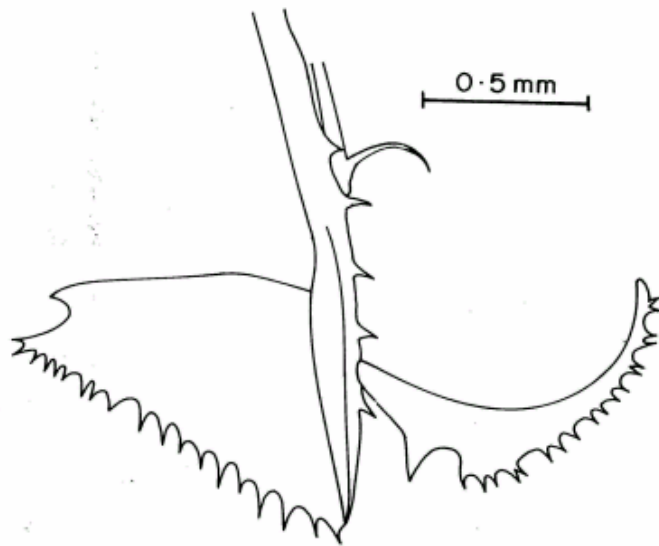


Fig. 36 A - Pattern of distribution of spines on urohyal, cleithra and posterior basypterygial processes of larvae of *E. mogkii*, 5.3 mm SL.

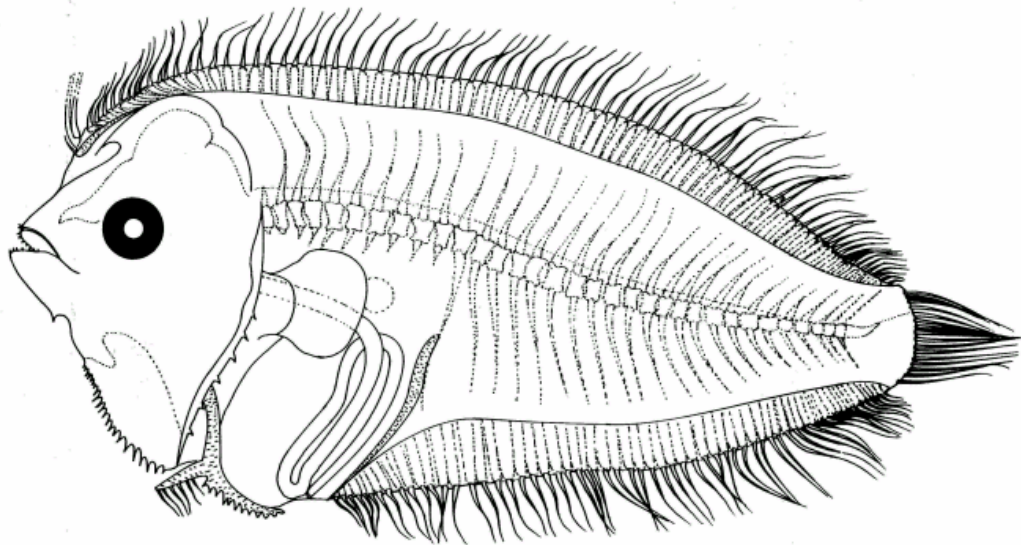


Fig. 37 – Larva of *E. grandisquamis*, 8.8 mm SL, from Lalithambika Devi, 1986.

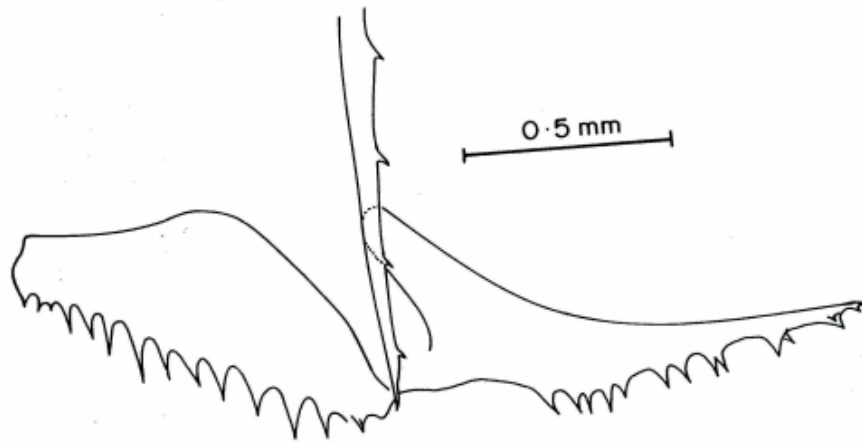


Fig. 37 A – Pattern of distribution of spines on urohyal, cleithra and posterior basipterygial processes of larva of *E. grandisquamis*, 9.3 mm SL.

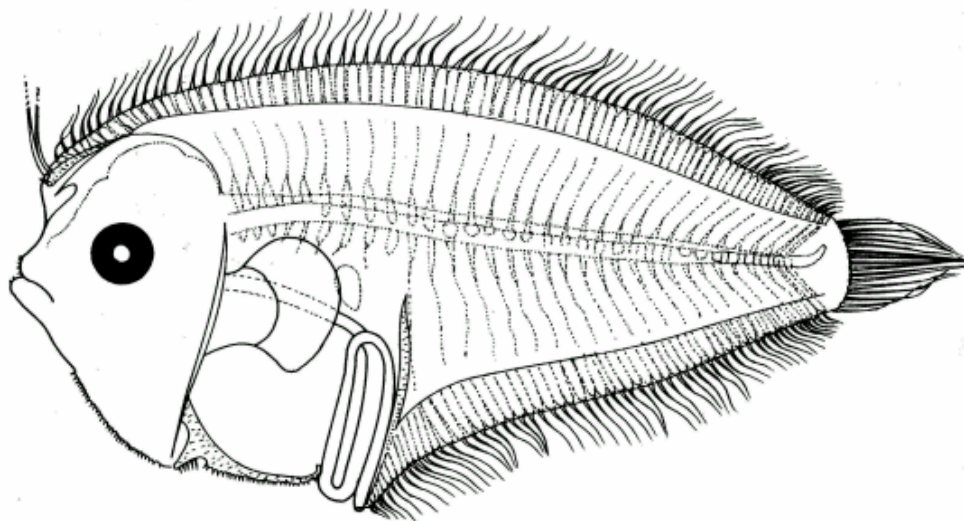


Fig. 38 – Larva of *E. sechellensis*, 9.3 mm SL, from Lalithambika Devi, 1986.

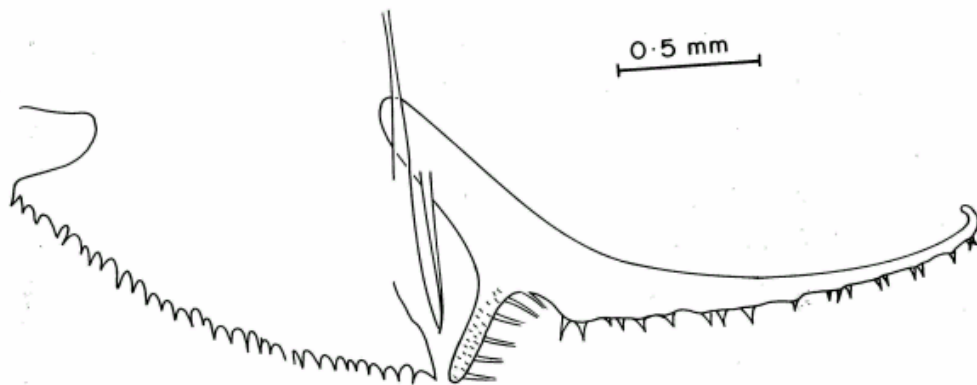


Fig. 38 A - Pattern of distribution of spines on urohyal, cleithra and posterior basypterygial processes of larvae of *E. sechellensis*, 9.3 mm SL.

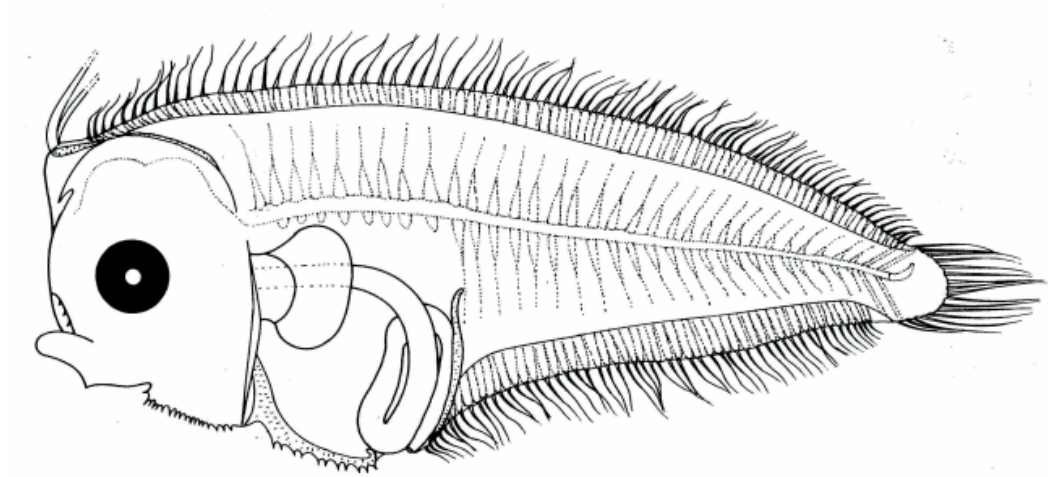


Fig. 39 – Larva of *E. multisquama*, 5.8 mm SL, from Lalithambika Devi, 1986.

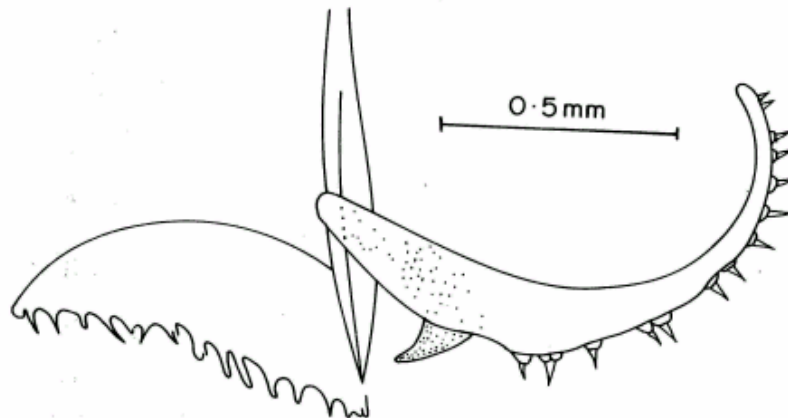


Fig. 39 A - Pattern of distribution of spines on urohyal, cleithra and posterior basipterygial processes of larvae of *E. multisquama*, 5.2 mm SL.

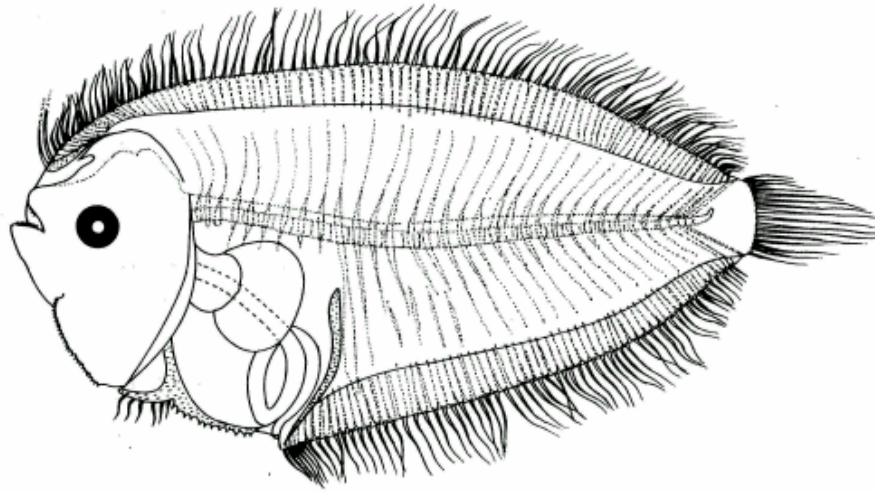


Fig. 40 – Larva of *E. xenandrus*, 15.8 mm from Lalithambika Devi, 1986.

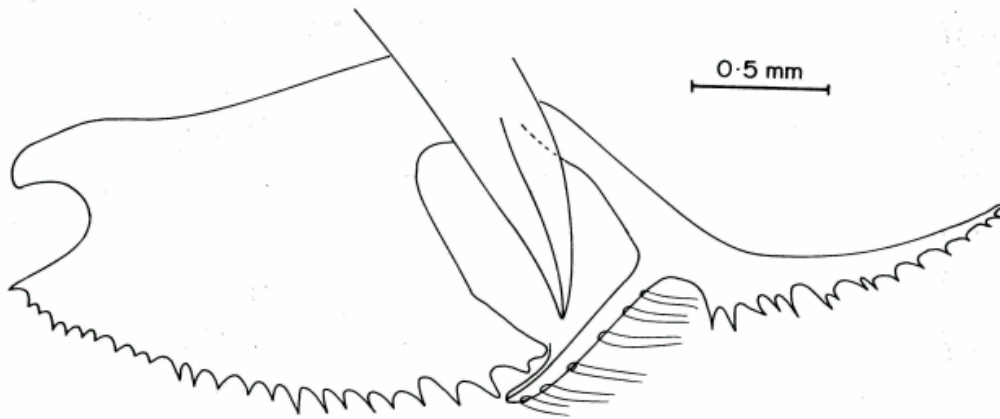


Fig. 40 A - Pattern of distribution of spines on urohyal, cleithra and posterior basipterygial processes of larvae of *E. xenandrus*, 11.7 mm SL.

Genus *Bothus*, Rafinesque

The larval body mostly oval in shape, the posterior basipterygial process long and extend beyond the mid level of the intestinal loop reaching to the anus; the distal ends of basipterygial processes curve dorsalwards and anteriorwards below the intestinal loop, spines are totally absent on cleithra, urohyal and basipterygial processes; elongated 2nd dorsal fin ray prominent only in early stages, presence of an elongated and asymmetrical left pelvic fin radial with elongated rays, the anterior three of which placed

in advance of the right fin. Intestinal loop not compact. The cartilaginous structure with minute prominences imparting a pitted appearance.

Preflexion stages of *Bothus* have a melanistic blotch near the the tip of the notochord; later larval stages unpigmented, except in transforming specimens of some species, *B. myriaster* (Amoaka, 1964) and *B. mancus* became heavily spotted over the body and fins (Ahlstrom *et al.*, 1984).

Seven species of adults are reported from the Indo-Pacific region by Norman (1934) and 3 species from the Japanese waters (Amaoka, 1969) which are similar to those of Norman.

Synopsis to species

1.	Deeply ovate body	2	
2.	Teeth		
2.1.	Jaws carry small teeth	4	
2.2.	Jaws devoid of teeth	5.2	
3.	Late development of fin rays and pelvic fin	4.2	
4.	Swim bladder		
4.1.	Swim bladder smaller than the eye diameter	5.1	
4.2.	Swim bladder larger than the eye diameter	5.3	
5.1.	Dorsal fin rays 86-92 (95), anal fin rays 62-71; vertebrae 10+(26-29)		<i>B. myriaster</i> Figs. 41a, b (from (Temminck and Schlegel) Lalithambika Devi,1986)
5.2.	Dorsal fin rays 96-103, anal fin rays 74-81, vertebrae10+(29-30) ...		<i>B. mancus</i> (Broussonet) Fig.42 (from Lalithambika Devi,1986)
5.3.	Dorsal fin rays 85-98,anal fin rays (64) 66-77, vertebrae 10+(27-32) __		<i>B. pantherinus</i> (Ruppell) Fig. 43 (from Lalithambika Devi,1986)

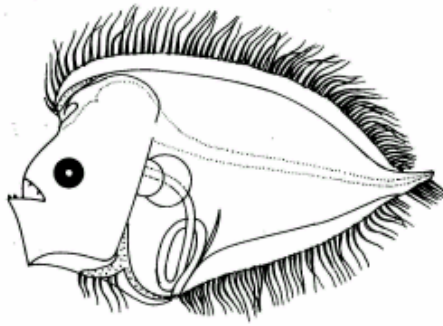


Fig. 41 - Larva of *Bothus myriaster*, 4.2 mm NL, from Lalithambika Devi, 1986.

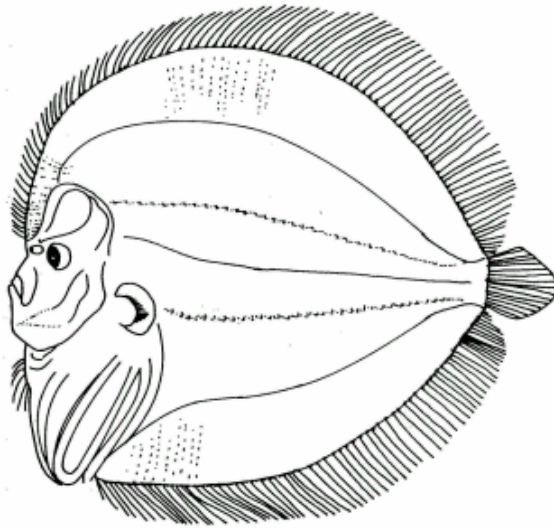


Fig. 41 A – Larva of *Bothus myriaster*, 13.0 mm SL, from Fukui, 1997.

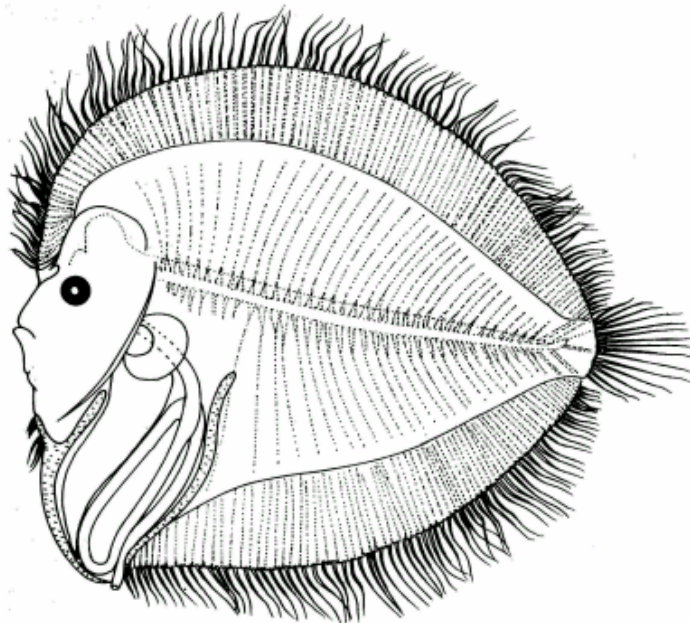


Fig. 42 – Larva of *B. mancus*, 18.9 mm SL, from Fukui, 1997.

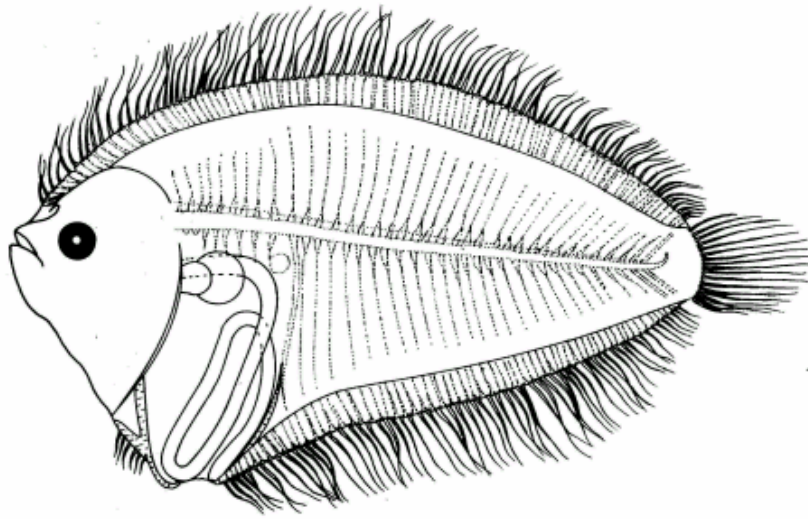


Fig. 43 – Larva of *B. pantherinus*, 15.6 mm SL, from Lalithambika Devi, 1986.

Genus *Grammatobothus*, Norman

Body oval; anterior 3 dorsal fin rays (2-4) elongated during the metamorphosing stage, of which the 3rd one the longest; in early stages only the 2nd ray elongated; spines present on the urohyal and posterior basipterygial processes in larvae nearing metamorphosis.

Three species of adults are reported from the Indo-Pacific region (Norman, 1934).

Dorsal fin rays 77-86, anal fin rays 61-69;

Vertebrae 10+27 .., *Grammatobothus*

polyophthalmus (Bleeker)

Fig. 44

(from Fukui, 1997)

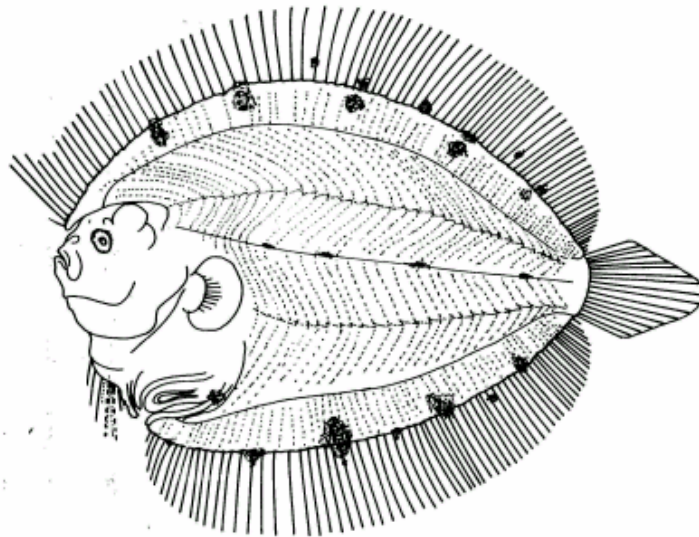


Fig. 44 – Larva of *Grammatobothus polyophthalmus*, 27.1 mm SL, from Fukui, 1997.

Genus *Asterorhombus* Tanaka

Lanceolate - shaped larval body, absence of spines on urohyal, cleithra and posterior basipterygial processes; posterior basipterygial processes extending only up to the middle of intestinal coil; short but asymmetrical left pelvic fin radial and rays. 2nd dorsal ray long and stout. Brown pigment spots on the abdomen over the swim bladder.

Only a single species of adult reported from Japanese waters by Amaoka (1969)

Dorsal fin rays 80-90, anal fin rays 60-63,

Vertebrae 10+(25-26) *A. intermedius*
(Bleeker)

Fig. 45 (From

LalithambikaDevi, (1986)

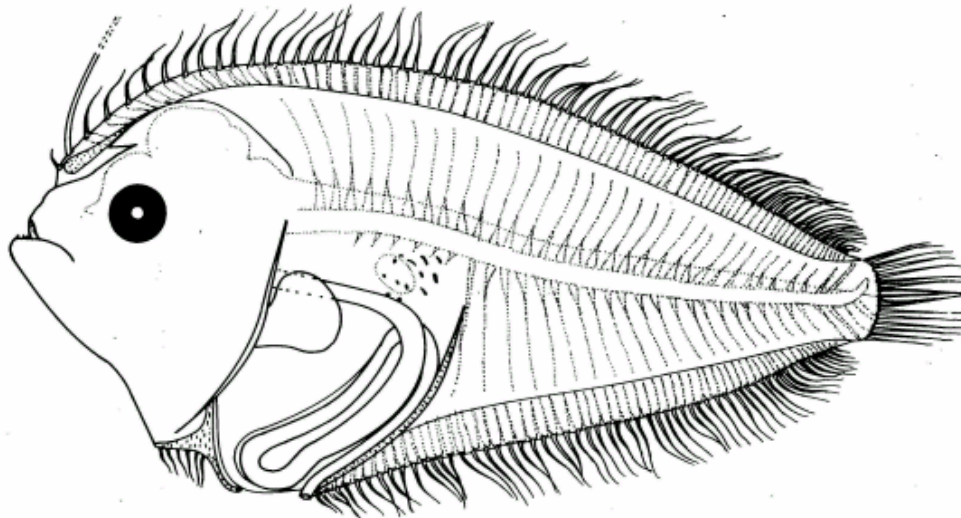


Fig. 45 – Larva of *Asterorhombus intermedius*, 7.8 mm SL, from Lalithambika Devi, 1986.

Genus *Psettina* Hubbs

Presence of pigmented urohyal appendage in early stages which gets progressively reduced during flexion stages; the spines on urohyal and posterior basipterygial processes and the absence of spines on cleithra ; the spines late to appear and restricted to proximal half of the posterior basipterygial processes, the distal half being devoid of spines.

Usually have melanophores above the brain, ventrally on the gut, above the swim bladder (gas bladder, Ahlstrom *et al.*, 1984) in series along the dorsal and ventral mid lines, and along the horizontal septum.

Three species of adults are reported from the Indo-Pacific (Norman, 1934) and three species from Japanese waters (Amaoka, 1969) of which one species is common.

Synopsis to species

- | | | |
|------|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| 1.1. | Spinules near the baseosts along the dorsal and ventral body wall as well as the rays | 2.1 |
| 1.2. | Spinules absent | 2.2 |
| 2.1. | Dorsal fin rays 80-95, anal fin rays 68-70(75) ;
vertebrae 10+(26-30) <i>P. iijimae</i>
(Jordan and Starks) | Fig. 46 (from
Lalithambika Devi, 1989) |

- 2.2.1. Dorsal fin rays 76-82, anal fin rays 58-66 ; Fig. 47 (fromvertebrae 10+(24-27)*P. brevirectis* (Alcock) Lalithambika Devi, 1986)
- 2.2.2. Dorsal fin rays 86-92, anal fin rays 68-71 ; Fig. 48 (fromvertebrae 10+(26-29)*P. hainanensis*, Wu Pertseva-Ostroumova, 1965)
- 2.2.3. Dorsal fin rays 89-103, anal fin rays 69-80 ; Fig. 49 (fromvertebrae (9+10)+(28-30) ...*P. gigantea*, Amaoka Fukui, 1997)
- 2.2.4. Dorsal fin rays 89-101, anal fin rays 69-82 ; Fig. 50 (fromvertebrae10+(28-30)... *P.tosana* Amaoka Fukui, 1997).

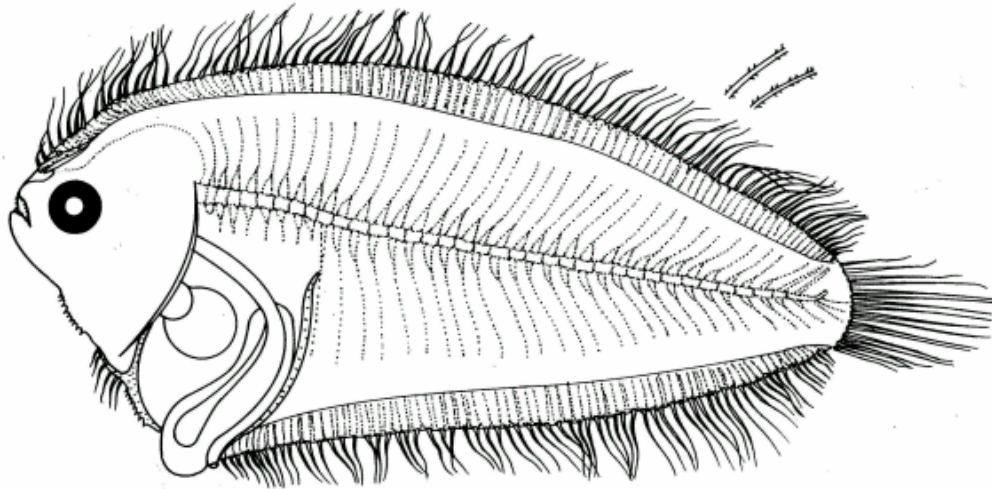


Fig. 46 – Larva of *Psettitina iijimae*, 19.7 mm SL, from Lalithambika Devi, 1989.

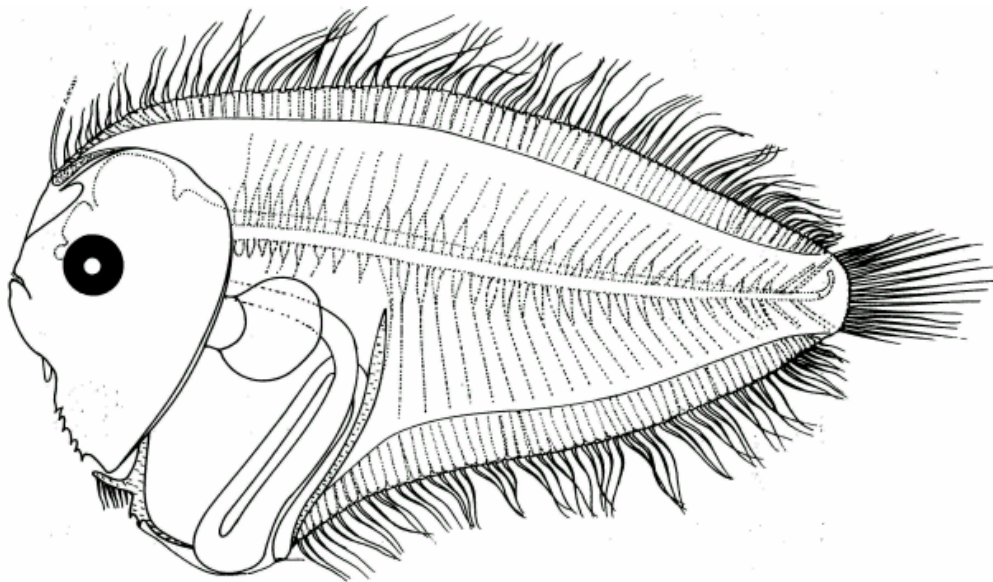


Fig. 47 – Larva of *P. brevirectis*, 9.5 mm SL, from Lalithambika Devi, 1986.

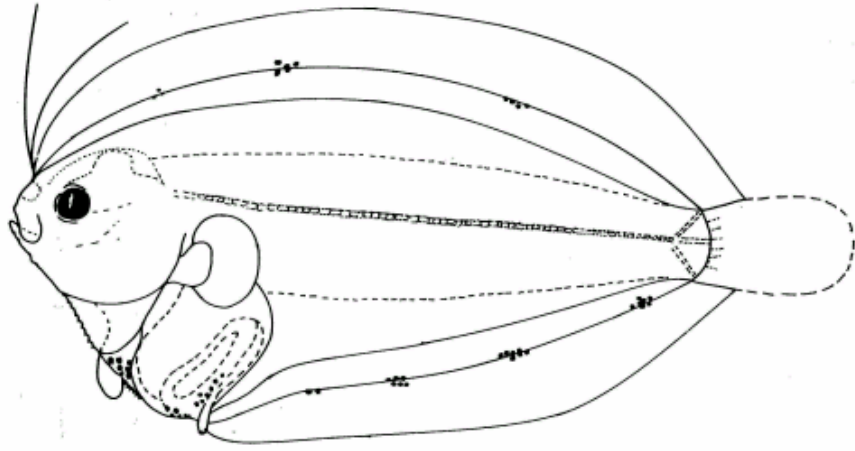


Fig. 48 – Larva of *P. hainanensis*, 18.1 mm SL, from Pertseva-Ostroumova, 1965.

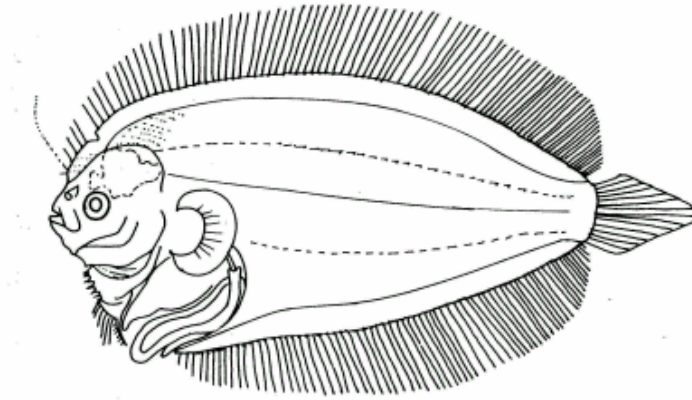


Fig. 49 – Larva of *P. gigantean*, 18.0 mm SL, from Fukui, 1977.

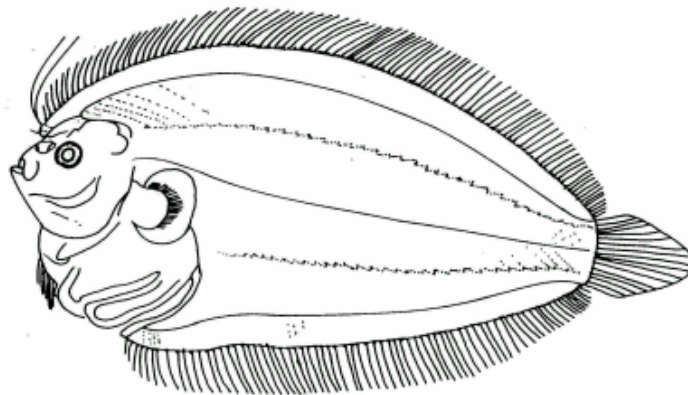


Fig. 50 – Larva of *P. tosana*, 23.2 mm SL, from Fukui, 1997.

Genus *Arnoglossus* Bleeker

Larval body long; elongated dorsal ray at the anterior end of the dorsal fin fold very prominent, longer than that found in other genera, generally elongated h ornamented and persists throughout the larval life ; spines absent on the urohyal, cleithra and posterior basipterygial processes; however, in some species spines present on discoid scutes (ctenoid scales) in different parts of the body ; the posterior basipterygial processes not extending to the anus ; left pelvic fin radial short ; usually have melanophores above the brain, ventrally on the gut, above the swim (gas) bladder, in series along the dorsal and ventral midlines, and along the horizontal septum (Ahlstrom *et al.*, 1984).

16 species of adults from the Indo-Pacific (Norman, 1934) and 4 from the Japanese waters (Amaoka, 1969).

Synopsis to species

1.1	Body thin, flat long	2.1
1.2.	Body thin laterally compressed comparatively short....	4.1
2.1.	Spines absent	3
2.2.	Discoid scutes with circlet of 9 spines each in between the distal ends of the pterygiophores and in different parts.....	5.4
3.	Elongated dorsal ray	
3.1.	Elongated dorsal ray about one time the body length and ends bifurcated	5.1
3.2.	Two elongated dorsal rays	5.3
3.2.	Elongated dorsal ray string - like and bears 6-7 branches	6.6
3.4.	Elongated dorsal ray with melanophores	6.7
4.1.	Presence of dorsal and anal rays and pelvic fin rays from very early stages	5.2
4.2.	Late development of median fin rays	5.3
4.3.	The urostyle remaining straight even after the hypural plates differentiated and also late development of caudal ray. ..	5.3&5.4
5.1.	Teeth absent	6.3
5.2.	Teeth present only during preflexion stages	6.2
5.3.	Teeth present but few in number	6.4
5.4.	Teeth present	6.5
6.1.	Dorsal fin rays (83) 93-97 (98), anal fin rays 65-74; vertebrae 10+31	Fig.51 (from <i>A. tapeinosoma</i> (Bleeker) Lalithambika Devi, 1986)
6.2.	Dorsal fin rays 72-81 (84), anal fin rays 52-67; vertebrae 10+(26-29).....	Fig.52 (from <i>A. aspilos aspilos</i> (Bleeker) Lalithambika Devi, 1986)
6.3.	Dorsal fin rays 100-103, anal fin rays 78-81; vertebrae 11+(34-36)	Fig.53 (from <i>A. elongatus</i> (Weber) Lalithambika Devi, 1986)
6.4.	Dorsal fin rays 77-83, anal fin rays 56-63; vertebrae 10+26	Fig.54 (from <i>A. intermedius</i> (Bleeker) Lalithambika Devi, 1986)
6.5.	Dorsal fin rays (94) 98-101 (106), anal fin rays (74)76-79(82);vertebrae 10+(32-35)	Fig.55 (from Lalithambika Devi, 1986)

..... *A. imperialis* (Rafinesque)

- 6.6. Dorsal fin rays 99-106, anal fin rays 76-83; Fig.56 (from
vertebrae 10+(32-34)*A. japonicus* (Hubbs) Fukui, 1997)
- 6.7. Dorsal fin rays 90-95, anal fin rays 70-74; Fig.57 (from
vertebrae 10+(30-31)*A. tenuis* (Gunther) Amaoka, 1974)

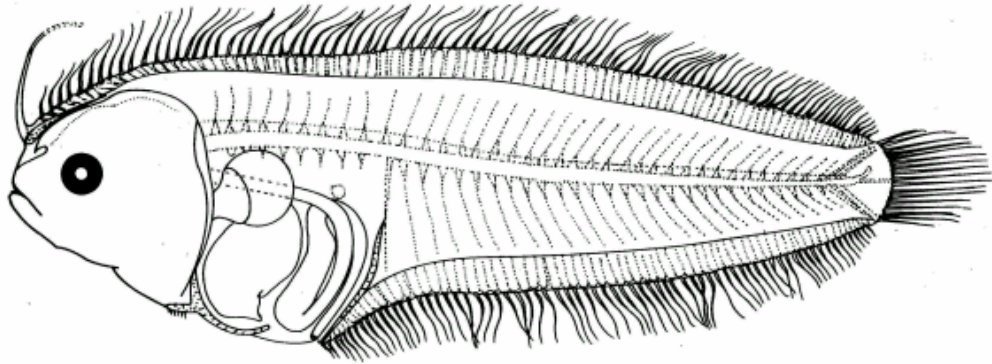


Fig. 51 – Larva of *Arnoglossus tapeinosoma*, 16.5 mm SL, from Lalithambika Devi, 1986.

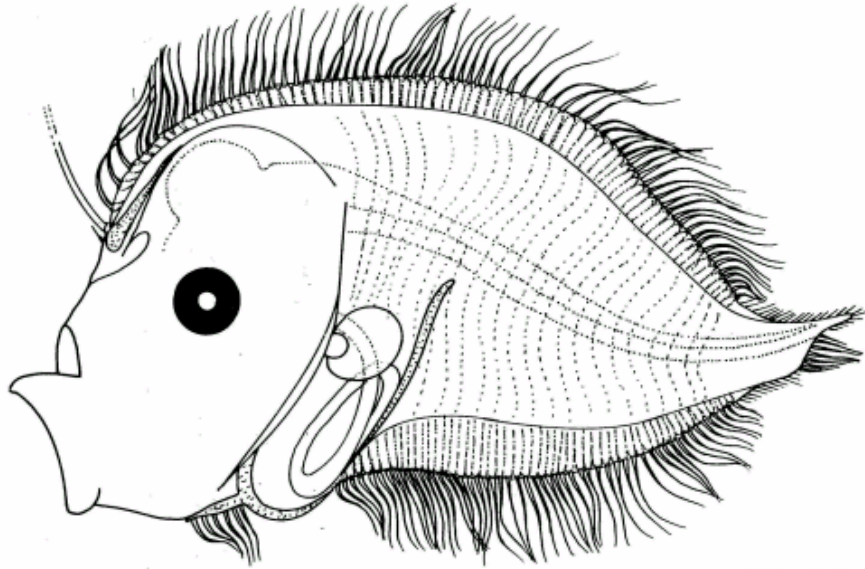


Fig. 52 – Larva of *A. aspilos*, 7.5 mm NL, flexion stage, from Lalithambika Devi, 1986.

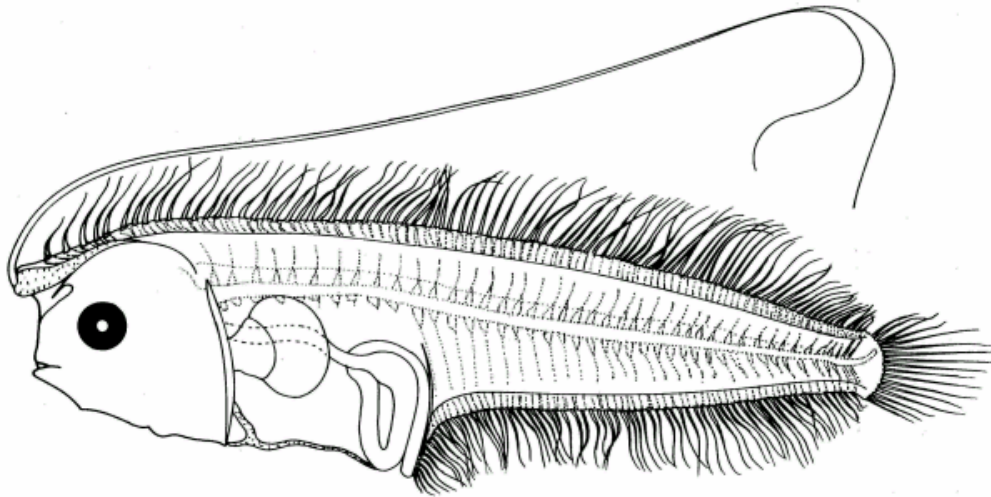


Fig. 53 – Larva of *A. elongatus*, 8.8 mm SL, from Lalithambika Devi, 1986.

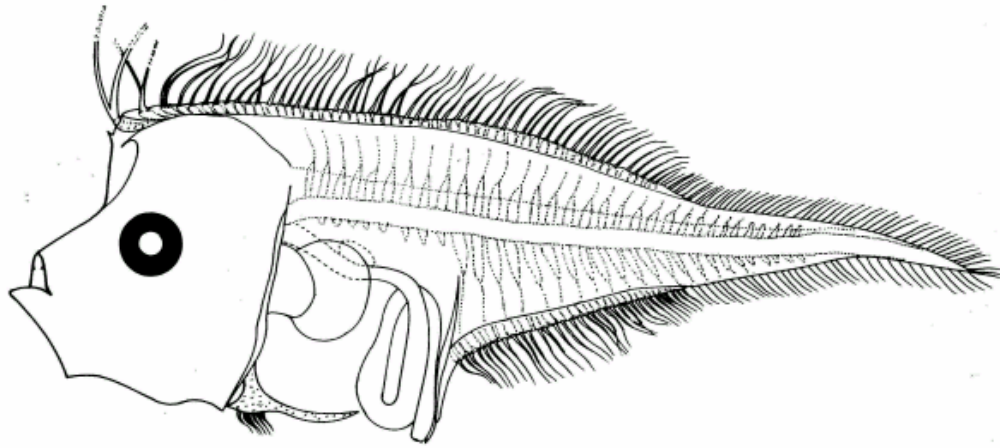


Fig. 54 – Larva of *A. intermedius*, 5.0 mm NL, from Lalithambika Devi, 1986.

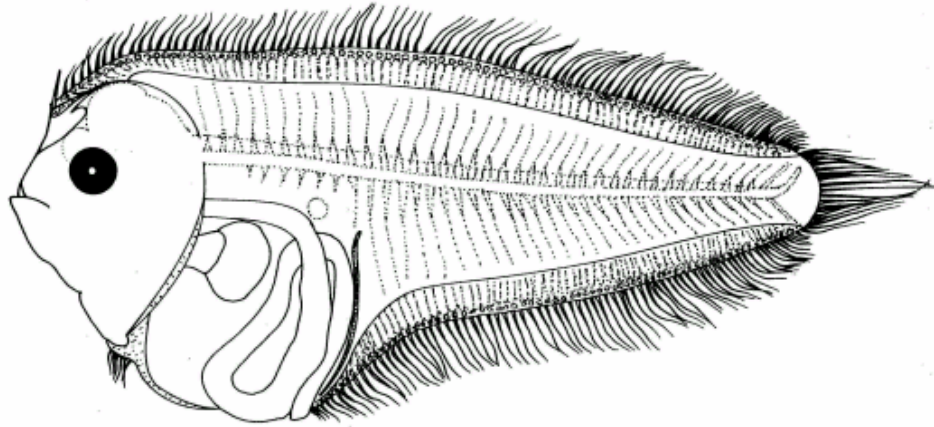


Fig. 55 – Larva of *A. imperialis*, 12.2 mm SL, from Lalithambika Devi, 1986.

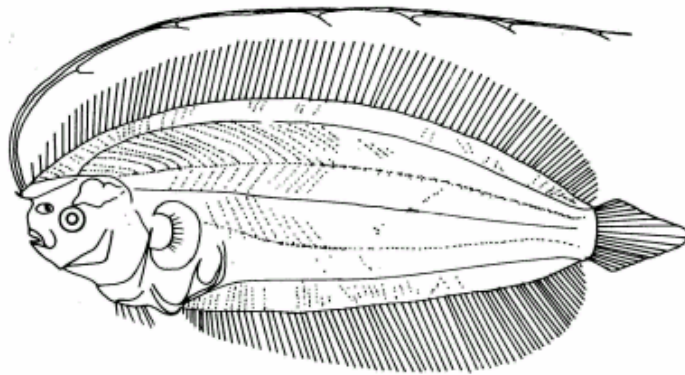


Fig. 56 – Larva of *A. japonicus*, 34.6 mm SL, from Fukui, 1997.

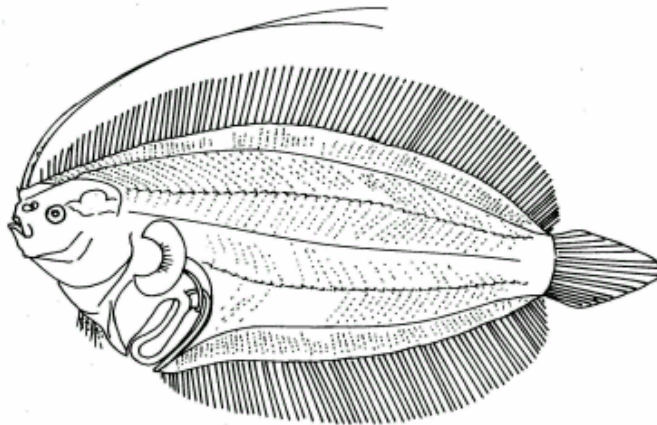


Fig. 57 – Larva of *A. tenuis*, 24.0 mm SL, from Amaoka, 1974.

Genus *Laeops* Gunther

The larvae with straight ventral body wall almost parallel to the dorsal body wall in preflexion stage; the intestinal loop directed backwards; the rectal portion remains

distinct and opens backwards; elongated dorsal ray at the anterior end of the dorsal fin fold; trailing abdomen in postflexion stages with the posterior basipterygial processes following the trailing abdomen up to the anus; liver not massive as in other bothids ; spineless urohyal, cleithra and basipterygial processes; asymmetrical left pelvic fin radial with 3 anterior rays lying in advance ; melanistic blotches forming an irregular pattern over the body and median fins (Ahlstrom *et al.*, 1984) 8 or 9 species of adults from the Indo-Pacific (Norman, 1934) of which 2 species were reported from Japanese waters by Amaoka (1969).

Synopsis to species

- | | | |
|----|-----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| 1. | Dorsal fin rays 85-98, anal fin rays 67-75;
vertebrae 11+ 35 <i>L. macrophthalmus</i> Alcock | Fig.58 (from
Lalithambika Devi, 1986) |
| 2. | Dorsal fin rays 96-102, anal fin rays 73-81;
vertebrae 10+35 <i>L. guentheri</i> , Alcock | Fig.59 (from
Balakrishnan, 1963) |
| 3. | Dorsal fin rays 100-106, anal fin rays 82-85;
vertebrae 11-12+37.. <i>nigromaculatus</i> , Von Bonde | Fig.60 (from
Fukui, 1997) |
| 4. | Dorsal fin rays (103) 105-114, anal fin rays
(76) 85-93; vertebrae 11-12+(39-41)
..... <i>L. kitaharae</i> (Smith and Pope) | Fig.61 (from
Fukui, 1997) |

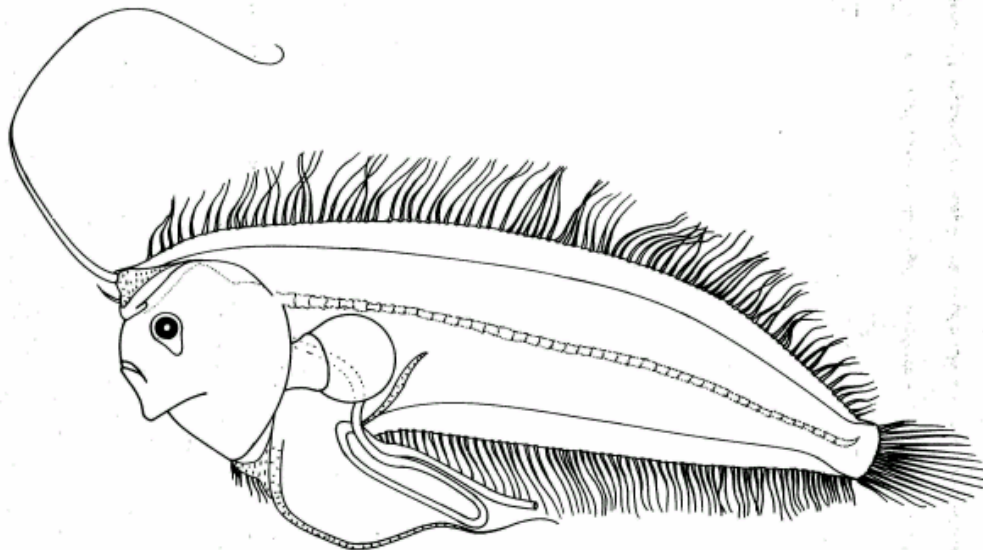


Fig. 58 – Larva of *Laeops macrophthalmus*, 19.0 mm SL, from Lalithambika Devi, 1986.

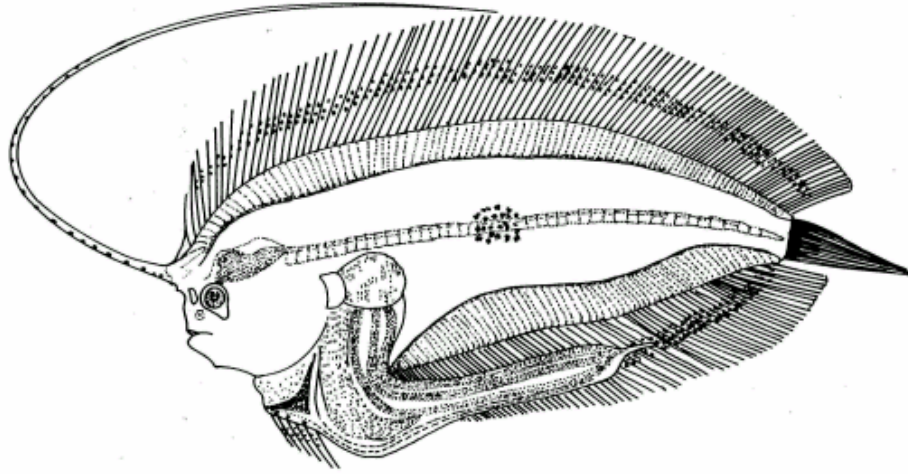


Fig. 59 – Larva of *L. guentheri*, 18.9 mm SL, from Balakrishnan, 1963.

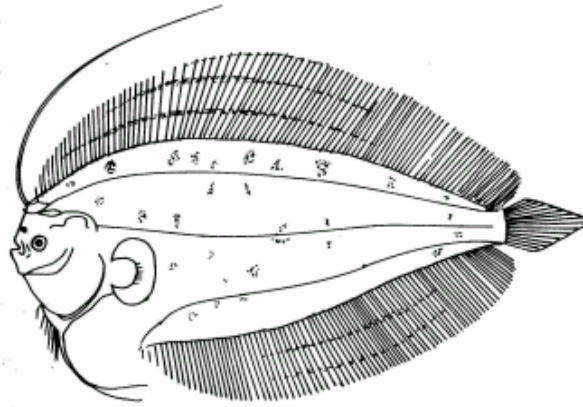


Fig. 60 – Larva of *L. nigromaculatus*, 56.6 mm SL, from Fukui, 1996.

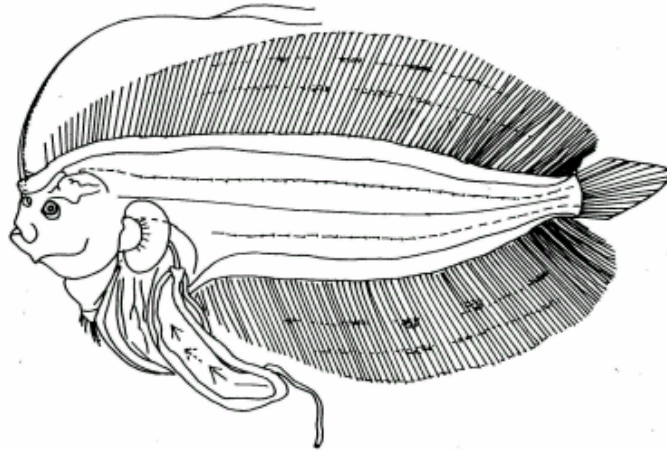


Fig. 61 – Larva of *L. kitahara*, 28.2 mm SL, from Fukui, 1997.

Genus *Chascanopsetta* Alcock

The elongate leaf - like body; small subterminal mouth, unlike adults; the urohyal, cleithra and posterior basipterygial processes without spines, elongated ray at the anterior end of the dorsal fin which persists till the end of the larval life. Short but asymmetrical pelvic fin and one left ray in advance of the right. Pre-caudal vertebrae more than 10. The first caudal pterygiophore long but not short and leaf - like.

Two species of adults from the Indo-Pacific region (Norman, 1934) of which one species from Japanese waters (Amaoka, 1969).

Synopsis to species

- | | | |
|----|----------------------------------------------------------------------------------------------------------|---------------------------------------|
| 1. | Dorsal fin rays 112-127, anal fin rays 78-88; vertebrae 16- 18+(37-41)... <i>C.lugubris</i> (Alcock) | Fig.62 (from Lalithambika Devi, 1986) |
| 2. | Dorsal fin rays 124-130, anal fin rays 93-98; vertebrae 15-17 +(42-44) . <i>C. micrognathus</i> (Amaoka) | Fig. 63 (from Fukui, 1997) |

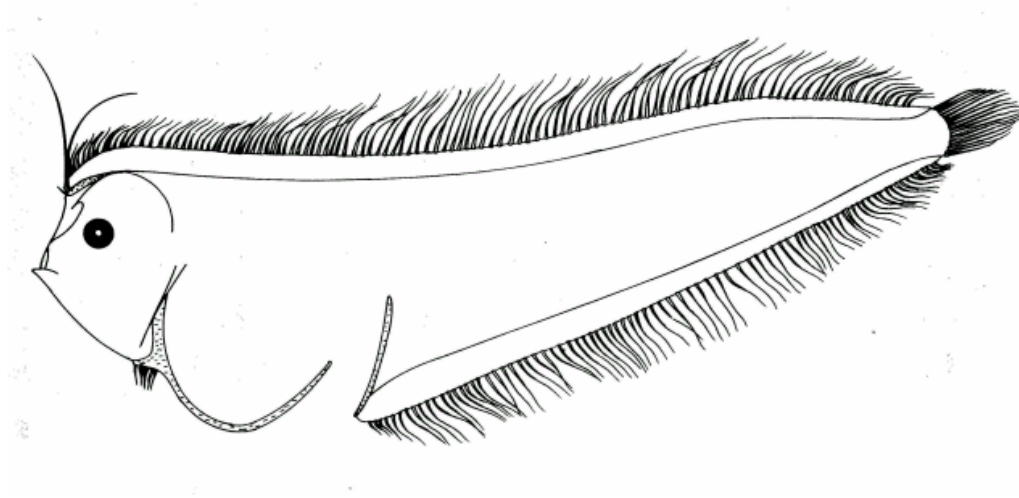


Fig. 62 – Larva of *Chascanopsetta lugubris*, 37.0 mm SL, from Lalithambika Devi, 1986.

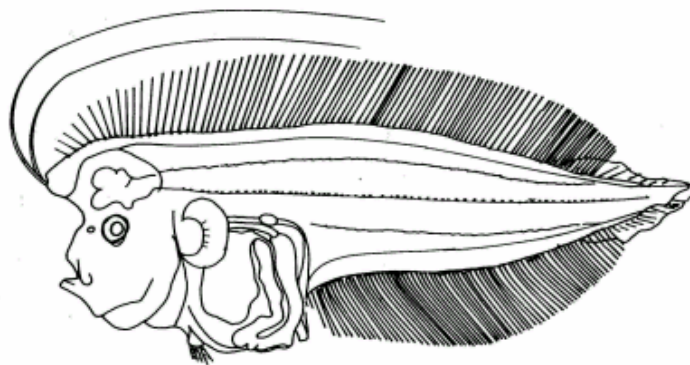


Fig. 63 - Larva of *C. micrognathus*, 10.8 mm SL, from Fukui, 1997.

12 *Bothus pantherinus* (Ruppell, 1830-31)

Larvae ranging from 3.3 mm NL to 16.0 mm SL and juveniles ranging from 29.3 to 34.9 mm SL are found in the IIOE and Naga Expedition collections. The larvae belonging to preflexion, flexion and postflexion stages as well as juveniles are available in the samples and are reported here (Figs. 12 A, B, C, D, E ; Tables 13 a, b, c, & 25).

Morphology :

Larval body oval, thin, transparent and symmetrical in early stages. Cerebral hemispheres have truncated shape at the front end in all stages examined unlike in many other species, eyes black, symmetrical, small and squarish in early stages, becoming lenticular as growth advances, right eye shows signs of movement to the left side in 11.0 mm SL larvae, and shifting completed in 29.3 mm SL specimens. Jaws carry small teeth, alimentary canal runs obliquely downwards, makes an elliptical coil at the posterior end of the abdominal cavity in 3.3 mm NL larva and the anus opens at the level of ninth vertebral segment. In later stages, ventral portion of intestinal loop is pushed obliquely forwards and the anus which opens posteriorwards lies at the level of the sixth vertebral segment in 34.9 mm SL specimen, the largest in collections. Intestinal loop not smoothly curved but flat with a depression at its ventral portion, loop is not compact, the space between the ascending and descending loops being filled with glandular tissue. A pair of caecal outgrowths occur directed dorsalwards at the junction of the oesophagus and intestine. Swim bladder present between eighth and tenth vertebral segments in early stages, later shifting below seventh and tenth vertebral segments. Liver massive, its ventral posterior portion tapers to form a finger-shaped diverticulum, lying under the intestinal loop, dorsoventral axis more than twice the anteroposterior axis in advanced stages. Spines absent on the urohyal, cleithra, posterior basipterygial processes or on the body. Cleithra remains more or less cartilaginous with a pitted appearance or tubercular projections even in advanced stages unlike in other species.

Relative head length and snout length increases from preflexion to flexion stages but decreases from flexion to postflexion and juvenile stage (Table 25). Relative snout to anus length decreases from preflexion to juvenile. Eye width and height decrease from preflexion to flexion and then show slight increase

