

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:

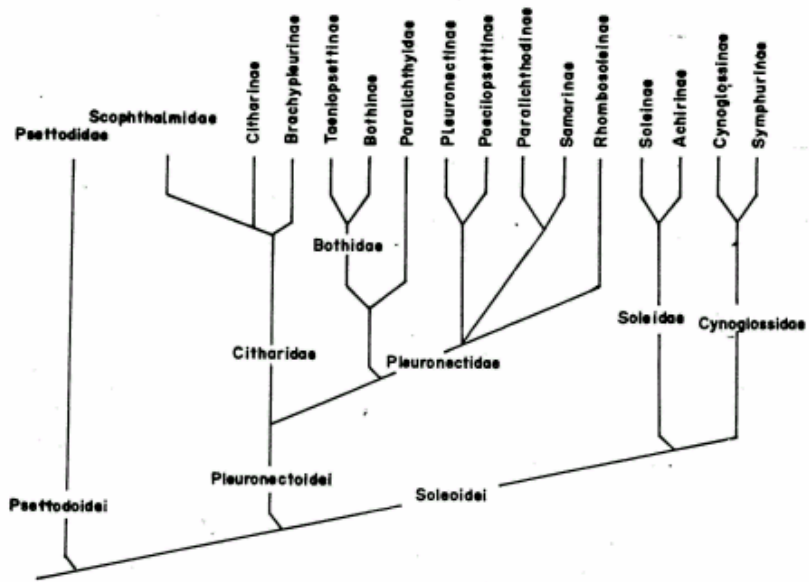


Fig. 25 – Current hypothesis for interrelationships of pleuronectiform fishes, from Hensley and Ahlstrom, 1984.

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.

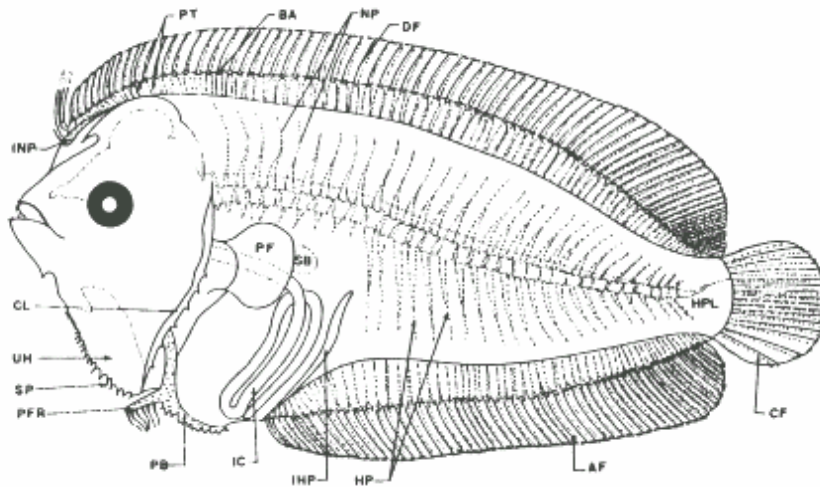


Fig. 25 - A larva of Bothid flat fish showing characters of diagnostic value. INP - 1st neural pterygiophore, PT - Pterygiophores, BA - Baseosts, NP - Neural processes, DF - Dorsal fin rays, HPL - Hypural plates, CF - Caudal fin rays, AF - Anal fin rays, HP - Haemal processes, IHP - 1st haemal pterygiophore, 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).

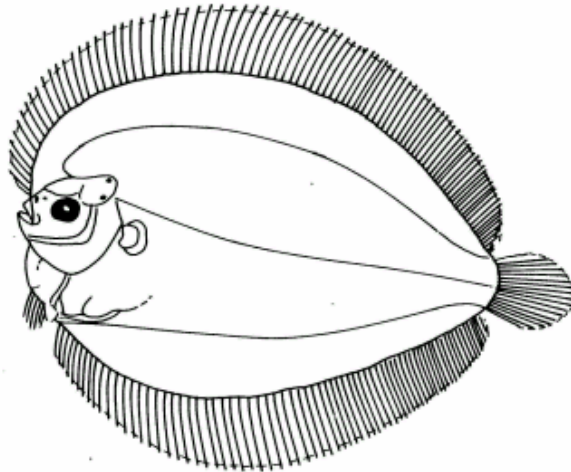


Fig. 27 – Larva of *Taeniopsetta ocellata*, 59.0 mm SL, from Amaoka, 1970.

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*

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|--|-----------------------|
| 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)

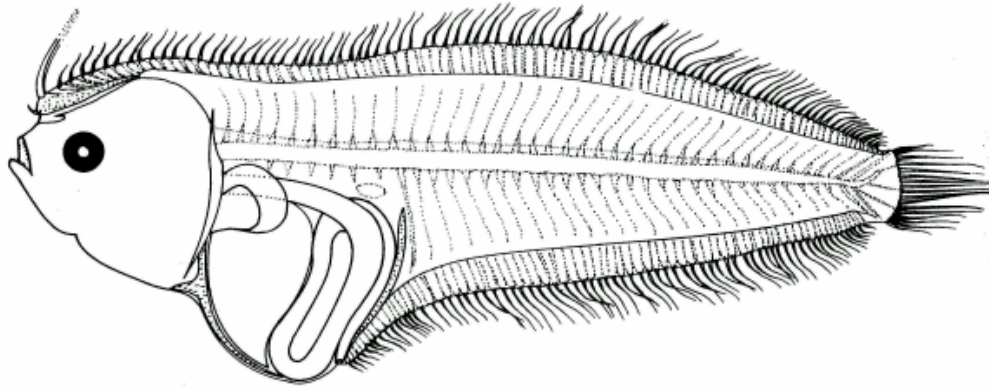


Fig. 28 – Larva of *Parabothus polylepis*, 14.6 mm SL, from Lalithambika Devi, 1986.

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.

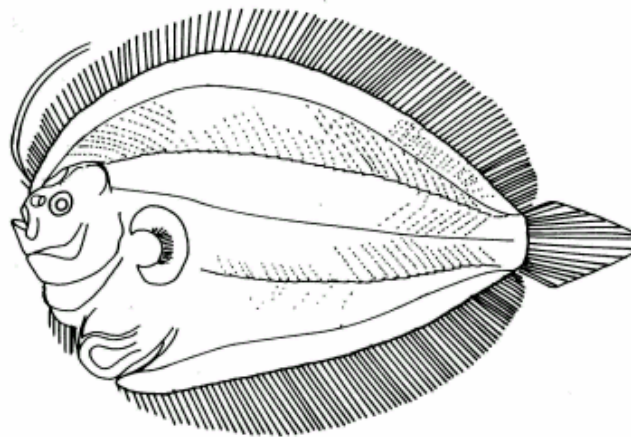


Fig. 29 – Larva of *Tosarhombus octoculatus*, 26.7 mm SL, from Fukui, 1997.

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)

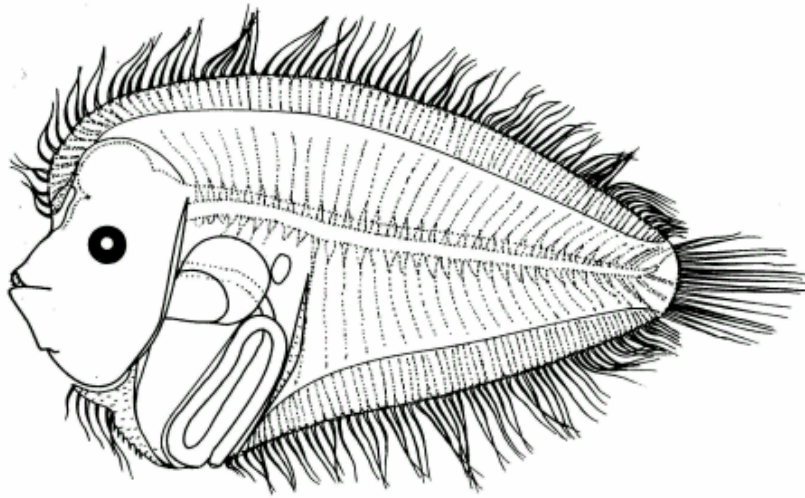


Fig. 30 – Larva of *Crossorhombus valde-rostratus*, 8.8 mm SL, from Lalithambika Devi, 1989.

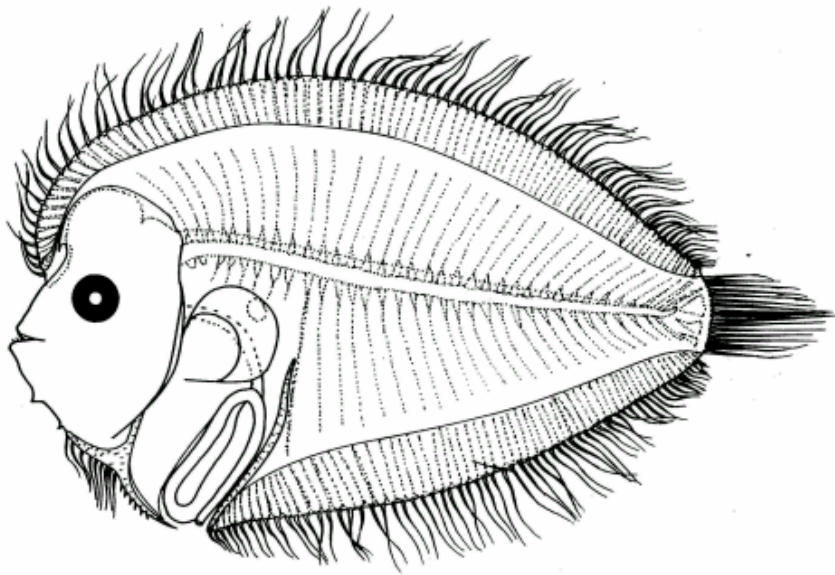


Fig. 31 – Lava of *C. azureus*, 12.4 mm SL, from Lalithambika Devi, 1989.

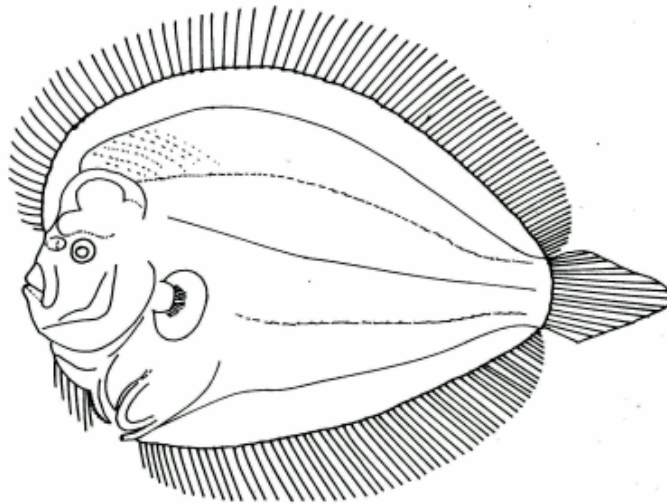


Fig. 32 – Larva of *C. kobensis*, 15.4 mm SL, Fukui, 1997.

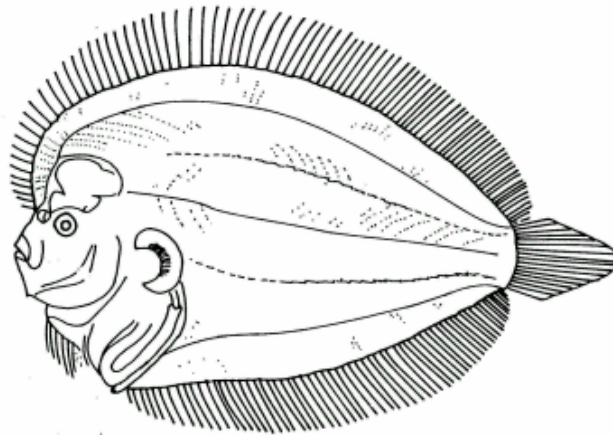


Fig. 33 – Larva of *C. kobensis*, 13.8 mm SL, Fukui, 1997.

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)

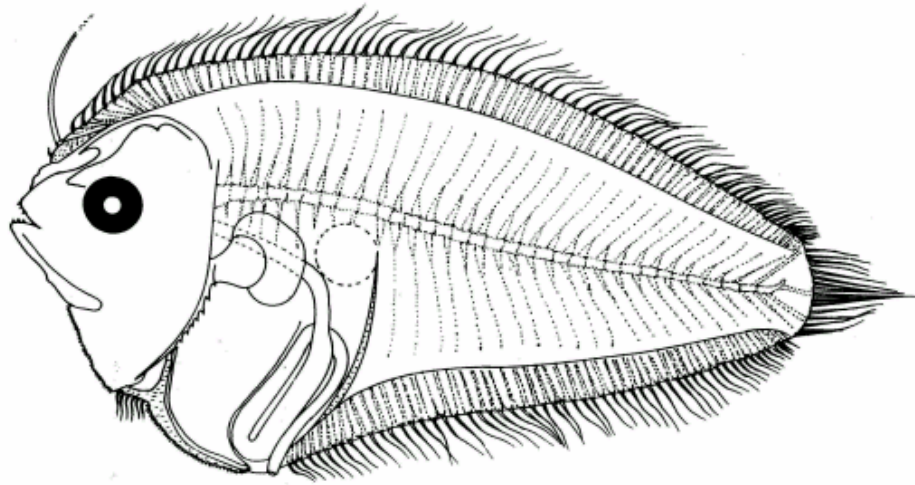


Fig. 34 – Larva of *Engyprosopon cocosensis*, 12.9 mm SL,
from Lalithambika Devi, 1986.

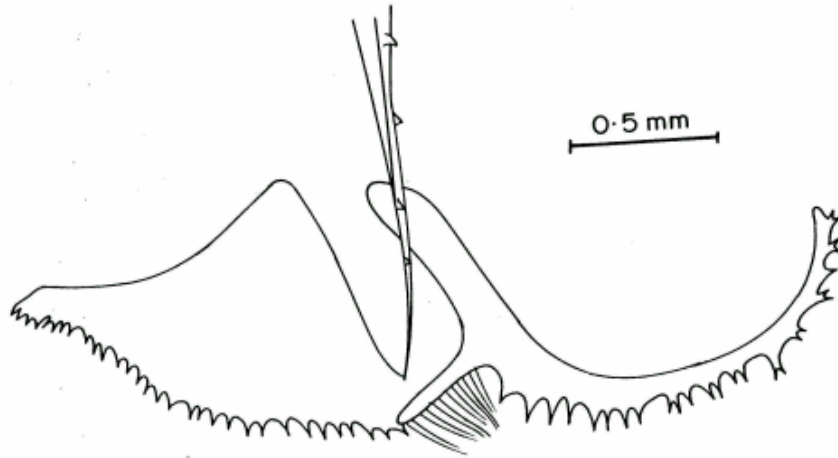


Fig. 34 A – Pattern of distribution of spines on urohyal, cleithra and posterior
basipterygial processes of larvae of *E. cocosensis*, 8.1 mm SL.

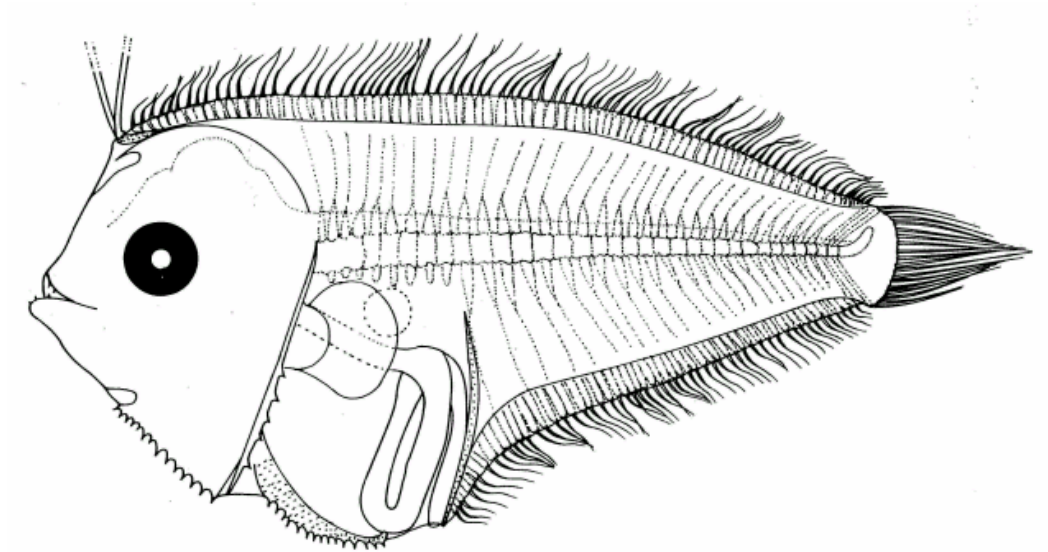


Fig. 35 – Larva of *E. latifrons*, 6.6 mm SL, Lalithambika Devi, 1986.

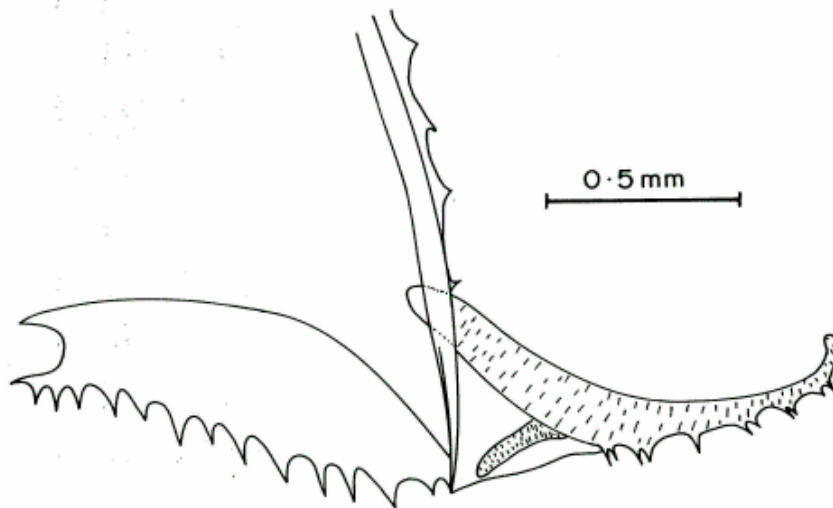


Fig. 35 A - Pattern of distribution of spines on urohyal, cleithra and posterior basypterygial processes of larvae of *E. latifrons*, 6.7 mm SL.

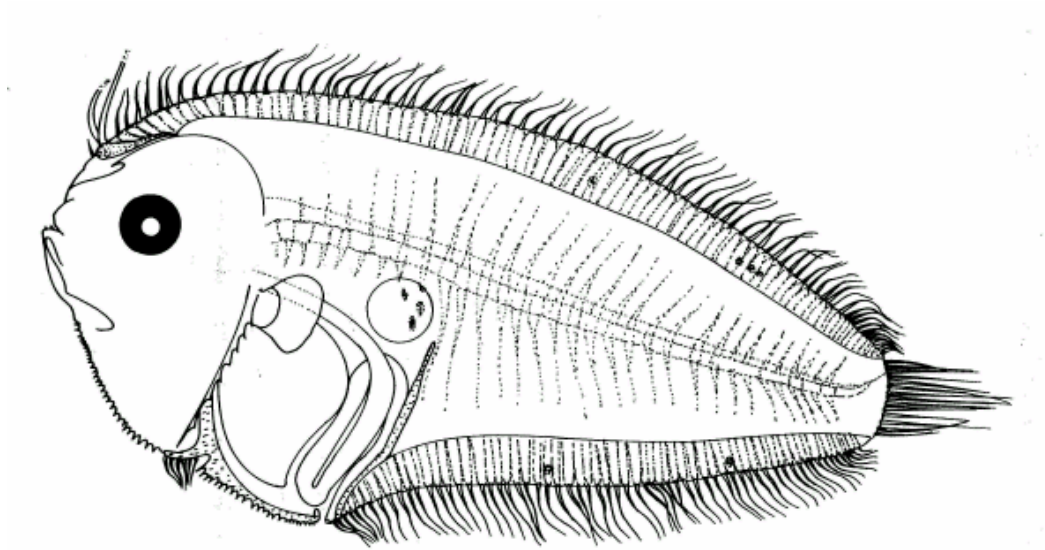


Fig. 36 – Larva of *E. mogkii*, 9.4 mm SL, from Lalithambika Devi, 1986.

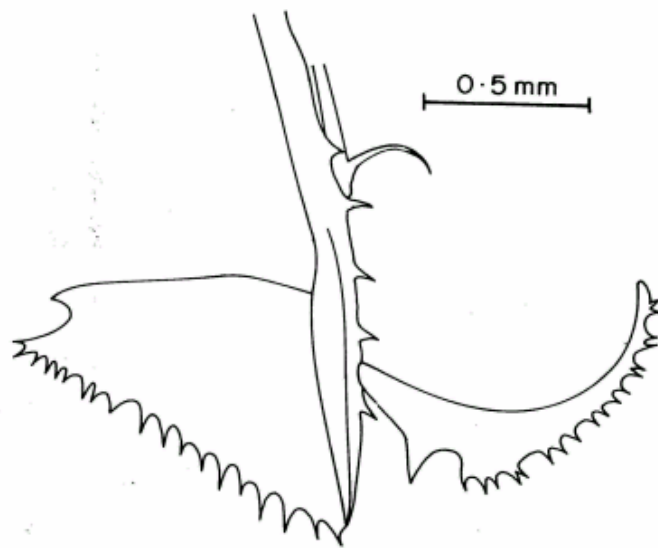


Fig. 36 A - Pattern of distribution of spines on urohyal, cleithra and posterior basypterygial processes of larvae of *E. mogkii*, 5.3 mm SL.

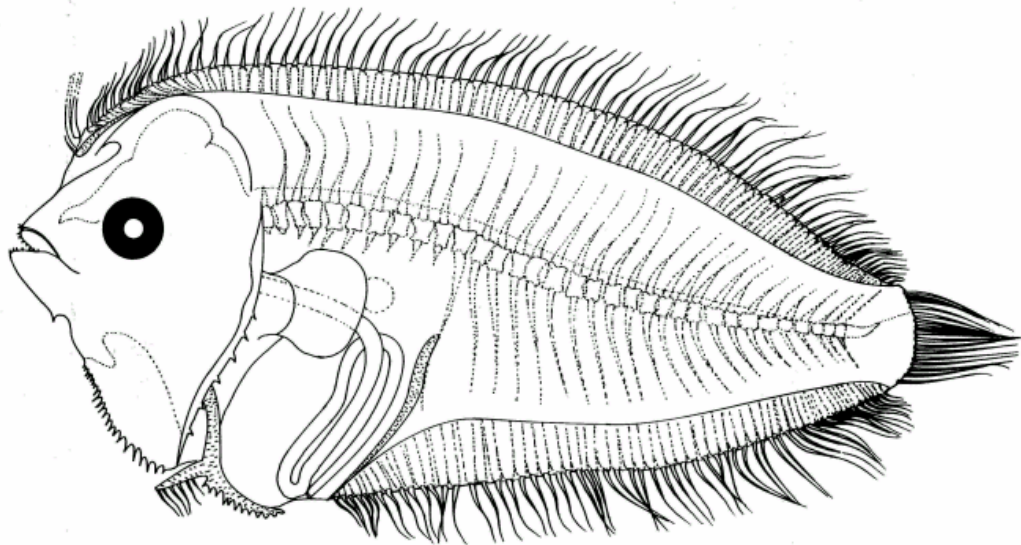


Fig. 37 – Larva of *E. grandisquamis*, 8.8 mm SL, from Lalithambika Devi, 1986.

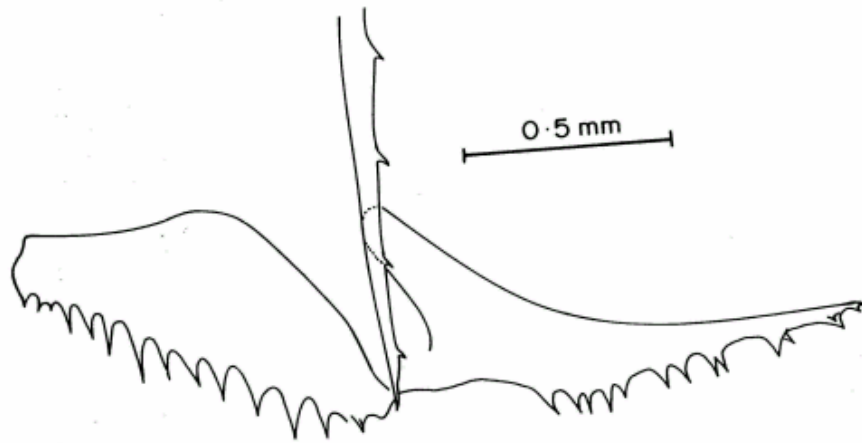


Fig. 37 A – Pattern of distribution of spines on urohyal, cleithra and posterior basipterygial processes of larva of *E. grandisquamis*, 9.3 mm SL.

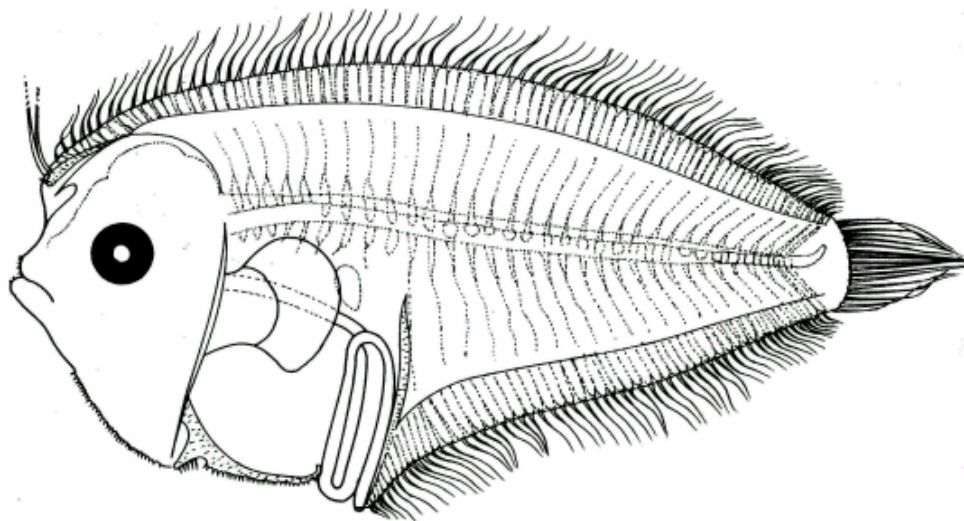


Fig. 38 – Larva of *E. sechellensis*, 9.3 mm SL, from Lalithambika Devi, 1986.

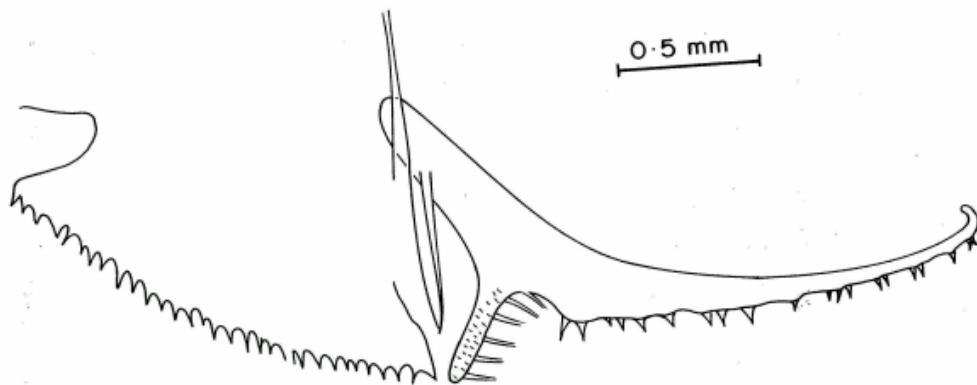


Fig. 38 A - Pattern of distribution of spines on urohyal, cleithra and posterior basypterygial processes of larvae of *E. sechellensis*, 9.3 mm SL.

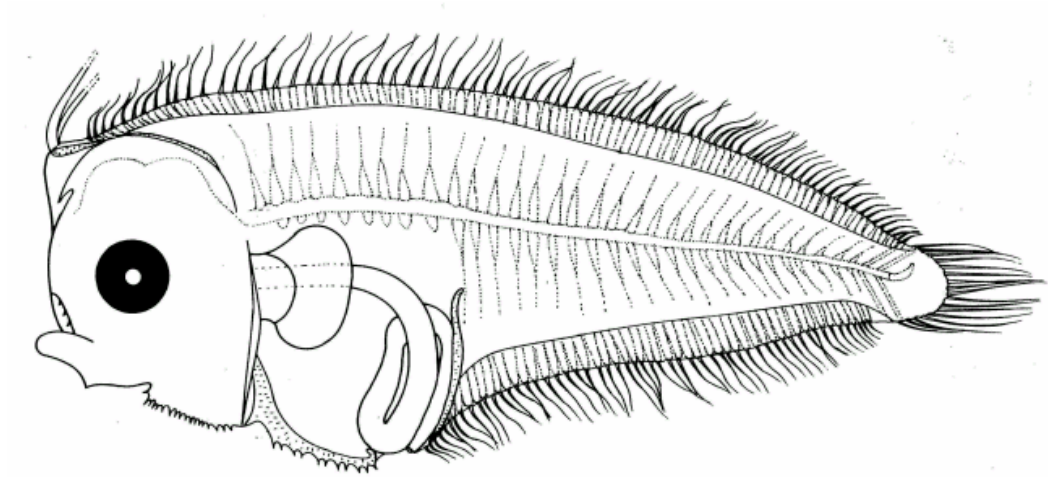


Fig. 39 – Larva of *E. multisquama*, 5.8 mm SL, from Lalithambika Devi, 1986.

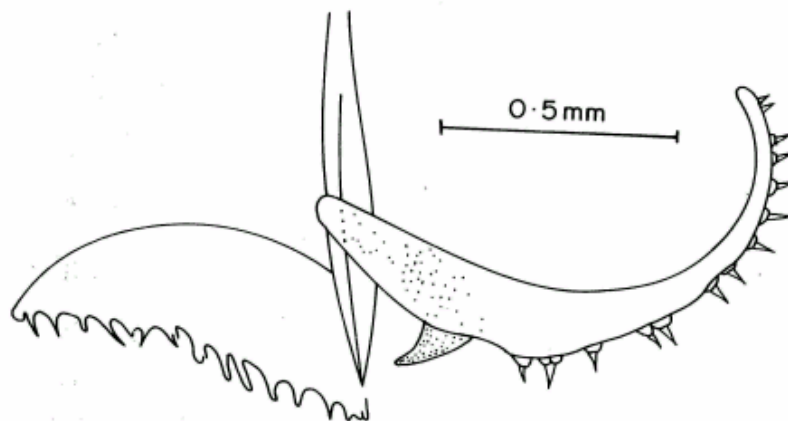


Fig. 39 A - Pattern of distribution of spines on urohyal, cleithra and posterior basipterygial processes of larvae of *E. multisquama*, 5.2 mm SL.

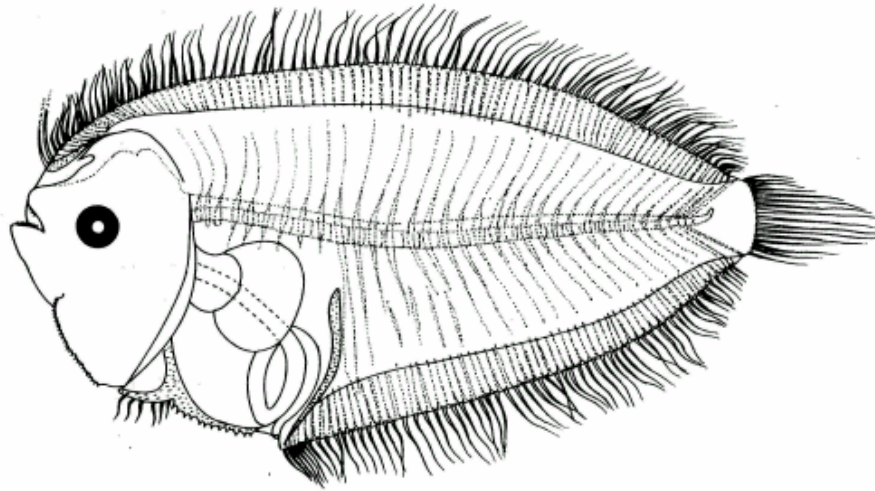


Fig. 40 – Larva of *E. xenandrus*, 15.8 mm from Lalithambika Devi, 1986.

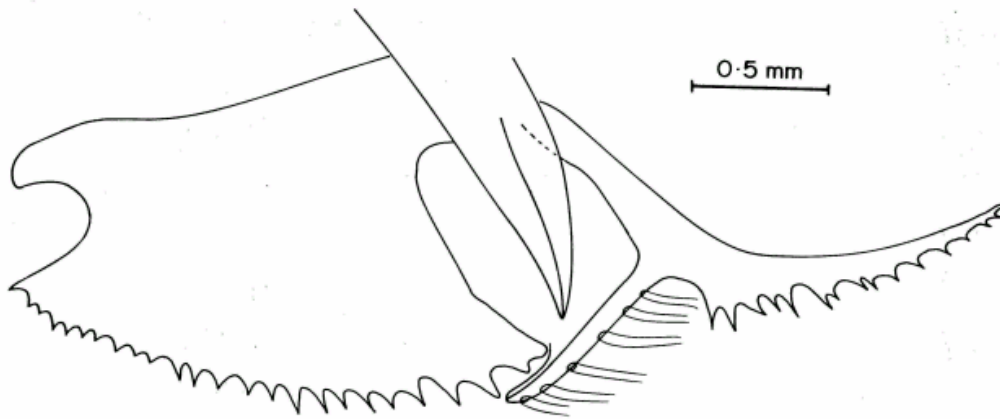


Fig. 40 A - Pattern of distribution of spines on urohyal, cleithra and posterior basipterygial processes of larvae of *E. xenandrus*, 11.7 mm SL.

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)

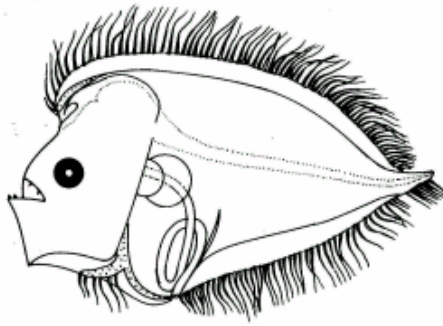


Fig. 41 - Larva of *Bothus myriaster*, 4.2 mm NL, from Lalithambika Devi, 1986.

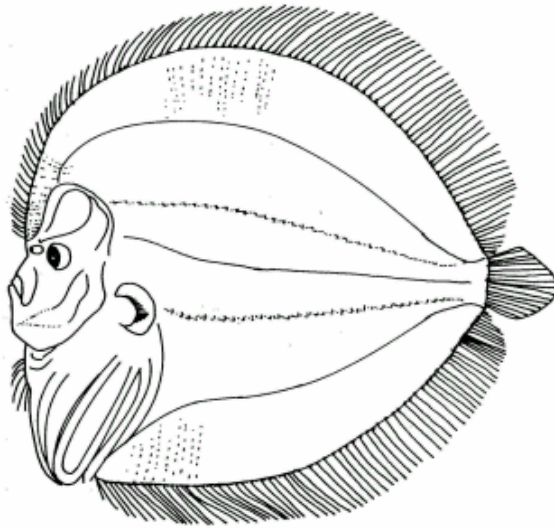


Fig. 41 A – Larva of *Bothus myriaster*, 13.0 mm SL, from Fukui, 1997.

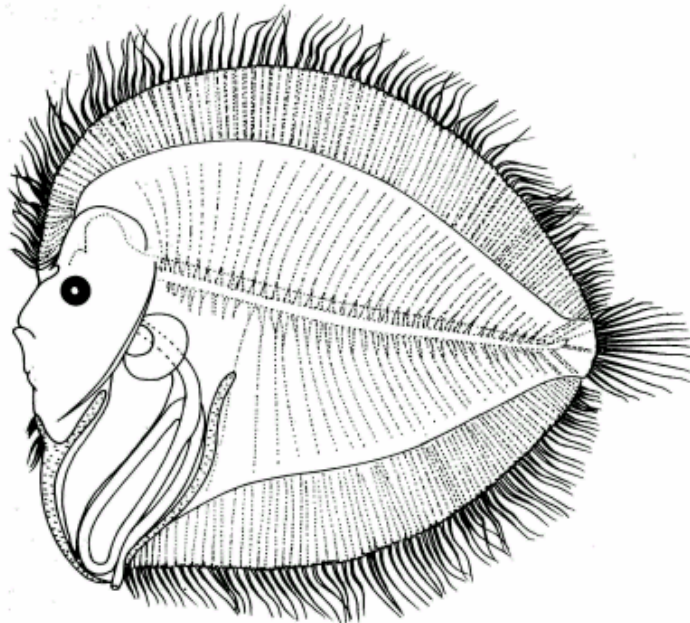


Fig. 42 – Larva of *B. mancus*, 18.9 mm SL, from Fukui, 1997.

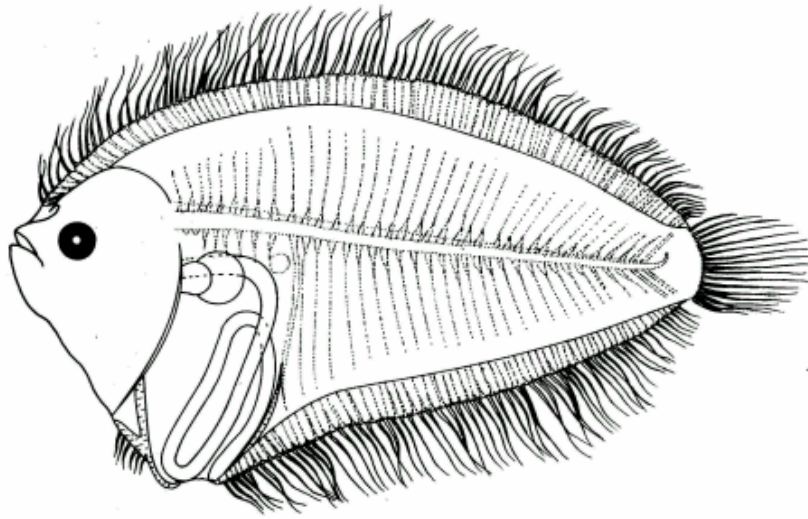


Fig. 43 – Larva of *B. pantherinus*, 15.6 mm SL, from Lalithambika Devi, 1986.

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)

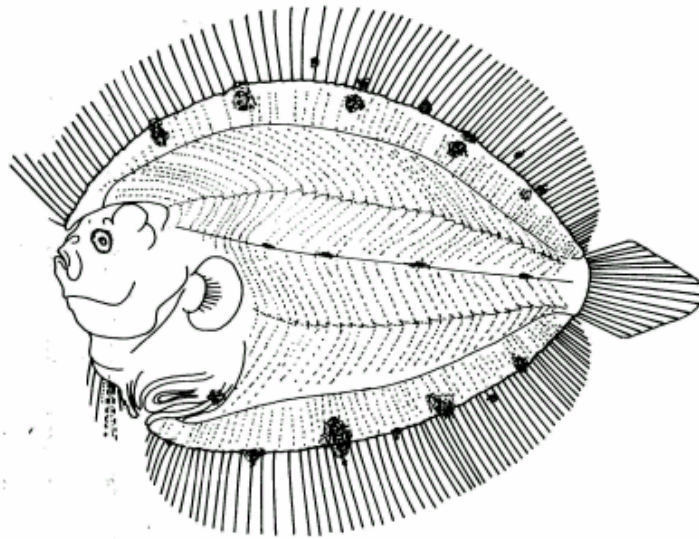


Fig. 44 – Larva of *Grammatobothus polyophthalmus*, 27.1 mm SL, from Fukui, 1997.

Genus *Asterorhombus* Tanaka

Lancet - 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)

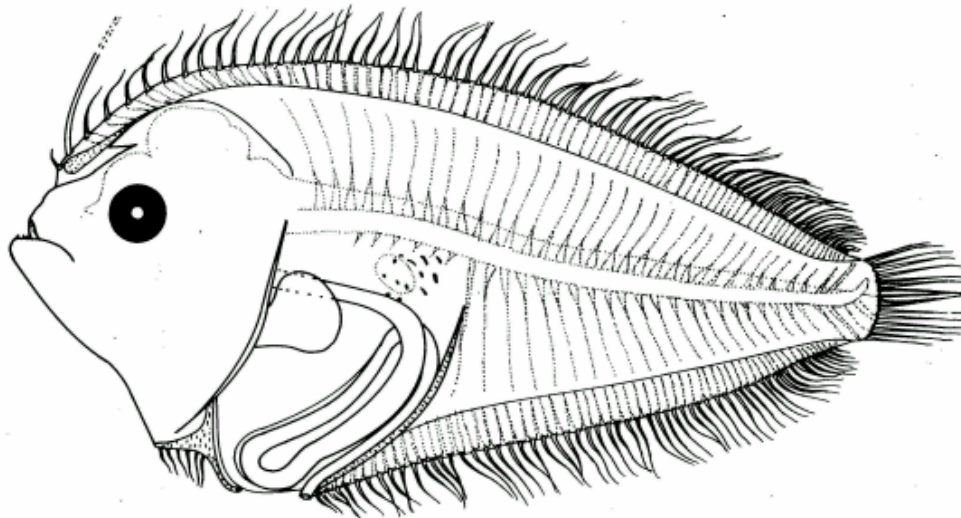


Fig. 45 – Larva of *Asterorhombus intermedius*, 7.8 mm SL, from Lalithambika Devi, 1986.

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).

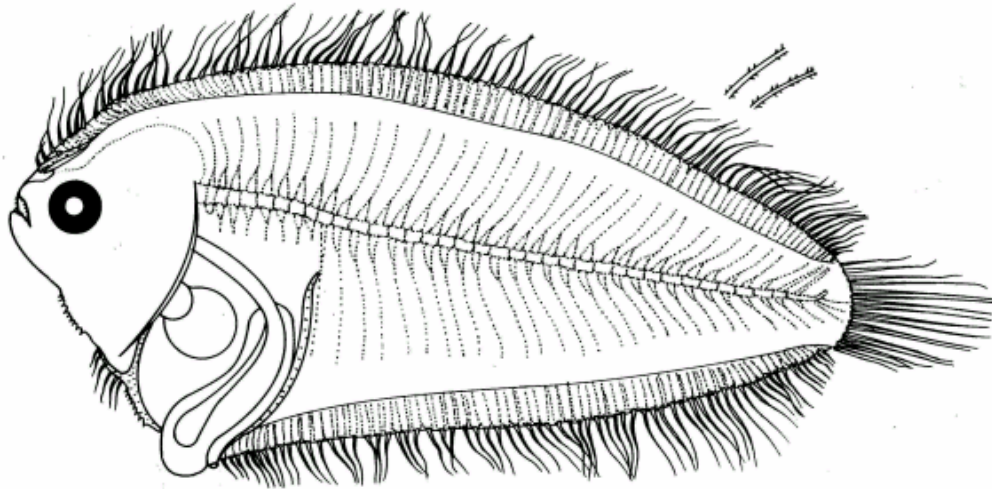


Fig. 46 – Larva of *Psettitina iijimae*, 19.7 mm SL, from Lalithambika Devi, 1989.

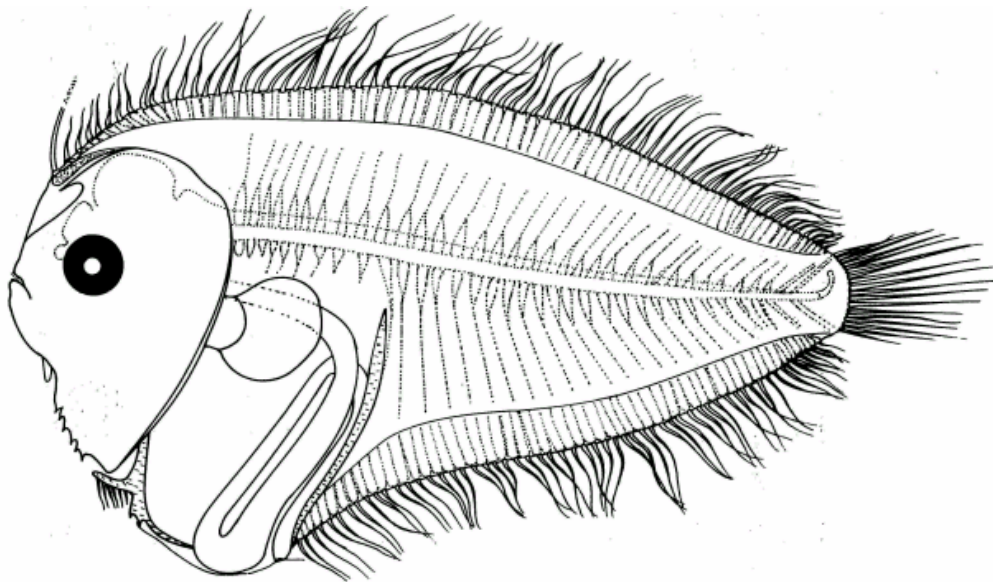


Fig. 47 – Larva of *P. brevirectis*, 9.5 mm SL, from Lalithambika Devi, 1986.

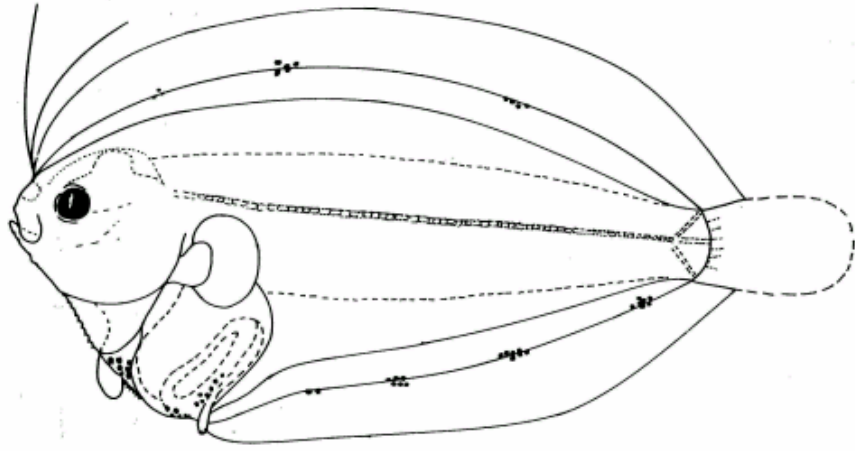


Fig. 48 – Larva of *P. hainanensis*, 18.1 mm SL, from Pertseva-Ostroumova, 1965.

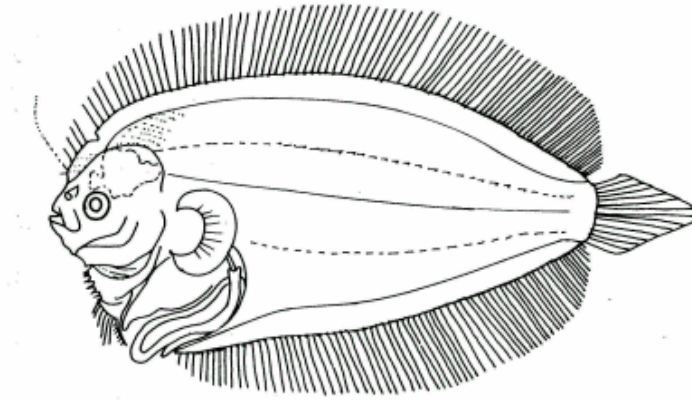


Fig. 49 – Larva of *P. gigantean*, 18.0 mm SL, from Fukui, 1977.

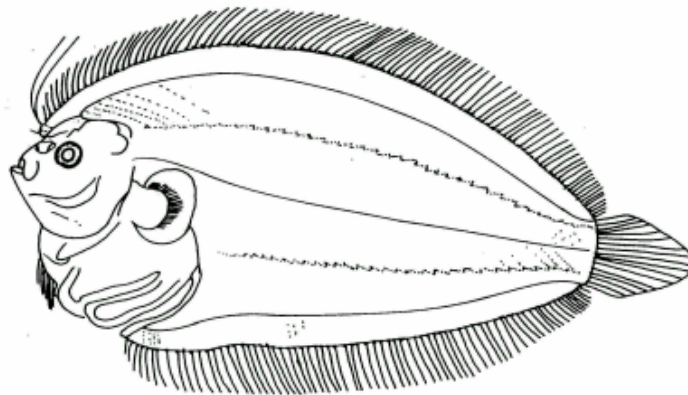


Fig. 50 – Larva of *P. tosana*, 23.2 mm SL, from Fukui, 1997.

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)

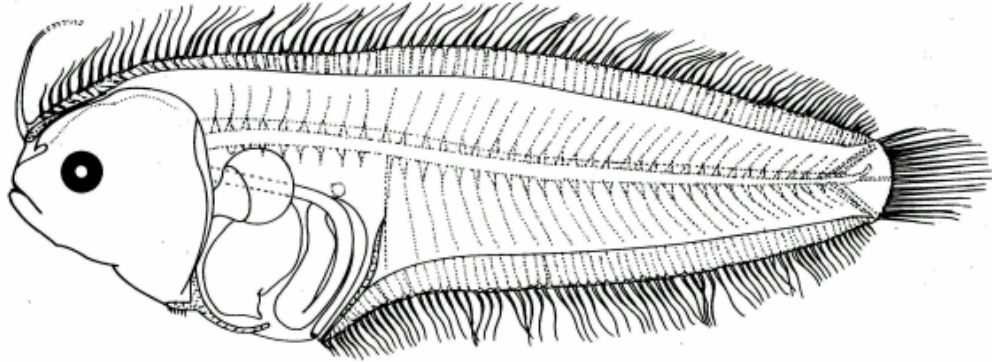


Fig. 51 – Larva of *Arnoglossus tapeinosoma*, 16.5 mm SL, from Lalithambika Devi, 1986.

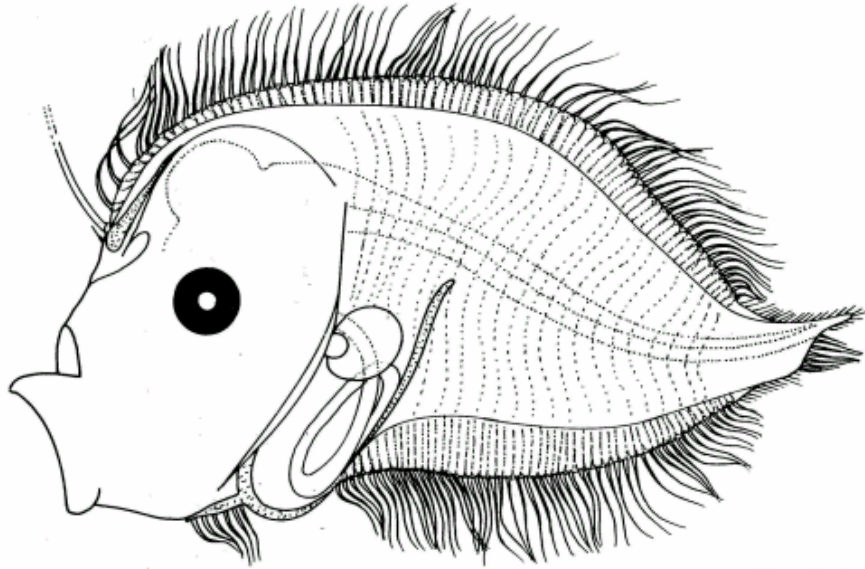


Fig. 52 – Larva of *A. aspilos*, 7.5 mm NL, flexion stage, from Lalithambika Devi, 1986.

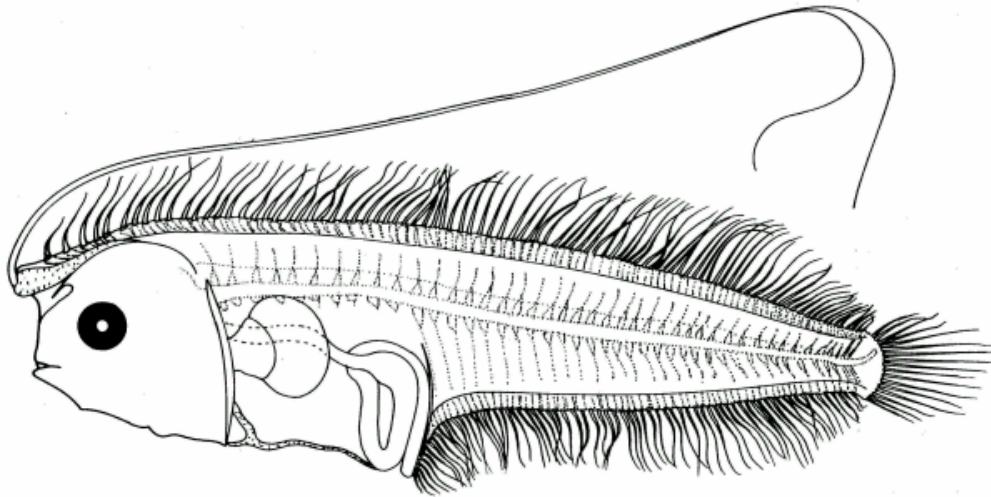


Fig. 53 – Larva of *A. elongatus*, 8.8 mm SL, from Lalithambika Devi, 1986.

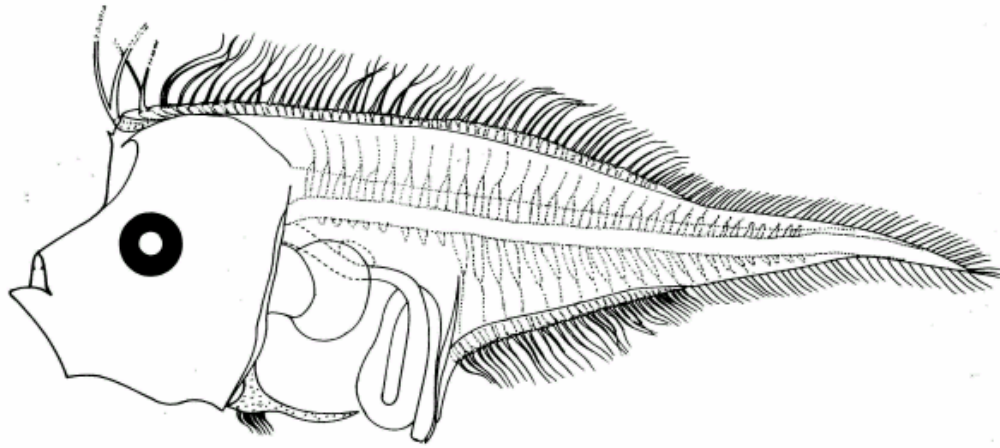


Fig. 54 – Larva of *A. intermedius*, 5.0 mm NL, from Lalithambika Devi, 1986.

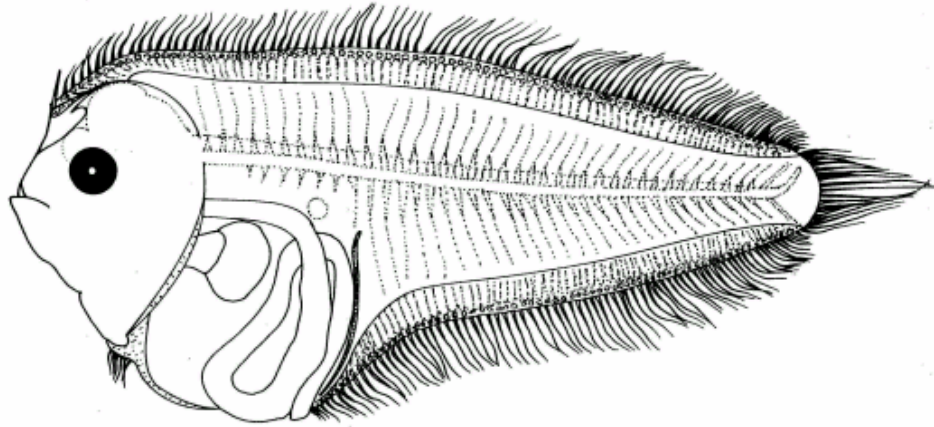


Fig. 55 – Larva of *A. imperialis*, 12.2 mm SL, from Lalithambika Devi, 1986.

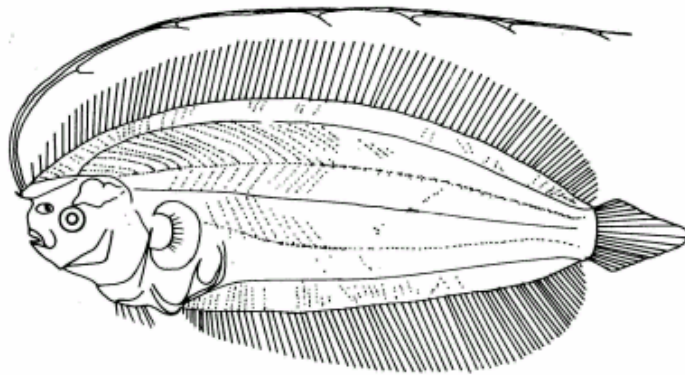


Fig. 56 – Larva of *A. japonicus*, 34.6 mm SL, from Fukui, 1997.

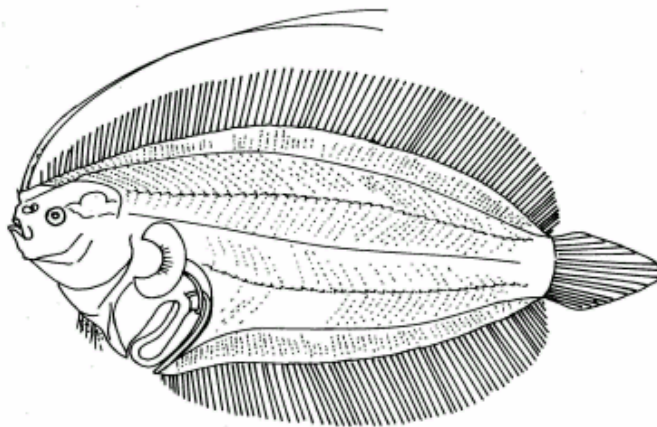


Fig. 57 – Larva of *A. tenuis*, 24.0 mm SL, from Amaoka, 1974.

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) |

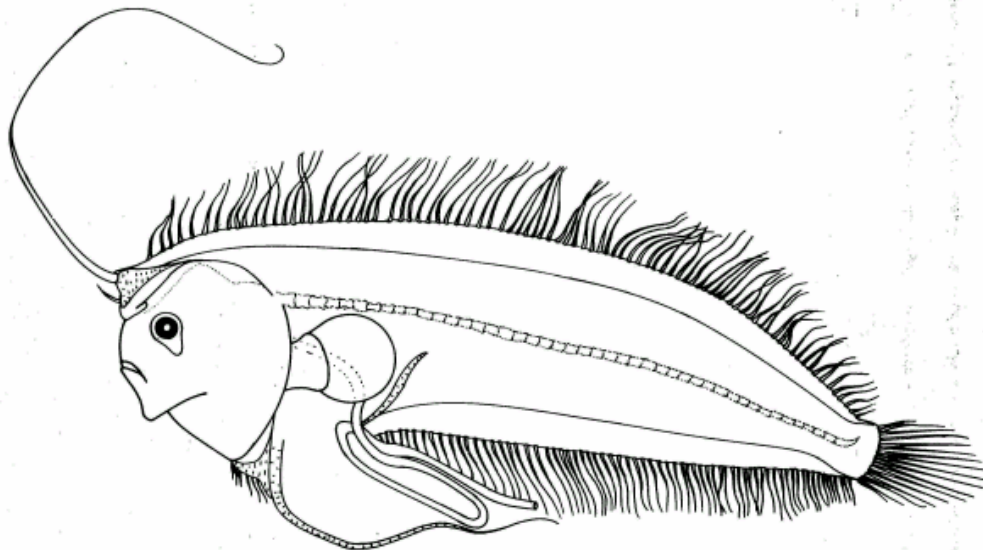


Fig. 58 – Larva of *Laeops macrophthalmus*, 19.0 mm SL, from Lalithambika Devi, 1986.

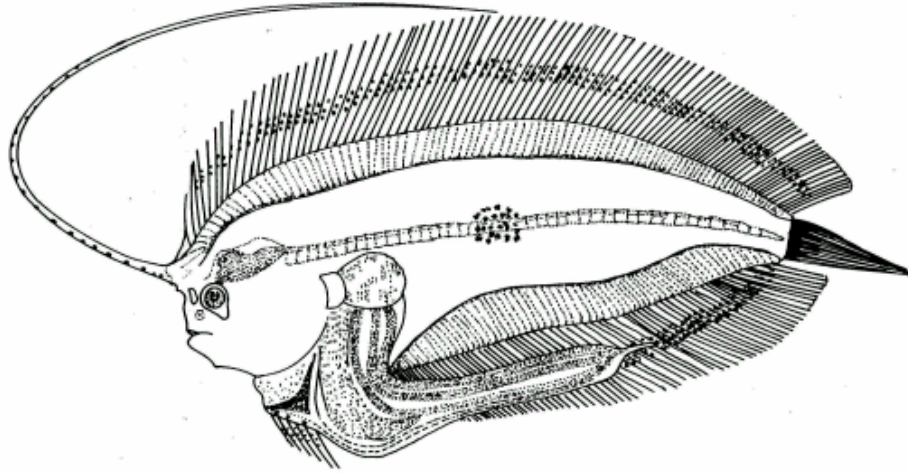


Fig. 59 – Larva of *L. guentheri*, 18.9 mm SL, from Balakrishnan, 1963.

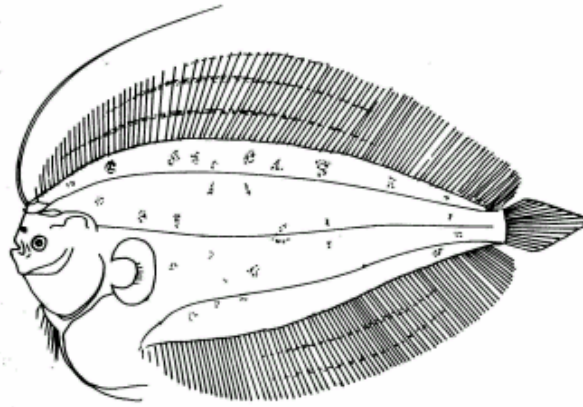


Fig. 60 – Larva of *L. nigromaculatus*, 56.6 mm SL, from Fukui, 1996.

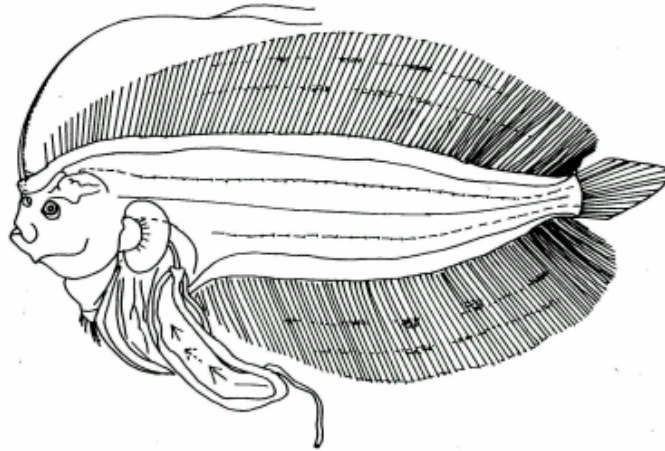


Fig. 61 – Larva of *L. kitahara*, 28.2 mm SL, from Fukui, 1997.

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) |

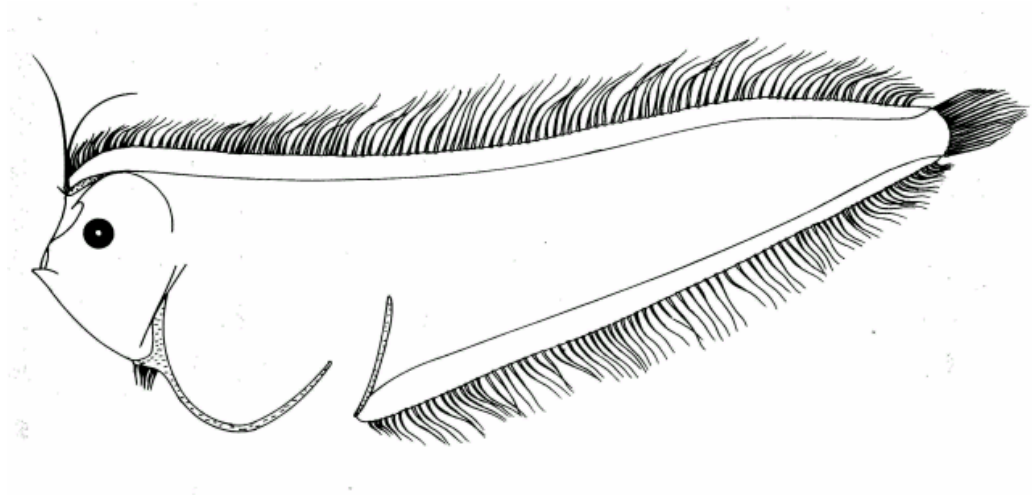


Fig. 62 – Larva of *Chascanopsetta lugubris*, 37.0 mm SL, from Lalithambika Devi, 1986.

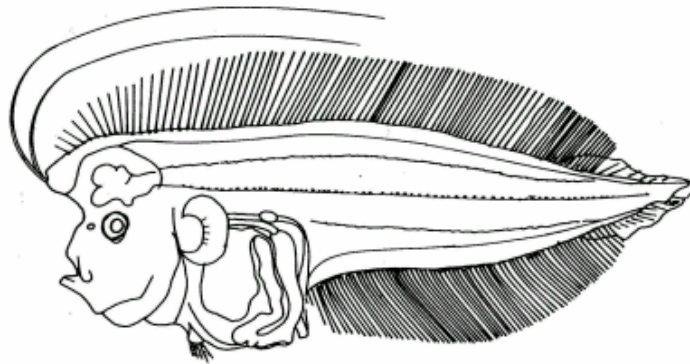


Fig. 63 - Larva of *C. micrognathus*, 10.8 mm SL, from Fukui, 1997.