
**THE REGIONAL TRAINING WORKSHOP ON LARVAL FISH IDENTIFICATION AND FISH EARLY LIFE HISTORY SCIENCE**

SEAFDEC/TD, SAMUT PRAKAN, THAILAND
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# TRD: 02 Guide to identification to Order and Family and Main characters of larvae of commercially important fish in the South East Asia region

List of Families of commercially important fishes in the South East Asia region (Dr. Y. Konishi)

| No | Order | Family | No | Order | Family |
|---|---|---|---|---|---|
| 1 | Elopiformes | Elopidae | 41 | Perciformes (cont'd) | Caesionidae |
| 2 | | Megalopidae | 42 | | Lobotidae |
| 3 | Anguilliformes | Anguillidae | 43 | | Gerreidae |
| 4 | | Muraenidae | 44 | | Haemulidae |
| 5 | | Ophichthidae | 45 | | Nemipteridae |
| 6 | | Congridae | 46 | | Sparidae |
| 7 | | Muraenesocidae | 47 | | Lethrinidae |
| 8 | Clupeiformes | Clupeidae | 48 | | Sciaenidae |
| 9 | | Pristigasteridae | 49 | | Sillaginidae |
| 10 | | Engraulidae | 50 | | Mullidae |
| 11 | | Chirocentridae | 51 | | Glaucosomatidae |
| 12 | Gonorynchiformes | Chanidae | 52 | | Monodactylidae |
| 13 | Siluriformes | Ariidae | 53 | | Drepaneidae |
| 14 | | Plotosidae | 54 | | Pentacerotidae |
| 15 | Aulopiformes | Synodontidae | 55 | | Cepolidae |
| 16 | Gadiformes | *Bregmacerotidae* | 56 | | Lactaridae |
| 17 | Lophiiformes | Antennariidae | 57 | | Terapontidae |
| 18 | Beryciformes | Berycidae | 58 | | Kyphosidae |
| 19 | | Holocentridae | 59 | | Stromateidae |
| 20 | Zeiformes | Zeidae | 60 | | Nomeidae |
| 21 | Mugiliformes | Mugilidae | 61 | | Polynemidae |
| 22 | Beloniformes | Hemiramphidae | 62 | | Labridae |
| 23 | | Exocoetidae | 63 | | Scaridae |
| 24 | | Belonidae | 64 | | Pinguipedidae |
| 25 | Scorpaniformes | Platycephalidae | 65 | | *Champsodontidae* |
| 26 | | Scorpanidae | 66 | | *Callionymidae* |
| 27 | Perciformes | Latridae | 67 | | Ephippidae |
| 28 | | *Acropomatidae* | 68 | | Siganidae |
| 29 | | Serranidae | 69 | | Acanthuridae |
| 30 | | Priacanthidae | 70 | | Istiopholidae |
| 31 | | *Apogonidae* | 71 | | Sphyraenidae |
| 32 | | Branchiostegidae | 72 | | Gempylidae |
| 33 | | Rachycentridae | 73 | | Trichiuridae |
| 34 | | Coryphaenidae | 74 | | Scombridae |
| 35 | | Menidae | 75 | Pleuronectiformes | Psettodidae |
| 36 | | Carangidae | 76 | | *Bothidae* |
| 37 | | Leiognathidae | 77 | | Soleidae |
| 38 | | Bramidae | 78 | | Cynoglossidae |
| 39 | | Emmelichthyidae | 79 | Tetraodontiformes | Balistidae |
| 40 | | Lutjanidae | 80 | | Monacanthidae |

Families in italic letter indicates that these are not commercial species but their larvae abundantly occur.

## How to identify fish larvae with this book

(From : Leis and Carson-Ewart (2000). The Larvae of Indo-Pacific Coastal Fishes : An Indentification guide to marine fish larvae. Fauna Malesiana Handbook 2)

A great deal of identification of any group depends on 'Gestalt' or integrated image or appearance of the animal in question. Usually this is obtained with experience with each group ('The doesn't look like a leptobramid'). When examining a larva, an impression of the larva should be developed:

- Is it deep-bodied?
- Is the gut long?
- Is the gas bladder visible?
- Approximately how many myomeres are there?
- Is the fish heavily or lightly pigmented?

With the Gestalt of the larva in mind, use Tables 1 and 2 to narrow the range of choices. Table 2 is a picture-based identification key to the families in this book. The text portion of the key is not dichotomous: at each level, there may be up to five options to consider. Moving through the text portion of the key leads to one of 19 groups defined by body and gut shape. For each of these 19 groups, illustrations are provided of each included family (in alphabetical order). Thus, the illustrations are placed in groups of similar body shape. The caption for each illustration gives the name of the taxon, the range of myomeres found in it, and an indication as to whether at least some family members have large head spines. Using the illustrations and the information in the captions, it will be possible to drastically narrow the range of possible identifications. Do not expect to be able to get to a single family using Table 2. Rather, a handful of possibilities will remain. Note also that most families occur in more than one group (the family Blenniidae occurs in five groups). This is due to two factors. First, in many families, there is a great deal of morphological diversity among different species leading to different body shapes. Second, there are ontogenetic changes to body shape that may result in a single species falling into a different group in the preflexion larval stage than when in the postflexion larval stage.

After using Tables 1 and 2, proceed to the family accounts**,** and turn to the sections on the remaining possibilities. Check to see if the drawings are similar to the larva. Next, compare your specimen with the text descriptions, drawings and meristics table. (*Finally, consult the Similar families section. In some cases, it may be most convenient to consult the Similar Families section (which is in effect a diagnosis) before the text description.)*

*** This workshop Fish larvae identificat guide is not include information explaned in the italic letter.

It is important to keep in mind that many families are not described in this book because their adults are not coastal fishes, and while we tried to include these in the Similar Families section, this was not always possible. In addition note upon what range of taxa each description has been based. This will give some idea of the range of potential variability in the family that we included. Where the description is based on a large percentage of the taxa in the family, it may be assumed that most of the variation actually present has been included; where the description is based on few taxa, be on guard for variation beyond that described. Some families are conservative in their larval development and show very little variation, but others are extremely variable.

It is usually not necessary to actually count all the myomeres of a larva. With a bit of experience, the number of myomeres can be estimated by their relative thickness or closeness of packing.

The terms 'body very elongate', 'body deep', etc. have purposely been left loosely defined Again, we rely on Gestalt for these. These are meant to serve as guides only, and in many cases there is enough morphological variation that larvae of a given family may 'spill over' into body depth categories adjacent to the listed ones.

**Table 1.** Characters of pelagic early life history stages that aid in identification to order (after Ahlstrom & Moser, 1967, with modifications and additions). Note that all taxa of each order, not just those covered in this book, are included in this Table.

| | ***Clupeiformes*** | ***Gonorynchiformes*** | ***Aulopiformes*** | ***Ophidiiformes*** | ***Gadiformes*** |
|---|---|---|---|---|---|
| **Type of fin element** | Rays | Rays | Rays | Rays | Rays |
| **PECTORAL FIN Formation** | Late | Late | Often early | Sometimes early | Sometimes Late |
| **PELVIC FIN Formation** | Late | Late | Early to late | Late | Often early |
| **Position** | Abdominal | Abdominal | Abdominal | Jugular | Thoracic or Jugular |
| **Formula** | Usually 7-10 | 9-12 | 7-11 | 0-2 | Various; 2-8 |
| **DORSAL FIN(s)** | 1 fin | 1 fin | 1 fin | 1 fin | 1-3 fins |
| **ANAL FIN** | 0 spine | 0 spine | 0 spine | 0 spine | 0 spine |
| **ADIPOSE FIN** | No | No | Usually present | No | No |
| **PRINCIPAL CAUDAL RAYS** | 19 | 19 | 19 | 0-14 | Various numbers |
| **LARVAE Predominant Body Shape** | Elongate, slender | Elongate, slender | Various, often elongate | Elongate | Various, elongate to deep-bodied |
| **Preanal length (%BL)** | 48-90%, may decrease ontogenetically | 77-90% | c.20-75% | 33-55% | Usually <50% |
| **Type of gut** | Straight | Straight | Straight, variously shaped | Coiled | Usually coiled |
| **Vertebrae** | 39-76 | 40-61 | 36-121 | 40-150 | 40-many |
| **Head spination** | None | None | Usually none, heavy in 3 genera | Limited to opercular spines | Usually none |
| **Early forming fin elements** | No | No | Occasionally P1 rays | P1 rays and vexillum in some | No |

**Table 1** (contrinued)

| | *Lophiiformes* | *Gobiesociformes* | *Atheriniformes* | *Beloniformes* | *Mugiliformes* | *Beryciformes* |
|---|---|---|---|---|---|---|
| **Type of fin elements** | Spines and rays | Spines and rays, or rays only | Spines and rays | Rays | Spines and rays | Spines and rays |
| **PECTORAL FIN Formation** | Sometimes early | Late | Late | Late | Late | Not late |
| **PELVIC FIN Formation** | Often absent, early to late | Late | Late | Late | Late | Often early |
| **Position** | Thoracic | Thoracic | Abdominal to thoracic | Abdominal | Subabdominal | Thoracic or Abdominal |
| **Formula** | 0 or 1, 3-5 | 1, 4 – 1, 5 | 1, 5 | 6 | 1, 5 | 0-1, 2-13 |
| **DORSAL FIN(S)** | 2 fins, anterior as illicium on head | 1 or 2 fins | 2 fins | 1 fin | 2 fins | 1 or 2fins |
| **ANAL FIN** | 0 spine | 0-1 spine | 0-1 spine | 0 spines | 2-3 spines | 0-4 spines |
| **ADIPOSE FIN** | No | No | No | No | No | No |
| **PRINCIPAL CAUDAL RAYS** | 8-10 | 8-14 | 17 | 15 | 14-15 | 18-19 |
| **LARVAE Predominant Body Shape** | Globular | Moderately to very stubby | Elongate | Elongate | Slender to moderate | Slender to stubby |
| **Preanal length (%BL)** | 30-90% | 50-85% | 20-50%, increase ontogenetically | 65-80% | 57-78% | c.30-79% |
| **Type of gut** | Deep, coiled | Initially straight, later coiled | Coiled | Straight | Coiled, underslung | Coiled |
| **Vertebrae** | 18-31 | 21-54 | 21-55 | 36-97 | 24-26 | 24-30 |
| **Head spination** | None | None or one opercular spine | None | None | None | None to markedly heavy |
| **Early forming fin elements** | Varies, none to P2 and anterior D | None | None | Caudal formed at hatching | None | Often P2 and anterior D |

**Table 1** (contrinued)

| | *Zeiformes* | *Gasterosteiformes* | *Scorpaeniformes* | *Perciformes* | *Pleuronectiformes* | *Tetraodontiformes* |
|---|---|---|---|---|---|---|
| **Type of fin elements** | Spines and rays | Spines and rays | Spines and rays | Spines and rays | Rays, except P2 spine in some | Spines and rays or rays only |
| **PECTORAL FIN Formation** | Late | Late | Various | Various | Late | Sometimes early |
| **PELVIC FIN Formation** | Various, early to late | Often absent, late | Intermediate | Sometimes early | Sometimes early | Often absent, late |
| **Position** | Abdominal thoracic | Abdominal | Thoracic | Various, usually thoracic | Thoracic to jugular | Thoracic |
| **Formula** | 0-1,3-10 | 0-6 | 1,5 or fewer | 1,5 or fewer | 1,5 or 0,2-6 | 0-1,5 |
| **DORSAL FIN(S)** | fin | 1 or 2 fins | 1 or 2 fins | 1 fin or 2 fins | 1 fin | 1 or 2 fins |
| **ANAL FIN** | 0-3 spines | 0-1 spine | 0-3 spines | Usually 1-3 spines | 0 spine | 0 spine |
| **ADIPOSE FIN** | No | No | No | No | No | No |
| **PRINCIPAL CAUDAL RAYS** | 9-13 | 0-15 | Variable, <18 | Usually 17 | Variable | 9-12 |
| **LARVAE Predominant Body Shape** | Deep, compressed | Various, often elongate | Various, usually stubby | Various, usually stubby | Various, markedly compressed | Various, usually Moderate |
| **Preanal length (%BL)** | 50-70% | Various, 45-90% | c.35-60% | Various,20-80% | Usually <40% | 40-90% |
| **Type of gut** | Deep, coiled | Usually straight | Coiled | Various, usually coiled | Coiled | Coiled |
| **Vertebrae** | 31-46 | 19-87 | c.25-65 | c.20-100+, often 24-28 | 25-65 | 16-30 |
| **Head spination** | None to markedly heavy | None to heavy, often associated with body plates | Usually | None to markedly heavy | None to heavy | Various |
| **Early forming fin elements** | Various, none to P2 | None to heavy, often associated with body plates | P1 can be large | Sometimes: D spine, P2 spine and rays | Often, 1-12 anterior D rays. Sometimes 2-3 P2 rays | P1 rays sometimes |

**Table 2**

Pictorial family identification guide for larvae of Indo-Pacific coastal fishes. This guide is not dichotomous, so under any heading, all options must be considered. Use the text portion of the guide to identify morphological groups (1-19). Then under these groups, use the illustrations plus the information in the captions on myomere number (the number following the family name) and head spination (indicated with an asterisk) to narrow the range of choices. Finally, consult the relevant chapters. Some families occur in more than one place because of species specific diversity in shape or ontogenetic changes in shape. See cautions and explanations in text. In the figure captions, the main text figure number or other source of the figure is given in square brackets [ ]. Only families covered in this book are included in this guide (including Chirocentridae and Pristigasteridae). Therefore, the following coatal Indo-Pacific fish taxa are excluded: Arcanidae, Ariommidae, Atherionidae, Banjosidae, Chaunacidae, Clinidae, Dichistiidae, Lophiidae, Macrurocyttidae, Notograptidae, Pseudotrichonotidae, Rhombosoleidae, Stromateidae, Syngnathidae, Tridontidae and the 9 coastal families of Elopiformes. Nothing is known about the italicized families. References are given to the other families in the relevant section (usually under the order).

| | | |
|---|---|---|
| I | Body very elongate (BL <10% BL) | |
| | A – Gut very long (PAL >70% BL) | Group 1 |
| | B – Gut of moderate length (PAL = 50-70% BL) | Group 2 |
| | C – Gut short (PAL < 50% BL) | Group 3 |
| II | Body elongate (BD 10-20% BL) | |
| | A – Gut coiled and compact early (by 3 mm) | Group 4 |
| | B – Gut coiled early but not compact | Group 5 |
| | C – Gut initially uncoiled | |
| | 1 – Gut coiled before flexion | Group 6 |
| | 2 – Gut coiled during or after flexion | Group 7 |
| | 3 – Gut remains uncoiled until hidden by body wall | Group 8 |
| III | Body depth moderate (BD 20-40% BL) | |
| | A – Gut coiled and compact early (by 3 mm) | Group 9 |
| | B – Gut coiled early but not compact | Group 10 |
| | C – Gut initially uncoiled | |
| | 1 – Gut coiled before flexion | Group 11 |
| | 2 – Gut coiled during or after flexion | Group 12 |
| | 3 – Gut remains uncoiled | Group 13 |
| IV | Body deep to very deep (BD > 40% BL) | |
| | A – Head and trunk very broad | Group 14 |
| | B – Head and trunk strongly compressed | Group 15 |
| | C – Head and trunk neither broad nor strongly compressed | |
| | 1 – Gut coiled and compact early (by 3 mm) | Group 16 |
| | 2 – Gut coiled early but not compact | Group 17 |
| | 3 – Gut initially uncoiled | Group 18 |
| V | Body (not just head) dorso-ventrally flattened | Group 19 |

## Group 1 (IA)

Body very elongate (BD < 10% BL). Gut very long (PAL > 70% BL)

**Belonidae** 53-97

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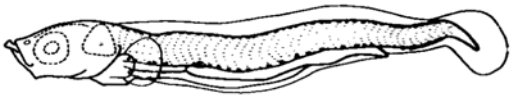

**Chanidae** (44-47)

Page 36

**Chirocentridae** 69-75

[*Chirocentrus*; after Delsman, 1923]

Page 36

**Clupeidae** 39-57

Page 35

**Engraulidae** 38-76

Page 36

**Fistulariidae** 76-85

**Gonorynchidae** 55-61

**Hemiramphidae** 37-63

Page 44

**Pristigasteridae** 41-62

[*Ilisha*; after Takita, 1988]

Page 36

**Schindleriidae** 31-44

**Solenostomidae*** 29-33

**Synodontidae** 39-65

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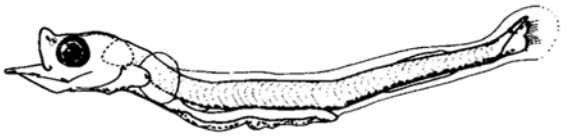
## Group 2 (IB)

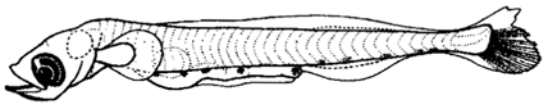
Body very elongate (BD < 10% BL). Gut of moderate length (PAL = 50-70% BL)



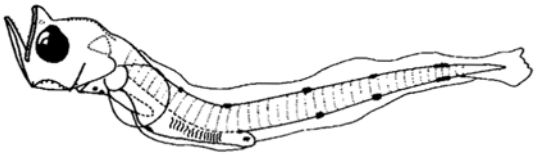
Ammodytidae 49-63

Microdesminae
Microdesmidae 48-59

Aulostomidae 61-65



Schindleriidae 31-44



Creediidae 37-60

Trichiuridae* 91-192

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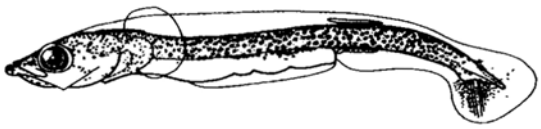
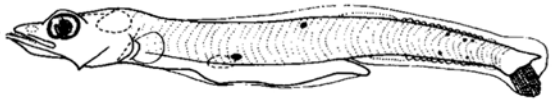


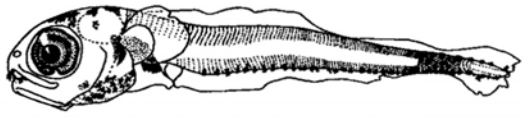
Echeneidae 26-41



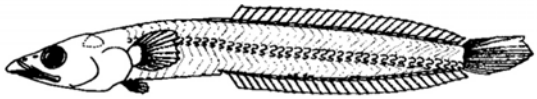
Trichonotidae 49-56

## Group 3 (IC)

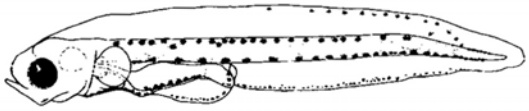
Body very elongate (BD < 10% BL). Gut short (PAL < 50% BL)



Blenniidae* 28-135
[*Xiphasia*; after Watson, previously unpublished]

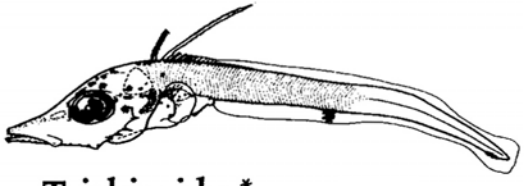


Creediidae 37-59



Ophidiidae 52-76

Carapidae 65-153



Trichiuridae* 91-192

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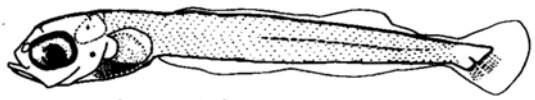
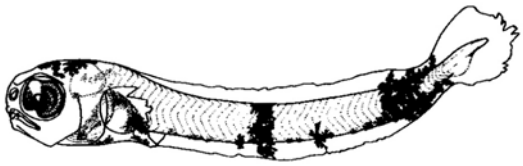
## Group 4 (II A)

Body elongate (BD 10-20% BL). Gut coiled and compact early (by 3 mm)

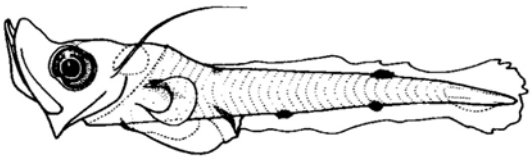


**Atherinidae** 30-47



**Blenniidae*** 28-135

**Carapidae** 65-153



**Champsodontidae*** 28-33

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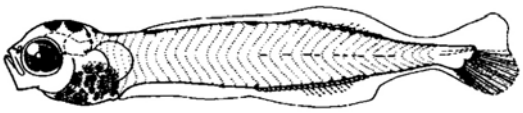
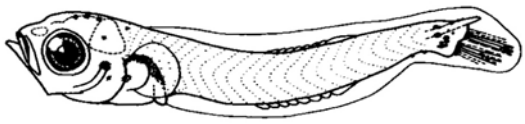
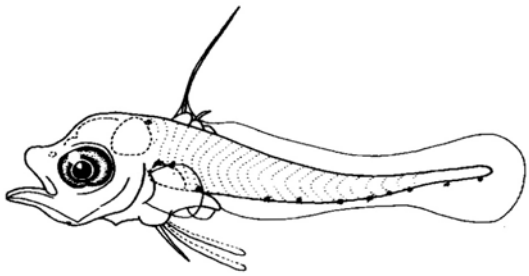


**Isonidae** 37-46

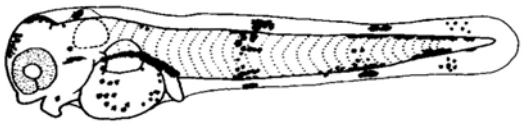


**Kuhliidae** 25



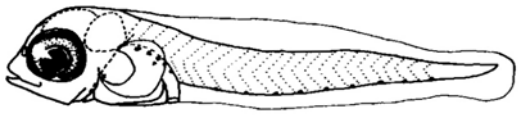
**Lutjanidae*** 24

Page 54



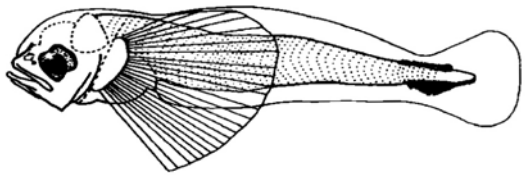
**Monacathidae** 19-31

Page 84

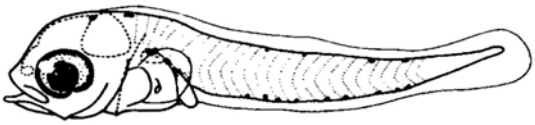


**Mullidae** 24

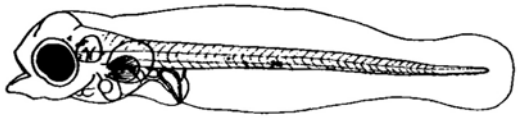
Page 60



**Ophidiidae** 52-76



**Pomacentridae*** 26



**Scombridae*** 31-56

[*Rastrelliger*; after Delsman, 1923]

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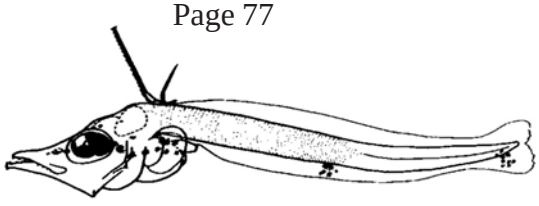

**Trichiuridae*** 91-192

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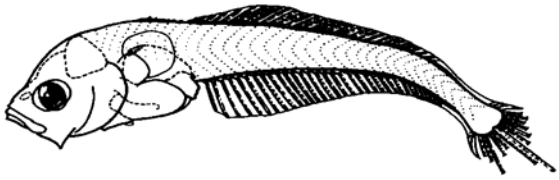
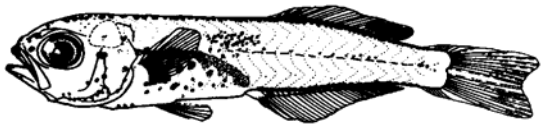
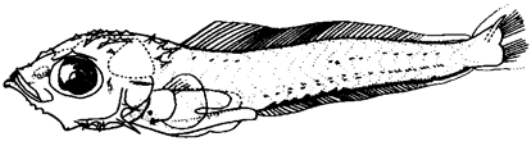
**Group 5 (II B)**
Body elongate (BD 10-20% BL). Gut coiled early but not compact



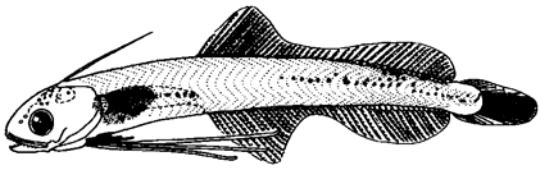
Amblyopinae Gobiidae 26-38



Leptobramidae 24



Malacanthidae* 24



Bregmacerotidae 43-59
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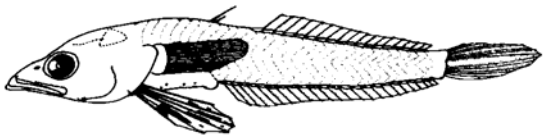
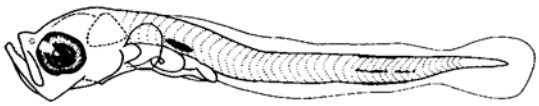
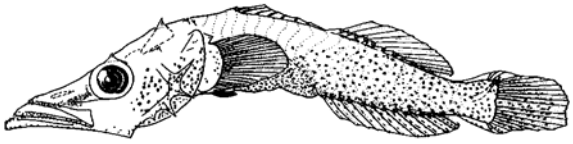


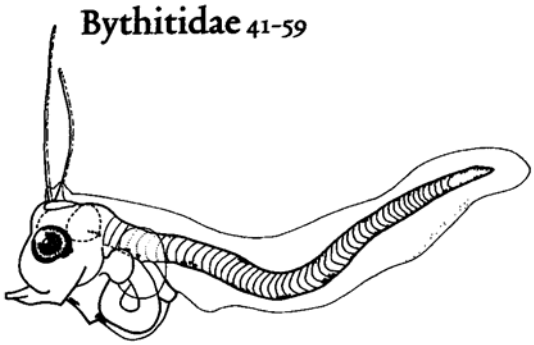
Percophidae 25-50



Bythitidae 41-59



Platycephalidae* 27-28
Page 45



Cynoglossidae 42-66
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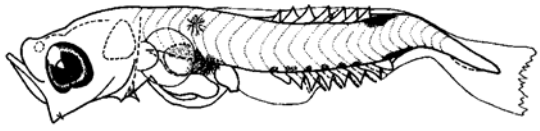
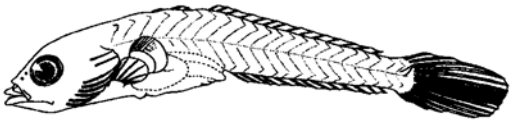


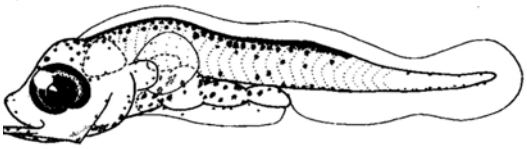
Xenisthmidae* 26-45



Draconettidae 22-24

## Group 6 (II $C_1$)

Body elongate (BD 10-20% BL). Gut initially uncoiled, coiling before flexion



Carangidae* 24-26

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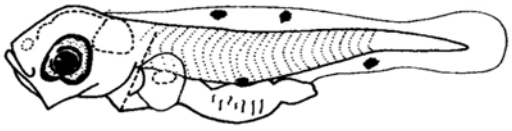

Labridae 23-28

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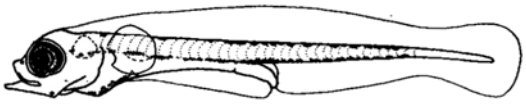
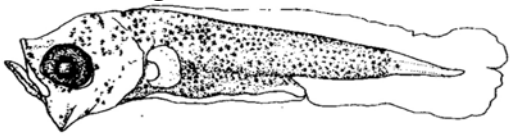
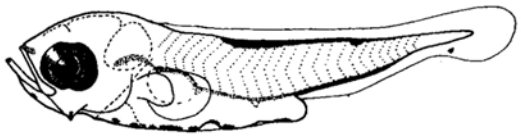


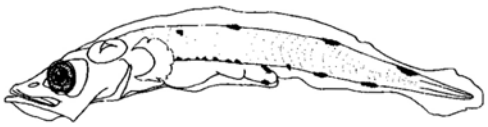
Cheilodactylidae 34-36



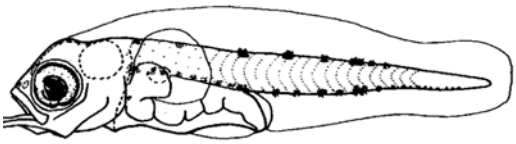
Monocentridae 27



Gobiidae 25-27



Percophidae 25-50



Kyphosidae 25-26

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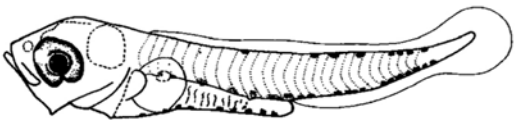
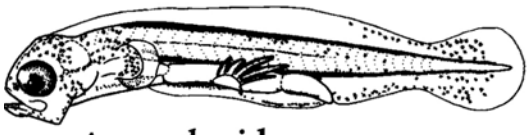


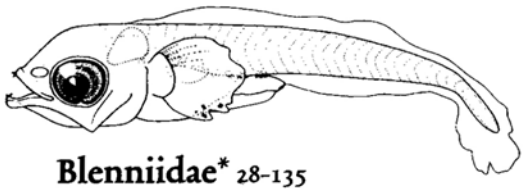
Pseudochromidae 26-33

## Group 7 (II $C_2$)

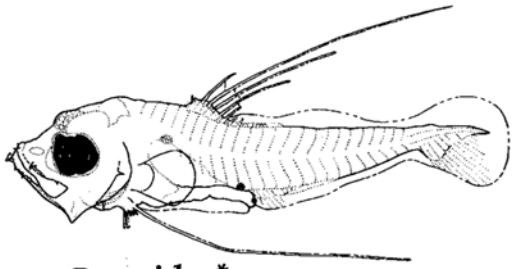
Body elongate (BD 10-20% BL). Gut initially uncoiled, coiling during or after flexion



**Anomalopidae** 29-30



**Blenniidae*** 28-135



**Berycidae*** 24

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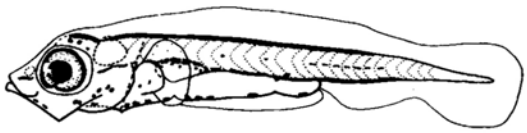
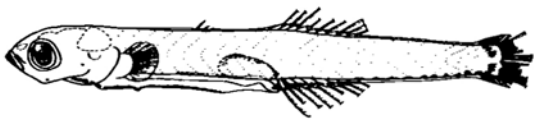
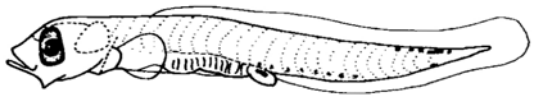


**Chaetodontidae*** 24



**Eleotrididae** 25-26



**Scaridae** 25

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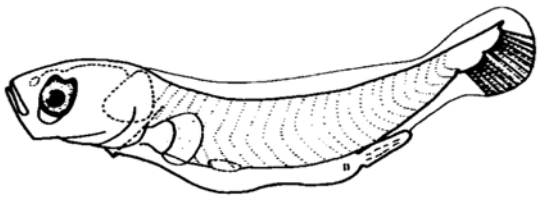

**Labridae** 23-28

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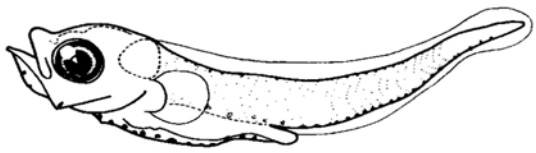

**Sillaginidae** 32-42

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**Rachycentridae*** 25

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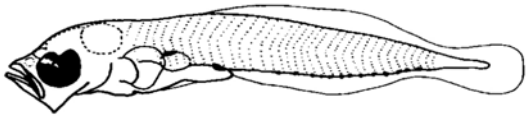
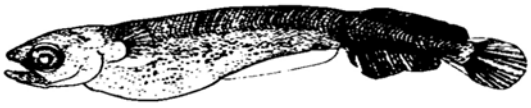


**Tripterygiidae** 34-39

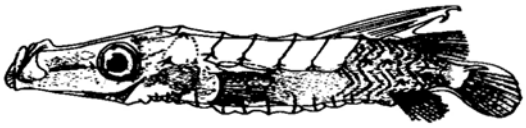
## Group 8 (II $C_3$)

Body elongate (BD 10-20% BL). Gut initially uncoiled, remaining uncoiled until hidden by body wall

**Ammodytidae** 49-63

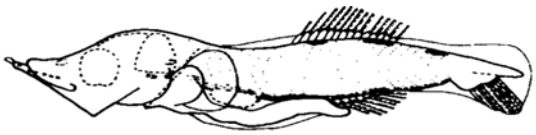


**Belonidae** 53-97



**Centriscidae** 20

**Chanidae** 44-47



**Cirrhitidae** 26

**Clupeidae** 39-57

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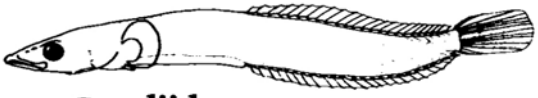
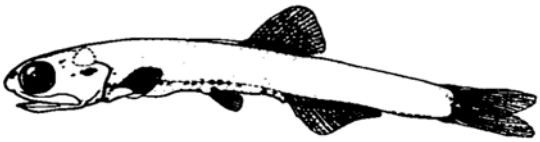


**Creediidae** 37-60

**Echeneidae** 26-41



**Engraulidae** 38-76

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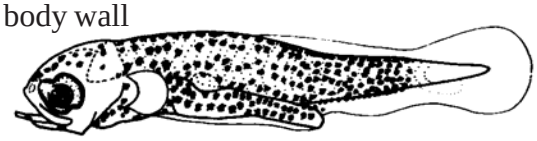
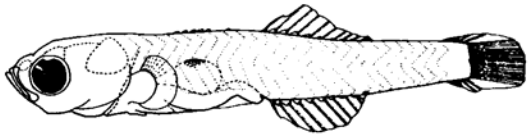
## Group 8 (II $C_3$)

Body elongate (BD 10-20% BL). Gut initially uncoiled, remaining uncoiled until hidden by body wall



Gobiesocidae 31-37



Gobiidae 25-27

Hemiramphidae 37-63 Page 44

Kraemeriidae 26-31

Microdesminae
Microdesmidae 48-59

Pristigasteridae 41-62
[*Ilisha*; after Takita, 1988]
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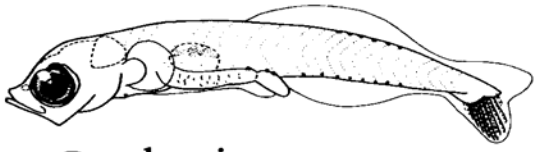
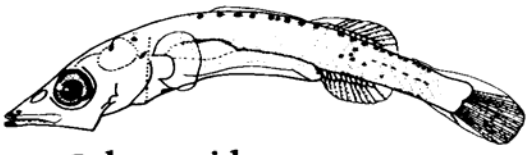


Ptereleotrinae
Microdesmidae 26

Solenostomidae 29-33



Sphyraenidae 24 Page 76

Synodontidae 39-65
[*Saurida*; after Okiyama, 1974]
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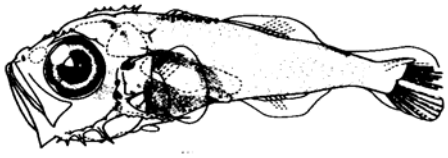
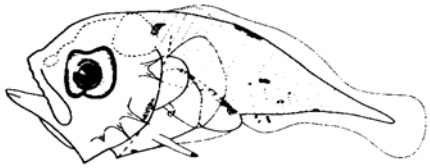
## Group 9 (III A)

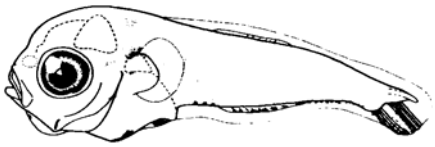
Body depth moderate (BD 20-40% BL). Gut coiled and compact early (by 3 mm)



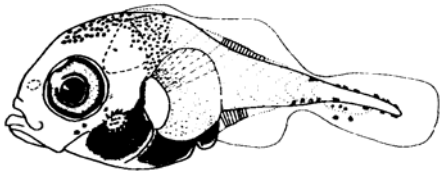
Acropomatidae* 25 Page 47



Anthiinae Serranidae* 26



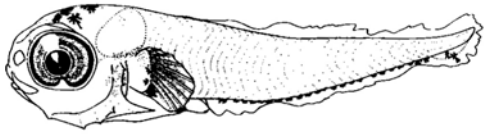
Ambassidae 24



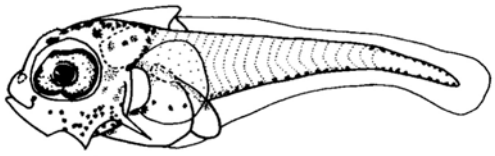
Balistidae 18 Page 83

## Group 9 (Continued)

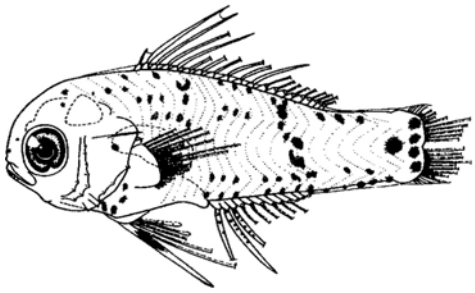
Body depth moderate (BD 20-40% BL). Gut coiled and compact early (by 3 mm)



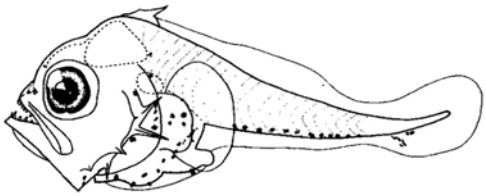
**Blenniidae*** 28-135



**Dactylopteridae*** 22



**Callanthiidae*** 24



**Ephippidae*** 24

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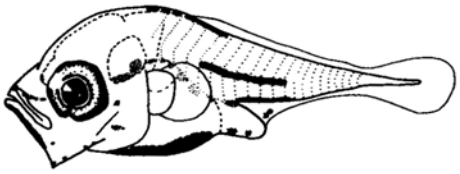

**Callionymidae*** 21-23

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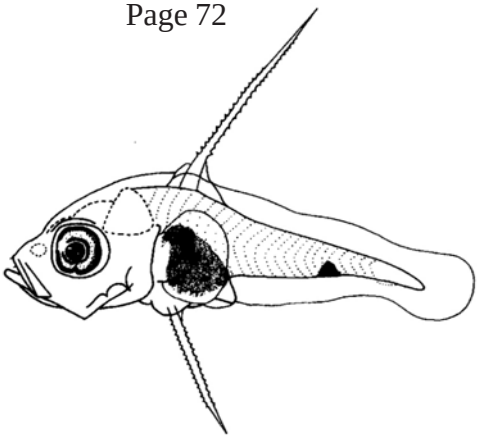
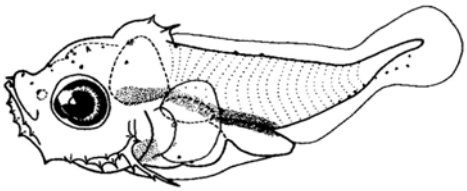
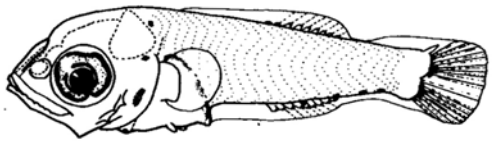


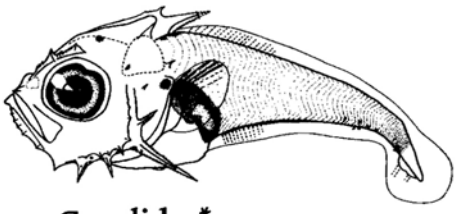
**Epinephelinae Serranidae*** 24-28 Page 47



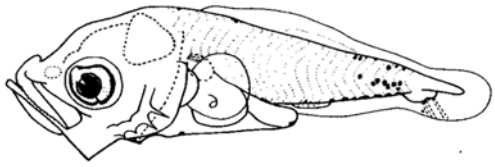
**Caproidae*** 21-22



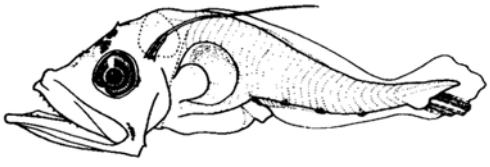
**Gerreidae** 24 Page 56



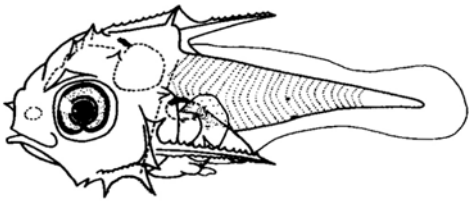
**Cepolidae*** 28-79 Page 64



**Haemulidae** 26 Page 57



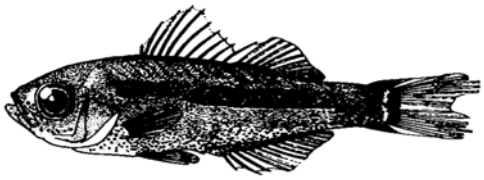
**Champsodontidae*** 28-33



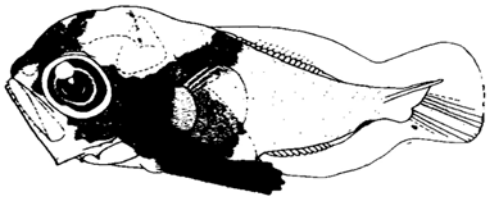
**Holocentridae*** 26-27 Page 41

## Group 9 (Continued)

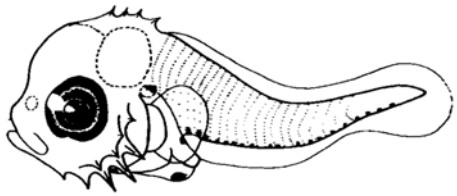
Body depth moderate (BD 20-40% BL). Gut coiled and compact early (by 3 mm)



**Kuhliidae** 25



**Monodactylidae*** 24 Page 62



**Leiognathidae*** 24
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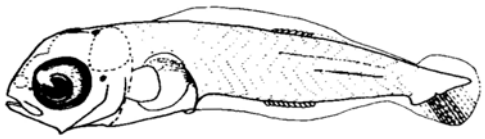
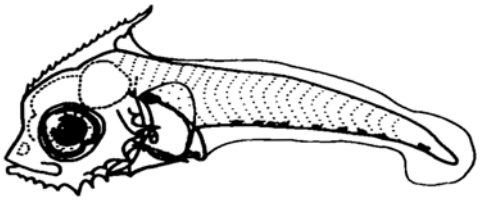
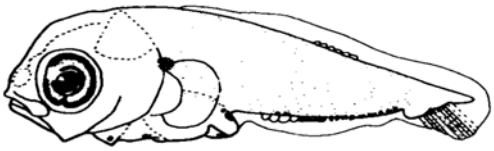


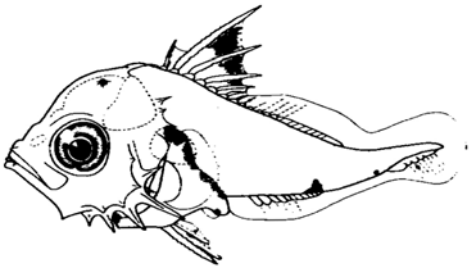
**Mullidae** 24 Page 60



**Lethrinidae*** 24 Page 58



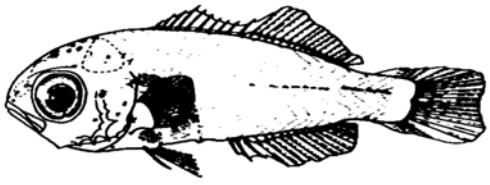
**Nemipteridae** 24 Page 58



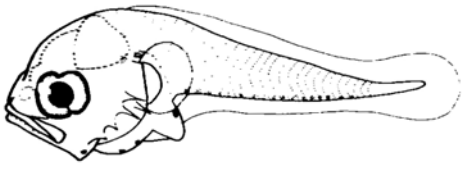
**Lutjanidae*** 24 Page 54

**Niphonini Serranidae*** 30 [94A]
Page 47

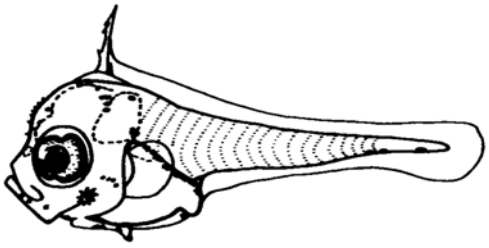
**Ogcocephalidae** 16-20



**Microcanthidae** 25



**Pinguipeididae** 29-33 Page 70

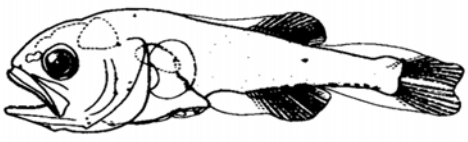


**Monacanthidae** 19-31 Page 84

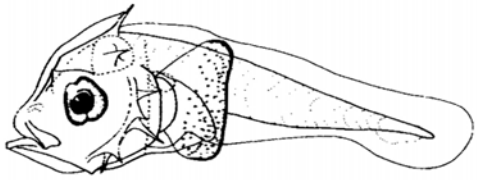
**Plesiopidae** 24-30

## Group 9 (Continued)

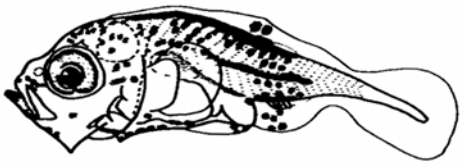
Body depth moderate (BD 20-40% BL). Gut coiled and compact early (by 3 mm)



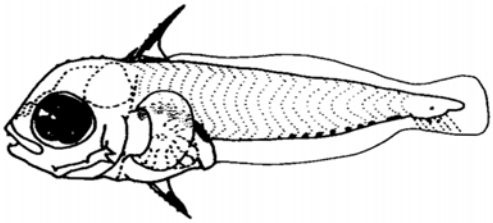
**Polynemidae** 24-27



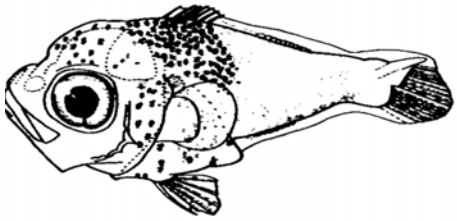
**Scorpaenidae*** 24-30 Page 46



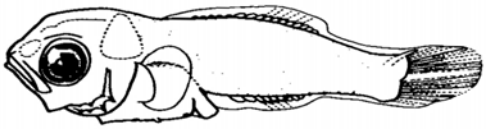
**Pomacanthidae*** 22-24



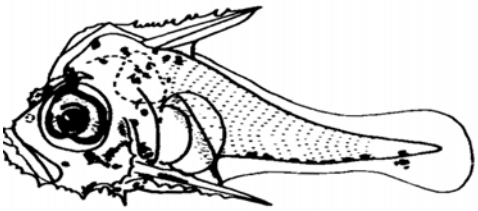
**Siganidae*** 23 Page 74



**Pomacentridae*** 26

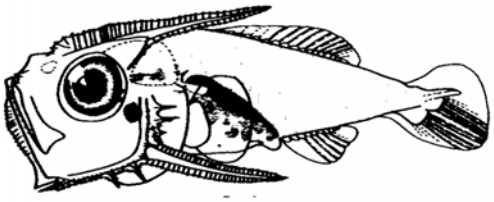


**Sparidae*** 24-25 Page 58

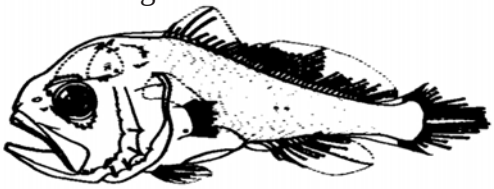


**Priacanthidae*** 22-23

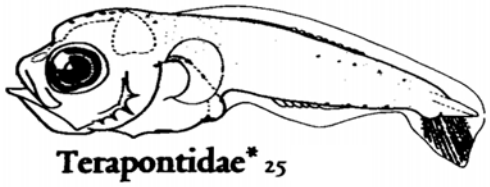
Page 47



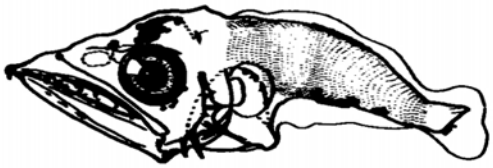
**Symphysanodontidae*** 25



**Sciaenidae*** 24-29 Page 59



**Terapontidae*** 25



**Scombridae*** 31-56

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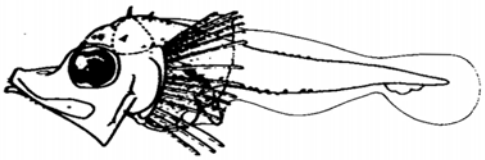
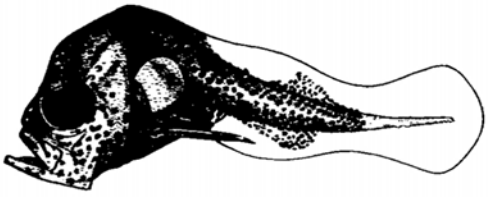


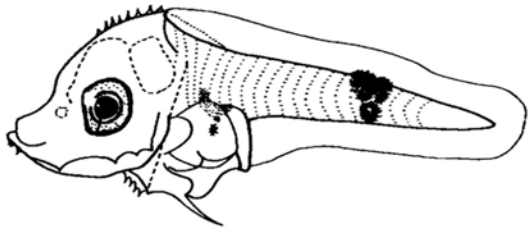
**Triglidae*** 25-39



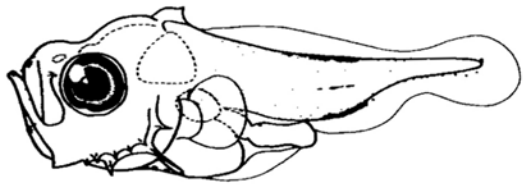
**Zeidae** 30-42 Page 42

## Group 10 (IIIB)

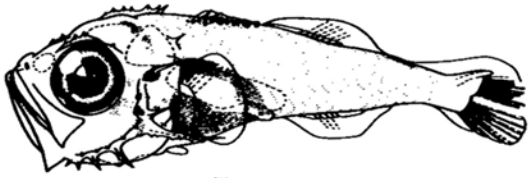
Body depth moderate (BD 20-40% BL). Gut coiled early, but not compact



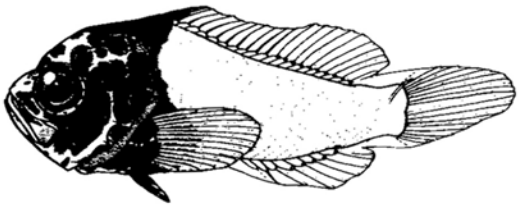
**Acanthuridae*** 22-23 Page 75



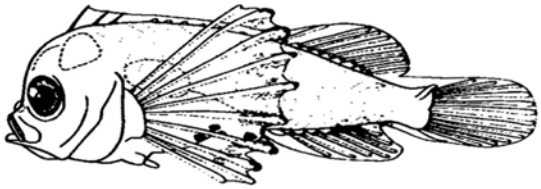
**Carangidae*** 24-26 Page 51



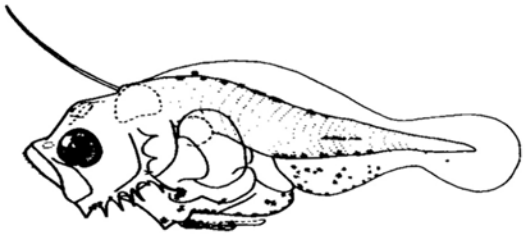
**Acropomatidae*** 25 Page 47



**Centrogeniidae** 25-26

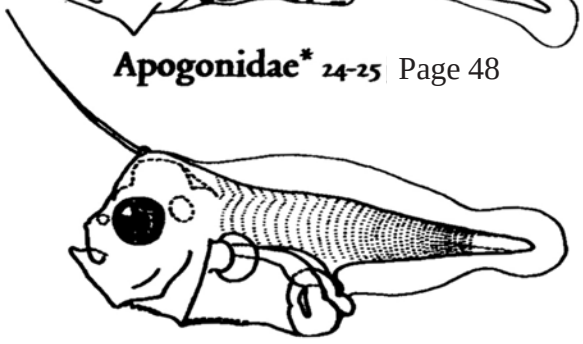


**Aploactinidae*** 21-31

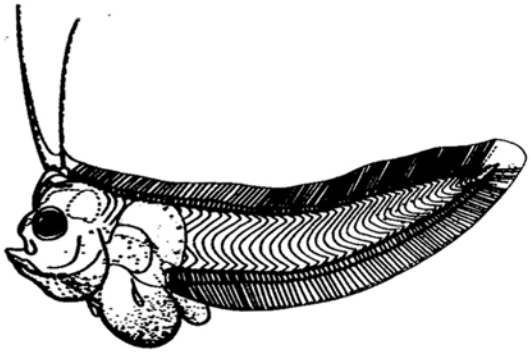


**Citharidae*** 30-35

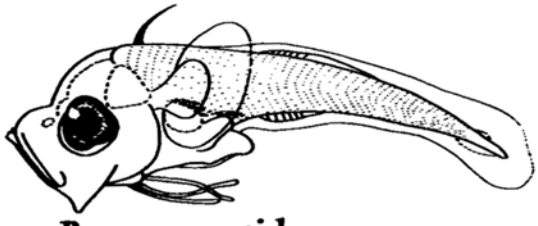
**Apogonidae*** 24-25 Page 48



**Bothidae** 33-61 Page 79



**Cynoglossidae** 42-66
Page 81

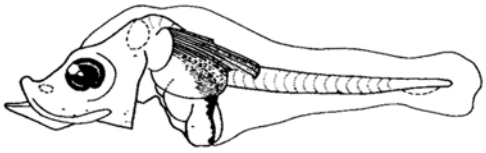


**Bregmacerotidae** 43-59
Page 39

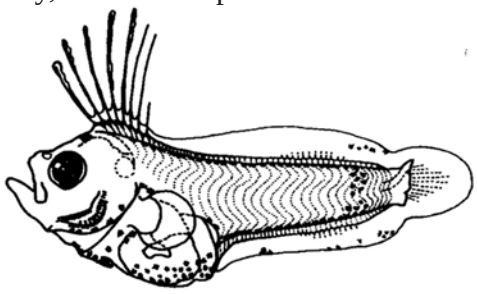
**Glaucosomatidae** 25
Page 61

## Group 10 (Continued)

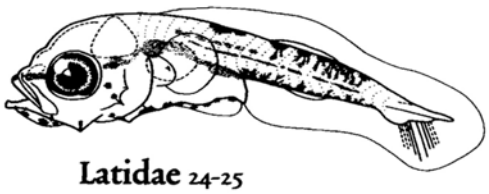
Body depth moderate (BD 20-40% BL). Gut coiled early, but not compact



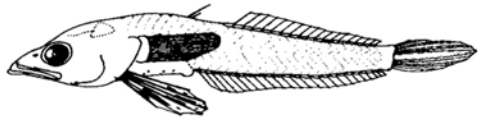
**Hoplichthyidae*** 26



**Paralichthyidae** 27-39

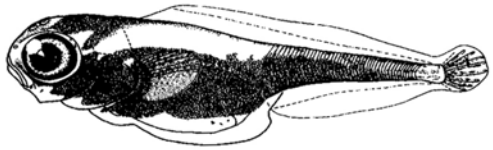


**Latidae** 24-25
Page 46

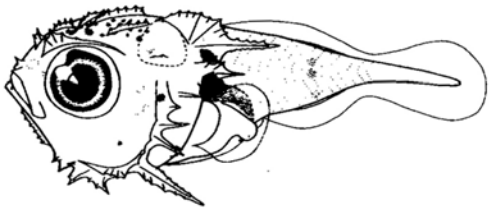


**Percophidae** 25-50

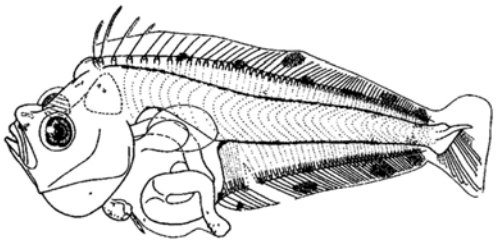
**Leptobramidae** 24



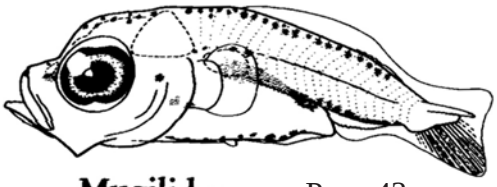
**Pholidichthyidae** 75-90



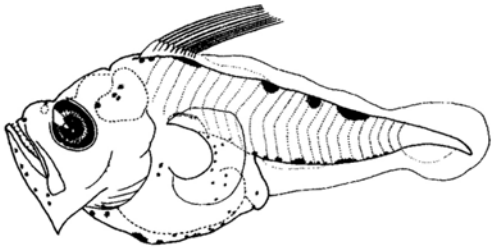
**Malacanthidae*** 24



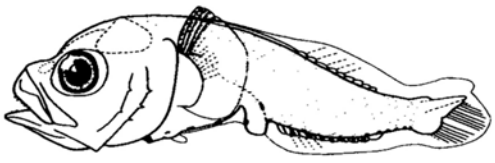
**Poecilopsettidae** 36-43



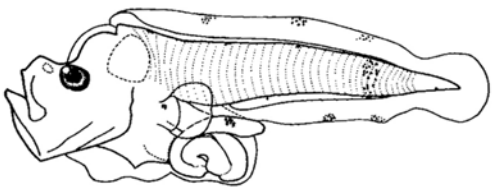
**Mugilidae** 24-25 Page 43



**Psettodidae** 24 Page 78



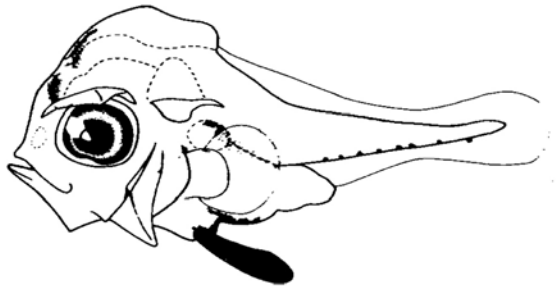
**Opistognathidae** 26-35



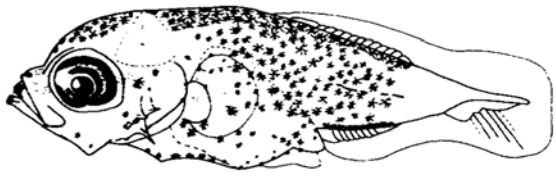
**Samaridae** 37-47

## Group 10 (Continued)

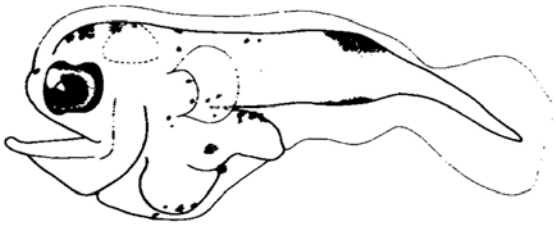
Body depth moderate (BD 20-40% BL). Gut coiled early, but not compact



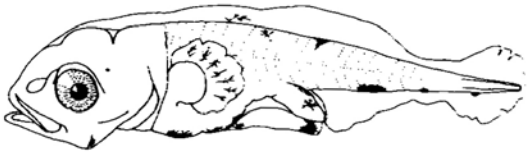
Scatophagidae* 23



Toxotidae 24



Uranoscopidae* 25-28



Serraninae Serranidae 24

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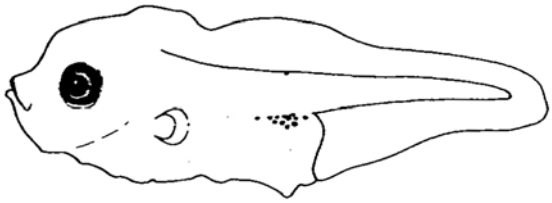
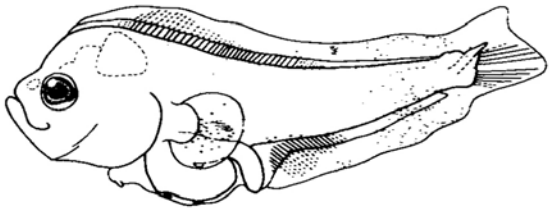
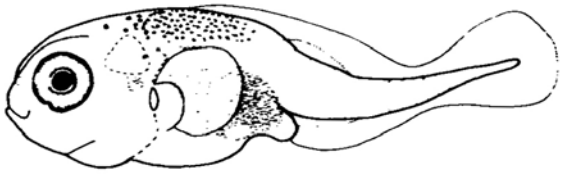


Zanclidae* 22



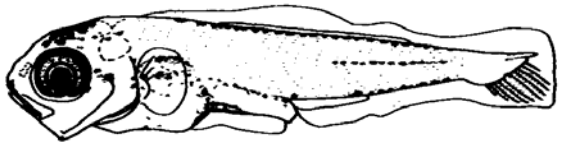
Soleidae 32-58 Page 80



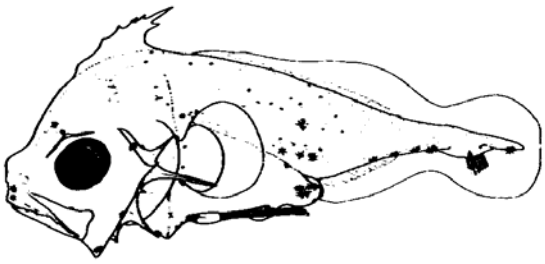
Tetraodontidae 17-24

## Group 11 ($IIIC_1$)

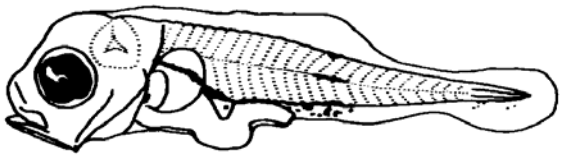
Body depth moderate (BD 20-40% BL). Gut initially uncoiled, coiling before flexion



**Cheilodactylidae** 34-36

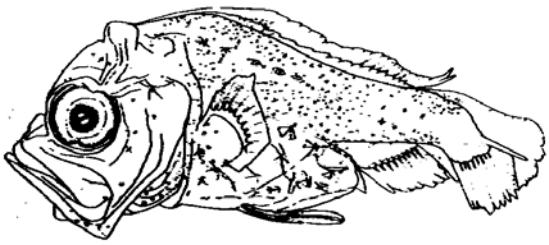


**Lobotidae*** 23-24 Page 55

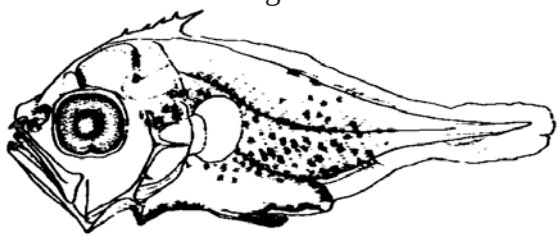


**Emmelichthyidae** 24

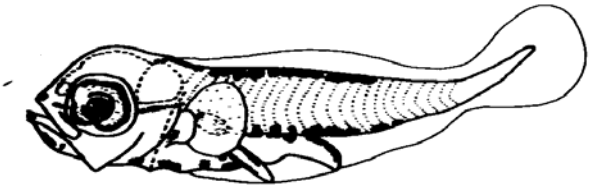
Page 53



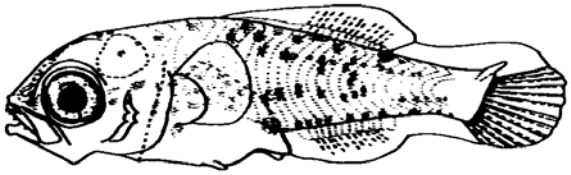
**Monocentridae** 27



**Hapalogenys** * 24



**Pempheridídae** 25



**Kyphosidae** 25-26

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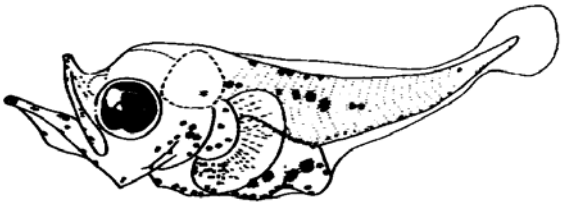
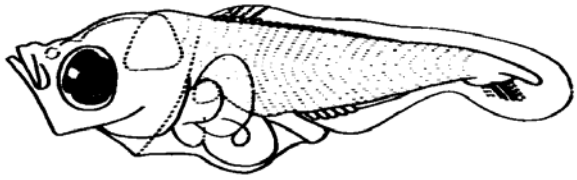
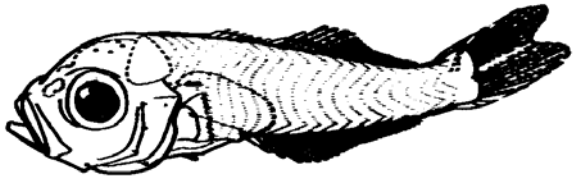


**Platycephalidae*** 27-28

Page 45



**Labridae** 23-28 Page 68

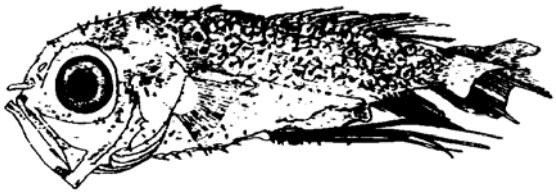


**Lactariidae** 24

Page 65

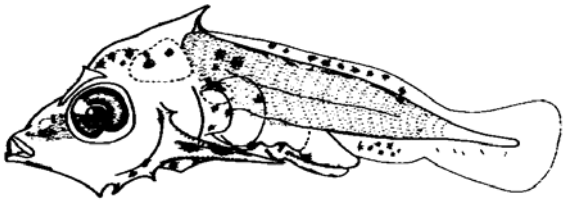
## Group 12 ($IIIC_2$)

Body depth moderate (BD 20-40% BL). Gut initially uncoiled, coiling during or after flexion

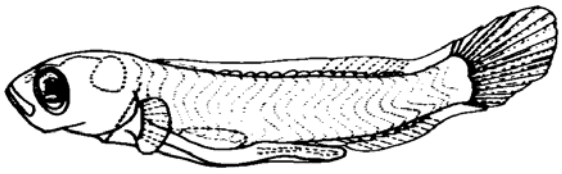


**Anomalopidae** 29-30

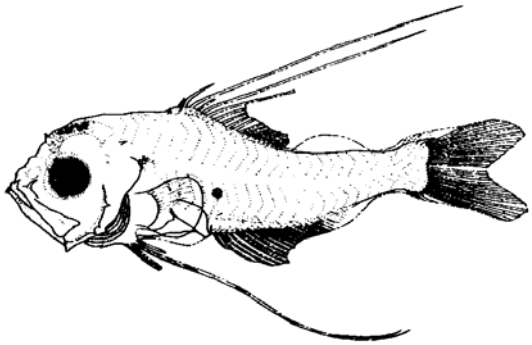
[*Kryptophanaron*; after Baldwin & Johnson, 1995; NB, not an Indo-Pacific genus]



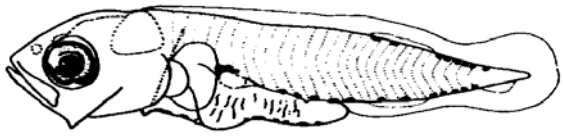
**Chaetodontidae*** 24



**Labridae** 23-28 Page 68

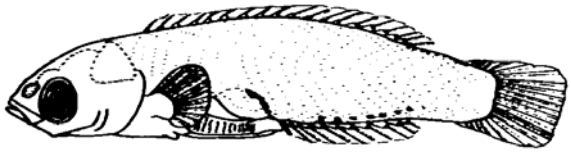


**Berycidae*** 24 Page 40



**Pseudochromidae** 26-33: to 35 in Anisochrominae, to 84 in Congrogadinae

**Blenniidae*** 28-135

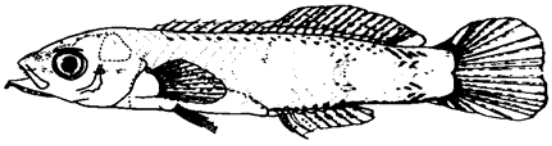


**Scaridae** 25

Page 69

## Group 13 ($IIIC_3$)

Body depth moderate (BD 20-40% BL). Gut initially uncoiled, remaining

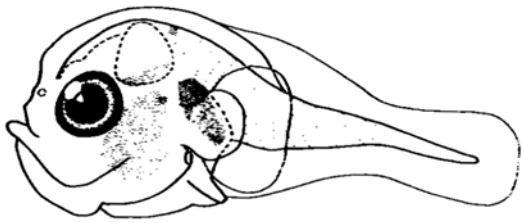


**Cirrhitidae** 26

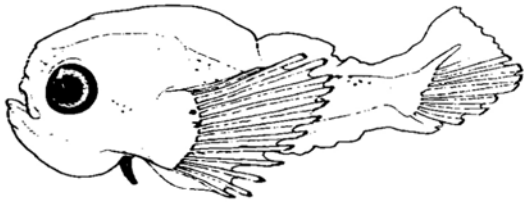
**Gobiesocidae** 31-37

## Group 14 (IVA)

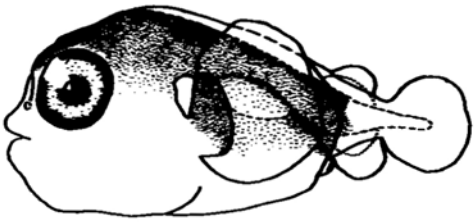
Body deep to very deep (BD > 40% BL). Head and trunk very board



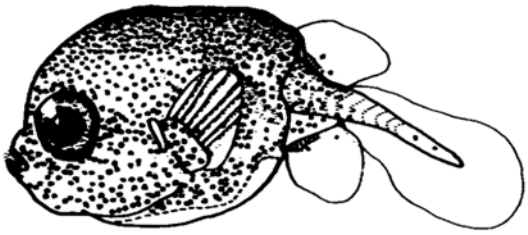
**Antennariidae** 18-23 Page 39



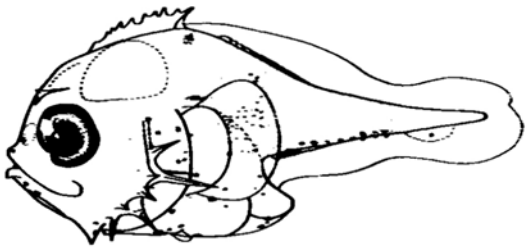
**Ogcocephalidae** 16-20



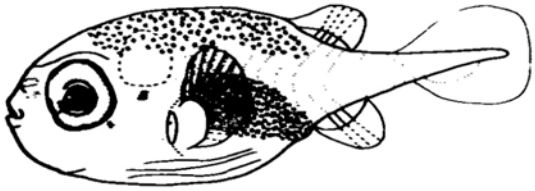
**Diodontidae** 19-23



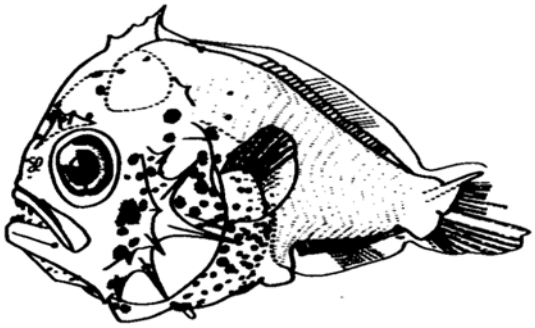
**Ostraciidae** 18



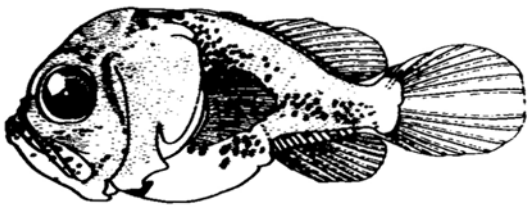
**Drepaneidae*** 24 Page 62



**Tetraodontidae** 17-24



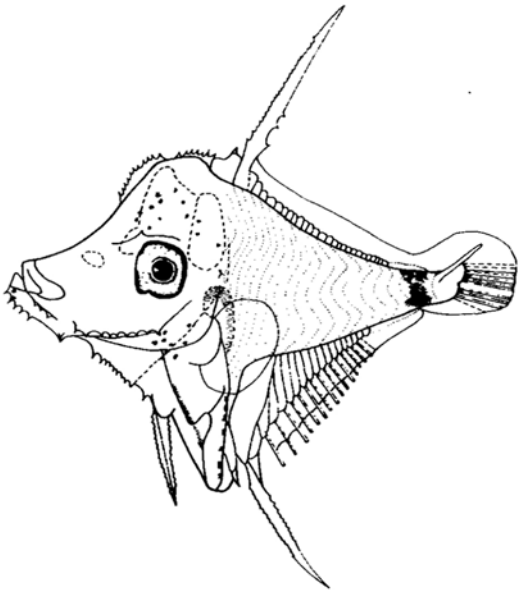
**Ephippidae*** 24 Page 72



**Uranoscopidae*** 25-28

## Group 15 (IVB)

Body deep to very deep (BD > 40% BL). Head and trunk strongly compressed



**Acanthuridae*** 22-23

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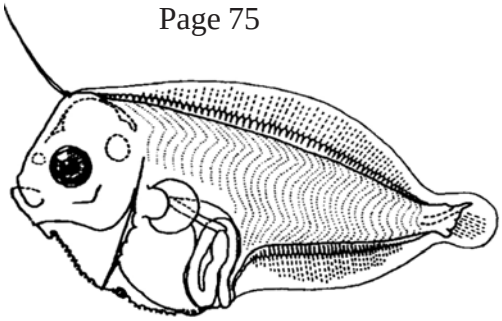

**Bothidae** 33-61

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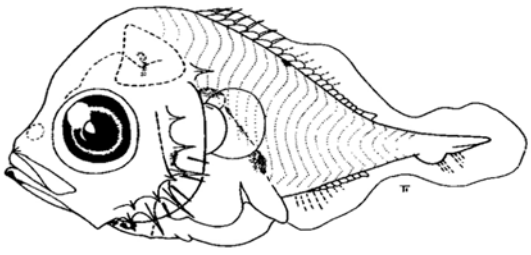
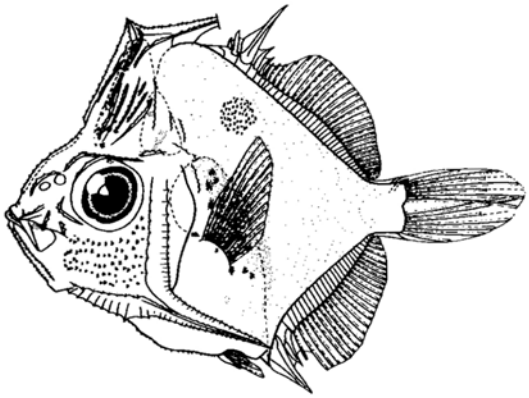
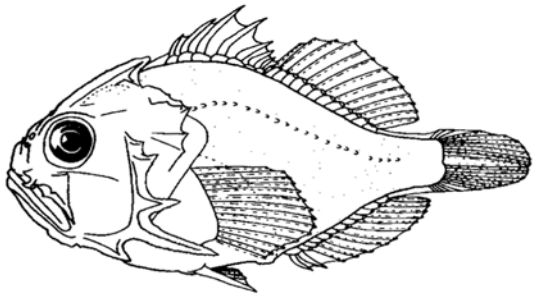


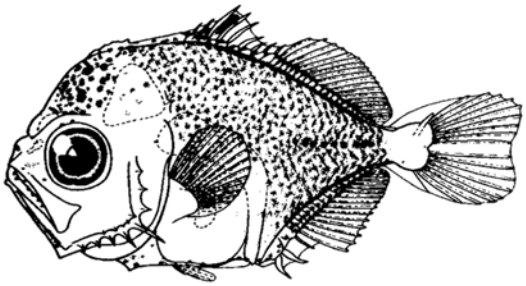
**Callanthiidae*** 24



**Caproidae*** 21-22



**Caracanthidae*** 23-24



**Carangidae*** 24-26

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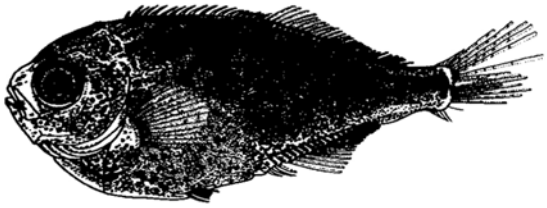
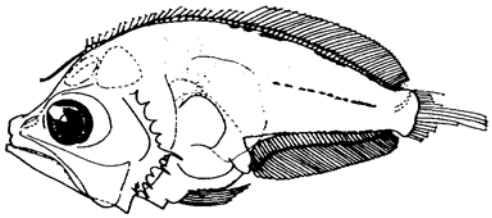


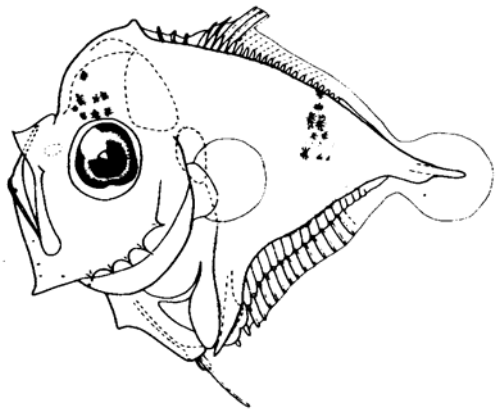
**Cheilodactylidae** 34-36

## Group 15 (Continued)

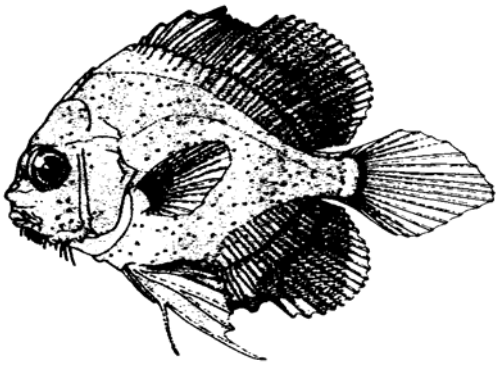
Body deep to very deep (BD > 40% BL). Head and trunk strongly compressed



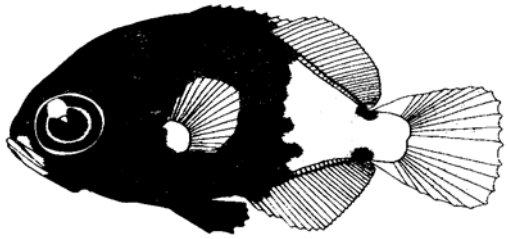
**Citharidae*** 30-35



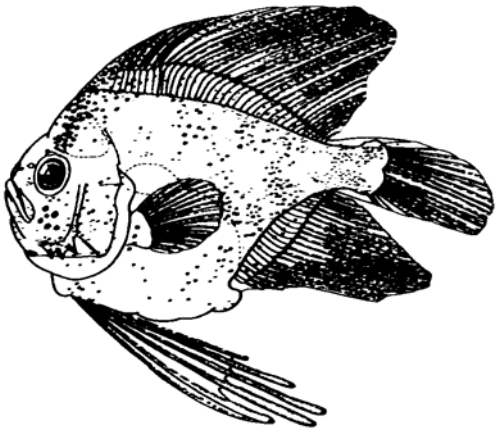
**Menidae*** 24 Page 50



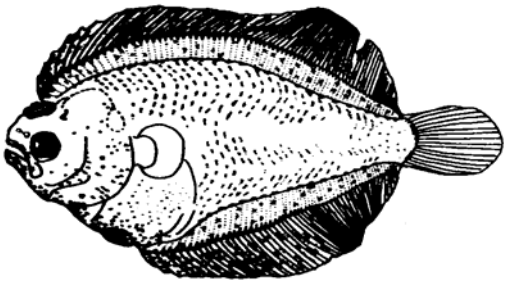
**Drepaneidae*** 24 Page 62



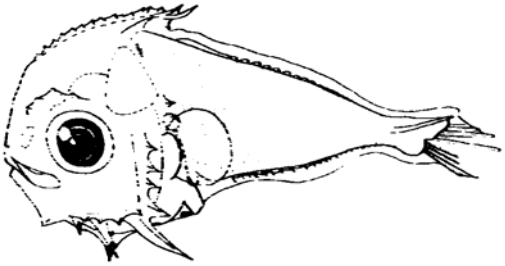
**Monodactylidae** 24 Page 62



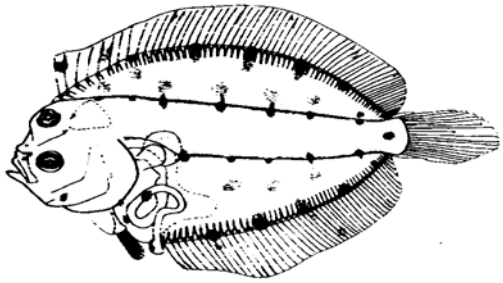
**Ephippidae*** 24 Page 72



**Paralichthyidae** 27-39



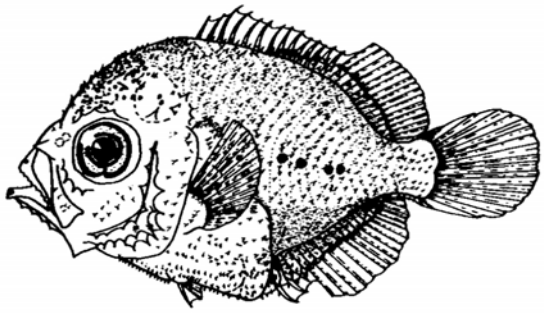
**Leiognathidae*** 24 Page 52



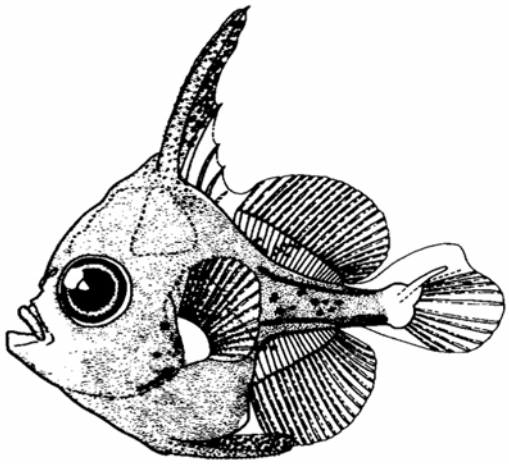
**Poecilopsettidae** 36-43

## Group 15 (Continued)

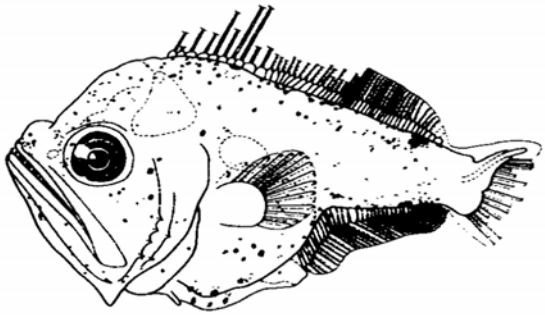
Body deep to very deep (BD > 40% BL). Head and trunk strongly compressed



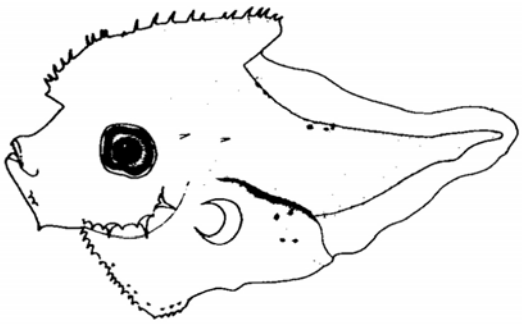
Pomacanthidae* 22-24



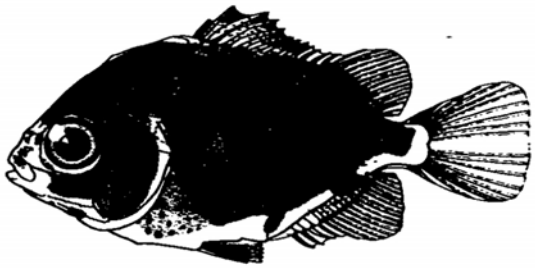
Triacanthidae 20



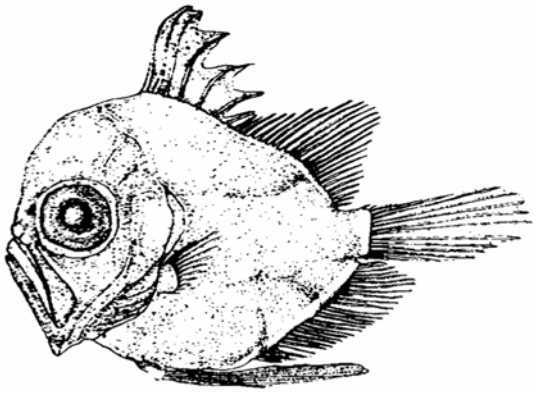
Psettodidae 24 Page 78



Zanclidae* 22



Scatophagidae* 23



Zeidae 30-42

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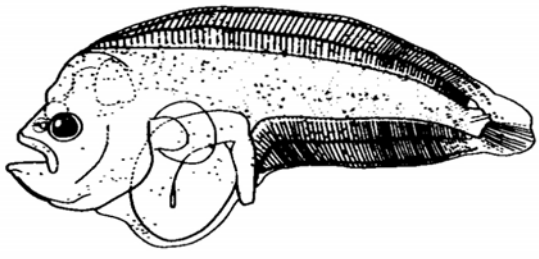

Soleidae 32-58

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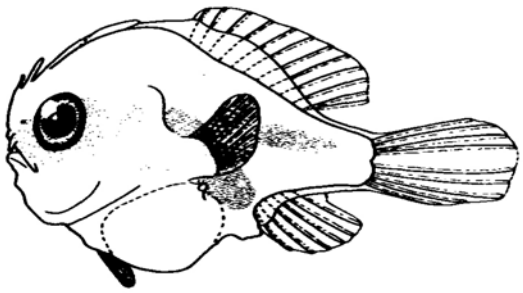
## Group 16 ($IVC_1$)

Body deep to very deep (BD > 40% BL). Head and trunk neither broad nor strongly compressed. Gut coiled and compact early (by 3 mm)



**Antennariidae** 18-23

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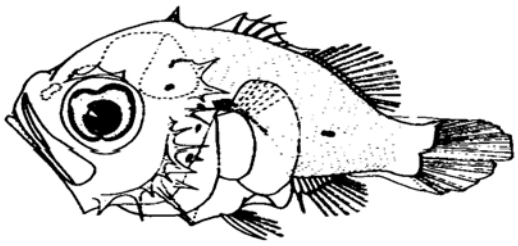
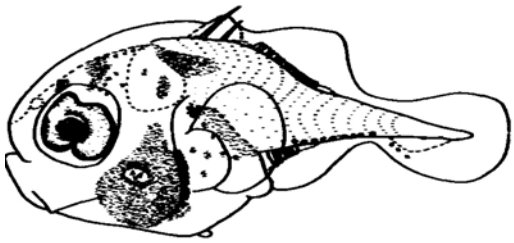


**Anthiinae Serranidae*** 26



**Balistidae** 18

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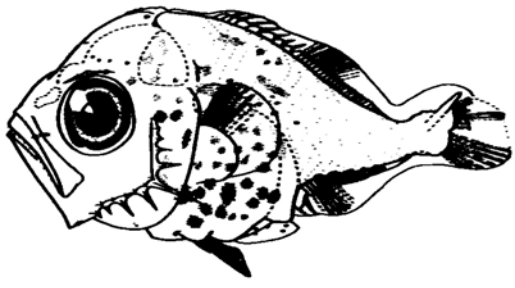

**Carangidae*** 24-26

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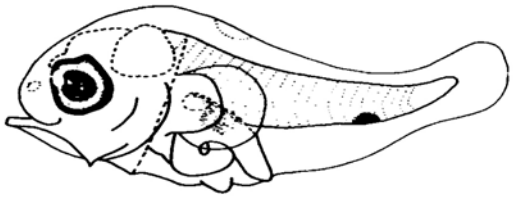
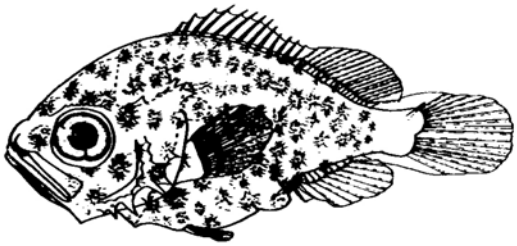
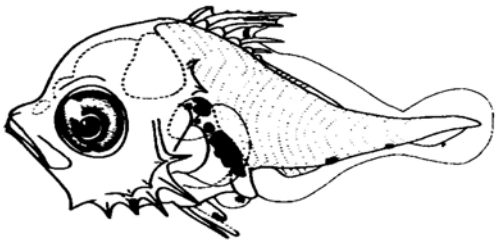


**Epinephelinae Serranidae***

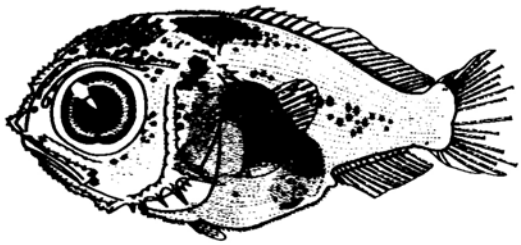
24 Page 47



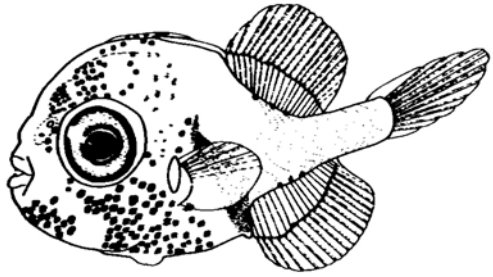
**Haemulidae*** 26 Page 57



**Lutjanidae*** 24 Page 54



**Malacanthidae*** 24



**Monacanthidae** 19-31

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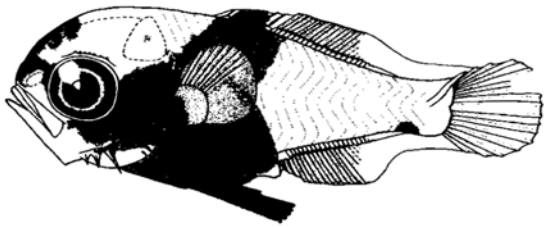
## Group 16 (Continued)

Body deep to very deep (BD > 40% BL). Head and trunk neither broad nor strongly compressed. Gut coiled and compact early (by 3 mm)



**Monodactylidae** 24

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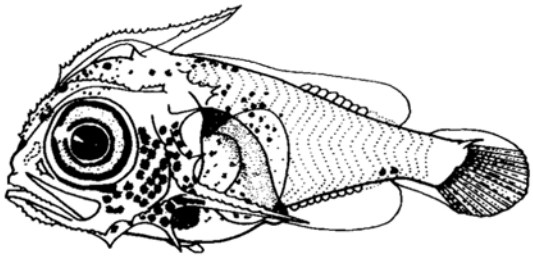

**Priacanthidae*** 22-23

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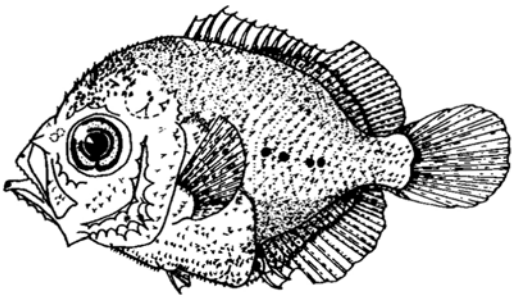
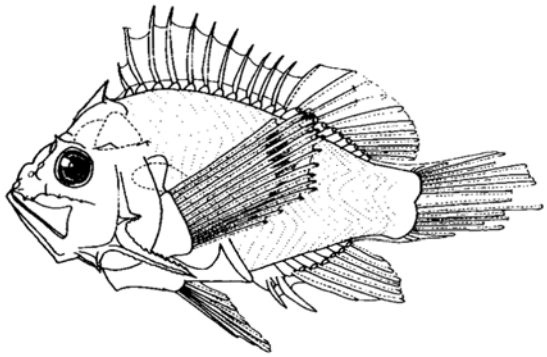


**Pomacanthidae*** 22-24



**Scorpaenidae*** 24-30

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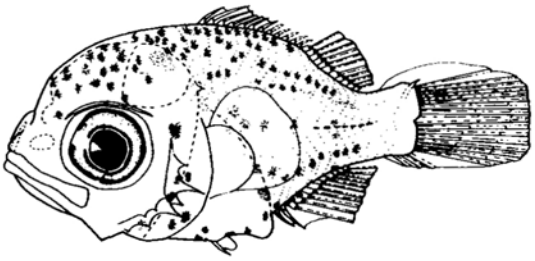
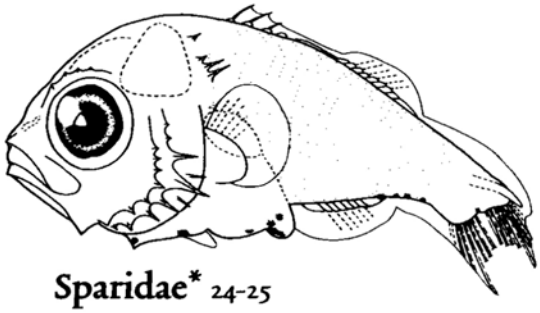


**Pomacentridae*** 26



**Sparidae*** 24-25

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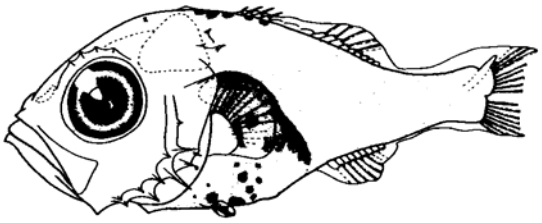
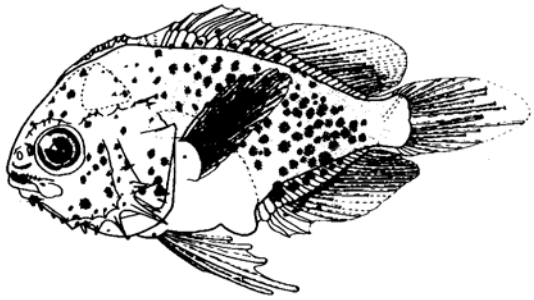
## Group 17 ($IVC_2$)

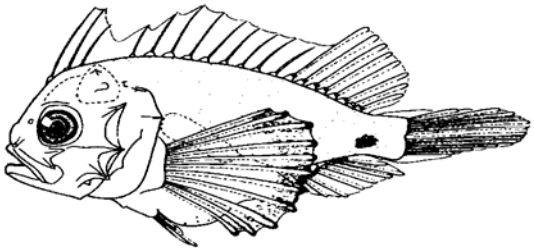
Body deep to very deep (BD > 40% BL). Head and trunk neither broad nor strongly compressed. Gut coiled early , but not compact



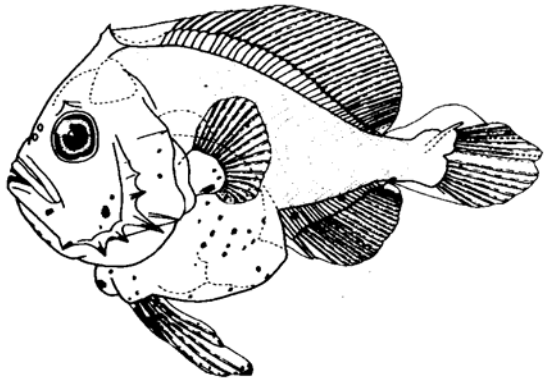
**Acropomatidae*** 25 Page 47



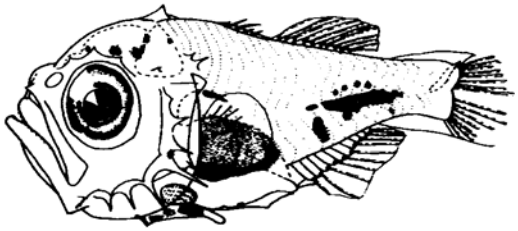
**Drepaneidae*** 24
Page 62



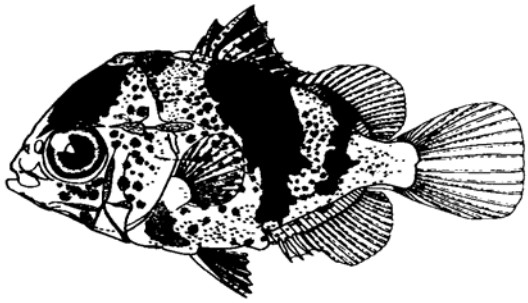
**Aploactinidae*** 21-31



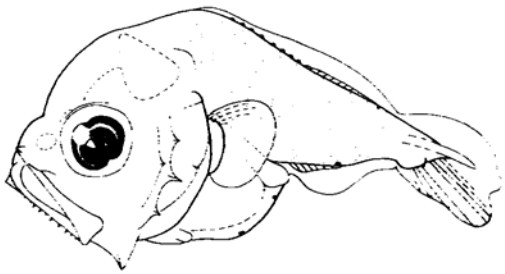
**Ephippidae*** 24
Page 72



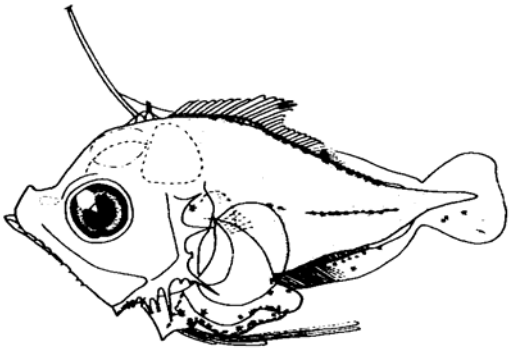
**Apogonidae** 24-25 Page 48
[*Siphamia*; after Leis & Bullock, 1986]



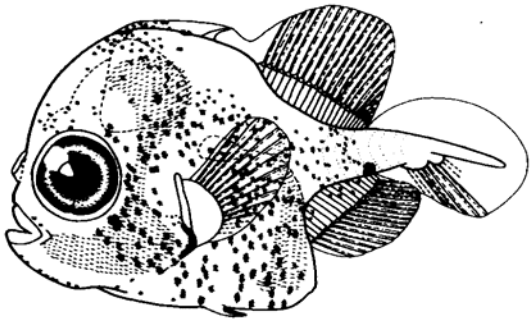
**Scatophagidae*** 23



**Centrogeniidae** 25-26



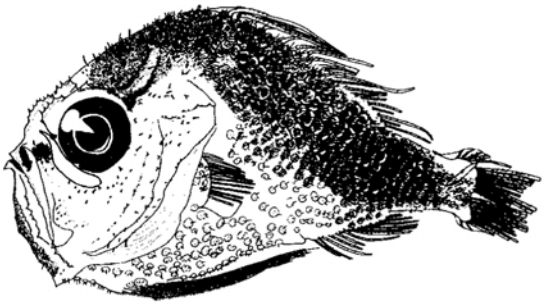
**Citharidae*** 30-35



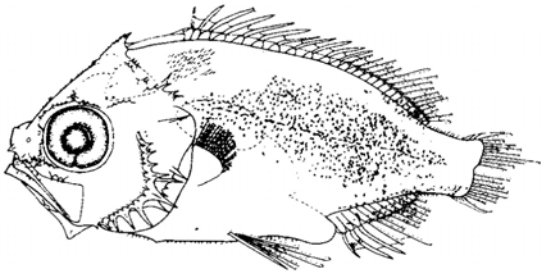
**Triacanthidae** 20

## Group 18 ($IVC_3$)

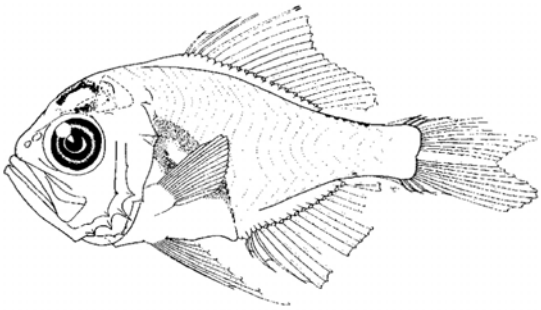
Body deep to very deep (BD > 40% BL). Head and trunk neither broad nor strongly compressed. Gut initially uncoiled.



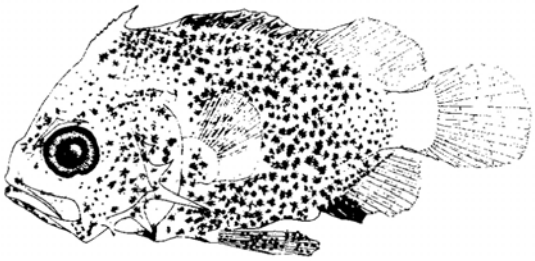
Anomalopidae 29-30



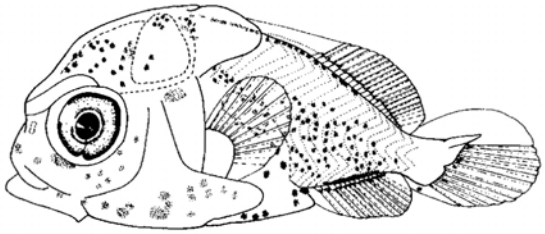
*Hapalogenys** 24



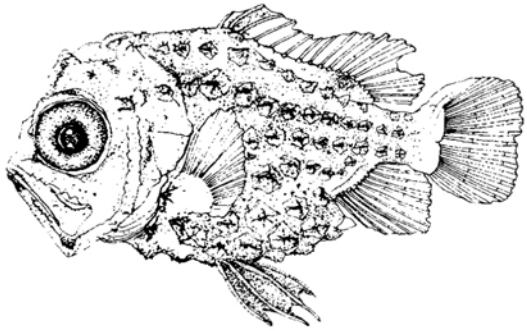
Berycidae* 24 Page 40



Lobotidae* 23-24 Page 55



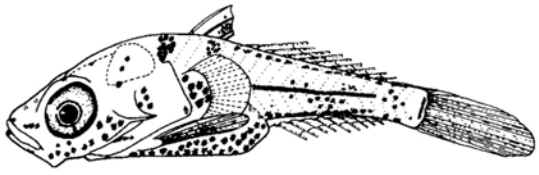
Chaetodontidae* 24



Monocentridae 27

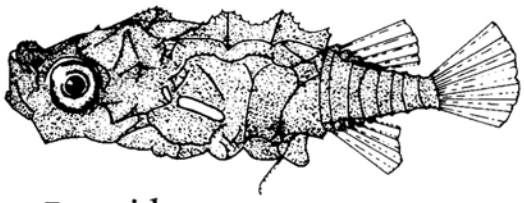
## Group 19 (V)

Body(not just head) dorso-ventrally flattened

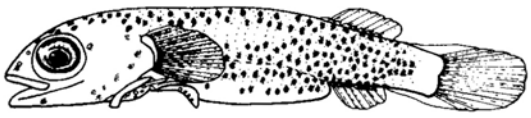


Callionymidae* 21-23

Page 71



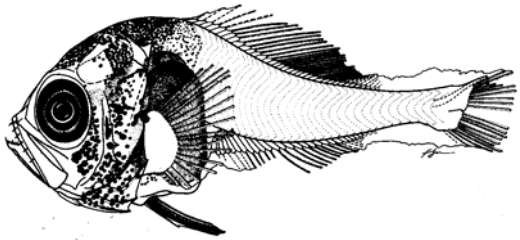
Pegasidae 19-22



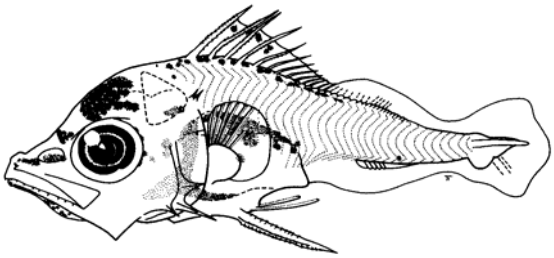
Gobiesocidae 31-37

The following are familay commercially important fishes in the South China Sea but not included in the Leis, J.M. and B.M. Carson-Ewart. 2000. The Larvae of Indo-Pacific Coastal Fishes: An identification guide to marine fish larvae

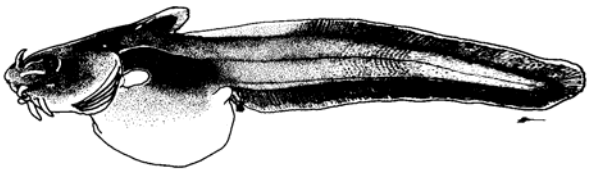
**From:** Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.



Bramidae , Page 53
36-54 myomeres

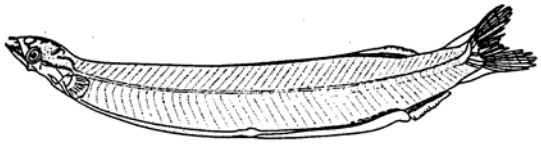


Gempylidae, Page 77
31-67 myomeres

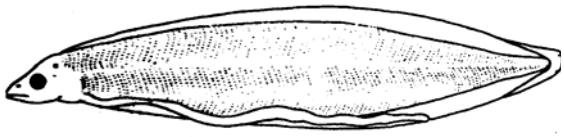


Plotosidae, Page 38
> 77 myomeres

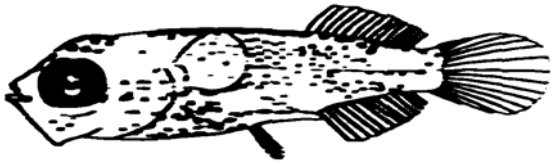
**From :** Fahay, M.P. 1983. Guide to the early stages of marine fishes occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf. *J. Northw. Atl*. Fish. Sci. 4



Elopidae , Page 34

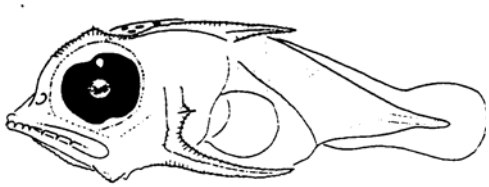


Anguillidae, Page 34

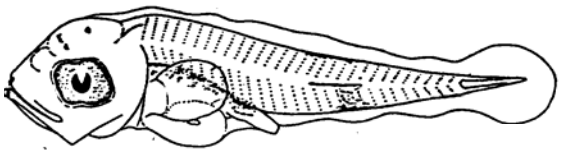


Exocoetidae, Page 44 -

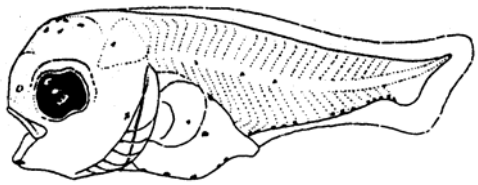
Branchiostegidae, Page 49



Istiophoridae, Page 76

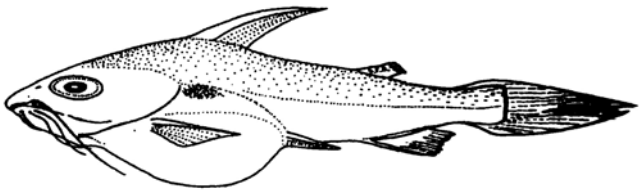


Nomeidae, Page 67



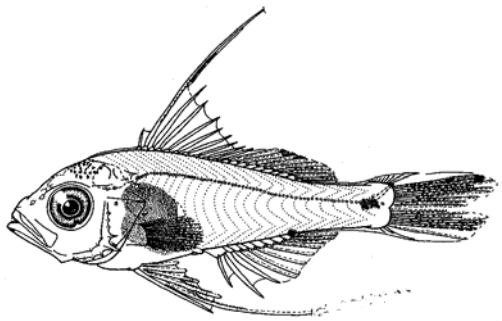
Stromateidae, Page 67

From M.J. Prince Jeyaseelan, 1998. Manual of Fish Eggs and Larvae from Asian Mangrove Waters. Science and Technology, UNESCO Publishing

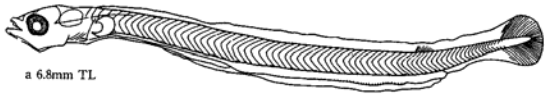


Arridae, Page 37

**From :** An Atlas of the Early Stage Fishes in Japan, edited by Muneo Okiyama

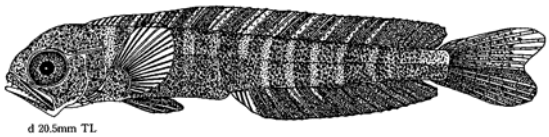


Caesionidae 10.8 mm (Leis and Rennis, 2000)
Page 55 (see Lutjaninae)

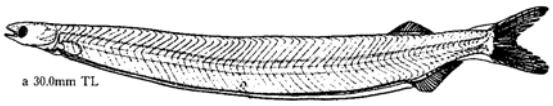



Chirocentridae- *Chirocentrus dorab*
6.8 mm (Takita, 1988)
Page 36


Congridae- *Conger myriaster* 108.7 mm
(Mochioka, 1988)
Page 35

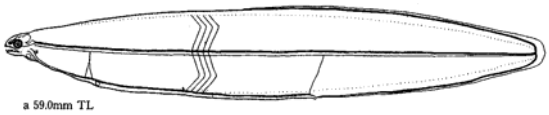



Coryphaenidae- *Coryphaena hippurus*
20.5 mm (Mito, 1956)
Page 50

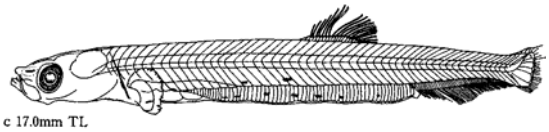



Megalopidae- *Megalops cyprinoides* 30.0
mm (Uchida et al., 1958)
Page 34

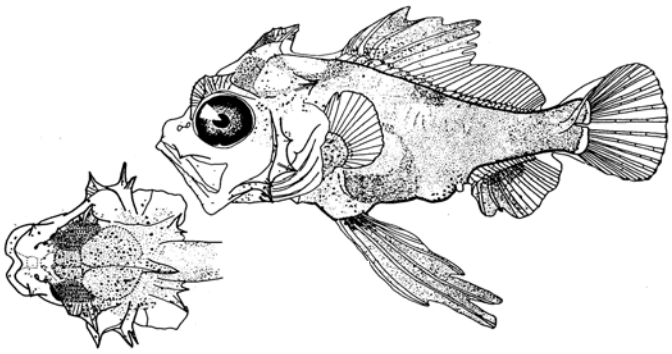

Muraenesocidae- *Muraenosox cinereus*
109.0 mm (Mochioka, 1988)
Page 35




Muraenidae sp. 59.0 mm (Mochioka, 1988)
Page 34




Pristigasteridae- *Ilisha elongata* 17.0 mm
(Takita, 1988)
Page 36



Pentacerotidae- *Evistias acutirostris 8.4 mm SL*
(Konisi, 1988) Page 64

# Main characters of larvae of commercially important fish in the South East Asia region

**Order Elopiformes**
**Family Elopidae (Base on *Elops saurus*)**
(From: Fahay, 1983. Guide to the early stages of marine fishes occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf.)

- 72-82 myomeres
- Leptocephalus-like with forked caudal fin, triangular head, and ribbon-like body
- Gut long, 80-90% total length
- Flexion occurs at 10-15 mm standard length
- Period of larval growth followes by shrinkage and tickening of body during metamorphosis, and then resumption of growth up to juvenile stage
- Dorsal and anal counts usually complete at about 25 mm (after metamorphosis)
- Maximum size before metamorphosis is about 43 mm.
- Pigmentation: dorsal edge of gut, mid-lateral body, and anal base; dorsal air bladder pigmented after metamorphosis.

**Order Elopiformes**
**Family Megalopidae (Based on *Megalops cyprinoides*)**
(From: Mochioka, 1988. *Megalops cyprinoids*. *In* An atlas of the early stage fishes in Japan, ed. Okiyama. Toakai Unversity Press, Tokyo, pp. 16-17.)

- 68-69 myomeres
- Leptocephalus with a well forked caudal fin
- Single dorsal fin and anal fin located near caudal fin nearly symmetrically
- Widely distributed in the warm waters of the Indian Ocean and Pacific Ocean

**Order Anguilliformes**
**Family Anguillidae (Base on *Anguilla rostrata*)**
(From: Fahay, 1983. Guide to the early stages of marine fishes occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf.)

- 102-111myomeres
- Leptocephalus
- Gut straight and long (about 70-75% TL), shortens at metamorphosis.
- Pectoral fin rays form late; pelvic fin absent.
- Maximum size before metamorphosis about 70 mm.
- Lower jaw protrudes in glass eel and elver.
- Pigmentation: none, except in eye, until glass eel stage.

**Order Anguilliformes**
**Family Muraenidae (Based on *Uropterygius* sp. 1)**
(From: Mochioka, 1988. *Uropterygius* sp. 1. *In* An atlas of the early stage fishes in Japan, ed. Okiyama. Toakai Unversity Press, Tokyo, pp. 39-40.)

- 123-125 myomeres

- Leptocephalus with a round caudal fin
- Pectoral fin reduced in size

**Order Anguilliformes**
**Family Ophichthidae (Based on Ophichthinae sp. 1)**
(From: Mochioka, 1988. Ophichthinae sp. 1. *In* An atlas of the early stage fishes in Japan, ed. Okiyama. Toakai Unversity Press, Tokyo, pp. 60-61.)

- 144-149 myomeres
- Leptocephalus
- More than 3 gut swellings with pigmentation

**Order Anguilliformes**
**Family Congridae (Based on *Conger myriaster*)**
(From: Mochioka, 1988. *Conger myriaster*. *In* An atlas of the early stage fishes in Japan, ed. Okiyama. Toakai Unversity Press, Tokyo, pp. 49-50.)

- 142-149 myomeres
- Leptocephalus
- A pigment spot in each of the dorsal and ventral side of the eye
- A punctate pigment in every 1 to 6 myomeres on the entire body just under the lateral line

**Order Anguilliformes**
**Family Muraenesocidae (Based on *Muraenosox cinereus*)**
(From: Mochioka, 1988. *Muraenosox cinereus*. *In* An atlas of the early stage fishes in Japan, ed. Okiyama. Toakai Unversity Press, Tokyo, pp. 53-54.)

- 144-156 myomeres
- Leprocephalus
- Origin of the dorsal fin situated at the anterior body (24th – 30th myomere)
- A distinct caudal fin

**Order Clupeiformes**
**Family Clupeidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 40-60 myomeres; muscle fibres in a cross-hatched pattern in most taxa, more evident in preflexion and flexion larvae
- Body very elongate to moderate (BD 5-23%), cylindrical to slightly compressed
- Head small to moderate (HL 8-31%), without spines
- Gut straight and long to very long (PAL 61-94%), with weakly to strongly striated hindgut
- Gut shortens in some taxa with growth, anus migrates anteriorly by 3-6 myomeres
- Gas bladder over midgut to hindgut, usually inflated
- Dorsal and anal fins posteriorly located; posterior end of dorsal fin and origin of anal fin usually separated by 1-10 myomeres, or overlapping by up to 2 myomeres.
- Body lightly pigmented; no pigment dorsally along trunk and tail prior to transformation
- A few melanophores around notochord tip in some taxa

**Order Clupeiformes**
**Family Pristigasteridae (Based on *Ilisha elongata*)**
(From: Takita, 1988. *Ilisha elongata*. *In* An atlas of the early stage fishes in Japan, ed. Okiyama. Toakai Unversity Press, Tokyo, pp. 7-8.)

- 53 myomeres
- No pigment on the dorsal side of the body
- About 10 myomeres between the end of the dorsal fin to the origin of the anal fin in 15-17 mm SL
- Body deepened and the anal fin origin extended anteriorly to the end of the dorsal fin in 21.5-mm TL larva

**Order Clupeiformes**
**Family Engraulidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 38-77 myomeres, typically 38-47; muscle fibres in a cross-hatched pattern, more evident in preflexion and flexion larvae
- Body very elongate to elongate (BD 7-19%), cylindrical to slightly compressed
- Head small to moderate (HL 11-28%), without spines
- Gut moderate to very long (PAL 48-81 %), straight and with strongly striated hindgut
- Gut shortens with growth, anus migrates anteriorly by up to 7 myomeres
- Gas bladder over midgut, usually inflated
- Dorsal and anal fins posteriorly located, posterior end of dorsal fin overlaps origin of anal fin by 1-4 myomeres (except in *Thryssa* in which the dorsal fin is entirely anterior to anus); degree of overlap varies
- among taxa and developmental stage
- Body lightly pigmented, pattern along dorsal surface of gut species-specific
- No pigment dorsally along trunk and tail prior to transformation

**Order Clupeiformes**
**Family Chirocentridae (Based on *Chirocentrus dorab*)**
(From: Takita, 1988. *Chirocentrus dorab*. *In* An atlas of the early stage fishes in Japan, ed. Okiyama. Toakai Unversity Press, Tokyo, pp. 11, 13-14.)

- 72-75 myomeres
- Very elongate body
- Anus situated from 53th to 58th myomere

**Order Gonorynchiformes**
**Family Chanidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Chanid larvae are elongate to very elongate. They are nearly round in cross-section at hatching but gradually become moderately compressed. There are 44-47 myomeres (32-37 + 10-12)*. Cross-hatched muscle fibres in the myomeres are absent. The very long, straight gut reaches to about 80% BL. The hindgut is not striated. In older larvae, the posterior-most portion of the gut is not

attached to the myomeres so the anus is actually slightly trailing. The small gas bladder of preflexion larvae enlarges and becomes conspicuous by the time flexion is complete. It is located approximately midway along the gut. The small, elongate and slightly dorsoventrally flattened head has a short snout that is somewhat concave dorsally in preflexion and flexion larvae but becomes rounded thereafter. The small mouth reaches to the anterior margin of the eye. A small knob forms at the dentary symphysis and becomes prominent during the flexion stage. Larvae (and adults) lack teeth. The eye is initially slightly elongate and moderate to large, but becomes round and small in postflexion larvae. Gill membranes are free from the isthmus. There is no head spination. The dorsal and anal fins are postetiorly-located, with the dorsal fin anterior to the anal fin. However, once all bases are present, the anal fin originates approximately ventral to the ultimate dorsal-fin-ray base. These two fins form concurrently: anlagen develop at about the time of notochord flexion, incipient rays are present in early postflexion larvae and all rays are present by about 9 mm. No pectoral fin rays have formed in our largest specimens. The pelvic fins are absent in larvae as large as 14.5 mm (Kumagai, 1984). The short, trailing portion of the gut protrudes ventral to the anal fin and the anterior most ray bases are thus not posterior to the anus. No scales are present in any of our larvae. At a size of 12-15 mm larvae migrate to shallow, inshore and estuarine waters where they undergo transformation, including anterior movement of the dorsal fin, development of pectoral and pelvic fins, and major changes to body shape and pigment (we have not included information on transforming individuals). Chanids have relatively unspecialized larvae.

*Pigment* – Milkfish larvae are lightly pigmented. The pigment changes significantly during development and varies among individuals. The pigment along the body margins is distinctive. Approximately paired melanophores are present dorsolaterally on the gut, and a single row of melanophores forms from anterior to posterior along the ventral midline of the gut, eventually reaching to about the middle of the hindgut. A separate, short row of melanophores is present on the ventral midline of the tail. The number of melanophores in the series along the dorsal midline of trunk and tail is highly variable. In addition, postflexion larvae have a single melanophores middorsally on the hindbrain, and a few melanophores on the head and caudal-fin rays. A series of midlateral melanophores form on the trunk and tail of many individuals.

**Order Siluriformes**
**Family Ariidae**
(From M.J. Prince Jeyaseelan,1998. Manual of Fish Eggs and Larvae from Asian Mangrove Waters. Science and Technology, UNESCO Publishing.)

Alevin stage.

The yolk-bearing larvae transform directly into the juvenile stage, hence are known as alevins. The alevins measure a maximum size of 47 mm in total length. The caudals are bifurcated but not deeply forked as in adults. Dark pigmentation in the form of a blotch is present on each side laterally, at the upper portion of the yolk sac. The dorsal spine is not yet serrated. Lateral lines are traceable. An adipose fin develops. One pair of maxillary barbels and two pairs of mandibular barbels develop. The maxillary barbels do not reach the pectoral base at this stage.

Early juveniles

The tooth palate is not yet fully developed (tooth patches on the palate are elliptical with densely packed molar-like teeth in fully metamorphosed fish). One pair of maxillary barbels reach as far as the tip of the pectoral fins. Two pairs of mandibular barbels do not reach beyond half the head length. Adipose fins pigmented.

**Order Siluriformes**
**Family Plotosidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- >77 myomeres
- Body elongate (BD 14-18%)
- No head spines
- 3-4 pairs of mouth barbels, pair at mouth angle usually shorter
- Gut moderate (PAL 38-44%), loosely coiled
- Large yolk sac at hatching
- Dendritic organ protruding from anus in marine species
- Second dorsal and anal fins confluent with caudal fin

**Order Aulopiformes**
**Family Synodontidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-Larvae are elongate to very elongate, round to ovoid in crosssection, and have 46-65* myomeres (32-51 + 9-21). The gut is long and straight, and rugae are prominent along the hindgut. The pre-anal length is two-thirds to nine-tenths of the body length. There is no apparent gas bladder. The head is small to (barely) moderate in size. In younger larvae the head is round with a short, rounded snout, but by the mid postflexion stage the head becomes dorsoventrally flattened and the snout becomes longer and may become pointed before settlement. The mouth is large, extending to at least mid eye. Tiny villiform teeth form in both jaws during the mid to late preflexion stage. The small to large eye is round to narrow. One *Saurida* species has a small mass of choroid tissue on the ventral edge of the eye. The gill membranes are free from the isthmus, and there is no head spination. Notochord flexion takes place at a large size. The anal-fin anlage forms at about the time of flexion, incipient rays appear shortly after flexion, and the full ray complement is present by about 14 mm. Synodontines have a prominent preanal fin fold that is absent in Saurida. The pelvic-fin buds may first develop during flexion (depending on species), but the fin rays do not begin to form until about 13 mm which is concurrent with pectoral-fin ray formation. Full development of both the pelvic and pectoral fins is attained shortly after full anal-fin development. The anlage of the short-based dorsal fin is not visible until about 13 mm, and the full dorsal-fin complement is present by 20 mm. The adipose fin, located directly over the anal fin, begins to form at about 10 mm as a gradual thickening of the finfold. By settlement, scales on the lateral line have formed, and juvenile morphology is attained in some species. There are no obvious specializations to larval life except the large size reached before settlement.

*Pigment*- Synodontid larvae have 3-13 paired, large, distinctive, petitoneal pigment patches lying dorsolaterally along the length of the gut (these are retained internally following settlement). Pigment also generally occurs along the base of the anal anlage or fin and along the tip of the notochord or caudal fin base. Dorsal pigment is rare except at the notochord tip. Prior to settlement, further pigment may occur on the brain and body while the melanophores along the gut become less distinct as they become internal.

**Order Gadiformes**
**Family Bregmacerotidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Bregmacerotids are compressed and initially of moderate depth with a hump-backed appearance. They become progressively more slender once the caudal fin is formed, and are elongate horn about 10 mm. There are about 50-60 myomeres, 12-16 of which are preanal. The gut is tightly coiled in the smallest larvae, and reaches to near midbody. The gut and abdomen are initially noticeably deeper than the tail, but this difference gradually decreases, and largely disappears by about 10 mm. The gas bladder is initially located over the anterior portion of the gut, but becomes larger and more conspicuous, spreading primarily posteriorly. The head is moderate in size, but has a very prominent lower jaw angle, and as a result, the head is deeper than the rest of the body until well into the postflexion stage. The snout is similar in size to the eye until the postflexion stage, during which it becomes somewhat larger. The dorsal profile of the head changes from strongly rounded to nearly straight. The large mouth is strongly oblique, and may reach to the anterior edge or middle of the eye: but it becomes more horizontal with growth. Teeth are present in the lower jaw of our smallest specimens, and appear in the upper jaw at about 4 mm. The round eye is moderate to large in preflexion larvae, decreasing to small to moderate in postflexion larvae. Gill membranes are free from the isthmus. There is no head spination. The first fins to form are the jugular pelvics. Buds are present at about 2.4 mm, the first rays are formed very soon after that, and all 5-7 rays are present by about 7 mm. The pelvic rays become thick and very elongate, reaching well past the anus by about 5 mm. The first, detached ray of the dorsal fin forms just after the pelvic bud forms in our specimens, but in some species it may form at the same time as the rest of the dorsal fin. This ray is initially located at the level of the pectoral base, but moves anteriorly onto the head after flexion. In some species, this ray becomes very long (> HL). The remaining dorsal- and anal-fin rays, form simultaneously: anlagen are present at about 3 mm, the rays begin to appear during formation of the caudal fin, and all are present by about 10 mm. The rays form from anterior and posterior toward the middle of the fin: those rays that will be the shortest in the adult form last. The caudal fin is not confluent with the dorsal or anal fins. The pectoral fin is paddle-like with a very narrow peduncle, and is initially located well above the lateral midline. Pectoral rays begin to form at about 5 mm, and when all are present at 10-12 mm, the fin has lost its narrow peduncle and is located near the lateral midline. Incipient scales are present at about 12 mm. The only larval specializations are the paddle-like pectoral fin, and the early-forming pelvic fins.

*Pigment* - Pigment of bregmacerotid larvae varies from nearly absent to heavy depending on species and stage of development. Most species have some pigment on the gas bladder, and lateral pigment on the tail in the postflexion phase: many have pigment on the angle of the lower jaw. Pigment generally increases as the larvae grow: otherwise, pigment is so species dependent and variable, no generalizations are possible.

**Order Lophiiformes**
**Family Antennariidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Antennariid larvae are deep bodied and robust in the head and trunk, but much less broad than deep. The tail is initially elongate and com-pressed. The notochord is initially straight but curves into an S-shape over the posterior portion of the gut from 1.7-2.1 mm. The tail then deepens

with growth. There are 19-21 myomeres (5-8 + 12-14)*. The body is initially sur-rounded by an inflated dermal membrane. This thickens, especially around the head and trunk. In most species, it is almost opaque by the completion of flexion, but in some, it may remain transparent well into the postflexion stage. The subdermal space becomes smaller and disappears during the postflexion stage or at settlement, depending on species. The triangular gut is coiled in our smallest specimen (1.4 mm) and reaches to about midbody in preflexion larvae, bur becomes relatively larger and more robust, and may extend to as much as to 88% BL in postflexion larvae. The abdomen apparently can be inflated in postflexion larvae of at least some species. A gas bladder is not visible. The large head is deeply rounded with a steep profile but, in larger postflexion larvae, the dorsal profile becomes less steep. The short snout is blunt and broadly convex. Conspicuous tubular nostrils which extend over the upper lip form during the preflexion or flexion stage. The initially small mouth falls short of the eye but, during the postflexion stage it becomes moderate to large and reaches to the anterior margin of the pupil in some species. The mouth becomes oblique in most taxa by the postflexion stage, and may become nearly vertical by settle-ment. Small, pointed teeth appear in the lower jaw from as early as 2 mm and subsequently become larger. The round eye is initially large, but its relative size reduces to moderate in postflexion larvae. The gill opening is a small ex-halent pore ventral to the pectoral-fin base. In postflexion larvae, the pore may migrate posteriorly more than half-way across the trunk. There is no head spination. Anlagen of the soft dorsal fin and short anal fin form during the flexion stage. The dorsal-fin spines begin to form during the flexion stage, but they are often difficult to see through the thickening dermal sac. Formation of dorsal- and anal-fin elements is well under way by 3 mm, and full fin comple-ments are present by 3.8-4-3 mm (by 2.3 mm in the eastern Pacific species *Antennatus strigatus* (Gill)). The first two and third dorsal spines form dorsal to the anterior margin of the eye and above the otic capsule, respectively. They may migrate anteriorly during development, so by the time the spines pene-trate the dermal sac, they are located dorsally on the snout and nearer the eye, respectively. The first dorsal spine becomes filamentous by 7.5-8.3 mm and is swollen distally in most species. This swelling forms the esca (fishing lure) before settlement. The pectoral fin is paddle-shaped and its peduncular base becomes increasingly elongate. Pectoral-fin rays begin to form during the flex-ion stage and ate all present by 3.0-3.4 mm. The developing pelvic-fin girdle is apparent within the inflated dermis from the late flexion stage. Pelvic buds emerge in early postflexion larvae, and by 3.8-6.0 mm, ossification of soft rays is complete. The small pelvic spine is the last to ossify: size at first appearance ranges from 4.5 mm 3.4 mm in A. *stri8atus)* to after 12 mm and is species dependent. A relatively long notochord tip remains exposed for a rime follow-ing flexion. The caudal-fin rays become elongate. In species with a persistent subdermal space, only the tips of the dorsal-, anal- and pelvic-fin elements project beyond the dermis. Scalation is variable in both larvae and adults. In some species, small scales in the form of spinules may form on the head and trunk before 2.3 mm (for instance, A. *stri8atus)*, while in others they are first ap-parent on the head at 8.3 mm and cover the entire body, including the medial fins, by 11 mm. Other species do not develop spinules until after 12 mm, while others lack spinules but are covered by soft dermal papillae by 10.5 mm. The only obvious specialization to pelagic life is the inflated dermal sac.

*Pigment*-Antennariid larvae are lightly pigmented. Melanophores are generally internal and are initially located primarily over the gut. In some species, internal pigment spreads onto the head and tail. Exter-nal pigment appears shortly before settlement and consists of the incipient juvenile pigment pattern.

**Order Beryciformes**
**Family Berycidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 23-24 myomeres
- Body elongate to moderate (BD 16-33%)
- Head rounded and moderately deep in postflexion larvae
- Weak to moderate head spination from late flexion stage
- Gut moderate to long (PAL 45-60%), initially straight but becoming coiled after flexion stage
- Elongate, early forming pelvic-fin elements
- Body lightly pigmented, pigment limited to dorsal surface of head and ventral surface of posterior portion of tail

**Order Beryciformes**
**Family Holocentridae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Larvae have a deep head and trunk but have a slender tail. There are 25-27 myomeres (6-11 + 14-20). The gut of small preflexion larvae may be tightly coiled or initially straight with coiling beginning at about 2 mm. when the gut is fully coiled the preanal length is 42-70% BL. A small gas bladder, which is covered by pigment and appears to be conspicuous only in larvae sampled at night, is present above the anterior portion of the gut. The moderate to large head is only slightly compressed laterally. Initially, the snout is short and truncate, but it becomes elongate and bulbous as the rostral spine develops. The mouth is small (reaching to less than mid eye) and initially terminal but becomes inferior with development of the rostral complex. Bands of small villiform teeth form in both jaws shortly before settlement. The eye is round and large. The gill membranes are free from the isthmus. At about 2.5 mm a large, complex, serrate rostral spine begins to form (initiating the so-called rhynchichthys stage). The spine (which is bifurcate in myripristines) varies in length depending on species and reaches maximum relative length shortly after notochord flexion. It then decreases in size and disappears by about 35 mm. A smooth spine at the angle of the preopercle and a supraoccipital crest with one posteriorly-directed spine (which later elongates) and one small dorsal spine are present in 1.9 mm larvae. By 2.2 mm two small dorsal spines may be associated with the crest. Transverse ribs and weak serrations begin to develop on the elongate supraoccipital spine and the preopercular spine at 2.4 mm. Both of these spines become extremely produced and attain maximum relative length by the completion of flexion. By 18 mm only a slightly raised ridge and small posteriorly-directed spine remain of the supraoccipital crest and spines, and by 30 mm these have disappeared. Other head spination begins to develop by 2.5 mm in myripristines and at about 3 mm in holocentrines; this may include a prominent opercular spine, two to three spines on the lower, outer border of the preopercle, a smooth or serrate inner preopercular border and serrate ridges over the eye and on the frontals, pterotic and parietal. At about 30 mm, small serrations develop around the eye and along the anterior edge of the snout in some species. Small supracleithral and posttemporal spines or ridges may form following flexion. The pelvic buds are present at 2.4 mm in myripristines and 3.3 mm in holocentrines, and by 3.4 mm, the soft dorsal-fin anlage is present. Pelvic elements begin to form by 3.5 mm in myripristine larvae but not until just after flexion in holocentrine larvae. Between 4.6 and 5.1 mm, incipient rays of the soft dorsal, anal, and pectoral fins appear concurrently with initial ossification of the dorsal-fin spines. By 7.6 mm all elements of the soft dorsal fin, pelvic fins, and anal fin (including the first three anal spines only) are complete. The fourth anal spine (which initially forms as a soft ray), the pectoral fin, and the spinous dorsal fin (including the last three spines which initially form as soft rays) are fully developed by 8.3 mm. Scales first form at 6.0-7.5 mm and are strongly ctenoid. At settlement the spine at the angle of the preopercle is short and smooth, strong serrations are present on the opercular and preopercular margins, the snout varies from short and rounded to tipped with a small spine, the mouth is terminal to slightly inferior, and the lateral line is complete (having formed at 10 mm). The main specialization to

pelagic life is the extensive spination of the head, and the early formation of the pelvic fins and scales.

*Pigment* - Young larvae are lightly pigmented but quickly become moderately to heavily pigmented on the gut and develop several moderate-size melanophores on the brain. Early myripristine larvae have one or two dorsal, lateral, and ventral melanophores on the tail which disappear at about the time the rostral spine begins to form. Melanophores may also occur on the ventral edge of the tail, on the pelvic buds and fins, on the tip of the rostral spine, and on the dorsal surface of the trunk. In larger postflexion larvae, pigment covers the entire body surface with the exception of the soft dorsal fins and the posterior portion of the tail. These larger pelagic stages are blue and silver in life, but may become reddish as settlement approaches.

**Order Zeiformes**
**Family Zeidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

Morphology-Zeid larvae are initially moderate in depth and slightly compressed, bur become deep and strongly compressed before flexion. They have 29-42 myomeres. The gut is coiled and becomes triangular early in the preflexion stage. The anus is located near mid body. A moderate gas bladder is present anteriorly over the dorsal surface of the gut. The head is initially of moderate size with a humpbacked profile, and it becomes large with a steeply sloping snout by the flexion stage. The mouth is oblique and large: its posterior margin reaches to below the middle of the eye. Teeth are absent. The round eye is moderate to large in preflexion larvae and large after flexion. Gill membranes are free from the isthmus. Head spines are absent or poorly developed. Preflexion larvae of *Zenopsis* have a small pteroric spine and a small spine posterior to the eye. Additional spines develop on the supraorbital and outer margin of the preopercle during flexion. Preflexion *Zeus* larvae have a small spine that develops ephemerally in the pterotic region prior to notochord flexion. Zeid larvae have a well-developed spinous dorsal fin and/or pelvic fin. Pelvic fins first appear in newly hatched larvae as a bud laterally on the posterior portion of the gut. Well before flexion the fins move ventrally and anteriorly to just posterior to the level of the pectoral fin. While this is happening, they enlarge greatly and extend to the middle of the anal fin at flexion. A full complement of pelvic-fin elements may be attained by the time flexion begins. Anlagen of dorsal and anal fins form at about 4-4 mm. In *Zeus*, the anlagen of the dorsal and anal fins are separated from the body margin in the median finfolds. In *Zeus* and *Zenopsis* the spines of the dorsal fin develop more rapidly than the rays and become very prolonged. *Cyttopsis*, in contrast, has relatively short dorsal-fin spines. Pectoralfin rays apparently form following flexion. *Zeus* has a full complement of fin rays by approx. 7 mm. There are no scales, incipient bony projections or bucklers in the specimens examined. In *Cyttus traversi* Hutton, a 60 mm pelagic juvenile possesses remarkably prolonged dorsal-fin spines and pelvic-fin rays with many leaf-like appendages. Specializarions to pelagic life include early formation of pelvic and spiny dorsal fins, and head spination in some species.

*Pigment*- Zeid larvae are heavily pigmented. In yolk-sac larvae, heavy pigment covers the entire body except the posterior region of the notochord and extends on to the median finfolds posteriorly. In *Zeus* and *Zenopsis*, the early forming, large pelvic and spinous dorsal fins are heavily pigmented. *Cyttopsis* is similarly pigmented except the spinous dorsal fin lacks pigment, and additional pigment appears on the posteriormost four rays of the dorsal and anal fins, and on the posterior half of the caudal fin. Pelagic juveniles of *Cyrrus traversi* are silver with lateral pigment blotches.

**Order Mugiliformes**
**Family Mugilidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-Mugilid larvae are elongate to moderate in depth and compressed, but after flexion, they deepen somewhat and some species may be relatively robust and squarish in cross-section. There are 24-25 myomeres (12-15 + 9-13). The gut is straight in our smallest specimen (2.4 mm) but a single coil develops by 2.7 mm. The massive underslung gut reaches 56-78% BL; the relative position of the anus is species dependent. The gas bladder is usually small but, in larvae greater than 10 mm, it may be large. It is often obscured by pigment. The relative size of the rounded head varies among species from moderate to large, but it is relatively largest in the flexion and early postflexion stages. The head becomes broad dorsally from 10-13 mm. The short snout is initially concave and becomes convex in postflexion larvae. The moderate mouth is slightly oblique in some species, but approximately horizontal in others. The mouth initially reaches the anterior edge of the pupil, but it becomes relatively smaller from 7-9 mm and thereafter falls short of the eye. Not all species develop teeth during the larval stage, but teeth are first visible from 9.3 mm in those that do. The eye is often slightly elongate and varies in size among species from moderate to large. There is no indication of an adipose eyelid in our specimens. Gill membranes are free from the isthmus. Head spination is limited to weak serrations on the infraorbital which form from 9.3 mm in some taxa. Apparently, the infraorbital serrations are retained in some genera, but lost in others. Dorsal- and anal-fin anlagen develop during flexion and by the time flexion is complete, incipient rays are present. The four spines in the separate and posteriorly-placed first dorsal fin start to form in early postflexion larvae. All dorsal- and anal-fin elements are ossified by 6.2 mm. However, the first soft ray in the anal fin begins to transform into a spine at about 25 mm; this probably does not happen in the anal fin of genera in which adults have only two anal spines. Pectoral-fin rays begin to ossify in early postflexion larvae, but the lower rays are slow to form, and ossification is not complete until 7-10 mm. During the flexion stage small pelvic-fin buds appear at about mid-gut, well posterior to the pectoral-fin base. Incipient rays are present by about 5 mm and all pelvic elements are ossified by 6-6.7 mm. The gap between the vent and anal fin is very small to absent. Time of scale formation varies greatly among species: scales may begin to form from as early as 6.2 mm to as late as 14 mm (XU et al., 1985), and be fully formed from as early as 6.7 mm in some taxa, yet still be forming at 22 mm in others. There are no apparent specializations to pelagic life. The term querimana is often applied to the late pelagic stage of some mullet species. The querimana stage is characterized by very silvery sides and belly, serrate infraorbital, two anal spines and poorly developed teeth.

*Pigment*- Mugilid larvae are moderately to heavily pigmented with differences in distribution and density of pigment among species. Melanophores are usually present along the dorsal and lateral midlines of the trunk and tail, along the ventral midline of the tail, on the dorsal surface of the gut and brain, and on the snout tip. In most taxa melanophores along the trunk and tail appear smudged together, forming a prominent stripe; in some taxa smudged melanophores may form additional stripes dorsolaterally and ventrolaterally. Some taxa also have melanophores along the lower jaw, gular region, branchiostegal membrane and along the ventral midline of the gut. Some species appear rancoloured due to the presence of very fine melanophores over most of the body. Pigment generally spreads as larvae grow, and larger larvae are often heavily pigmented over the entire head and body. In life, postflexion larvae are very silvery laterally and ventrally, and dark dorsally.

**Order Beloniformes**
**Family Hemiramphidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Larvae are elongate to very elongate, squarish in cross-section to moderately compressed, with 51-57 myomeres (35-40 + 15-19)*. The gut is relatively thick, straight and long, and reaches to about three-quarters of BL. The conspicuous gas bladder is located over the anterior half of the gut, but becomes thin and more elongate (hence, difficult to see) beyond 10 mm. The initially ovate head becomes increasingly elongate. Snout length remains relatively constant (2-5% BL) but the lower jaw increases in length: 3-7% BL in larvae less than 6 mm; 25-74% in larvae around 20 mm - unfortunately, the elongate lower jaw of larval hemiramphids is fragile, and is often broken during capture. The small mouth tends to be oblique and in young larvae reaches almost to the pupil. However, the mouth subsequently moves forward relative to the eye so, by about 13 mm, the maxilla does not reach the eye. Very small, pointed teeth are present on both jaws in the smallest specimens. The eye is slightly elongate. An inconspicuous dorsal lappet, derived from the iris, appears over the pupil shortly after hatching. Gill membranes are free from the isthmus. There is no head spination. Small nasal papillae (see Belonidae) are first apparent as a small fleshy lump in each nasal fossa at about 16 mm. Larvae hatch with a well-developed caudal fin: most caudal-fin rays are ossified at hatching. The dorsal and anal fins are situated far back on the body and have subdivided anlagen in the smallest specimen. Their rays begin to ossify from 4.6-6.1 mm with full fin complements present between 7.0 and 9.4 mm. Incipient pectoral rays first appear between 5.4 and 6.1 mm, and they are all ossified by 13 mm. Small pelvic-fin buds appear well-back on the body at 8-12 mm; incipient rays develop from 10 mm, and full fin complements are present by 13 mm. A long (29-47% BL) preanal finfold persists until all fins are fully developed (about 16 mm). Scales were not present in the largest specimens of our series. Only the advanced state of development at hatching could be considered a larval specialization.

*Pigment* - Hemiramphid larvae are moderately to heavily pigmented. Discrete longitudinal rows of melanophores are characteristic, primarily dorsally and sometimes ventrally, on the trunk and tail. The presence and extent of lateral pigment series varies ontogenetically and among species. Pigment may also occur on the dorsal surface of the head, both jaws, opercle, gut, urostyle, and later on caudal-fin rays and bases, and postetior lobes of the dorsal and anal fins.

**Order Beloniformes**
**Family Exocoetidae**
(From: Fahay, 1983. Guide to the early stages of marine fishes occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf.)

- 39-50 myomeres
- Body deep anteriorly, tapers to narrow peduncle.
- Persistent preanal finfold generally not present.
- Caudal fin well developes at hatching; lower lobe longer and with more rays than upper lobe; fin unque with 7+8 principal rays.
- Pectoral rays last to form.

**Order Beloniformes**
**Family Belonidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification

guide to marine fish larvae.)

*Morphology* - Larvae are elongate to very elongate, slender-bodied and cylin-drical in cross-section to slightly compressed laterally. There are 68-94 myo-meres (41-65 + 25-36)*, although these may be difficult to count due to heavy pigment. The gut is straight and extends to more than two-thirds of BL. A gas bladder dorsal to the anterior portion of the gut is conspicuous in Tylosurus, but inconspicuous in the other, more darkly pigmented genera. The small to mo-derate head is elongate, initially with a pointed snout, which becomes sharp and extremely elongate as the jaws develop. In *Tylosurus*, the upper and lower jaws are always approximately the same length (upper jaw 73-98% 0 flower jaw). In the other genera, the jaws are short and sub equal at hatching, but the lower jaw grows faster and it is soon much longer than the upper. During this 'half-beak phase', the upper jaw is 10-67% of the lower-jaw length. The upper jaw later becomes almost as long as the lower jaw. The small *(Platybelone)* to large *(Tylosurus)* mouth reaches to the anterior edge of the pupil Small canine teeth are present on both jaws of the smallest specimens and these increase in size and number. The eye is small to moder-ate and slightly elongate. A prominent dorsal lappet, derived from the iris, extends over the pupil. The gill membranes are free from the isthmus. Most taxa lack spines on the head. However, at least two species of *Strongylura* have serrate ridges. Our 13.5 mm specimen of S. *incisa?* (Valenciennes) has tiny serrations on the dentary, and a 29 mm specimen of the same species has additional serrations on the lower limb of the preopercle and supraocular ridge. Job & Jones (1938) and Nair (1952) describe more extensive spination on the supraocular ridge, pterotic?, preopercle and dentary in 6.8-14 mm S. *strongylura* (van Hasselt). However, this spination is not shown in *S. leiura* (Bleeker) or S. *strongylura* by Chen (1988). The olfactory pit does not roof over as it does in most fishes, but a nasal papilla forms in the pit. A rudimentary papil-la appears between 18 and about 30 mm. Flexion is complete at hatch-ing with most rays of the medial and pectoral fins present. Dorsal and anal fins are set far back on the body. pelvic-fin buds are located posterior to midbody. Our small-est *Ablennes* (11.8 mm) and *Tylosurus* (8.4 mm) have pelvic buds; full ray comple-ments are present by 17-28 mm. pelvic-fin buds develop sometime between 11 and 29 mm in *Strongylura* and between 9.2 and 21 mm in *platybelone;* all rays may be present as early as 25 and 21 mm, respectively. A long preanal finfold is pre-sent in the smallest larvae, and runs anteriorly from the anus along the ventral midline for 10-53% of the body length. This finfold persists until after all fins are formed (29-65 mm). Scales in belonids are small, and are not apparent in our largest specimens. The 'halfbeak phase' of all belonids except *'Tylosurus,* the head spination of at least some *Strongylura,* and the advanced state of develop-ment at hatching in all belonids are considered larval specializations.

*Pigment* - Belonids are heavily to very heavily pigmented over the entire body. The dorsal melano-phores vary in density and arrangement in a taxon-specific manner, but the general impression is of more-or-less uniform, heavy pigment. The head and ventral surfaces are often more lightly pigmented than the rest of the body, but 'reverse countershading' is found in some individuals. Pigment may also be present on caudal-, dorsal- and anal-fin rays and bases. *Tylosurus* spp. develop a prominent, heavily pigmented lobe on the dorsal fin and bars on the body.

**Order Scorpaniformes**
**Family Platycephalidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 25-28 myomeres, typically 27
- Body elongate to moderate (BD 14-26%), becoming dorsally compressed at settlement

- Head initially round and compressed, becoming greatly depressed, with an elongate, flattened snout by settlement stage
- Eyes are round and laterally positioned in all larval stages, but become slightly ovoid and migrate to a dorsal position after settlement
- Well developed and extensive head spination, including preopercular (preflexion stage), supraocular.,pterotic, small parietal, posttemporal, cleithral and supracleithral spines; these are retained after settlement
- Gut moderate to long (PAL 50-70%), coiled and compact
- Gas bladder inconspicuous, visible above foregut in preflexion and flexion larvae
- 2 separate dorsal fins; dorsal-fin spines form earlier than soft dorsal-fin rays
- Pectoral fins large and wing-shaped from early stages; rays start to form during preflexion stage
- Moderate to extensive pigment on pectoral-fin base; melanophores along pectoral-fin rays and scatterOC over connecting membranes
- Melanophores usually along ventral midline of tail and scattered laterally over trunk and tail

**Order Scorpaniformes**
**Family Scorpanidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 24-31 myomeres, typically 24-27
- Body initially elongate, becoming moderate to deep with development (BD 12-51%)
- Head initially small to moderate, becoming moderate to large with development (HL 13-46%), laterally compressed
- Well developed and extensive head spination, including large preopeocular and parietal spines which may be serrate, and also supraocular, infraorbital, opercular, pterotic, posttemporal and cleithral spines
- Gut moderate to very long (PAL 35-73%), coiled and compact soon after hatching
- Small gas bladder above gut, lost in the adults of some taxa
- Small to no gap between anus and origin of anal fin
- Single, continuous dorsal fin
- Pectoral fins often wide-based, large and fan-shaped from early stages; rays start to form during preflexion stage and may become long and reach caudal peduncle in some taxa
- Body lightly to moderately pigmented prior to transformation
- Melanophores along pectoral-fin rays and scattered over connecting membranes

**Order Perciformes**
**Family Latridae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 33-45 mvomeres
- Body initially very elongate to elongate, moderate by postflexion stage (BD 4-24%)
- No head spines
- Gut long (PAL > 500J6) and straight
- Moderate gap between anus and origin of anal fin
- Finfold enclosing most of body in early stages
- Prominent preanal membrane, persisting through to postflexion stage

- Dorsal and anal fins long-based
- Pelvic fins abdominal, located between pectoral-fin bases and anus
- Body heavily pigmented in *Latris*, pigment along dorsal and ventral surfaces of trunk and tail

**Order Perciformes**
**Family Acropomatidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 25 myomeres
- Body elongate to deep (BD 23-43%), laterally compressed
- Mouth large and oblique, with small villiform teeth in both jaws
- Moderately to well developed and extensive head spination, including preopercular, subopercular, opercula and supracleithral spines, and a serrate supraocular ridge; supraoccipital crest present in some genera except *Apogonops* and *Malakichthys*
- Gut moderate to long (PAL 48-62%), coiled and compact
- Large, inflated gas bladder
- Small to moderate gap between anus and origin of anal fin; anus is located closer to pelvic-fin base to anal fin origin by postflexion stage (*Acropoma* and *Apogonops*)
- Prominent internal melanophore at nape in most taxa
- Gut heavily pigmented
- Little or no pigment on tail

**Order Perciformes**
**Family Serranidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 26-28 myomeres
- Body initially elongare, becoming moderate to deep with development (BD 18-44%) . Preflexion larvae rypically 'hunchbacked'
- Head moderate to large .with short snout
- Weak to well developed, extensive head spination, always including prominent preopercular spines and interopercular spines, and, sometimes, spines or serrations on most exposed head bones
- Spiny scales and/or serrate fin spines in some taxa
- Gut moderate to long (PAL 48-69%), coiled early in development
- Second or third dorsal-fin spine elongate in some taxa
- First pelvic-fin ray produced in some taxa
- Anterior dorsal-fin spines and pelvic-fin spine sometimes ossify before other fin elements
- Body lightly to heavily pigmented, pattern species-specific

**Order Perciformes**
**Family Priacanthidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-Larval priacanthids are somewhat laterally compressed and of moderate depth before flexion, but are deep bodied afterward. There are 23-24 myomeres (6-10 + 14-17), with the number of preanal myomeres increasing with development. The coiled gut is deep and broad, ovoid, and usually extends to beyond midbody. There is a small, inconspicuous gas bladder which is usually obscured by body musculature and pigment. The head is large and fairly broad, with a short, steeply sloped snout. The mouth is moderate and reaches to about mid eye. Small teeth develop in the upper jaw before flexion (approx. 3 mm) and in the lower jaw following flexion (10.8 mm). The eye is round and large. Gill membranes are free from the isthmus. Spination on the head is well-developed. At 2 mm, there is a thickening of the dorsal finfold on the posterior portion of the head which quickly elongates, ossifies, and becomes a serrate, conspicuous supraoccipiral crest that extends over the mid and hind brain. A large retrorse spine, circular in cross-section, is present at the posterior end of the crest and reaches its maximum relative length shortly after flexion, following which both spine and crest gradually become reduced and disappear by 20 mm. The spine is initially smooth but becomes moderately serrate before flexion as do many of the spines on the head. The supraoccipital spination combined with the even larger spine at the angle of the preopercle, is impressive and unique. Other head spination, most of which forms before flexion, includes a prominent, serrate supraocular ridge; serrate ridges on the pterotic, frontal, infraorbitals and lower jaw; spines on the interopercle and subopercle; spines on both inner and outer borders of the preopercle; postemporal and supracleithral spines; and one to two opercular spines. Small spines even appear on the branchiostegals in larger postflexion larvae. Most of this spination is retained until settlement, although reduced in size. Pelvic-fin buds form during flexion: the spine ossifies following flexion (by 5.5 mm), and by 6 mm it is serrate and the soft rays are present. Pectoral-fin rays begin w form during flexion (3.9-4.8 mm) and are all present by 7 mm. The spines and soft rays of the dorsal and anal fins begin to ossify near the end of flexion (4-8 mm), and all elements are present by about 7 mm. Dorsal- and anal-fin spine development proceeds from antetior to postetior. The third anal spine initially forms as a soft ray before becoming a spine at 6 mm. Coarse serrations occur on the dorsal-fin spines by 7 mm and on the anal-fin spines by 11 mm. Small serrations on the soft rays of both fins are present at 11 mm. At 6 mm, small papillae, which ossify into weak spines and are the precursors of the scales, form on most of the body. The first scales are present at 20 mm and cover the body before settlement. At settlement the body is laterally compressed and ovoid, the eye is extremely large, and the lateral line is complete. Specializations to pelagic life include the remarkable head spination including the supraoccipital crest and spine and the prominent serrations of the fin spines.

*Pigment*- Preflexion larvae have heavy pigmentation on the gut, head, and in some species along the ventral edge of the tail. With increasing body size, melanophores spread over the dorsal surface of the trunk and tail to eventually cover the entire head, body, and all fins except the pectorals.

**Order Perciformes**
**Family Apogonidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 23-25 myomeres, typically 24
- Body elongate to deep (BD 19-44%), laterally compressed
- Mouth large, with small villiform teeth from early stages
- Head spines, when present (e.g. preopercular, opercular, posttemporal), become greatly reduced or disappear just before settlement
- Gut moderate to long depending on taxon (PAL 39-67%), initially straight but becoming coiled

and compact with development
- Conspicuous gas bladder, often extending above entire gut, pigmented
- Small to no gap between anus and origin of anal fin
- 2 well separated dorsal fin; first spine of second dorsal fin and anal-fin spines are initially soft rays but transform into spines before settlement
- Body lightly to heavily pigmented

**Order Perciformes**
**Family Branchiostegidae**
(From: Michael P. Fahay, 1983. Guide to the Early Starges of Marine Fishes Occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf. J. of Northwest Atlantic Fishery Science)

- 24 Myomeres
- Hatching occurs at 2.6 mm notochord length (NL), and flexion at 4.4-5.5 mm NL.
- Robust body, spiny ridges develop on head, and spinous scales develop on body; preopercle spination developed early and cranial spines form sequentially in groups, all being well-developed by 5 mm NL.
- Preanus length increase from about 55% to 70% NL, body depth increases from about 22% to 40% NL, and head length increase from about 30% to 45 % NL; all three measurements reach maximum relative proportions at 5-6 mm NL, shortly after notochord flexion.
- Teeth present at about 5 mm NL, and vertebrae ossified by 8 mm standard length (SL).
- Pelagic juveniles descend to bottom between 9.0 and 15.5 mm SL.
- Pigmentation: in yolk-sac larvae, few spots on head and area of light pigment on body over gut and anus, and few spots on oil globule; in later larvae, body pigment intensifies into dark midline streak and scattered accumulations of melanophores.

**Order Perciformes**
**Family Rachycentridae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-Larvae are elongate to moderate in depth, with a subcylindrid body and 25 myomeres which are difficult to count due to heavy pigmentation. The gut extends to about two-thirds BL (56-68% BL) and is initially straight but forms a loose coil prior to flexion. This gives the ventral profile of the visceral mass a bulbous appearance through the early postflexion stage. A gas bladder is not visible. The head is moderately large with a short snout, and is deeper than the trunk at the angle of the lower jaw until after flexion. The mouth is large and oblique, and reaches to about mid-eye. Small, villiform teeth are present in both jaws by 5 mm. The eye is round and initially moderately large but decreases to moderate in size before flexion. Gill membranes are free from the isthmus. Head spinarion is well developed and simple. Preflexion larvae have a single spine on the supraorbital ridge, a series of small to moderate spines along both the inner and outer border of the preopercle, and laterally swollen pterotics by 4-5 mm. Four spines are found along the inner border and four to five along the outer preopercular border by 14-15 mm. The two spines near the angle of the outer border are the largest. A single spine is present on the supracleithral bone by 11 mm and two spines form on the posttemporal bone by 12 mm; all are small. Development of dorsal and anal fin anlagen coincides with notochord flexion. Dorsal and anal fin-rays begin to form by about 10-11 mm, with anal rays developing before

dorsal rays; the spines are the last elements to form. Dorsal spines are very difficult to count because they are short and often covered by integument. The soft dorsal fin originates anterior to the anus. Pelvic buds form by 6 mm and pectoral rays by 10 mm. A full complement of rays is present in all fins by early transition (about 20 mm) when the caudal fin becomes distinctly spatulate. There is no gap between the anus and anal fin. Minute epithelial spicules (scales) cover the body by 4 mm but are best observed on the head and larval finfold, becoming more visible as larvae grow. Specializations to larval life include the head spines and epithelial spinules, and the large size at formation of dorsal- and anal-fin rays.

*Pigment*- Preflexion larvae are moderately to heavily pigmented with pigmentation heavier ventrolaterally than dorsolaterally on the trunk and tail; the caudal peduncle is unpigmented. Internal pigment on the roof of the mouth, below the hindbrain and beneath the otic capsule gives the impression of a stripe through the snout. The caudal peduncle, ventral rays of the caudal fin, and posterior one-third of the anal finfold and developing anlagen become pigmented during flexion. Pelvic buds are pigmented by 13 mm; pectoral fins lack pigment except basally on the upper few rays. Juveniles are heavily pigmented including the pelvic and caudal fins, except for the distal tips of the upper few principal caudal rays. The posterior rays of the dorsal and anal fins are more heavily pigmented than are the anterior rays.

**Order Perciformes**
**Family Coryphaenidae (Based on *Corypahaena hippurus*)**
(From: Konishi, 1988. *Corypahaena hippurus*. *In* An atlas of the early stage fishes in Japan, ed. Okiyama. Toakai Unversity Press, Tokyo, pp. 482-483.)

- 30-31 myomeres
- Elongate body
- Anus located in the half body
- Body well pigmented
- Pigment stripes occurred in the post-flexion larva and juvenile stages
- Several spines at the anterior and posterior margins of the preopercle bone

**Order Perciformes**
**Family Menidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-Menid larvae are very deep in head and trunk, have a relatively short, tapered rail, and are extremely laterally compressed. There are 24 myomeres (6-10 + 14-18). As the larvae grow, body depth increases markedly, especially in the trunk; from 12 mm, maximum BD is greater than or equal to BL. The caudal peduncle remains narrow. PAL is 38-54% BL in preflexion larvae, but increases to about 50-60% BL in postflexion larvae. The gut is coiled and deep, and the hindgut becomes extremely produced as the body deepens. The conspicuous gas bladder is located over the hindgut. The large head is initially kidney-shaped with a domed cranium. At about 10 mm, the dorsal profile of the head becomes more or less straight, and makes the head roundly triangular. The moderately long snout is rounded and initially has a deep concavity dorsally which is lost in larger larvae. The large, extremely protrusible mouth is oblique to vertical. The ascending premaxillary process is very long (initially as long as the rest of the premaxilla, but it gradually reduces to about 2/3rds of its length). The maxilla falls short of the eye and its sharp anterior tip projects conspicuously beyond the profile of

the snout. The angle of the lower jaw is acute and prominent. Minute teeth in the lower jaw are first visible in flexion larvae. The large to moderate eye is round. Gill membranes are free from the isthmus. Our smallest specimen has a supraoccipital crest with a single apex and has a single series of small preopercular spines. The supraoccipital crest is relatively smaller in postflexion larvae, is reduced to a low crest by 7 mm and disappears between 10 and 12 mm. The preopercular spines remain small and about the same size. They are gradually overgrown and disappear by 8 mm. The dorsal-fin anlage and some incipient anal-fin rays are present in our smallest specimen. Fin elements begin to ossify at 3 mm. Ossification of the anal soft-rays is more advanced than that of the dorsal soft-rays. The anterior-most dorsal soft-rays become elongate as they ossify and remain so. Three protruding supraneural bones are present by 3 mm. The first pterygiophore of both dorsal and anal fins enlarges and develops an anterior spine-like structure in postflexion larvae. Dorsally, the supraoccipital crest, the supraneurals and the first pterygiophore form a keel. Ventrally, the first anal pterygiophore and the modified anal elements (see below) do likewise. Three dorsal- and two anal-fin spines form during flexion and the first anal ray transforms to a spine by the end of flexion. The posterior-most dorsal and anal rays are slow to form, but all are present by 5.1-6.0 mm. The spines and first few rays of the anal fin develop into 'y' - and 'T' -shaped structures in postflexion larvae and become triangular in older larvae. Most of the remaining anal rays become bifurcate by 10-12 mm. The pelvic fins of our smallest specimen have the spine and one ray ossified. This ray, which becomes markedly elongate before 3 mm, is often split longitudinally. The first soft ray remains elongate in adults. The remaining pelvic rays are present by about 11 mm. Pectoral-fin rays begin to form in early postflexion larvae (3.5-3.8 mm), and all are present by 6.3-7.7 mm. Scales are not apparent in the largest specimen. The only apparent specialization to pelagic life is the head spination. The other oddities of larval morphology seem to be connected with attaining the specialized adult morphology.

*Pigment*- Menid larvae are lightly to moderately pigmented. Initially, pigment is present dorsally on the midbrain, gas bladder and hindgut, ventrally on the tail and anal-fin bases, and on the lower jaw and caudal-fin membrane. A distinctive cluster of melanophores is present dorsa-laterally on the tail. In postflexion larvae, pigment spreads over the brain, anal-fin base and laterally on the tail, and internal pigment develops on the tail, particularly in association with vertebrae and myosepta. As the juvenile stage approaches, a countershaded pigment pattern develops.

**Order Perciformes**
**Family Carangidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 24-26 myomeres, typically 24-25
- Body elongate to deep (BD 17-64%), strongly to moderately compressed
- Extensive head spination, including shon ro long preopercular spines, one at angle usually long, and, in most taxa, posttemporal and supracleithral spines, a smooth to strongly serrate supraocular ridge, and emergent median, serrate or smooth supraoccipital crest (present but non-emergent in Seriola)
- 3 anal-fin spines, first 2 separated fiom third (II + I), gap between spines more pronounced after transformation; third anal-fin spine is initially a soft ray
- Gut moderate to very long (PAL 44—75%), initially straight but becoming coiled and large (triangular shaped) early in development
- Prominent gas bladder, pigmented
- Preanal membrane persisting through to postflexion stage, often lightly to heavily pigmented

in preflexion and flexion stages
- Melanophore series along dorsal and ventral surfaces of trunk and tail, often in alternate and/or paired pattern dorsally along tail
- Melanophore series along lateral midline of tail

**Order Perciformes**
**FamilyLeiognathidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - There are three distinct morphs of leiognathid larvae, differing in pigmentation, head spination, and relative length of dorsal spine 2 and anal spine 2. Larvae are moderate to deep, strongly compressed laterally, and have 23-25 myomeres (5-11 + 12-20). Some species become deeper following flexion. The gut is compactly coiled in our smallest specimen and remains that way. PAL never exceeds 50% BL. The anus protudes beyond the body margin in pre-flexion and flexion larvae. The anus moves anteriorly, and the gut becomes vertically ovoid, so that by 6-8.5 mm the anus is no longer the most posterior portion of the gut. The small to moderate gas bladder is dorsal to the apex of the gut. The moderate to large head is initially deeply ovate with a steep, blunt, concave snout. However, in postflexion larvae, the dorsal profile of the head becomes shallower, and the snout becomes pointed. The mouth is small and reaches to about the anterior edge of the eye. The mouth is extremely protru-sible and a large, conspicuous ascending premaxillary process develops by the flexion stage (by 2.6-3.5 mm). Small teeth are present in both jaws from the preflexion stage. The moderate to large eye is round; it is relatively larger in morph 2 larvae than in other morphs. Gill membranes are narrowly attached to the isthmus by 6.5 mm. At 1.8 mm the preopercular spines and serrate supra-occipital crest are present. Initially, at least in morph 2 larvae, the crest does not extend anterior to the hind-margin of the eye, but it grows anteriorly and, by 2.7 mm the crest extends well forward of the eye. By 2.2-2.8 mm, a prominent posteriorly-directed spine on the crest also develops, and is either smooth, serrate or multipronged, depending on species. The posteriorly-directed spine is weak or absent and the serrations on the crest are reduced by 7 mm. The crest is retained in adults as a smooth nuchal crest. The preopercular spines are either smooth, finely serrate or strongly serrate, depending on species. The spine at the preopercular angle is long during the preflexion stage, but does not reach the anus in morph 2 larva and extends beyond the anus in morphs 1 and 3. This elongate spine becomes progressively shorter; in morph 1 and 3 lar-va it reaches the level of the anus by 7 mm and 4 mm respectively; in morph 2 larvae, the preopercular spines become little more than serrations on the pre-opercular border by about 8 mm. A supraocular ridge develops by 2.2 mm and is serrate prior to flexion. It becomes smaller following flexion and reduces to a low, smooth ridge at about 12 mm. A small spine separates from the supraocu-lar ridge anteriorly in postflexion larvae larger than 6 mm, and is retained in adults as the antero-orbital spine. A single posttemporal spine, one or two supracleithral spines and a nasal spine develop during flexion. A sphenotic ridge develops in the postflexion larvae, and it has a small spine from 4.8 to about 10 mm. The angle of the lower jaw is particularly prominent, and the cleithral symphysis and ventral portion of the post-cleithrum are pronounced, resembling spines. Flexion takes place at a small size. Anlagen of the long-based dorsal and anal fins are present in preflexion larvae by 1.8-2.7 mm, depending on taxon. Incipient spines and rays appear during noto-chord flex-ion, and full fin-complements are present at about 5 mm (dorsal spine 1 is the last to form). The locking mechanism on dorsal spines 3 and 4, and anal spine 3 (see Seigel, 1982) is first seen in early postflexion larvae as a smooth flange at the base of the spine anteriorly. The flange becomes toothed shortly thereafter, and the locking mechanism is then presumably functional. Dorsal spine 2 and anal spines 1 and 2 are serrate on the leading edge in morph 1 larvae, but are smooth in morph 2

and 3. Dorsal and anal spines 2 are longer in morph 1 larvae than they are in morph 2 and 3 larvae. In all morphs, the distal portion of the anterior pterygiophore of both the dorsal and anal fins expands into a large pick-like structure often called a procumbent spine. This is clearly visible externally once all the fin spines are present. Because of this pterygiophore base and the anterior migration of the anus, there is a small gap between the anus and the origin of the anal fin that tends to increase in size with larval growth. Pelvic-fin buds begin to form in postflexion larvae by 4.5-5.7 mm. The spine ossifies first and all elements are present by 8.6-10 mm. Incipient pectoral rays form early in the postflexion stage. Full development of the pectoral fin is attained by 7.9-10.5 mm. No scales were present on any of the examined specimens, although the anterior portion of the lateral line is present from about 12 mm. The serrate dorsal- and anal-fin spines of morph 1 larvae, and the strong head spination, with serrae in some morphs, are the most striking specializations to pelagic life.

*Pigment* - Leiognathid larvae ate relatively lightly pigmented. Preflexion leiognathids have characteristic ventral pigment along the midline of the tail that consists of vertically elongate embedded melanophores with one to three melanophores per myomere. These subsequently move onto the anal finfold and coalesce so that there is approximately one to each soft-ray base. Melanophores are also present on the finfold anterior to the anus, over the gut and gas bladder, and often on the ventral midline of the gut and the cleithral symphysis. Later, pigment appears on the brain, angle of the lower jaw, pectoral-fin base, caudal vertebrae, caudal-fin rays and bases, and widely over head, trunk and tail. In morph 1 larvae, the long preopercular-angle spine has melanophores along its axis. Morph 2 and 3 larvae have internal pigment at the nape from the late preflexion to early postflexion stage.

**Order Perciformes**
**FamilyBramidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 23-24 myomeres
- Body elongate to moderate (BD 16-33%)
- Head rounded and moderately deep in postflexion larvae
- Weak to moderate head spination from late flexion stage
- Gut moderate to long (PAL 45-60%), initially straight but becoming coiled after flexion stage
- Elongate, early forming pelvic-fin elements
- Body lightly pigmented, pigment limited to dorsal surface of head and ventral surface of posterior portion of tail

**Order Perciformes**
**Family Emmelichthyidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Emmelichthyid larvae are of moderate depth, although preflex-ion larvae are more slender than postflexion larvae. They become compressed in the flexion stage. Pelagic juveniles are slender and similar in body shape to the adults. There are 24 myomeres. The gut becomes coiled by about 3.5 mm, and is thereafter triangular. Position of the anus varies with developmental stage: it is located near mid body in preflexion larvae, at 57-59 % BL in postflex-ion larvae, and at > 60 % BL in pelagic juveniles. A gap between the anus and the anal-fin origin is prominent and proportionally largest in the postflexion stage. The gap has not closed in the largest larvae examined, but is absent in pelagic

juveniles. The conspicuous gas bladder is moderate and is located over the anterodorsal portion of the gut. The head is initially moderate and be-comes large with growth, but becomes relatively reduced due to body elonga-tion in pelagic juveniles. Larvae have a swelling at the ascending process of the premaxilla that results in a convex dorsal profile of the snout. No teeth appear during the larval stage, but the largest pelagic juvenile of *Emmelichthys struhsak-eri* Heemstra & Randall examined (24 mm) possesses a small canine tooth on the tip of the lower jaw. The round eye is initially large but becomes moderate in size in larger larvae. Gill membranes are free from the isthmus. Head spina-tion of emmelichthyid larvae is at best moderately developed compared with other percoid larvae. First ornamentation appears as a small spine on the outer margin of the preopercle by 4.5 mm. The spines increase in number, and small spines occur additionally on the inner margin of the preopercle in preflexion larvae and on the opercle, interopercle, posttemporal and supracleithrum in postflexion larvae. The head of pelagic juveniles remains ornamented, particu-larly by serrations on the posterior margins of the preopercle, interopercle and subopercle. The anlagen of the dorsal and anal fins are opposed and appear just prior to notochord flexion. Soft rays of the dorsal and anal fins develop during flexion, prior to the spines which form at about 6 mm. The third spine of the anal fin forms initially as a soft ray, and transforms to a spine between 6 and 7 mm. Fin spines remain short, slender and smooth. In postflexion larvae and early pelagic juveniles, the dorsal fin is continuous, bur moderately notched. A 2.4 mm pelagic juvenile of *E. struhsakeri* has a divided dorsal fin. Pelvic-fin buds appear just prior to notochord flexion and the fins are fully ossified at the early postflexion stage. Incipient pectoral-fin rays develop in preflexion larvae and a full complement of rays seems to be present in late postflexion larvae. No scales appear during the larval stage, but the body and maxilla of the juveniles are well scaled: a gap in the size series means that the size at which the scales appear is unknown. Specializations to pelagic life seem limited to the relative-ly weak head spination.

*Pigment* - Emmelichthyid larvae are sparsely pigmented. In the larval stage, the only consistent pigment is that over the gut. Some species lack pigment on the tail, but the larvae of *E. struhsakeri* have characteristic tail pigment: in early preflexion larvae there are dorsal, lateral and ventral pigment patches near the anus; thereafter, the patches are located at the posterior end of the dorsal and anal fins. Light pigment may appear ephemerally near the notochord tip and in the otic region in preflexion larvae. In postflexion larvae, further pigment is scattered on the brain, opercle, pectoral-fin base and pelvic fin. In some species, the head and trunk may become heavily pigmented near the end of the larval stage. Pelagic juveniles are heavily pigmented, usually with dark, vertical bands.

**Order Perciformes**
**Family Lutjanidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Larvae are initially elongate, but quickly become moderate to deep bodied and laterally compressed. There are 24 myomeres (7-11 + 13-17). The gut begins to coil shortly after hatching and when fully coiled is triangu-lar and extends to 40-67% BL. A small gas bladder is located above the anterior portion of the gut. The gas bladder is generally inflated in 2.3-4 mm preflexion larvae but seems to be inflated only at night in larvae larger than 4 mm. The head is moderate to large and moderately compressed. Preflexion larvae have a short, round snout, but during flexion the snout becomes more elongate. The horizontal to somewhat oblique mouth is moderate to large and can reach from as little as the anterior edge of the eye to as much as mid-eye. Tiny villi-form teeth are visible in both jaws toward the end of the preflexion stage, and postflexion larvae of many species develop prominent canine teeth. The round eye is initially large, but may be moderate in postflexion larvae. The gill mem-branes are free from the isthmus. Small, smooth spines are present early in the preflexion

stage (approx. 2-3 mm) on both borders of the preopercle; these become larger and more numerous (but remain smooth), and the spine at the angle becomes the largest on the head during the flexion and postflexion stages, before decreasing in size just prior to settlement. Before or early in the flexion stage (from as little as 3 mm in some species), spines form on the supracleithrum, interopercle, posttemporal, opercle, and during or just after flexion, a spine forms on the postcleithrum (4.5 mm). The first three may elaborate into several spines following flexion, the opercle develops a second spine and the postcleithral spine remains single. The supraocular ridge forms before flexion (3.5 mm), and in some species it is serrate from the flexion stage. In most taxa, spines form on the subopercle (5 mm), and low ridges appear on the frontal (6 mm) and pterotic (5 mm) following flexion. Head spination is especially well developed in caesionines and some lutjanines; in some of these, the spine at the preopercular angle may develop fine serrations. Much of the head spination may have disappeared by the time of settlement. The pelvic spine and the second spine of the dorsal fin are the first fin elements to form early in the pre-flexion stage (2-3 mm); either may form first, depending on species, but forma-tion is nearly simultaneous. These two spines grow quickly and become very produced reaching maximum relative length by 8-10 mm: Dsp2 reaches up to 96% BL, and P2 sp reaches up to 50% BL in some species. Depending on species, these fin spines vary from whip-like and smooth to robust and ornamented with moderate serrations. If serrations are present, they will have formed by the late preflexion stage. The same lutjanines and caesionines that have elabo-rate head spines have the most elaborate fin ornamentation. However, recurved hooks are never present on the fin spines. Several dorsal-fin spines are present before the soft rays begin to appear just before or during flexion. Spine two remains the longest, and the others decrease in size posteriorly. The poste-rior-most one to several fin spines form first as soft rays before transforming to spines following flexion at 4-8 mm. Pelvic-fin rays start to form very soon after the spine, and all are present by the time flexion begins. Some pelvic rays, espe-cially the first, are as long or longer than the spine. The anal-fin rays form simultaneously with the dorsals, and the third anal spine does not transform from a ray to a spine until 4-10 mm. The pectoral-fin rays begin to form at about the time of flexion, and are completely developed by 8-14 mm. Scales may begin to form at about 6.5 to > 25 mm, depending on species; they may all be present in larvae as small as 9 mm, or may not appear until settlement. A small gap between vent and anal fin closes before flexion. Specializations to pelagic life include the notable head spination; elongate, early-forming pelvic spine and second spine of the dorsal fin; and serrations of the fin spines of some species.

*Pigment* - Lutjanid larvae are lightly pigmented initially. Melanophores are present on the dorsal surface of the gut and gas bladder, along the membranes of the dorsal- and pelvic-fin spines and along the ventral edge of the tail in most species, the number of melanophores in the series ventrally on the tail decreases with development until flexion. Pigment may also occur on the brain, laterally on the caudal peduncle and at the cleirhral symphysis. A num-ber of taxa have dorsal pigment on the trunk and tail, and heavily-pigmented spiny dorsal-fin membranes. These pigments may spread following flexion.

**Order Perciformes**
**Family Caesionidae**
See Lutjanidae (page54 )

**Order Perciformes**
**FamilyLobotidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Early preflexion *Lobotes* are moderate in depth and compressed, becoming deeply ovate by early postflexion stage (approx. 5 mm), but *Coius* is apparently not as deep-bodied as

*Lobotes*. In *Lobotes,* the 24 myomeres (11-13 +-11-13) become difficult to count shortly after flexion because they are obscured by heavy body pigmentation. The gut is triangular and extends past mid-body, eventually reaching 70-80% BL in postflexion larvae. The air bladder is oblong and sits above the anterior to middle of the gut. The head is moderately large. The dorsal profile of the forehead is initially slightly concave, but by flexion is moderately convex, becoming notably concave during transition. The snout is short. The mouth is large and oblique with the upper jaw extending to about mid-eye. Small cardiform teeth are present in both jaws by flexion. The eye is large and round, becoming proportionally smaller during transition. Gill membranes are narrowly united and free from the isthmus. Head spination is well developed. Early preflexion larvae are characterized by a vaulted, coarsely serrate supraoccipital crest originating above mid-eye, and numerous spines and simple ridges elsewhere on the head. Preflexion larvae have several short, blunt spines on the inner preopercular border and three to four moderate to large spines on the outer preopercular border with the longest at its angle. The angle spine is about 80% of orbit diameter in early postflexion *Lobotes* from the Indo-Pacific and western North Atlantic but 100-125% orbit diameter in simi-lar size larvae from the eastern Pacific; the angle spine decreases in relative length thereafter. Eight or nine spines are present along the outer preopercular border at transition. A single spine develops along the heavy, laterally-projecting supraorbital ridge by early flexion as does a single spine on both the posttemporal and supracleithral bones. As the upper jaw develops, the ascend-ing maxillary process extends out over the snout and gives this 'nasal' process the appearance of an anteriorly projecting nasal spine. Shortly after flexion (6.0-6.5 mm), a low ridge develops along the pterotic bone, as does a spine on the subopercle just dorsal to the preopercular angle spine. A small, flexible spine also develops on the opercle by 10 mm but this spine is difficult to locate on unstained larvae. Serrations on the supraoccipital crest become relatively less coarse with growth and the crest is resorbed by 15-16 mm. The supraor-bital ridge is resorbed by 19 mm and the subopercular spine by 20 mm. Spines on the posttemporal and supracleithral bones (which are partially covered by integument) and along the outer preopercular border are present on the largest specimen examined, as is the pterotic ridge. At 8 mm, *Coius polota* (Hamilton) has an extremely elongate (about 1.3 times orbit diameter) spine at the preopercular angle that reaches almost to the pelvic-fin origin. The pterotic ridge is well developed and there are two spines on the anterior infra-orbital, but other head spination is similar to that of *Lobotes*. Pelvic buds begin to form by 3 mm in *Lobotes,* and a full complement of elements is present by early flexion. pelvic fins are elongate (usually> 20% BL), and inserted near mid-body, usually about 40-50% BL. Dorsal- and anal-fin anlagen form during early flexion, with spines developing prior to rays in each fin. Anterior-most spines develop first, with a full complement of dorsal- and anal-fin elements present by 6.5 mm. The third anal element initially forms as a ray before transforming into a spine. Pectoral rays form during flexion in *Lobotes,* and all are present by 7 mm. scales appear at about 9.0-9.5 mm. Specializations to larval life include early formation of pelvic fins, the large eye, serrate supraoccipital crest, and head spination.

*Pigment* - Early preflexion larvae are lightly pigmented with pigment primarily restricted to the head, visceral mass and ventral midline of the gut and tail. Pelvic fins are heavily pigmented by flexion. Pigmentation rapidly increases over the head and trunk from flexion, forming blotches and mottled areas by early transition (8-9 mm). Thereafter, various bars and pigment bands form on the head, trunk and tail. Melanophores appear on the dorsal- and anal-fin spines by 6 mm, extend onto the anterior-most dorsal- and anal-fin rays by ear1y transition, and cover all but the distal rips of the rays by 15 mm. The pectoral fins remain sparsely pigmented at all sizes.

**Order Perciformes**
**Family Gerreidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 24-25 myomeres
- Body elongate to moderate (BD 19-28%)
- Prominent, elongate ascending premaxillary process, visible from late preflexion stage; mouth highly protrusible in postflexion larvae due to ascending process
- Weak head spination, including small preopercular and supracleithral spines
- Gut short to long (PAL 22-54%), rightly coiled and compact
- Small to large gap between anus and origin of anal fin
- 2 melanophores ventrally along gut
- Melanophore series along ventral midline of rail

**Order Perciformes**
**Family Haemulidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - (Note - at least two Plectorhinchus species, P. cinctus (Temminck & Schlegel) and P. gibbosus (Lacepede), have deeper bodies, earlier formation of fins, and more extensive head spination than other members of the family). Larvae are moderate to deep-bodied and laterally compressed. Myomeres number 26-27 (10-15 + 12-17). The gut begins to coil following yolk absorption, and forms a loose to compact mass, depending on species. In haemulines, the number of preanal myomeres increases with growth as the anus moves posteriorly, but in plectorhinchines, there is little, if any, change. The gut extends to 50-74% of body length. An often inconspicuous gas bladder is located above the anterior portion of the gut. The head is large, and the snout is short to moderate, and ranges from moderately pointed to blunt. The large, moderately oblique mouth reaches at least the anterior edge of the eye and may reach past mid eye. Small, villiform teeth are present in the upper jaw by 3.0 mm and in the lower jaw by 4.2 mm. The moderate to large eye is round, and gill membranes are free from the isthmus. Posttemporal, supracleithral, opercular, subopercular, and preopercular spines are found in all species; a serrate supraocular ridge is found in all genera but Parapristipoma; interopercular spines are present in most taxa; and pterotic spines are only present in a few species. Smooth preopercular spines are present in our smallest larva (2.3 mm). The preopercular spines range from thin to robust, occupy both inner and outer borders, and the spine at the angle is not particularly enlarged. The other spines form by the end of the flexion stage. An exception is the interopercular spination, which, if present, usually forms following flexion, and constitutes only 1-2 spines. One to four spines form on each of the posttemporal and supracleithral bones; two broad, flat spines form on the posterior edge of the opercle; and subopercular spines may number up to 7. The supraocular ridge forms at about the time of flexion, and serrae usually form soon after. The pterotic ridge is usually low and spineless, but in some taxa 1-2 spines may form. A postcleithral and a cleithral spine may each be present, but are difficult to see. Head spination is reduced at settlement, and only the preopercle spination, in the form of serrations, is retained in adults. Two deep-bodied Plectorhinchus species have full fin complements just before flexion, but otherwise, fin formation is as follows: dorsal- and anal-fin anlagen form just before flexion, soft rays begin to form near the end of flexion (5.2-5.4 mm) and are all present by 5.4-6.4 mm; dorsal- and anal-fin spines begin to ossify at 5.4 mm and are fully formed by about 8 mm (except the last spine in both dorsal and anal fins which initially forms as a soft ray and changes into a spine after settlement); pelvic buds appear during flexion, pectoral rays are first present following flexion (6.4 mm), and both pectoral and pelvic fins have all elements by 9.1 mm. A small gap between the vent and anal fin occurs in Pomadasys spp., but is virtually closed by about 10 mm. Scales begin to form on the trunk at about 10-13 mm. The only apparent specializations to pelagic life are the head spination and the mouth, which is relatively much larger in larvae.

*Pigment* - Haemulid larvae are lightly to moderately pigmented. *Pomadasys* and *Paraprisripoma* are lightly pigmented and have small melanophores on the ventral edge of the tail and gut, on the symphysis of the cleithra, and on the pelvic buds. Larvae of *Diagramma* and *Plectorhinchus* are fairly lightly pigmented initially but become progressively more heavily pigmented. Large, distinct melanophores are found on the head, trunk, tail, and caudal-fin rays before settlement. Deeper-bodied *Plectorhinchus* spp., in addition to a heavily pigmented body, have pigmented dorsal-fin spines and pelvic-fin elements but no pigment on the caudal fin or caudal peduncle.

**Order Perciformes**
**Family Nemipteridae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 22-24 myomeres
- Body moderate (BD 23-34%), laterally compressed by postflexion stage
- Head round, with a steep profile and a short, round snout
- No head spines except for small posterior preopercular spines in some taxa from postflexion stage (e.g. *Scolopsis*)
- Gut moderate to long (PAL 33-68%), tightly coiled and compact
- Small to moderate gap between anus and origin of anal fin, closed as anus migrates posteriorly
- Body lightly pigmented
- Series of small melanophores along entire ventral midline of tail in preflexion and flexion larvae, about: per myomere; number varies among taxa

**Order Perciformes**
**Family Sparidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 24-25 myomeres
- Body moderate to deep (BD 21-44%)
- Moderately to well developed, extensive head spination, including short to long anterior and posteria preopercular spines, and an opercular spine; subopercular, interopercular, posttemporal and cleithral spines, and a second opercular spine may also form depending on taxa; supra ocular and supraclei ridges, if present, smooth or with spines depending on taxon
- Gut moderate to long (PAL 41-63%), coiled and compact
- Small to moderate gap between anus and origin of anal fin, closed by postflexion stage
- Body initially lightly pigrnented, usually heavily pigmented at settlement
- None to a few melanophores over head in preflexion larvae; rarely any pigment dorsally along trunk or tail before postflexion stage
- Pigment dorsally over gas bladder and gut
- Melanophores ventrally along gut and midline of tail
- Small melanophores under notochord tip in preflexion larvae

**Order Perciformes**
**Family Lethrinidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Larvae are of moderate depth, laterally compressed, and have 23--25 myomeres (6-10 + 14-18). The gut coils to become compact and triangular shortly after hatching and extends to less than midbody in preflexion larvae and to slightly more than midbody following flexion. A small gas bladder, which appears to be inflated only in larvae sampled at night, is situated above the anterior portion of the gut. The head of early preflexion larvae is of moder-ate size and round with a short, rounded snout. By the middle of the preflexion stage, however, the head has become large, and more triangular with a more elongate snout. The moderately oblique mouth is terminal and moderate in size, and reaches to about the anterior edge of the eye. Small, pointed teeth become visible in both jaws during flexion. The round eye is moderate to large. Head spination forms shortly after hatching, and becomes very well-developed and distinctive. The supraoccipital crest first appears as an anlage on the nape, but it quickly ossifies, becomes serrate, and develops a posteriorly-directed, elongate and serrate spine which is laterally flattened (not round) in cross-section. The fully ossified crest of early preflexion larvae (complete ossifi-cation occurs at about 2.3 mm) originates over the anterior edge of the eye, and the spine reaches to about the anus. However, with increasing larval size, the crest origin moves posteriorly and the spine decreases in relative length. By about 15 mm, the crest is merely a low, spineless, serrate ridge on the nape, and at settlement it is absent in some species. Spination is also found along both preopercular borders from less than 2 mm. The spine at the angle is particular-ly enlarged, and may reach well past the anus from the preflexion stage; from the mid-postflexion stage, it decreases in length. It is strongly serrate, with the ornamentations in some species consisting of recurved hooks. Serrate ridges form on the dentary and supraorbital in preflexion larvae, and from flexion on the maxilla, infraorbitals, pterotic, posttemporal, supracleithrum. opercle, subopercle and interopercle. The spines become reduced as settlement approaches, and some may be retained following settlement. Soft rays of the single dorsal fin and the anal fin begin to form shortly after the completion of flexion (4.5-5.2 mm). The dorsal spines begin to ossify at about 5.2 mm. The first two anal spines ossify shortly after development of the soft anal fin (at about 6.5 mm). The third anal spine transforms from a soft ray from about 16 mm, bur this may not be complete before settlement. Otherwise, full dorsal- -and anal-fin complements (two anal spines) are attained by 7 mm. A small gap exists between the anus and the first anal-fin element, but it decreases in rela-tive size as the larvae approach settlement. Pelvic-fin buds develop during the late flexion to early postflexion stage (4.0-5.2 mm) and pectoral and pelvic-fin ray formation begins at 5.8 mm and 6.3 mm, respectively. Full development of these fins is achieved by 10 mm. Scales begin to form on the trunk and tail by 10 mm, and by settlement, scales are also present on the cheek. The cheek scales in *Lethrinus* start to disappear shortly after settlement, but a few are still visible in settled individuals as large as 38 mm. The extensively developed head spina-tion is the notable specialization to pelagic life.

*Pigment* - Lethrinid larvae are fairly lightly pigmented. In preflexion larvae, melanophores occur along the dorsal surface of the gut and on the ventral midline of the tail. With increasing larval development, the ventral midline pigment is lost and pigment appears on the brain. On larger (< 16 mm) individuals, additional pigment may also develop on the dorsal, anal and pelvic fins, on the head, and on the rest of the body in bars or patches.

**Order Perciformes**
**Family Sciaenidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 24-29 myomeres, typically 25-26
- Body moderate to deep (BD 27-43%), rail slightly narrow

- Head generally deep, with a large, oblique mouth
- Moderate head spination, including early forming, short to moderate preopercular spines, and supraocular, subopercular, interopercular and supracleithral spines; serrate infraorbital, pterotic, low supraoccipital and posttemporal ridges in some taxa
- Gut moderate to long (PAL 40-62%), coiled and compact
- Large gap between anus and origin of anal fin in most taxa, reduced by late postf1exion stage
- Dorsal-fin rays at least twice as numerous as anal rays; dorsal spines usually form last
- Length of anal-fin base about 25-35% of dorsal-fin base
- Pigment ventrally on head species-specific, usually including melanophores along dentary and/or midline of gular membrane and along isthmus, and 1 melanophore at angle of lower jaw
- Pigment externally and/or internally at nape, and dorsally over gut and gas bladder
- Pigment usually over- anterior surface of gut
- Tail pigment usually restricted to ventral midline, pattern species-specific

**Order Perciformes**
**Family Sillaginidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 32-45 myomeres
- Body initially very elongate to elongate, becoming elongate to moderate with development (BD 9-22%)
- Elongate, pointed snout in postflexion larvae
- Very small preopercular spines (absent in Sillaginodes); very small posttemporal and supracleithral spines in *Sillago* by late postflexion stage
- Gut moderate to long (PAL 44-64%), initially straight but coils during development; weak striations develop along midgut in most taxa prior to flexion stage
- Prominent gas bladder in larvae caught at night, inconspicuous during day
- Prominent, persistent preanal membrane
- Melanophore at angle of lower jaw
- Melanophore series along dorsal midlines of trunk and tail; in most taxa, these tend to disappear posteriorir during flexion stage and reappear during postflexion stage
- Melanophore series along ventral midline of gut (sometimes they appear to be along preanal membrane) and along entire ventral midline of tail

**Order Perciformes**
**Family Mullidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-Mullid larvae are elongate to moderate in depth and laterally compressed. Total myomeres number 23-25. Early preflexion larvae have about 5-6 preanal myomeres, but this increases with growth: shortly after flexion there are about 8, and by 10 mm there are about 10. The gut is short and rounded, extending initially to about 30 to 40% body length. As it extends posteriorly, the gut becomes less rounded and following flexion it reaches to 60% BL. The gas bladder is covered by heavy pigment, and difficult to see. The moderate size head is rounded dorsally, and the snout is short and steeply sloped. The profile of the snout becomes less steep, but remains rounded. The large eyes are round to slightly ovoid. The mouth is small to moderate in size, extends to about the anterior edge of the pupil and is terminal and slightly oblique. Small teeth begin to form in the upper jaw at 8-9 mm just prior

to formation in the lower jaw. At approximately the same time, the chin barbels begin to form as thickenings along the edge of the branchiostegal membrane that originate at the hypohyal symphysis. During formation they are difficult to see. The barbels are completely formed and free of the membrane by 17-18 mm but are hidden under the lower jaw. The barbels may move forward relative to the eye during the pelagic phase, but it is not until after settlement that the barbels move to the position under the tip of the lower jaw that they occupy in adults. The gill openings are free from the isthmus. Larvae of most mullid species have no head spination, but some species have one to three, very small spines near the angle of the preopercle. These form during flexion, but disappear by about 10 mm. The anal-fin elements begin to form during flexion (about 4 mm), just before the dorsal-fin soft rays begin to form. Both fins are fully ossified by approximately 6 mm. There is a large gap (approx. 50% head length) between the anus and the anterior border of the anal fin during flexion, but this begins to close and is gone by 10 mm. The spinous dorsal fin starts to form short; after flexion (5.6 mm) and is fully ossified by about 7 mm. The pectoral-fin rays begin to form during flexion (4.0-4-5 mm), and development is complete b; about 8 mm. The pelvic-fin buds are present at 5.5 mm, and the fins are fully formed by 7 mm. The smallest specimen with scales was 13 mm, but because the scales are deciduous, they may form in smaller fish. The very short gut of small larvae may be a specialization to pelagic life, as are the small preopercle spines of some species. Mullids may have a protracted pelagic juvenile stage that is distinguished by colour pattern but is otherwise not obviously specialized for pelagic life.

*Pigment*- Preflexion larvae have pigment on the dorsal surface of the gut and small melanophores along the ventral midline of the tail that are generally lost before flexion. Brain pigmentation forms before flexion (about 3 mm) with three melanophores (the posterior of which forms first) in a triangular pattern on the midbrain; the brain pigment becomes more extensive during development. A stripe along the mid-lateral surface of the tail begins to form before flexion, along with internal melanophores over the notochord. Rows of melanophores on the mid-dorsal and mid-ventral edges of the tail and trunk form after flexion. Thereafter, pigment spreads so that by the time all fins are fully formed, the larvae are heavily and more uniformly pigmented. In life, the heavily pigmented larvae are blue dorsally and silvery laterally and retain this colour until settlement.

**Order Perciformes**
**Family Glaucosomatidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Larvae are initially elongate, but become moderate to deep by the completion of flexion. There are 24-25 myomeres (10-13 + 12-15). The anus reaches to about 50-70% BL. The gut initially comprises a short, coiled foregut and an elongate, uncoiled hindgut, but it becomes fully coiled from the late preflexion stage, and triangular and compact by the late postflexion stage. A short, preanal membrane is present until the late flexion stage. A small inflated gas bladder is evident over the dorsal surface of the gut from 2.5 mm. The head is initially small, but is large from the flexion stage, constituting up to approx. 60% BL late in the postflexion stage. The snout is short and rounded. The large, oblique mouth reaches to about midpupil. Small viIliform teeth develop along the premaxilla in preflexion larvae from 2.6 mm and along the dentary from 3.1 mm. The medium to large eye is round. Gill membranes are free from the isthmus. Larvae possess small to moderate head spines. Two spines form on the outer preopercular margin in preflexion larvae, followed by 3-5 spines on the inner margin in flexion larvae; spines on both margins increase to 7-10 from 6.0 mm and remain small. A single, small spine forms on the subopercuIum by 4.2. A small interopercular spine forms by 4.8 mm, and 4-5 are present by 6 mm. A smooth supraocular ridge forms during flexion and becomes prominent from 5.1 mm. A small sphenotic ridge develops from 5.2 mm and becomes blunt from 7.0 mm. A low posttemporal ridge forms

during flexion and it develops up to four spines. The supracleithral spine begins to form soon after notochord flexion is complete and develops 2-4 small spines from 5.2 mm. All spines, and the supraocular ridge, were present in the largest larva (8.l mm) and two juveniles examined (22.5-24.2 mm). Pectoral-fin buds form in early preflexion larvae from 2.3 mm; incipient rays appear in late flexion larvae from 4.6 mm and all rays are formed in postflexion larvae from 6.1 mm. Pelvic-fin buds, and dorsal-, caudal- and anal-fin anlagen appear simultaneously in late preflexion larvae from 3.8 mm. Incipient pelvic-fin rays are present in flexion larvae from 4.0 mm and all elements are developed in early postflexion larvae from 4.8 mm. Incipient dorsal- and anal-fin rays appear in flexion larvae from 4.0 mm; all elements are present in early postflexion larvae from 4.8 mm except for the posterior-most spine of both dorsal and anal fins which remain as soft rays until 6.6 and 8.l mm, respectively. There is no gap between the anus and the anal-fin origin. Scales start to form in late postflexion larvae from about 7.0 mm and were still developing in the largest larva examined. As the head spination is retained in juveniles, the relatively early development of the pelvic fins constitutes the only apparent specialization of larvae to pelagic life.

*Pigment* - Larvae are initially moderately pigmented, becoming heavily pigmented with growth. At any size, pigment intensity varies considerably. Initially, pigment is present on the lower jaw, dorsal and ventral surfaces of the gut, and both dorsally and ventrally on the midline of the trunk and tail. In late preflexion to late flexion larvae, most of the trunk and the anterior half of the tail are heavily pigmented; and pigment is present along the lower jaw and ventrally along the gut. The head, gut and tail become heavily pigmented by the late post flexion stage except for the posterior-most caudal myomeres. Before flexion, internal pigment forms on the snout, fore brain, ventrally along the mid and hindbrain, cleithrum, nape and dorsally along the notochord. Pigment on the pelvic-fin buds forms during the late flexion stage and the fins are heavily pigmented from the early postflexion stage; all other fins remain unpigmented except for: dorsal-fin spines I-VII and the interconnecting fin membrane; and the bases of the second dorsal and anal fins.

**Order Perciformes**
**Family Monodactylidae (based on *Monodactylus*)**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 24-25 myomeres
- Body moderate to deep (BD 31-59%)
- Moderate head spination, including prominent preopercular spines, a low serrate supraocular ridge, and small interopercu1ar, posnemporal and supracleithral spines
- Gut long (PAL 50-62%), coiled and compact
- Early forming pelvic-fin rays, elongate in early stages but reducing in size with growth
- Body initially moderately pigmented, becoming heavily pigmented with growth
- Distinct wide band of heavy pigment from snout ventrally across opercle to anus in preflexion larvae
- Pelvic fins heavily pigmented early in development
- 2 large opposing melanophores on dorsal and ventral surfaces of caudal peduncle in postflexion larvae

**Order Perciformes**
**Family Drepaneidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Larval drepaneids are initially deep-bodied with a relatively rotund head and trunk and a relatively compressed tail. They become increas-ingly deep-bodied and laterally compressed with growth. There are 24 myo-meres (10-13 + 11-14) which become obscured by heavy pigment in postflexion larvae. The large, triangular gut is tightly coiled and the anus is located at 47--64% BL. The inconspicuous gas bladder is centred over the gut, and elongates posteriorly with growth. The head is large and initially round but, after noto-chord flexion, it develops a steep profile and becomes increas-ingly deep. The short snout is slightly concave in preflexion larvae and becomes rounded during the flexion and early postflexion stages. The mouth is initially large, slight-ly oblique, and the maxilla reaches to the posterior margin of the pupil. With growth, the mouth becomes inferior and relatively smaller; from about 16 mm, the maxilla reaches only to the anterior margin of the eye. Small, pointed teeth are present in the lower jaw by 2.2 mm and in both jaws by 3.2 mm. The lips become fleshy by 10 mm and may conceal the teeth. The eye is large and round in the smallest specimen, but in larger larvae, relative eye size ranges from small to moderate. Gill membranes become broadly attached to the isthmus between 7 and 8 mm. Head spination is well-developed, complex, and present in all specimens exam-ined; spination increases from the preflexion to the post-flexion stage, and then variably decreases from about 20 mm. Spination in the smallest specimen comprises a supraoccipital ridge, a narrow spine associated with the dorsal margin of the interopercle, small to large spines associated with the inner (3) and outer (4) borders of the preopercle, and a small supraocular ridge. The supraoccipital ridge is initially long (39% HL), strongly serrate, and located at the dorsal-most point on the body. With growth, the body deepens resulting in the dorsalmost point being posterior to the ridge. The supraoccip-ital ridge in postflexion larvae may have up to 10 spines. Preopercular spines are smooth and the one at the angle is longest (41% HL at 2.2 mm BL). In postflex-ion larvae, there may be as many as 7 and 6 spines on the inner and outer bor-ders, respectively. The sole spine on the interopercle is retained until 13 mm. One or two weak spines are present on the subopercle in larvae between 3.2 and 13 mm, but they are not easily discerned and are not illustrated. A posttempo-ral ridge is present by 3.2 mm; the ridge is reduced in preflexion larvae, becomes relatively larger in postflexion larvae, and is present in the largest specimen examined. A bony ridge on the maxilla projects anteriorly over the premaxilla near the ascending process in larvae between 3.2 and 10 mm. A lat-eral flange, distally on the maxilla, is apparent by 7 mm. Spines associated with the infraorbital sensory canal system form early. Those associated with the anterior infraorbitals are present by 4.3 mm, and are in three distinct areas: up to five spines located beneath the posterior margin of the pupil; up to three spines beneath the anterior margin of the eye; and up to seven spines associat-ed with the lachrymal. Up to two groups of very small spines on the posterior infraorbitals are present by 7.1 mm (not illustrated). Parietal and tabular spines are present by 7.1 mm. Between 7 and 10 mm, the serrate ridges on the supra-ocular, pterotic, sphenotic, posttemporal, and supracleithral bones become nearly continuous. A low nasal ridge is present from about 8 to 20 mm. A weak spine is present on the opercle by 10 mm. Barbels from the chin to the isthmus begin to appear in pairs by 7 mm. Development of barbels is variable, but by 14 mm, 11 pairs are present; these persist until about 250 mm (Maug & Heem-stra, 1984a). Sensory pores on the chin begin to develop at about 7 mm but are not distinct until 13 mm. Dorsal- and anal-fin anlagen are present by 2.2 mm; both soft rays and then spines appear during flexion. All dorsal- and anal-fin elements are present by 7.1 mm, but the first soft ray of each fin transforms into a spine by 8 mm. Spines are weak when they begin to ossify, but become very robust by 7 mm. The procumbent spine of the first dorsal-fin pterygio-phore is present in postflexion larvae. Supraneurals are apparent between the supraoccipital crest and the dorsal-fin origin in postflexion larvae. Pelvic-fin buds are present at 2.2 mm, and incipient rays are present by the end of the flexion stage. Pelvic-fin rays increase in length from a maximum of 23% BL dur-ing flexion to 46% BL in postflexion larvae. The first pelvic ray is much longer than the other rays, and is branched. Ossification of the pelvic fins is complete by the end of flexion, at which time the fins reach to or beyond the anus. Pec-toral-fin rays begin to ossify early in the flexion stage and all rays are present by the time flexion is complete. The lateral line begins to form

at about 8 mm and is complete by 14 mm; at this length, the entire body is scaled. From 13 mm, scales, each with a single small spine appear anteriorly on the body above the lateral line, and on the top and sides of the head, the opercle, the cheek, and on and ventral to the pectoral-fin base. There is no distinct settlement stage; instead, a gradual transition to the juvenile form and habitat takes place. Specializations to pelagic life include the large, initially robust head with associated spination and the large mouth.

*Pigment* - Larvae initially are lightly pigmented. Preflexion larvae variously possess scattered melanophores associated with the snout, abdomen, pelvic and pectoral-fin rays, gas bladder, and gut. The rest of the body is unpigmented. By 7.2 mm, there is a proliferation of melanophores covering the majority of the body, except for the caudal fin. By 10.4 mm, the dorsal, anal, and pelvic fins are darkly pigmented. By 13.8 mm, pigmentation on the body has increased and the barbels on the chin are now pigmented. Pigment on the caudal fin is confined to the basal portion (approx. 15% of fin is pigmented). By 17.6 mm, the dorsal and anal fins are completely pigmented except distally in the postetiormost rays. A large melanophore is associated with the membrane between the bases of each dorsal- and anal-fin ray.

**Oreder Perciformes**
**Family Pentacerotidae (Based on *Evistias acutirostris*)**
(From: Konishi, 1988. *Evistias acutirostris*. *In* An atlas of the early stage fishes in Japan, ed. Okiyama. Toakai Unversity Press, Tokyo, pp. 553-554.)

- Body compressed
- Pigmentation on the body well developed
- Elongated pelvic fin with heavily pigmented
- The top of the head and eyes ornamented by characteristic spination

**Order Perciformes**
**Family Cepolidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Cepolid larvae are of moderate depth anterior to the anus, have a hunchback appearance and have an elongate, compressed, tapering tail. Owstoniine larvae become deep but cepolines do not. There are 29-72 myomeres (3-13 + 18-68)*: the total number and the ratio of pre- to postanal myomeres varies among species. The posterior-most myomeres of cepolines are extremely narrow and difficult to distinguish. The anus is anterior to the posterior margin of the gut in some species leading to very low preanal myomere counts. The triangular gut is strongly coiled and reaches to about 60% BL in the shorter, deep-bodied owstoniines. In the cepolines, PAL ranges from 27 to 55% BL. The conspicuous gas bladder is located above the apex of the gut, but may be very large and extend over most of the gut; this is not clearly correlated with species or time of capture. The broad, moderate to large head is approximately round with a prominent jaw angle. The short snout is initially slightly concave but, with the development of the ascending premaxillary process in preflexion larvae, the snout becomes slightly rounded and irregular in profile. The large, oblique mouth increases in relative size with growth and reaches to the posterior margin of the pupil. Small teeth appear in both jaws during the preflexion or early flexion stage (about 5 mm). These may become relatively long in some species. The moderate to large eye is round. Gill membranes are free from the isthmus. Head spination in our smallest specimen consists of a large supraoccipital ridge which has: an anterior spine with a serrate leading edge and a long, posteriorly-directed spine; a supraocular ridge with one spine; a serrate

dentary ridge; preopercular spines including a very long, serrate spine at the angle; and a rugose frontal region. All of these spines and ridges become increasingly serrate during the preflexion and flexion stages. The relative lengths of the large supraoccipital and preopercular-angle spines vary among species. The lengths of these two spines are longest in preflexion larvae, reaching as much as 20 and 33% of BL, respectively. Additional spination forms from about 2.8-3.5 mm. These include: a small supracleithral spine; a laterally-projecting spine on the mid-operculum (cepolines only); and a spine on the anterior tip of the maxilla. Other spines vary in extent of development among species. In flexion larvae these include: a projecting, often serrate ridge on the anterior portion of the maxilla, a posttemporal spine, a small pterotic spine, and a sharp lower-jaw angle. In postflexion larvae an opercular spine, and an infraorbital ridge may be present. The head spines become relatively reduced from about 6-9 mm, depending on species, but all are still present in our largest specimens. Based on the size range involved, flexion takes a long time to complete. The caudal fin is small. The long dorsal and anal fins develop incipient rays anteriorly during the preflexion stage. By the time flexion commences, the anterior-most rays are ossified. Ossification of the fin rays proceeds posteriorly and the fins are fully ossified from as early as the late flexion stage to as late as 10 mm. Pectoral-fin rays are all present prior to the completion of flexion. Pelvic-fin buds appear in late preflexionor early flexion larvae, and the fins are fully ossified prior to the completion of flexion. The pelvic fins can be long and may reach beyond the anus. Scales are present in one species by 9.1 mm, but are yet to form at 13.5 mm in other species. Head spination is the principal specialization to pelagic life.

*Pigment* - Cepolid larvae are lightly to moderately pigmented, with melanophores on the dorsal surface of the head, gut and gas bladder, on the lateral surface of the operculum, on the nape, and along the ventral midline of the tail Species-specific pigment may occur on the lower margin of the dentary, on the margin of the preopercle, on the pectoral fin, on the dorsal midline of the tail, on the caudal peduncle and on the caudal-fin base or membrane.

**Order Perciformes**
**Family Lactariidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - (based solely on postflexion larvae). The larvae are laterally compressed and of moderate depth. There are 24 myomeres (9-10 + 14-15). The anus is located at 40-47% SL and the gut is coiled. A very large and conspicuous gas bladder is located above the gut, and extends a considerable distance posterior to the anus. The head becomes increasingly pointed with growth, primarily due to increased protrusion of the lower jaw as the mouth becomes more oblique. The snout becomes proportionally shorter with growth and the profile less steep. The mouth is moderate to large, but does not reach the pupil until > 10.3 mm. Small, slightly recurved teeth are present in both jaws of the smallest larva. Enlarged, symphysial canines are present in both jaws by 23 mm. Judging from the size of the orbit, the eye is large, but it appears to have shrunk in the available specimens. Gill membranes are free from the isthmus. Head spination is confined to the preoperculum and operculum. Preopercular spination is limited to a small spine at the angle, only in the smallest specimen (6.0 mm). A weak opercular spine is present in all larvae, and a small second opercular spine, dorsal to the first, appears by 10.3 mm. In the smallest larva, the dorsal fin has six incompletely-formed spines, and all but the posterior-most soft rays of the dorsal and anal fins are present. The anterior rays of the long-based dorsal and anal fins are more than twice as long as the posterior rays. The first spine of the anal fin is present, but the next two elements, which ultimately become spines, appear to be soft rays. Only incipient rays are present in the pectoral fins, and the pelvic fins are merely buds. By 10.3 mm, the full complement of rays is present in all fins, except that the ventral rays of the pectoral fin are still incipient.

The fin spines are all slender and weak, none are particularly elongate, and none have any external ornamentation. There is no gap between the anus and the anterior margin of the first anal pterygiophore of the anal fin. Only the largest specimen has any indication of scalation, but it is not clear if this is incipient scales, or damaged scale pockets. The only apparent specialization to pelagic life is the occurrence of small spines on the preopercle and opercle.

*Pigment* - Lactariid larvae are not heavily pigmented. The most prominent pigment is a series of melanophores along the bases of both soft dorsal and anal fins and continuing on to the caudal peduncle. The ventral series gradually decreases in number of melanophores and extent, so that by 23 mm, the only ventral pigment remaining is on the midline of the peduncle. Scattered melanophores occur on the dorsal surface of the brain, spreading posteriorly onto the nape by 23 mm. Only a few, mostly small, melanophores are present elsewhere.

**Order Perciformes**
**Family Terapontidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 25-26 myomeres, typically 25
- Body elongate to moderate (BD 16-35%)
- Weak to well developed head spination, often including preopercular, opercular, cleithral and interopercular spines, and low, smooth supraocular and supracleithral ridges; supracleithral and sub opercular spines and a serrate infraorbital in some taxa
- Gut moderate in pretlexion through to posttlexion larvae (PAL 30-47%), long in larvae near settlement, (PAL to 65%), coiled and compact .
- Moderate to large gap between anus and origin of anal fin, closed by late postflexion stage; conspicuous postanal membrane along gap
- Small gas bladder, pigmented
- Body initially lightly pigmented, heavily pigmented near settlement
- One or two large melanophores ventrally along gut in early stages
- Melanophore series along ventral midline of tail

**Order Perciformes**
**Family Kyphosidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 25-26 myomeres
- Body initially elongate, becoming moderately deep in postflexion stage (BD 14-38%)
- Weak head spination, including small preopercular, supracleithral and opercular spines (small subopercular spines in *H. azurea* but absent in *Kyphosus*)
- Last spines of dorsal and anal fins are initially soft rays but transform into spines before settlement
- Gut moderate to long (PAL 48-69%), initially straight but becoming coiled and compact by flexion stage
- Small gas bladder over foregut
- Body moderately to heavily pigmented, pigment over head and a melanophore series along dorsal and ventral midlines of tail; trunk and tail covered by small to large stellate melanophores in postflexion larvae
- Melanophores on snout, particularly at tip of upper jaw (upper border of premaxilla)

- Melanophores under notochord tip in most taxa; caudal peduncle unpigmented prior to settlement

**Order Perciformes**
**Family Stromateidae (Base on *Peprilus triacanthus*)**
(From: Fahay, 1983. Guide to the early stages of marine fishes occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf.)

- 30-33 myomeres
- Hatching occurs at 1.68-1.75 mm total length; eyes unpigmented.
- Body deepens early in development; preanus length about 50% total length; small terminal mouth.
- Tiny opercle spines present at about 7 mm.
- Dorsal and anual fin rays begin to form at about 5 mm, and complete at 12-18 mm; no pelvic fins.
- Pigmentation: row of postanal spots ventrally; spots developon top of head and on opercle margin of gut pigmented ("like a solid line of stitching")

**Order Perciformes**
**Family Nomeidae (Base on *Cubiceps pauciradiatus*)**
(From: Fahay, 1983. Guide to the early stages of marine fishes occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf.)

- 31 myomeres
- Hatching occurs at 1.5-22 mm; eyes unpigmented.
- Flexion occurs at 3.7-4.3 mm notochord length
- weak preopercle spines (4-5) present at 5-11 mm standard length
- Teeth begin to form at 6.2 mm standard length.
- Pigmentation: dorsal line of embryonic pigment moves to ventral edge shortly after hatching; characteristic dorsal, lateral and ventral straks at myomeres 20-23; single midventral spot anterior to cleithral symphysis; spots on head and body increase with development.

**Order Perciformes**
**Family Polynemidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-Polynemid larvae are moderate to deep bodied and compressed. The gut is coiled and triangular and reaches to 44-62% BL. There are 24-27 myomeres (7-11 + 14-19). The conspicuous gas bladder is located near the apex of the gut mass. The moderate to large head is initially round but is slightly elongate by 7 mm. The snout is initially variable in profile, however, in postflexion larvae, it becomes rounded and, from about 7 mm, the snout enlarges, becomes bulbous, and extends beyond the mouth. The large mouth is initially oblique and reaches to midpupil, but by about 6 mm it becomes more-or-less horizontal, inferior, and reaches beyond the posterior margin of the eye. Many small, villiform teeth are present in both jaws at 2.5 mm. In the smallest larvae (< 3 mm), the round eye is large, but otherwise, it is of moderate size until the early postflexion stage, after which it is relatively small. The adipose eyelid of adults is not present in any of our larvae (to 15 mm), but is present by settlement. Gill membranes are free from the isthmus. Only a few, weak spines are present on the head. A very small spine appears at the anterior tip of the maxilla at about the time of flexion and disappears shortly thereafter. A few very small preopercular spines appear during flexion, and can be prominent on the outer margin by settlement; these are the precursors of the serrate preopercular margin of adults.

The supracleithrum is pronounced in postflexion larvae, but an emergent ridge and spine do not form until about 15 mm. Dorsal- and anal-fin anlagen appear in preflexion larvae from 3.0-4-1 mm, and the sott rays develop during flexion. There are approximately equal numbers of soft rays in the dorsal and anal fins. The feeble spines of the anal and separate first dorsal fins start to form in early postflexion larvae. All elements are present in the dorsal and anal fins by 7.3 mm. Pectoral-fin rays begin to differentiate in late flexion to early postflexion larvae. The rays of the upper lobe are fully ossified by 6.5 mm, at which time the rays of the lower lobe begin to ossify. All pectoralfin elements are ossified shortly after 7 mm. The pectoral-fin base is initially level with the top of the gut, but begins to move ventrally shortly after flexion, and is eventually located near the ventral margin of the body by about 12 mm except in *polynemus* species (R.M. Feltes, pers. comm.). The fin divides into two lobes as it moves. The lower lobe moves antetiorly relative to the upper and separates from it. The detached lower rays become long and thicker than the upper rays and lack a membrane. Small, abdominal pelvic-fin buds are present by 5.6-6.9 mm. Incipient rays are apparent by 6.5-7.3 mm and all the elements become ossified sometime between 7.3 and 11.5 mm. A gap of variable size exists between the vent and anal-fin origin and this persists in our largest larvae. Scales begin to form laterally on the trunk and tail from about 12 mm. All scales are present by 15 mm. There is no distinct transformation to the adult form; instead, development is direct and gradual. The oblique mouth and small maxillary spine are the only apparent specializations-to larval life.

*Pigment*- Polynemid larvae are lightly to moderately pigmented with considerable variation in location and density of pigment among taxa. Melanophores typically occur along the ventral midline of the tail and gut, on dorsal surfaces of the gas bladder and gut, and on the jaw angle and nape. Depending on species, pigment may appear at the base of the soft dorsal rays, on the caudal fin, along the vertebral column, and laterally on the trunk and operculum. Some areas of pigment spread in the late larval stage, and pelagic juveniles may be heavily pigmented.

**Order Perciformes**
**Family Labridae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - The morphology of labrid larvae is extremely variable, and there are few all-encompassing characteristics. Larvae are elongate to moderate in depth and laterally compressed. The caudal peduncle is usually deep. There are 23-28 myomeres (10-18 + 7-16): the majority of species have 25. The gut is initially straight (although it may be strongly constricted or partially swollen) and may extend to 81%BL prior to coiling (although usually less than 67%). The stage at which the gut coils varies depending on species and ranges from the mid preflexion (for instance, Thalassoma, Cheilinus, Stethojulis) to the late postflexion stage (for instance, Xyrichthys, Cymolutes). When the gut is fully coiled, the preanal length ranges from 37 to 74% BL. A small, often inconspicuous, gas bladder is located above the anterior to middle portion of the gut and is generally inflated only in larvae caught at night. The head is laterally compressed but otherwise varies in shape from triangular and moderate in size to large and deep. The snout is extremely variable in shape, ranging from blunt to elongate and very pointed. The mouth is small and does not usually reach the anterior edge of the eye. Small, conical teeth are present in both jaws by about 6.3 mm, but may be hidden by the lips. The eye varies from small to large, and may be ovoid, round, or squarish and frequently has a mass of choroid tissue on the ventral margin. If the eye is ovoid, the long axis may be diagonal, rather than perpendicular, to the body axis. Some species of the tribe Cheilinini develop a double pupil (figure-eight shaped) during the late postflexion stage. The gill membranes are free from the isthmus. With the exception of one taxon which has 4-5 very small preopercular spines, there is no head spination other than a very weak, smooth, supraocular

ridge in some species. Dorsal- and anal-fin anlagen are present by 3.0-5.6 mm. The soft rays of both the dorsal and anal fins begin to form at 3.5-5.6 mm. Formation of the spines of the dorsal fin is variable. The spines usually form slightly later than the soft rays, but they may form simultaneously with the rays, and in a few taxa, the spines form before the rays (beginning at as small as 3.2 mm). They initially develop as weak filaments (hard to distinguish from soft rays) and are most easily identified as spines by their small triangular bases. In most taxa, the spines are no longer than the rays, but the dorsal-fin spines in the taxa with early-forming spines may be much longer than the rays (nearly = BD), and in a number of genera some (for instance, Bodianus, Xyrichthys) or all (for instance, Thalassoma) of the dorsal-fin spines become elongate during the mid to late postflexion stage. In all cases, the fin spines remain slender, unornamented and usually flexible. Full dorsal- and anal-fin complements are present at 5.5-7.3 mm with the exception of Xyrichthys which does not have fully ossified dorsal and anal spines until about 11. 5 mm. The long-based dorsal fin originates at about the level of the pectoral base, except in Xyrichthys which has the dorsal-fin origin on the head. Some species of the tribe Novaculini may have a gap between the second and third dorsal spines. There is not usually a gap between the vent and anal fin, but Cheilio has a small gap shortly before settlement. The dorsal-most rays of the pectoral fins are present by 4.0-5.3 mm, and the fins are fully developed by 5.7-6.0 mm. The pelvic buds are first present at 4.0-7.5 mm: the rays may be present at 7.0 mm in some species but not ossified at 12 mm in others. Size of the pelvic fins are variable: they may be very small or may reach to about the anus. Scales do not develop prior to settlement. Some species bury in the sand upon settlement and undergo transition from pelagic to demersal morphology while buried. The only apparent specializations to larval life are the preopercular spines of at least one taxon, the elongate or early-forming dorsal-fin elements of some taxa, and the narrow eyes and choroid tissue of some others.

*Pigment* - Most postflexion labrid larvae are unpigmented until elements of the juvenile pigment pattern begin to appear just before settlement (see Kojima, 1988c). In most species, when pigment does occur, it is limited to a few melanophores that may be found above the vent, on the posterior dorsal and ventral midlines of the tail, along the myosepta of the rail, on the dorsum of the gut, on the brain, on the lower jaw, or on the dorsal- and anal-fin elements. Except for larvae of the Tribe Hypsigenyini, which tend to be more heavily pigmented, it is rare for any species to have pigment at more than a few of the locations noted. Preflexion lab rid larvae usually have pigment at 2-3 of the locations noted, but some are entirely unpigmented. Very young lab rid larvae often have a few relatively large melanophores on the finfold.

**Order Perciformes**
**Family Scaridae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-Preflexion larvae are elongate, and some species may become moderate in depth following flexion. The body is ovoid in cross-section, with a deep caudal peduncle, and 25 myomeres (9-13 + 12-16). The body is increasingly laterally compressed with growth. The rugose gut extends to slightly beyond midbody and is initially straight with a slight constriction at the posterior end. Shortly after flexion, the anterior portion of the gut becomes coiled, but this is usually obscured within the body. A large gas bladder is located above the middle of the gut and moves posteriorly to near the end of the gut before settlement. The gas bladder appears to be inflated only at night. The head is small initially but increases in relative si2e to moderate after flexion. The snout is slightly pointed to rounded. The small, nearly horizontal mouth may reach the anterior part of the eye. No teeth are present before settlement. The eye is small to moderate. It is usually ovoid to rectangular (with the width narrower than the height) and becomes rounded in late postflexion larvae. However, some species have a distinctly narrow eye

with a ventral mass of choroid tissue throughout the larval stage. There are no spines on the head or pectoral girdle. The dorsal-fin anlage is present at about 3.5 mm, and shortly before flexion, the soft rays of the dorsal fin begin to form from posterior to anterior. The soft rays of the anal fin form very shortly thereafter. By 5.5 mm initial ossification of the dorsal-fin spines occurs. These spines develop from posterior to anterior and are difficult to distinguish from the soft rays. The anal spines form concurrently with the pectoral-fin rays (at 6-7 mm). All dorsal- and anal-fin elements are present by 7 mm, but the last spine is not completely transformed from the first ray until about 8 mm. The pelvic buds are present as early as 5.8 mm, but all pelvic elements are not present until 8 to 14 mm (depending on species). All fin spines are short, slender, weak and unornamented with the exception of the antetior dorsal-fin spines of settlement-stage *Cetoscarus bicolor* (R ppell) which are markedly elongate. No scale formation occurs prior to settlement. The only apparent specializations to pelagic life are the ovoid to narrow eye of some species and the choriod tissue.

*Pigment*- Scarid larvae are lightly pigmented. They have pigment over the gut immediately anterior to the anus and along the ventral midline of the tail (1 to 12 melanophores). Pigment may also occur along the dorsal midline of the caudal peduncle, on the pectoral-fin base, and in the pectoral-fin axil.

**Order Perciformes**
**Family Pinguipedidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 29-34 myomeres
- Body moderate (BD 24-40%)
- Head short and round before flexion stage, elongate and depressed at settlement
- Moderate head spination, including 3-4 small to moderate posterior preopercular spines and 1-4 small opercular spines
- Gut moderate to long (PAL 31-56%), coiled and compact
- Pelvic fins thoracic, inserted slightly anterior to pectoral-fin bases; pelvic-fin rays usually form before or during flexion stage
- Body lightly pigmented
- Melanophore at angle of lower jaw
- Single melanophore series along ventral midline of tail in preflexion and flexion larvae, about 1 melanophore per anal pterygiophore in postflexion larvae; series disappears at settlement
- Expanded ventral melanophore on posterior region of tail, prominent in preflexion through to early postflexion larvae

**Order Perciformes**
**Family Champsodontidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Champsodontid larvae may be moderately elongate and slender, or more robust, depending on species. The slender larvae remain so. The more robust larvae become more elongate during the postflexion stage. All champsodontid larvae have 28-33 myomeres (usually 30-32 = [9-13] + [17-22]). Soon after yolk absorption the straight gut folds into an 'S' shape (as early as 2.5 mm) and becomes coiled. Thereafter, the gut is relatively short, although PAL is 45-68% BL due to the large head. The gas bladder in preflexion larvae is small, spherical and located above the anterior portion of

the gut, but by the postflexion stage it is oval and often extends nearly the length of the abdominal cavity. The head is roughly triangular initially, due to the large lower jaw, but subsequently becomes elongate as the head length increases. The snout initially is slightly concave but becomes straighter and longer in postlexion larvae. The mouth is very large. The maxilla reaches to at least the posterior border of the eye. Teeth appear in both jaws during the preflexion stage, before 4.0 mm. Numerous teeth develop, and those in the lower jaw become long and needlelike in postflexion larvae. The eye is round to slightly elongate and decreases in relative size from moderate to large in preflexion larvae to small to moderate following flexion. Gill membranes are free from the isthmus. The most striking feature of larval champsodontids is the spinous opercular appendage, which develops before hatching and persists into the postflexion stage. This ossified spine reaches a maximum 30-40% BL during the preflexion stage and remains 26-30% BL until it is lost or resorbed by 6 to mote than 10 mm, depending on species. Because the opercular appendage is long and delicate, it is often broken in field-collected specimens. Champsodontids acquire moderate preopercular spines as well as low, serrate nasal, supraocular, frontal and parietal ridges which first appear in preflexion larvae between 2.6 and 4- 5 mm. These spiny ridges may become relatively elaborate in postflexion larvae, although the spines themselves always remain small. During the flexion stage one or two small spines may develop near the upper end of the ascending processes of the premaxillae, and a small pterotic spine usually develops. Postflexion larvae may acquire additional small spines along the lower margins of the articular and dentary, on the posttemporal and on the infraorbitals. The degree of spination varies among species; larvae of the more slender form acquire fewer spines later in development on the nasal, supraocular, frontal and parietal ridges, and apparently do not have the premaxillary, dentary, articular and infraorbital spines. Most of the head spines persist into the juvenile stage, but all are very small in juveniles except the strong spine at the preopercular angle. Late in the postflexion stage, the postetior margins of the opercle and subopercle develop numerous, closely-spaced serrations. Near settlement a short, fleshy cirrus forms above each eye. Anal- and soft dorsal-fin anlagen form during flexion. The rays begin to ossify in early postflexion larvae between 4.2 and 5.7 mm whereas the spines of the first, separate dorsal fin start to ossify slightly later (from 5.2 mm). Dorsal- and anal-fin elements are fully ossified by 6.1 mm. Pectoral-fin rays start to ossify from the late flexion stage and full fin complements are present from as early as 7.6 mm to as late as 11.5 mm, depending on species. Pelvic-fin buds appear during the late flexion stage, and all elements are ossified in postflexion larvae by 6.1 mm. Once formed, the pelvic fin becomes long and reaches a maximum of 25-29% BL. Scales begin to develop at 19.5 mm in at least one species. The extensive head spination and opercular appendage are specializations to pelagic life.

*Pigment* - Champsodontids are lightly pigmented initially, but become more heavily pigmented during the postflexion stage. All have pigment along the dorsal surface of the gut and gas bladder that increases greatly in postflexion larvae, and have some pigmentation on the trunk or tail. Pigment dorsally on the trunk is initially limited to one or two melanophores near the level of the anus. Tail pigment in preflexion and flexion larvae consists of 1-5 melanophores ventrally, often one melanophore dorsally and, frequently, a band of internal pigment posteriorly. Later, dorsal pigment-saddles form on the trunk and tail, and counter-shading develops. Head pigment is variable in preflexion larvae, but by the end of notochord flexion all champsodontids have pigment at least on the forebrain, and usually over the midbrain.

**Order Perciformes**
**Family Callionymidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Development in callionymid larvae is seemingly rapid: most species have full fin complements and are able to settle at a small size. Larvae are robust, and of moderate depth. They are initially round in cross-section, and have 20-22 myomeres (7-13 + 7-13). After flexion, the body and head flatten dorsoventtally, and in some species, dorsolateral and venttolateral ridges form on the trunk and tail. The posterior end of the notochord is greatly produced beyond the last myomere. At the end offlexion, the notochord tip extends well past the hypural plate and may be as long as the caudal fin rays; however, this tip extension soon begins to disappear. The rotund, coiled gut extends to at least midbody, and may extend to over 75% BL. The gas bladder lies anteriorly above the gut, but is inconspicuous. The moderate to large head is initially rounded, but broadens and becomes relatively longer and dorsoventrally flattened after flexion. The snout is short but elongates slightly with increasing body size. The prorrusible mouth is small and terminal, and no teeth are visible until shortly before settlement. The round eye is moderate to large. Following fin formation, the eyes begin to move to a more dorsal position. In most species, the gill membranes are initially free from the isthmus but become broadly attached duting flexion so that the gill opening is reduced to a small foramen. The only head spination is a posteriorly-directed preopercular spine that begins to form following the full development of the soft rays of the medial and pelvic fins. This spine is often large with hooks and other ornamentation. The pelvic-fin buds form shortly after yolk-sac absorption (about 2 mm), and all pelvic-fin rays are present shortly after flexion (2.6-3.8 mm): the rays then elongate and by about 4.5 mm (in most species) extend beyond the anus. The base of the pelvic fins is well in advance of the pectoral-fin base. Various structures reported in the medial fin-fold of reared callionymids (such as 'serrations', 'spine-like' and 'vacuoles': see Houde, 1984a) are not visible in field-captured larvae. Anlagen of the dorsal and anal fins develop shortly after yolk-sac absorption, and soft rays of these fins are fully formed by 4 mm. The pectoral-fin rays and the spines of the first dorsal fin are not fully formed until about 5 mm and are thus the last to form. The spines of the dorsal fin remain short and flexible until after settlement. Shortly before settlement, the preopercular spine begins to branch and all fin elements begin to elongate. Callionymids do not have scales. What appear to be recently-settled callionymid larvae are occasionally captured in plankton tows in coral-reeflagoonal waters at night, suggesting the possibility of re-entry into the pelagic environment following settlement. There is no obvious specialization to pelagic life as the preopercular spination is retained in adults. The absence of a gas bladder in adults is a specialization, rather than its presence in larvae.

*Pigment* - Callionymid larvae are generally heavily pigmented and are unusual in frequently having heavier pigment on ventral than on dorsal surfaces. All species are moderately to heavily pigmented on the ventrum, and most are moderately pigmented on the head, lower jaw, dorsum of tohe gut, and on the lateral and dorsal surfaces of the tail. Most larger larvae have moderately pigmented pectoral-fin bases and melanophores on the pelvic, pectoral, and first dorsal-fin elements. The Hawaiian species, *Eleutherochir pogognathus* (Gosline), has an unusual neustonic stage coloured dark blue dorsally and silver-rose laterally when alive. When preserved, this species is more-or-less uniformly dark.

**Order Perciformes**
**Family Ephippidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Young ephippid larvae have a moderate to deep body, with the head and trunk combined into a ball-like unit, nearly as broad as high. The tail is relatively compressed. Postflexion larvae are initially deep-bodied and laterally compressed, and become even more so with growth. There are 24 myomeres (8-13 + 11-16). The gut is triangular to round and rightly coiled, and reaches to 45-68% BL. A conspicuous gas bladder is located dorsal to the anterior portion of the gut, but expands poste-

riorly with growth. The large head is initially round to rhomboid, and becomes deeply ovate in postflexion larvae. Later, the head becomes increasingly deeper than long. The profile becomes steep during the preflexion stage and remains so. The mouth is initially large, and slightly oblique, with sub equal jaws, but it becomes relatively smaller in postflexion larvae and is more or less horizontal by 13 mm. The maxilla reaches to the posterior margin of the eye in preflexion larvae, but becomes relatively shorter with ontogeny, barely reaching the anterior margin of the eye by 12 mm. Teeth are present by 2.5-2.8 mm, and are large, numerous, and pointed. Teeth with three cusps or points begin to form as early as 12.3 mm. The eye is small to moderate and round. Gill membranes are initially free from the isthmus; they become attached to each other anteriorly by 3 mm, broadly attached to one another during flexion, and then broadly attached to the isthmus during flexion in some species. Head spination is well-developed in most species. The inner border of the preopercle has up to four very small spines on a ridge. The outer border of the preopercle possesses small, smooth spines in some species by 2.5 mm. Some spines, particularly the one at the angle, may become long. The spines are initially naked, but are soon covered basally by thick dermal tissue. After about 13 mm, the preopercular spines are short, rounded and almost completely enclosed by the tissue and may persist in this state to about 80 mm. A posteriorly-directed supraoccipital spine with a weakly to strongly serrate leading edge (i.e., crest) is present by 2.5-2.9 mm. Depending on species, the supraoccipital crest and spine range from fully exposed to completely covered except for the spine tip. The supraoccipital spine becomes reduced and completely engulfed by flesh by as early as 11 mm in some species. A weak opercular spine is apparent by 2.8-3.7 mm, and disappears in Platax by 12-14 mm. A posttemporal spine appears as early as 2.9 mm: it is retained in postflexion larvae of some species but is reduced to a low ridge in others. A supracleithral spine appears during flexion in Ephippus, whereas it may be absent in some Platax species but may appear by 6.2 mm in others. The supracleithral ridge and spine disappear by 9-14 mm in Platax. A supra ocular ridge appears by 2.6-3.3 mm and varies among species from low and smooth to large and strongly serrate; most species have serrations with one serration longer than the others. The supraocular ridge disappears by 10-12 mm in Platax. The opercular, supracleithral and supraocular spines are unreduced in our largest Ephippus (6.1 mm). One interopercular spine appears at 2.6-3.3 mm, and is reduced but present in the largest Platax examined. Some spination forms only in Ephippus: a small pterotic spine by 4.8 mm, a small, serrate infraorbital series and a small tabular spine (both from 6.1 mm). Platax may rarely develop a pterotic ridge. Dorsal- and anal-fin anlagen form in preflexion larvae by 3.3-3.8 mm and incipient rays appear during flexion. All dorsal and anal elements are present by 6.1-7.7 mm, and the spines and posteriormost rays are the last to ossify. The first anal ray and, in some species, the first dorsal ray transform to a spine by 9 mm. The fin membranes become thick and fleshy and the elements become very long in postflexion larvae, continuing to increase in relative length through the early juvenile stage. Pectoral-fin rays begin to form before flexion and all rays are ossified in postflexion larvae by 6.1-8.9 mm. Small pelvic-fin buds appear prior to flexion (at approx. 3.2 mm) and all elements are ossified in early postflexion larvae. The pelvic fin becomes extremely elongate and reaches beyond the anus in larvae larger than 8 mm; the longest ray may reach as far as the base of the thirteenth anal-fin ray and measure up to 64% SL. Scales are present only in the largest larva (14.4 mm) and they cover nearly the entire body; each scale has a single small spine. Lateral-line pores may be apparent by 11 mm. Specializations to larval life include the globose body, large mouth and head spination.

*Pigment* - Larvae are initially lightly pigmented. Preflexion larvae variously possess scattered melanophores associated with the head, abdomen, pectoral--fin base, pelvic-fin buds, gut, gas bladder, and ventral midline (up to one melanophore per myomere). The rest of the body is unpigmented. At about 5.7-11 mm (variable among species) there is a proliferation of melanophores covering the majority of the body. By 11 mm, larvae are heavily pigmented, with melanophores present on the entire head

(including lips) and body, except distally on the caudal peduncle, dorsal and anal fins, and the entire cau-dal fin. This distinctive pattern (absence of pigment distally on fins) is present from as early as 5.7 mm and continues to at least until14 mm.

**Order Perciformes**
**Family Siganidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-Larvae are initially elongate, but become moderate in depth before flexion. They are laterally compressed, and have 22-2.4 myomeres (6-10 + 12-18). The small yolk sac that is present at hatching is absorbed by about 3 mm. The gut folds shortly after hatching, is ovoid in shape, and extends to about midbody. Rugae on the gut are often visible. A gas bladder is present (although often inconspicuous) above the anterior portion of the gut in preflexion larvae but moves posteriorly after flexion. The head is initially moderate in size and round, and the snout is blunt; by flexion, the head becomes moderate to large, deepens and the snout elongates. The nearly-horizontal mouth is small: it does not reach the pupil in preflextion larvae, and as the snout elongates, it fails to reach the eye. It is terminal, but shortly before settlement, it becomes inferior. Teeth are present in both jaws before flexion (4-2 mm). The round eye is large in preflexion larvae but moderate to large following flexion. At 3 mm, larvae develop spines along both preopercular borders: these remain small to moderate. Serrate tidges form shortly thereafter along the top of the head (supraoccipital and frontal), and laterally on the snout (nasal). During and following flexion, small spines or serrate ridges form on the supraocular, pterotic, posttemporal, supracleithrum, angular, infraorbital (lachrymal) and lateral ethmoid. In addition, during flexion, the pelvic girdle develops a serrate ridge anterior to the fin. Most of the head spination is lost before settlement. Fin development is distinctive. Pelvic buds and the dorsal anlage (which begins to form just posterior to the head) are present before all yolk is absorbed (2.2 mm). The first fin elements to ossify are the second dorsal spine and the first pelvic spine at 3.4 mm. Both become serrate at a spine length of 0.5 mm (remaining serrate until late in the postflexion stage), are subequal in length throughout development, and remain the longest elements until shortly before settlement. The remaining dorsal-fin spines (including the socalled procumbent spine, an anterior extension of the first dorsal pterygiophote) begin to form at 3.8 mm, and the anal spines start to ossify at 5.5 mm. All spines of both dorsal and anal fins become serrate shortly after ossification. The soft rays and second spine of the pelvic fin form between 5.8 and 6.4 mm. The dorsal, anal, and pectoral fin rays begin to form at 6.4 mm. By 7 mm all fin elements are present, and after this, the second spine of the dorsal fin and the first pelvic fin spine decrease in relative length. No scales form prior to settlement. Specializations to pelagic life include the head spination, early-forming, relatively long dorsal- and pelvic-fin spines, and serrate fin spines.

*Pigment*- Pigment varies according to the developmental stage, but in general, larvae have pigment on the dorsal surface of the gut and along the ventral midline of the tail. The number of melanophores in the latter series decreases with development until flexion. Larger larvae develop pigment above the brain, on the upper and lower jaws, along the caudal-fin base on the dorsal midline of the tail, and on the membranes of the spinous dorsal and pelvic fins. Prior to settlement, further body pigment develops, and late pelagic stages are very silvery.

**Order Perciformes**
**Family Acanthuridae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Preflexion larvae are of moderate depth until about 2.3 mm, after which they ate deep in both head and trunk; they become even deeper following flexion. Throughout, they are strongly compressed laterally, and the tail is much less deep than the trunk. They have 21-23 myomeres (5-10 + 11-16). The gut is coiled in our smallest specimen and extends to 44-61% BL in preflexion larvae. At about the time of flexion, the body becomes kite-shaped (i.e., very deep) with the gut mass growing downward, thus on average decreasing the relative preanal length. The body may become nearly as deep as long, and the dorsal and anal spines accentuate this effect. A small, often inconspicuous, gas bladder is located above the anterior portion of the gut. The moderate to large head is laterally compressed with a vaulted brain case, and may have either a concave or convex profile depending on species. The snout is long, resulting in a triangular head. The mouth is small (never reaching the eye) and terminal with small conical teeth that form in both jaws at about 4 mm. The round eye is moderate to large until after about 15 mm, when it is consistently large. The gill membranes are broadly attached to the isthmus. Head spination is extensive. Our smallest larvae (1.8 mm) have a serrate supraoccipital crest over the brain. At this size, small spines may also be present on the preopercle, lower jaw (dentary and angular), and along the throat (on the midventral keel and pelvic girdle). Following flexion, supracleithral spines, posttemporal spines, opercular serrations, and serrations above the eye (frontal), along the snout (nasal), and just posterior to the maxilla (lachrymal and lateral ethmoid) may also be present. However, none of the spines are produced. The first fin elements to form are the elongate second spine of the dorsal fin and the pelvic spine; these are first visible at about 2.3 mm. This is somewhat species-dependent (for instance, in Naso, the pelvic spine forms first). Both spines are serrate by 2.8 mm when further dorsal-fin spines begin to form. An anal spine (which becomes the elongate second spine) begins to ossify at 3 mm and is serrate shortly thereafter. Immediately following flexion the soft rays of the dorsal and anal fins begin to form, and a second anal spine (posterior to the first) ossifies. The anal-fin rays may form prior to the dorsal-fin rays. The rays of the pectoral fins begin to form after flexion (4.6 mm). By 5-6 mm, full complements are attained in the pectoral, anal, and dorsal fins. By 8 mm, all pelvic-fin elements are present. The elongate pelvic spines and second spines of the dorsal and anal fins reach maximum relative length between 12 and 17 mm; the first spines of the dorsal and anal fins remain markedly short. In all genera but Paracanthurus and Zebrasoma, scales initially form at about 5 mm as small, specialized, broad-based (fan-shaped or triangular) lamina that project upright from a basal plate. These are arrayed in vertical rows at about 8 mm. The acronurus stage begins with the formation of the caudal peduncle spine (approx. 17 mm). The lateral line is complete by 24 mm. Before settlement, larvae have become extremely laterally compressed, disc-shaped to oblong, and they retain head serrations that are relatively reduced in size. Specializations to pelagic life include the elongate dorsal and pelvic spines, relatively strong head spination, early-forming larval scales, and bizarre morphology of the acronurus stage.

*Pigment*-Acanthurid larvae are generally lightly pigmented but may have localised areas (for instance, the gut) of heavy pigment. Preflexion larvae are moderately pigmented on the brain and gut; melanophores may also occur along the throat, on the lower jaw, and on the dorsal surface of the gas bladder. Some species have a strong band of pigment around the tail posteriorly that becomes located on the caudal peduncle following flexion. Following flexion, further pigment may appear on the head, along the lateral surface of the tail, on the bases of the dorsal and anal fins, and on the membranes of the caudal fin rays and the first two dorsal-fin spines. The acronurus stage has a silvery gut and may have the beginnings of the juvenile pigment pattern (for instance, bars in *A. triostegtus*).

**Order Perciformes**
**Family Istiopholidae (Base on *Istiophorus americanus*)**
(From: Fahay, 1983. Guide to the early stages of marine fishes occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf.)

- 24 myomeres
- Body robust, with elongate snout.
- Teeth well developed.
- Gape extends to well behind the eye with development.
- Flexion occurs at about 5-6 mm.
- Spination includes serrated supraorbital ridge, pair of pterotic spines with 3 edges; preopercle spine with 2 edges; secondary preopercle spine which reduces with growth; serrated ridge on lower jaw.
- Pelvic buds form at about 5 mm and rays complete at about 8 mm.
- Dorsal fin (42 rays) formed at 8.1 mm and beco,es very high at 18.2 mm.
- Anal fin (10 rays) formed at 8.1 mm.
- Pigmentation: large spots on head, spreading to dorsal snout and body with growth; lower jaw unpigmented.

**Order Perciformes**
**Family Sphyraenidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Larvae are elongate, are moderately compressed initially, but become approximately round in cross-section, and have 24 myomeres (13-17 + 7-11). The gut is straight and long, extending to 60-80% BL. Weak striations are present along the gut. A prominent gas bladder is located above the anterior portion of the gut in preflexion larvae, but it moves posteriorly with increasing larval size. Preflexion larvae smaller than 3 mm have a moderate-size head with a short, round to pointed snout. In larvae larger than 3 mm, the head rapidly elongates becoming large to very large and the snout becomes more pointed and dorsoventrally flattened. The horizontal mouth is large but barely reaches the anterior edge of the eye. Small teeth are present in both jaws by 3.5 mm. The round eye is large relative to BL, but small to moderate relative to the large head. Head spination is extremely limited. One or two small, inconspicuous spines appear near the angle of the preopercle during flexion. These disappear at about 8 mm in most species, but may persist to much larger sizes in some species. Anlagen of the short-based anal and second dorsal fins begin to form at about the time flexion begins, and the soft rays begin to form simultaneously at about 6 mm. The second dorsal-fin origin is just anterior to the anal-fin origin, and the two dorsal fins are well separated. The spines of both dorsal fins and the anal fin begin to form at about 8 mm and incipient rays of the pectoral-fins are present at this time. The pelvic-fin rays are not formed in 8 mm larvae. The pelvic fin is located posterior to the pectoral-fin base near the level of the spiny dorsal fin. By 16 mm, full fin complements are present in all fins. At 16 mm, the young barracuda resembles a miniature adult except for the lack of scales which begin to form at about 23 mm. There is a gradual transition from the pelagic larval stage to the semi-pelagic juvenile stage. The only apparent specializations to pelagic larval life are the small preopercular spines.

*Pigment* - Barracuda larvae are moderately to heavily pigmented. Characteristic pigment includes: melanophores ventrally on the tail that continue over the gut; pigment below the brain and onto the snout giving the impression of a line through the eye; and relatively heavy dorsal pigment on trunk and tail that varies with species from large, stellate, biserial melanophores to small, uniformly scattered

melanophores that can extend laterally to the midline. Pigment may be present on the head, ventrum of the gut, and laterally on the tail, but this varies with size and species.

**Order Perciformes**
**Family Gempylidae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 31-67 myomeres
- Body elongate to moderate (BD 17-33%), compressed
- Head moderate to large (HL 22-46%); moderate mouth with canine-like teeth in both jaws
- Moderate head spination, with small to large preopercular spines
- Gut moderate to long in preflexion larvae, becoming long to very long in postflexion larvae due to posterior migration of anus (PAL 34-79%), coiled and compact .
- Large gap between anus and origin of anal fin, closed by postflexion stage due to posterior migration of anus
- Dorsal-fin spines elongate and serrate (except in *Thyrsitops*), formed prior to dorsal soft rays and anal-fin elements
- Early forming pelvic fins; pelvic-fin spine elongate and strongly serrate (except in *Thyrsitops*)
- Pigment over snout, and fore- and midbrain
- Pigment along dorsal-fin base
- None to light pigment along tail in early stages
- Pigment dorsally along gut and gas bladder

**Order Perciformes**
**Family Trichiuridae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 84-198 myomeres
- Body very elongate to elongate (BD 5-17%), compressed
- Moderate head spination, including small to moderate preopercular spines, and a low, smooth to finely serrate supraocular ridge; other spines species-specific (e.g. opercular, low and smooth supraoccipital ridge, serrate frontal ridges)
- Head small to large (HL 10-35%), with long, pointed snout; teeth usually along premaxilla and dentary from preflexion stage
- Gut initially short but becoming long with posterior migration of anus (PAL 24-67%), coiled and compact
- Large gap between anus and origin of anal fin, reduced to a small gap by postflexion stage due to posterior migration of anus

**Order Perciformes**
**Family Scombridae**
(From: Niera, Miskiewicz and Trnski, 1998. Larvae of Temperate Australian Fishes: Laboratory Guide for Larval Fish Identification.)

- 30-66 myomeres, typically 31-46
- Body elongate to moderate (BD 16-38%), laterally compressed
- Head moderate to large (HL 22-69%), with a short, rounded to extremely elongate and pointed

snout depending on taxon
- Mouth moderate,jaws usually equal in length (upper jaw projects beyond lower jaw in postflexion larvae of some taxa); conspicuous teeth along premaxilla and dentary from early preflexion stage
- Moderately to well developed head spination in most taxa, completely absent in some (e.g. Rastrelliger, Scomber); when present, head spination includes preopercular, opercular, supraocular, pterotic and supraoccipital spines
- Gut moderate in preflexion larvae, becoming very long in postflexion larvae due to posterior migration of anus (PAL 38-81%), coiled and compact
- Moderate to large gap between anus and origin of anal fin, closed by postflexion stage due to posterior migration of anus
- Pigment usually over midbrain and along dorsal and ventral midlines of tail
- Heavily pigmented gut and pigment dorsally over gas bladder
- Melanophore series ventrally along tail, pattern species-specific

**Order Pleuronectiformes**
**Family Psettodidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Preflexion larvae are moderate to deep bodied and postflexion larvae are deep bodied. They are slightly compressed with the trunk and tail becoming strongly compressed after about 7.0 mm. There are 24 myomeres (9-12 + 13-16). The gut is tightly coiled and moderately thick. The terminal section drops steeply downwards toward the anus which is located around midbody (40-66% BL). A small to moderate gas bladder is found above the coiled portion of the gut dorsal to the pectoral-fin base. It is large and conspicuous in larvae captured at night. The large head initially has a steep dorsal profile which becomes broadly convex in postflexion larvae. The mouth is extremely large and oblique, and the lower jaw protrudes slightly beyond the snout. The maxilla extends to the anterior margin of the eye in preflexion larvae. The maxilla increases rapidly in length following flexion and reaches well past the eye in larger specimens. Long, recurved, canine teeth form in both jaws by 3.7 mm. Small preopercular spines begin to develop in early postflexion larvae from 3.7 mm onwards, and increase in number to 4-9 and 2-3 spines on the inner and outer borders, respectively, by late flexion. These are subsequently lost in postflexion larvae between 10.3 and 15.3 mm. The small to moderate eye is round. The eye starts to migrate at approximately 8.0 mm and reaches the dorsal midline by 10.3 mm. It is still there in a slight depression in the largest specimen examined (15.3 mm). The anterior dorsal-fin rays are extremely long and spinelike. They are the first to form at about 3.0 mm and all of the 9-10 elongate rays are present by 4.0 mm. The rays of the long-based dorsal and anal fins are all present at or prior to 5.8 mm. The elongate anterior dorsal elements become the same length as the remaining dorsal rays between 10.3 mm and 15.3 mm. Pelvic-fin buds are present at 4.2 mm, with all elements formed by 7.8 mm. Incipient pectoral rays are present after flexion is complete and all rays are formed by 10.3 mm. Transition to the asymmetrical condition involves little more than movement of one eye over the dorsal midline. Scales are not found in any of the larvae examined. The elongate, anterior dorsal-fin rays and preopercular spines are apparent specializations to pelagic life.

*Pigment* - Preflexion larvae have four large, well-spaced melanophores on the dorsal midline from the nape to the posterior of the tail. The most posterior of these melanophores opposes another usually less prominent melanophore on the ventral midline; both persist until the beginning of metamorphosis. The remaining pigment is mostly limited to the dorsal and ventral midlines with small melanophores along the trunk, tail, gut and lower jaw. A few melanophores are also found on the brain and pectoral fin. Pigment

spreads laterally from the head and midline areas during flexion. The medial and pelvic fins develop a scattering of melanophores between 6.4 and 8.0 mm. Prominent pigment forms and persists in three areas in postflexion larvae: a band between the opposing melanophores on the tail at 5.7-7.7 mm; an intense band on the posterior portion of the gut by 7.7 mm; and, a dense mass on the snout after 8.0 mm. The ocular side becomes heavily pigmented by 8.0 mm. The future blind side is similarly pigmented, but with many fewer melanophores. The caudal peduncle and fin remain unpigmented.

**Order Pleuronectiformes**
**Family Bothidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Larval bothids are extremely laterally compressed and vary in body shape both ontogenetically and among species. The body is initially moderately deep and bilaterally symmetrical, but changes shape with development. Larvae may become fairly slender (for instance, Amog1ossus, Chascanopsetta, Laeops), ovate (for instance, Asterorhombus, Engyprosopon) or deep and round (for instance, Bothus, Grammatobothus, 'Taeniopsetta). The trunk and tail usually become considerably deeper than the head. There are 32 to 60 myomeres (10-18 + 22-43). The prominent liver, which often partially surrounds the gut and otherwise fills the abdomen, is bordered ventrally by the elongate posterior process of the pelvic bone. The gut tube is of small diameter, and shortly after hatching develops a single coil which elongates vertically with development. The anus moves gradually anteriorly with development and is located at about 50% BL in preflexion larvae, 33-50% BL in flexion larvae, 25-50%BL in early postflexion larvae, and 20-33% BL in later postflexion larvae. In most species, the gut protrudes only slightly beyond the ventral profile and rarely trails posteriorly. However, in Laeops and Chascanopsetta, protrusion of the gut and liver are considerable, and the gut may trail posteriorly. The gut becomes deeper to various degrees depending on species. The small to moderate gas bladder is usually inflated at night. Initially, it is located dorsal to the anterior portion of the gut coil, or slightly anterior to it. As the gut moves anteriorly, the coil moves relative to the gas bladder, and is located directly below the gas bladder by the end of flexion. The gas bladder may not be noticeable in larger postflexion larvae and apparently disappears before the right eye begins to migrate. The head is moderate to small and initially squarish, but becomes more rounded and relatively smaller with development. It is bordered ventrally by an expanded urohyal bone. The dorsal profile of the head is steep and straight, but can be concave in some species. A rostrum above the snout (an anterior projection of the dorsal-fin base) develops in Amoglossus, Chascanopsetta, Laeops and Parabothus. The snout is short and steep to concave. The small, oblique mouth seldom reaches the anterior margin of the eye. Minute teeth are apparent by 3 mm in some species. The eyes are round to elliptical, generally small and have a ventral lunate choroid tissue mass. The eyes become relatively smaller with development and choroid tissue disappears during right-eye migration. Timing and rate of right-eye migration varies with species and sometimes among individuals of the same species. Migration may begin at less than 13 mm in some species, but not until 80-120 mm in others. The eye migrates over the dorsal midline of the head and under the dorsal-fin base. If the anterior-most portion of the dorsal-fin base is attached to the snout, the eye moves through a hole between the fin base and the cranium; if not, it moves through a narrow slit in the dorsal profile. The migration of the right eye may be complete from as early as 13 mm to as late as 125 mm. Nasal organs are developed on both sides of the head. Gill membranes are free from the isthmus. Depending on taxon, minute to small spines can be found along the edges of the urohyal, posterior pelvic process and cleithrum. Thoracic spination varies from absent (Amoglossus, Bothus, Chascanopsetta, Laeops, most Psettina, Tosarhombus) to present in all areas listed above (for instance, some Engyprosopon). If present, spines first develop along the urohyal between 2.8-4.5 mm. The spines may degenerate or be overgrown in larger specimens. In addition, small epiotic spines

develop in taeniopsettines and some Asterorhombus spp. All head and thoracic spines are lost before settlement. Bothids develop a characteristic elongate dorsal-fin ray (usually the second ray; but 3-4 elongate rays in Grammatobothus, and 9-10 in Parabothus) over the head from early in the preflexion stage to the flexion stage. These rays are weak and slender in most genera, but more robust in Arnoglossus, Chascanopsetta and Laeops. They vary in length among genera and gradually shortens relative to adjacent fin rays in most taxa. In Grammatobothus, the elongate dorsal-fin rays are retained by adults. Fleshy, pigmented membranes grow over these elongate rays in some taxa (for instance, Arnglossus). The other dorsal- and anal-fin rays develop simultaneously. The anlagen appear in preflexion larvae, incipient rays are present by the end of flexion, and full complements are formed by the early postflexion stage. The dorsal fin occupies the entire dorsal margin from head to near the caudal fin. Likewise, the anal fin occupies the ventral margin of the tail from near the caudal fin to the anus, where the base is turned down anteriorly to meet the anus. Neither fin is confluent with the caudal fin. The dorsal-fin origin moves anteriorly onto the snout: the extent and timing of this movement varies widely among species, but it usually takes place during the postflexion stage. The dorsal- and anal-fin pterygiophores are long: the body depth between the distal margins of the pterygiophores is 1.2 to 2 times the depth of the body musculature. The pterygiophores are well-defined and lack a proximal translucent region (see Poecillopsertidae and Samaridae). The pelvic fins are supported by a triangular cartilaginous anterior pelvic process located between the urohyal and posterior pelvic process. Pelvic-fin buds appear between 3 and 10 mm depending on species, and all rays are present from the late flexion to the middle postflexion stage (5-2.4 mm). After pelvic-fin rays develop, the left fin moves so that the first ray of the right fin is opposite the second to fourth ray of the left fin. Rays do not form in the pectoral fins prior to settlement. Scales are absent prior to settlement in most taxa, but small scales, often with spinules, may be present in late larvae of some Arnglossus, Grammatobothus, and Psettina species. Specializations to pelagic life include extremely laterally compressed body, head and thoracic spination, the elongate posterior pelvic process, elongate dorsal-fin rays, and delayed formation of the pectoral-fin rays.

*Pigment* - Pigmentation varies among species in bothid larvae, but is generally sparse to absent. Preflexion and flexion larvae may have sparse, fine melanophores along the ventral margins of the head and trunk, and dorsally on the gas bladder and gut. In some species, pigment can also occur along both the dorsal and ventral margins of the body, on the head and fins, and as spots or blotches laterally on the body. Pigmentation is generally present only on the left side, although some larvae are pigmented similarly on both sides (for instance, Grammatobothus). Pigmentation can also occur on dorsal, anal and pelvic fins, and on the fleshy membranes of the elongate dorsal-fin rays. During right eye migration, the juvenile pigmentation pattern may begin to form.

**Order Pleuronectiformes**
**Family Soleidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-Larval soleids have a moderate to deep body, are extremely laterally compressed and have a deep, massive gut. They are initially bilaterally symmetrical. There are 33-47 myomeres (4-20 + 20-38)*. The number of preanal myomeres decreases with growth because the anus moves anteriorly. The thick gut tube is coiled, and although it protrudes below the ventral profile, it is not pendulous. The anus may be slightly trailing. In preflexion larvae PAL is generally greater than 50% BL, but because the anus moves anteriorly, in postflexion larvae it is less than 50% BL. From the flexion stage, the gut coils more tightly and retracts into the abdominal cavity, thus the anus is not the posterior-most portion of the gut. A small gas bladder is present in some species and is located over the middle to

posterior portion of the gut. The compressed head is moderate in size and variable in shape, but does tend to be rounded with a convex dorsal profile (except during eye migration in some species). The snout is short and generally rounded. However, in some species, it increases in length during eye migration. The mouth varies among species from oblique to horizontal. It reaches to midpupil in some species but is short of the eye in others. In many taxa the mouth decreases in relative size as larvae undergo transformation. Small villiform teeth become visible on the blind side in transforming larvae of some species. The round eye is large until about 3 mm, is moderate in size until about the beginning of flexion, and is small thereafter. Eye migration may commence as early as the flexion stage: riming and rate of migration vary among species. The route of eye migration also varies among species: in some, the eye passes over the dorsal midline of the head anterior to the fin, while in others, the eye passes through the head ventral to the dorsal-fin base. Nasal organs develop on both sides of the head, and are retained in adults; however, the left organ is usually smaller. Gill membranes become broadly attached to the isthmus in postflexion larvae. There are no head spines, however dermal papillae may develop on the branchiostegal membrane in transforming larvae of some species. Dorsal and anal fins develop simultaneously: anlagen appear in preflexion larvae, incipient rays develop during flexion, and full fin complements are present in late flexion to early postflexion larvae. There are no elongate dorsal rays. The dorsal-, caudal-, and anal-fin membranes remain fused until fin rays are ossified, after which the fins separate in some genera, but remain confluent in others. Dorsal and anal pterygiophores may become elongate and, in species with elongate ones, a narrow translucent region may develop proximally, adjacent to the body musculature. The depth between dorsal and anal pterygiophore margins is usually up to 1.7 rimes the depth of the body musculature (however, in a few taxa, the ratio may reach 3.0). The anterior pterygiophores of the anal fin dip downward to meet the anus until the gut retracts into the abdominal cavity. In postflexion larvae, a triangular transparent region is located immediately posterior to the gut between the pterygiophores and the body musculature. Pectoral rays do not form prior to settlement. The pectoral fin may atrophy prior to settlement; some species do not retain it as adults. Paired pelvic-fin buds form just anterior to the gut mass in late flexion to early postflexion larvae, and full fin complements are present by 5.0-12.5 mm. The pelvic bone is never long, curved and flexible. A thin, loosely attached dermal membrane enclosing the body is a characteristic feature of larvae of some species. Scales are present only in our *Aseraggodes* specimens; these first appear posteriorly on the tail before eye migration is complete, and fully cover the body before settlement. Many soleids transform and settle at very small sizes 10 mm), but at least Asera88 des can reach a relarively large size before settlement (approx. 25 mm). Adults lack the following features found in larvae: bilateral symmetry, a slightly protruding, massive gut and, in some species, pectoral fins or extremely long pterygiophores.

*Pigment*- Intensity of pigmentation in soleids varies among species. At one extreme, pigment in Hawaiian *Aseraggodes* spp. initially consists of a very few scattered melanophores on the tail and gut. By settlement, a few small, faint patches of melanophores along fin bases and the body midline are present. At the other extreme, in some unidentified species and *Aseraggodes kobensis* (Steindachner) (Minami, 1988f), the entire body is heavily covered with melanophores throughout development.

**Order Pleuronectiformes**
**Family Cynoglossidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - Cynoglossid larvae are initially elongate (cynoglossines) to moderate (symphurines) in depth, compressed and bilaterally symmetrical. They become extremely compressed and deeper after notochord flexion is complete. The head and trunk are initially much deeper than the tapering tail. The

tail gradually becomes deeper, but it remains less deep than the rest of the body. There are 43-59 myomeres (7-10 + 36-50)*. The gut is thick and coiled into a single, large loop and protrudes markedly from the ventral body margin. The degree of protrusion varies both ontogenetically and among species, but the protruded gut may double the body depth. A pigmented flap occurs in some species at the extremity of the protruded gut: the combined length of these two projections may exceed 60% BL (Yevseyenko, 1991). The anus is usually somewhat trailing and in flexion and postflexion larvae projects to the right of and posterior to the origin of the anal fin. The gut (PAL measured to the anal fin origin once anal fin forms) reaches to 30-40% BL. However, the gut retracts within the body margin in transforming larvae and then reaches only to 23-30% BL. The gas bladder is located over the posterior portion of the gut. It is inflated at night but is otherwise small and apparently disappears during transformation. The small to only just moderate head is inirially deep and round and has a short, rounded snout. The rostral hook of adult cynoSlossus and Paraplasusia originates on the head as an enlargement under the bases of the elongate dorsal rays. As the incipient rostral hook grows, it slides forward and down across the cranium and onto the snout. This forward movement begins slowly at about the time of notochord flexion, and accelerates as eye migration approaches. As the incipient rostral hook moves over the snout, a gap for migration of the right eye remains along the original profile of the snout (see below). Near the end of transformation the rostral hook fuses with and extends the now-enclosed snout well beyond the mouth. In Symphurus, the process is apparently similar, but the hook does not proceed as far, and the adult mouth varies from terminal to slightly inferior. The moderate mouth reaches to the posterior margin of the pupil. villiform teeth become visible during transformation. The round eye is initially moderate to large, but is small to moderate in postflexion larvae. In larvae larger than 2.5 mm the eye has a prominent posterior projection that persists until metamorphosis. The stage and size at which eye migration begins varies widely among taxa from late flexion to late postflexion and from 11 to 30 mm*", but it takes place over a narrow range of sizes in any particular species. The right eye moves through a temporary opening formed during the downward movement of the rostral hook, thereby attaining the adult condition of both eyes on the left side. Gill membranes become broadly attached to the isthmus in preflexion larvae from about 4 mm. The branchiostegal rays are long and, together with the branchiostegal membrane, form a shield covering the base of the pelvic fin and anterior portion of the gut. This is retained in adults of some species. Head spines are absent, but in some species subopercular, and occasionally interopercular, radiations are present from about 11 mm. These are exposed distally and may resemble spines protruding over the branchiostegal rays. Flexion generally occurs at a relatively large size"" and the caudal fin is the last medial fin to form. Zero to six (number varies among species) elongate to very elongate (to> 50% BL) anterior rays are present in the dorsal fin. These elongate rays are the first to form and become relatively smaller as transformation approaches, then degenerate and disappear during transformation. The non-elongate dorsal-fin rays and the anal-fin rays develop concurrently. Anlagen first appear posteriorly at about 3.5-4 mm, and incipient rays are present prior to the commencement of notochord flexion. Ossification of all dorsal- and anal-fin rays is complete in flexion larvae. The dorsal and anal fins are confluent with the caudal fin once it forms and together form a continuous fin from snout to anus. Pterygiophores do not become particularly elongate. Large, paddle-shaped (i.e. very constricted at the base) pectoral fins are present but rays never develop. The pectoral fins degen erate during transformation, with a vestigial flap retained only in adults of Symphurus (Menon, 1977). A single, medial pelvic-fin bud develops from the pelvic bone of the blind side (Menon, 1977; Hensley & Ahlstrom, 1984) in preflexion larvae. In most taxa, incipient pelvic rays develop during flexion, and fully ossified rays are present by its completion. However, in some Symphu TUS species, a large, elongate pelvic fin with ossified rays is present prior to flexion. Scales first appear on the head at 14.5 to 18.5 mm. A full set of scales is present as transformation nears completion. No lateral lines are apparent in our larvae. Transformation occurs prior to settlement. Adults lack the following characteristics present in the larvae: bilateral symmetry, elongate anterior dorsal rays, pectoral fins, gas bladder and protruding gut.

*Pigment* - In cynoglossids, clusters and longitudinal series of melanophores are initially found along the dorsal and ventral body margins, and later along the bases of dorsal and anal fins and sometimes on the rays. Additional, more scattered pigment occurs at the base of the elongate dorsal rays and ventrally on the head and trunk: snout, jaws, branchiostegal membrane, cleithral symphysis, pelvic-fin base, anus and gut. Pigment may also appear on the dorsal surface of the gas bladder, elongate dorsal rays, pectoral fin and, in postflexion larvae, midlaterally on the tail. A few species become heavily and relatively uniformly pigmented during metamorphosis.

**Order Tetraodontiformes**
**Family Balistidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology* - At hatching, larvae are elongate and slightly compressed, but by 1.6 mm (2.5 days post hatch) they are of moderate depth. Thereafter, preflexion larvae are moderate to deep: postflexion larvae are deep. Larvae are initially rotund in the trunk but become laterally compressed during flexion, and have a slender, compressed tail. There are 18-19 myomeres (5-10 + 10-13). The gut is deep and coiled from the time of yolk absorption, and the pre-anal length is 47 to 58% BL prior to flexion and 63-73% BL thereafter. A small, inconspicuous, gas bladder is located above the anterior portion of the gut. The head is moderate to large prior to flexion and large following flexion. It is deep, initially with a short, round snout that elongates with development. The mouth is small (reaching the eye only in small larvae) and terminal. The incisiform teeth form just prior to flexion. The large eye is round, and becomes moderate in the juve-nile stage. The gill membranes are initially broadly attached to the isthmus, but by flexion, the gill opening is reduced to a small slit anterior to the dorsal portion of the pectoral-fin base. The only head spination is a tuft of spinules on the preopercle that forms by the time the eyes are fully pigmented (approx. 1.5 mm, 2.5 days after hatching). The tuft of spinules disappears just prior to or during the early flexion stage in conjunction with appearance of spinule-like scales on the head and body. Spines 1 and 2 of the dorsal fin are the first fin ele-ments to form, first projecting above the finfold at about 3 mm. They quickly elongate, and spine 1 is strongly barbed by the start of flexion. Incipient soft rays in the dorsal and anal fins are present at the start of flexion as is dorsal spine 3. Pectoral-fin rays begin to form during flexion. All fins but the soft dor-sal have full complements of elements at 4-5 mm, just before or after noto-chord flexion is complete. All soft dorsal rays are present by 6.5 mm. A pelvic bud forms before flexion (3 mm), and a barbed spine at the symphysis of the pelvic bones is present by 5.2 mm. The pelvic fin is otherwise absent, but a fil-ament (lacking rays) may be present at the symphysis of the pelvic bones. Shortly before the preopercular tuft of spinules disappears, small weak spin-ules appear scattered over the head or gut: they may first appear on the dorsal, dorsolateral or lateral portions of the head, or laterally or ventrally on the gut. The spinules rapidly spread to cover the body by the middle of flexion. These spinules (scales) do not transform into the specialized scales of the adult until the pelagic-juvenile stage. The larval stage ends at about 10 mm, after which there is an extended pelagic juvenile stage. At settlement, the body is more compressed, the snout more elongate, and the hooks on the first dorsal-fin spine are much reduced in size. The only apparent specializations to pelagic life are the tuft of spinules on the preopercle, the pelvic filament, and the large, recurved hooks on the dorsal-fin spine.

*Pigment*-Balistid larvae have a heavy pigment on top of the head and nape and over the gut and operculum. There is a series of melanophores on the ventral midline of the tail which often extends around the notochord tip to the dorsal midline. The membrane of the spiny dorsal fin acquires pigment

about the same time the spine acquires barbs, and the pelvic symphysis filament is often pigmented. Pigment spreads rapidly following flexion, and by the end of the larval stage, which is well before settlement, pigment is spread widely, and juvenile patterns may be emerging.

**Order Tetraodontiformes**
**Family Monacanthidae**
(From: Leis and Carson-Ewart, 2000. The larvae of Indo-Pacific coastal fishes: An identification guide to marine fish larvae.)

*Morphology*-There are two distinct morphs, or types, of monacanrhid larvae that differ in morphology and development. These are contrasted in Table 8; in addition, within the first morph, there is a wide range of body shapes. Larvae range from deep bodied to elongate and from strongly to moderately compressed. There is a tendency for larvae to become more compressed with growth. There are 17-31 (5-16 + 9-22) myomeres. In *Oxymonacanthus*, there is an apparent ontogenetic loss or fusion of myomeres: the 28-30 myomeres present between hatching (2.5 mm, Barlow, 1987) and 3.4 mm are reduced to 26 myomeres at 4.9-6.5 mm. published illustrations of newly-hatched reared larvae (Kawase & Nakazono, 1994b; Akagawa et al., 1995) suggest a similar process may occur in other genera (for instance, *Brachaluteres*, *Paramonacanthus*, *Rudarius*), but confirmation is required. The gut is strongly coiled even in the smallest post yolk-sac larvae. The preanal length ranges widely from 35 to 70% of BL. A small, inconspicuous, gas bladder is positioned above the anterior portion of the gut. Head size is species-dependent, but may be as great as 47% of BL. The head is round in early larvae, but may become deep and triangular as flexion approaches. The snout is short initially but becomes longer in many species. The mouth is always small and may not reach the eye; this is especially so in larger larvae. Small teeth form in both jaws as early as 3.3 mm. The eye is round and often large. The gill membranes initially are broadly united to the isthmus, but prior to flexion, the gill openings become reduced to a small slit just anterior to the pectoral-fin base. Larvae of morph 1 have a small, early-forming tuft of spinules on the preopercle that disappears prior to flexion. Larvae of morph 2 lack this cluster of spinules. Dorsal-fin spine 1 may be the first fin element to form as early as 2.1 mm or be among the last elements to form as late as the postflexion stage, depending on species. The spine forms on the nape: in most species, it migrates to a position anterior to the centre of the eye and in some species, it may even be located on the snout. This spine may be smooth or strongly armed with hooks and barbs, depending on species (spine 2, if present, is small and unarmed). The presence of a pelvic spine is also species dependent, but, if present, it may form as early as 3 mm from a small bud and may become barbed. A true pelvic fin does not form. Incipient rays in the posteriorly-located dorsal and anal soft fins are present prior to flexion, but the full complement of rays is not present until flexion is complete. The pectoralfin rays are last to form in morph 1 at 7-15 mm. In morph 2 larvae, the pectoral rays form during the postflexion stage at about 4 mm; at this size the posteriormost few rays of the D and A fins may still be forming. In morph 1, the tip of the notochord extends to the middle of the caudal rays for a time following flexion. Small spinules may form in the interorbit as early as 2.3 mm. In most species, small papillae form on the body at about the time of flexion, and ossify into tiny spinules that, together with the existing head spinules, become the scales characteristic of monacanthids. Several species temporarily develop small, pigmented flaps or filaments on the preopercle (*Aluterus*), laterally on the tail (*Pseudalutarius*) or at the terminus of the pelvic bones (several unidentified spp.). These usually disappear prior to flexion. The larval stage ends with the formation of the rays of the pectoral and medial fins, but many monacanthids remain pelagic to relatively large sizes as juveniles. The only apparent specializations to pelagic life are the small tuft of spinules on the preopercle, and the pigmented flaps in those species that have them.

*Pigment*- Monacanthid larvae are moderately to heavily pigmented, and pigment becomes heavier with increasing body size. Pigment on the gut is heavy, and large areas of the head are covered with small melanophores. Depending on species, there may be pigment blotches on the rail, a ventral melanophore series, or no rail pigment at all.