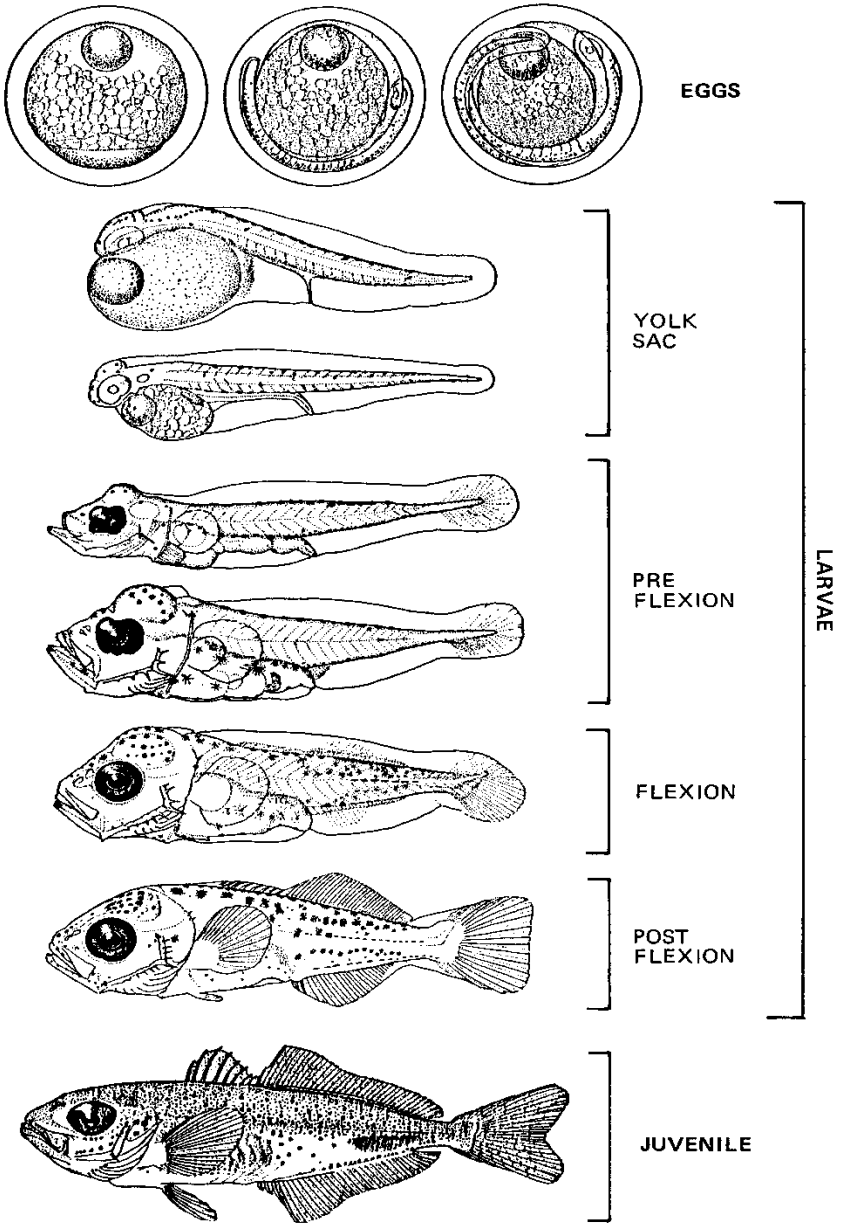
Morphological characters useful for larval fish identification

Yoshinobu KONISHI

Formerly, *Seikai* National Fisheries Research Institute
Nagasaki, JAPAN

Early life history stages of *Trachurus symmetricus*



from Kendall et al., 1984
(originally Ahlstrom and Ball, 1954)

Kendall, A. W. Jr., Ahlstrom, E. H. and Moser, H. G. 1984: Early life history stages of fishes and their characters. Pages 11-22 *in* Moser, H. G., Richards, W. J., Cohen, D. M., Fahay, M. P., Kendall, A. W. Jr. and Richardson, S. L. (eds.) Ontogeny and systematics of fishes. Am. Soc. Ichthyol. Herpetol. Spec. Publ. I.

Developmental stages of bony fish

from Jones et al., 1978

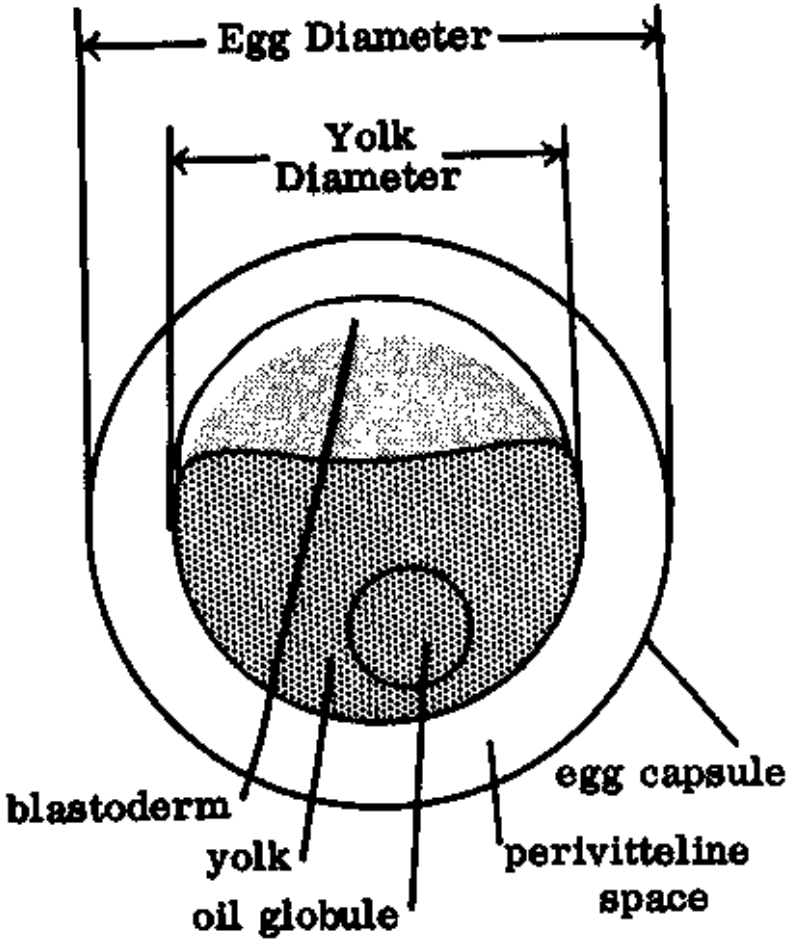
- **Egg**
- **Yolk-sac larva**
  stage between hatching and absorption of yolk
- **Larva**
  stage between absorption of yolk and acquisition of minimum adult fin ray complement
- **Juvenile**
  stage between acquisition of minimum adult fin ray complement and sexual maturity with assumption of adult body form (***prejuvenile***: with assumption of incomplete adult body form)
- **Adult**
  sexually mature

Jones, P. W., Martin, F. D. and Hardy, J. D. Jr. 1978: Development of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stages. Volume I Acipenseridae through Ictaluridae. U. S. Dep. Interior, Fish Wildl. Serv., Biol. Serv. Prog. FWS/OBS-78/12. 366 pp.

Eggs and yolk-sac larvae

General structure and measuring method of fish egg

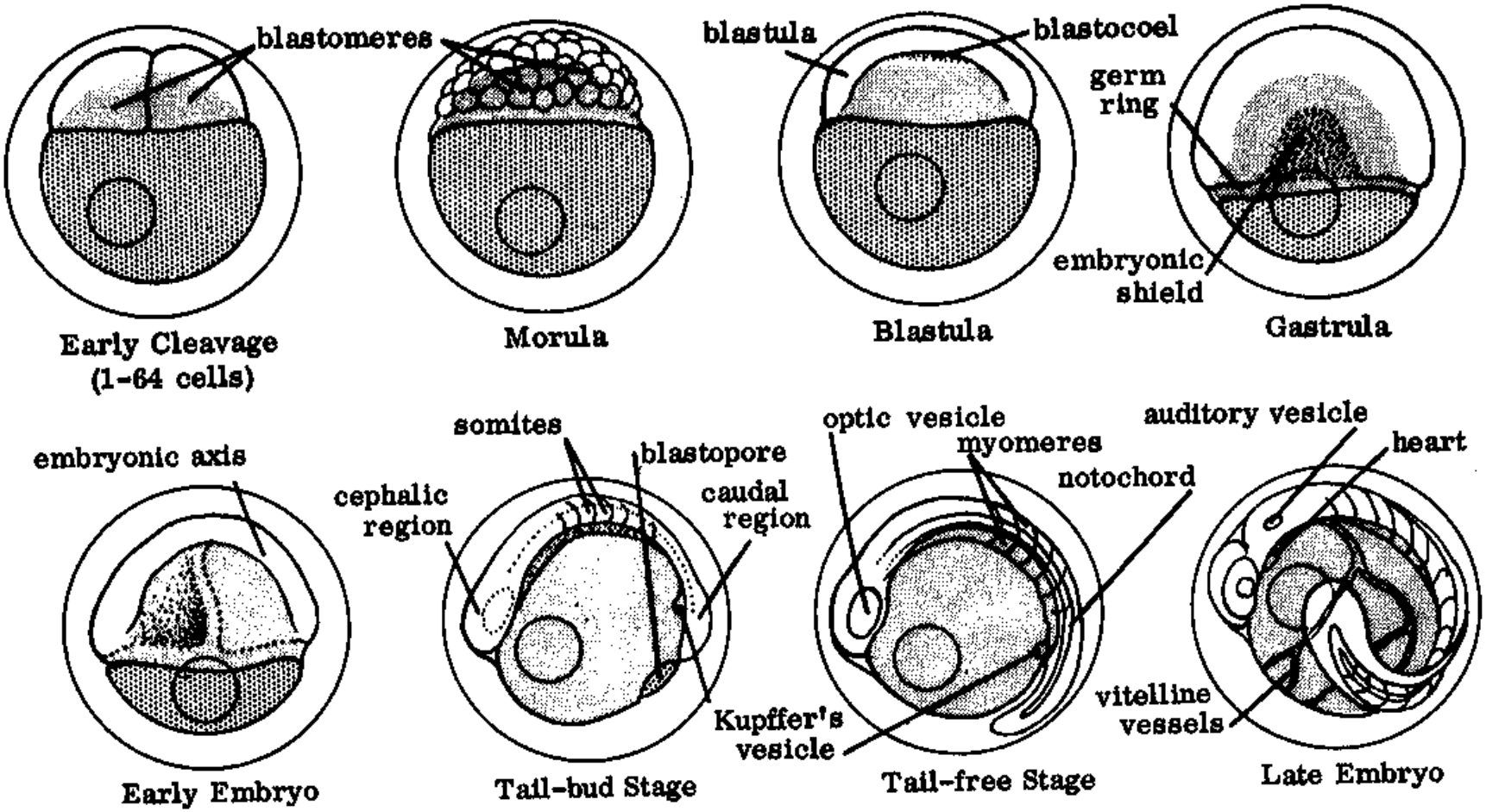
from Jones et al., 1978



Egg capsule
(Chorion, Egg membrane)
Oil globule
(Oil drop)

Jones, P. W., Martin, F. D. and Hardy, J. D. Jr. 1978: Development of fishes of the Mid-Atlantic Bight. An atlas of egg, larval and juvenile stages. Volume I Acipenseridae through Ictaluridae. U. S. Dep. Interior, Fish Wildl. Serv., Biol. Serv. Prog. FWS/OBS-78/12. 366 pp.

Developmental stages of fish eggs



Early stage: spawning – blastpore closure

Middle stage: blastpore closure – tailbud free

Late stage: tailbud free - hatching

from Jones et al., 1978

Various types of fish eggs

modified Mito (1979)

Pelagic eggs

✓ ***Isolated eggs*** **(mostly)**

The spawned eggs are isolated, not forming any mass

✓ **Agglutinated eggs (Lophiidae)**

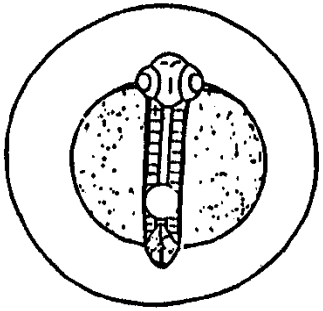
The spawned eggs are embedded in a gelatinous ribbon/balloon, or agglutinated to each other forming a mass

Demersal eggs

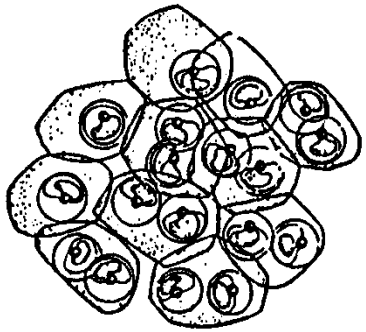
✓ **Adhesive eggs (Exocoetidae, Gobiidae)**

The spawned eggs adhesive to substratum with adhesive egg membrane or filaments

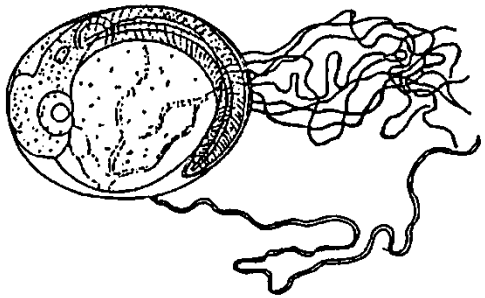
✓ **Non-adhesive eggs (Salmonidae)**



Sadinops melanostictus



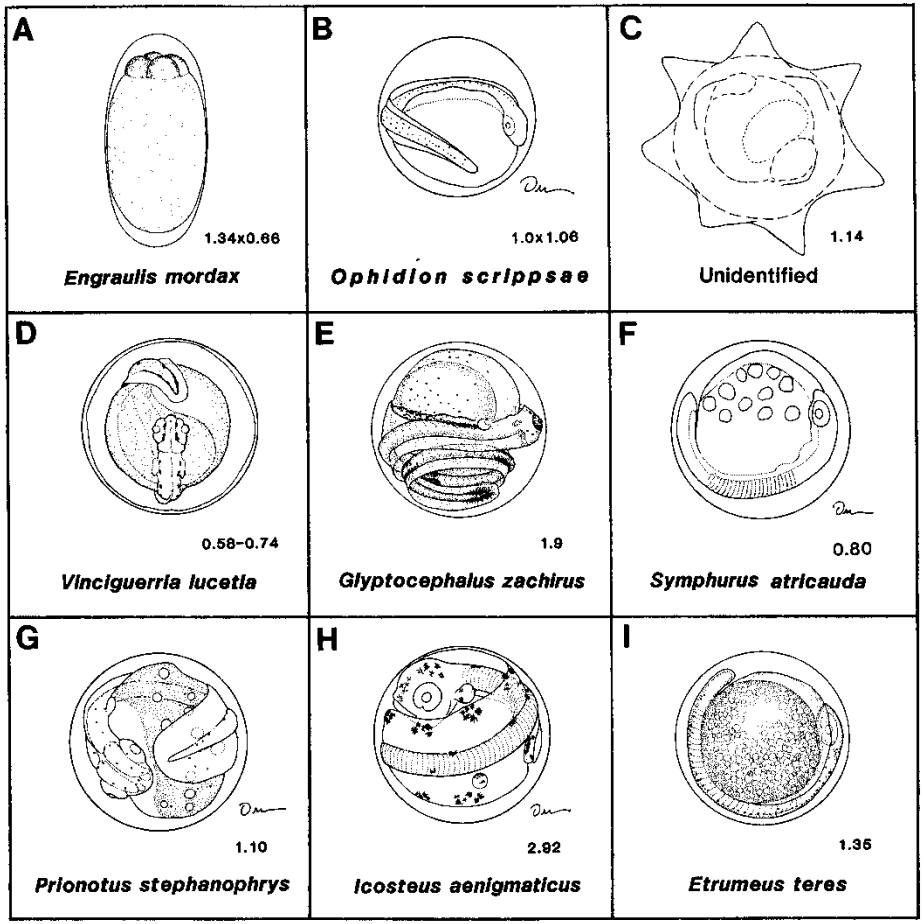
Lophiomus setigerus

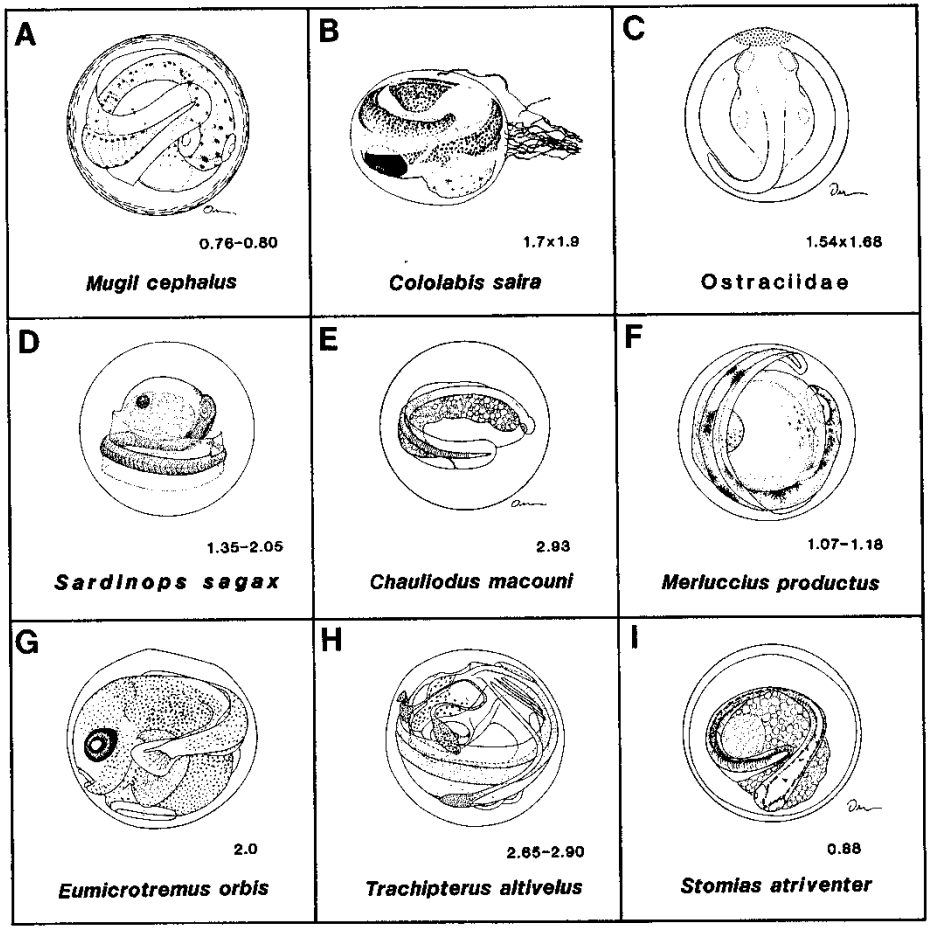


Cololabis saira

Various types of isolated pelagic fish eggs

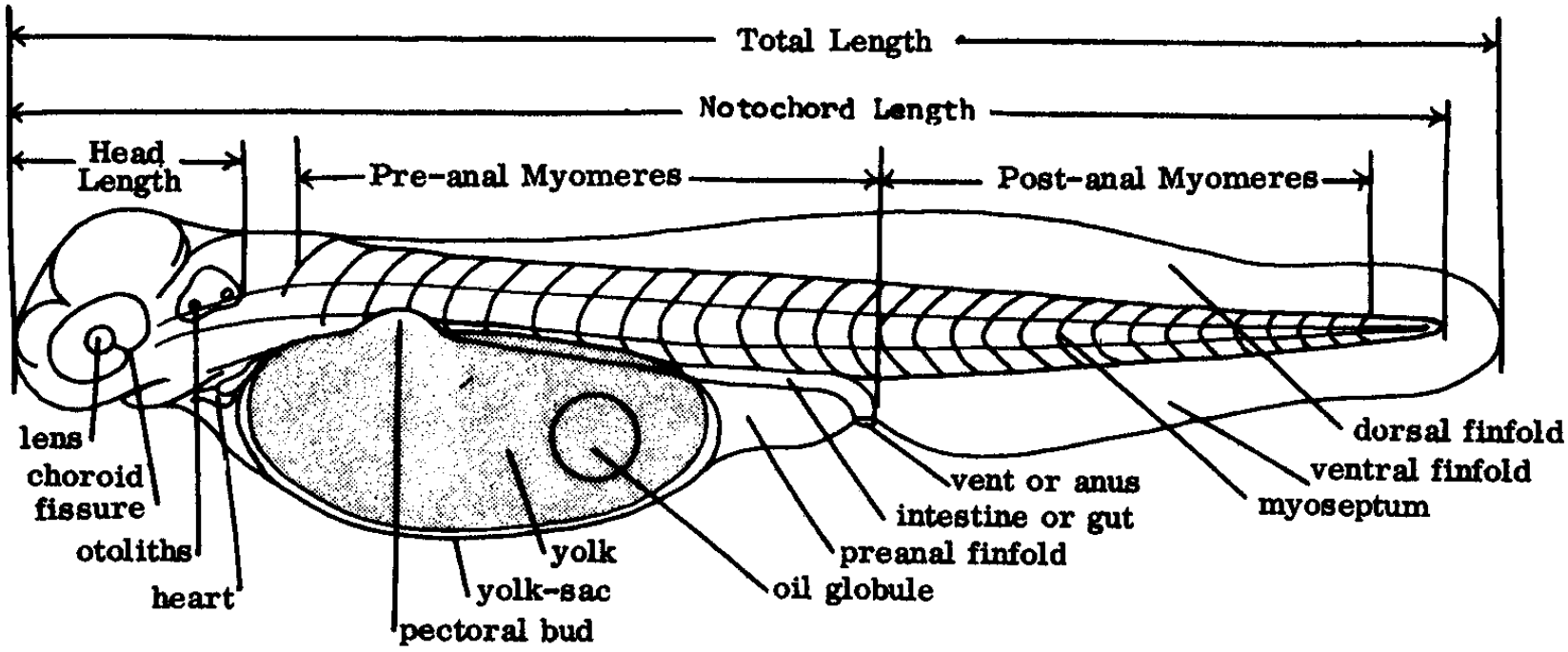
from Kendall et al., 1984





Kendall, A. W. Jr. 1984: Identification of fish eggs, p. 27-31. *in* Ontogeny and systematics of fishes. Moser, H. G., Richards, W. J., Cohen, D. M., Fahay, M. P., Kendall, A. W. Jr. and Richardson, S. L. (eds.) Amer. Soc. Ich. and Herp. Spec. Pub., No. 1.

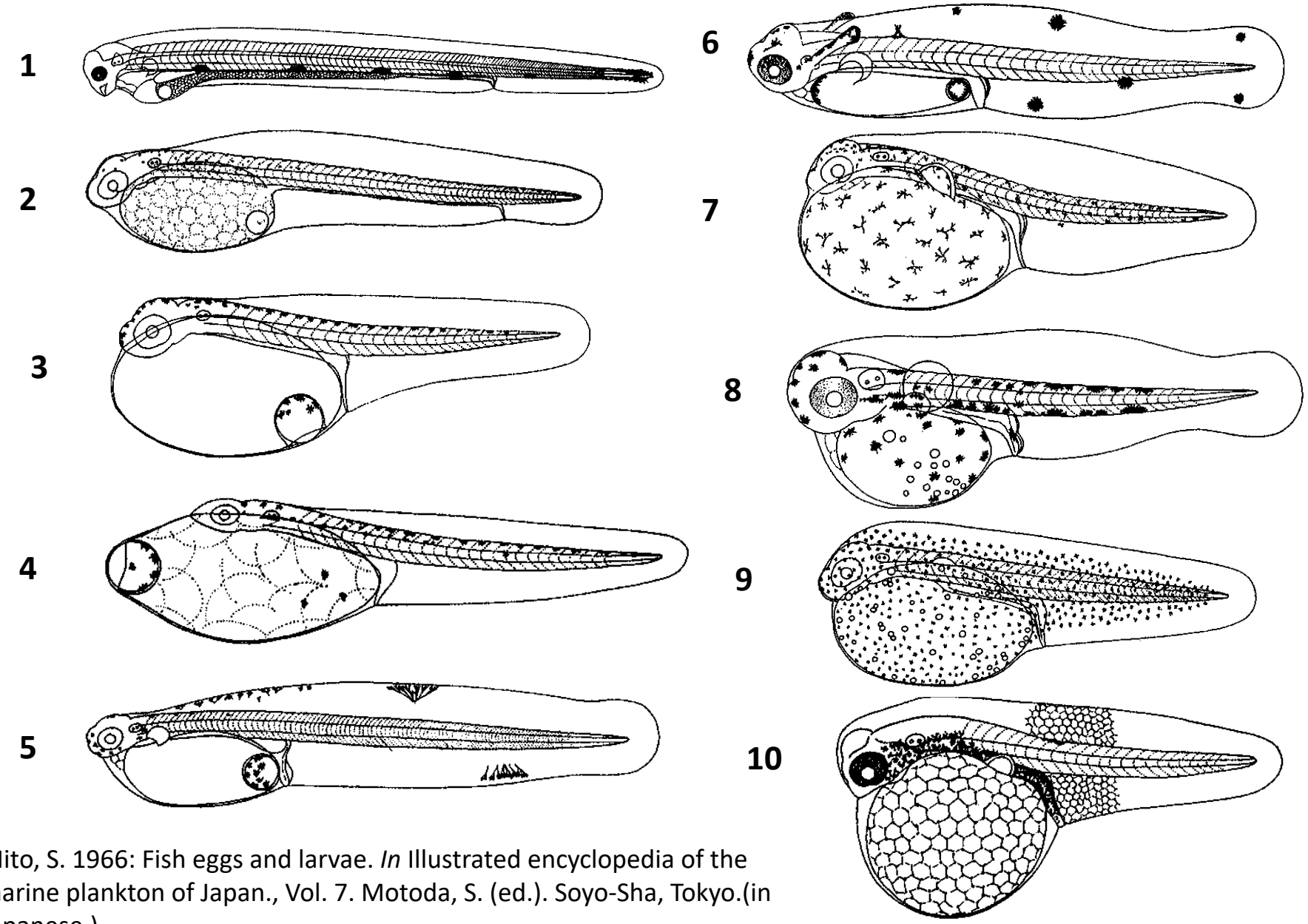
Structure and measuring method of yolk-sack (newly hatched) larva



from Jones et al., 1978

Various types of yolk-sack larvae

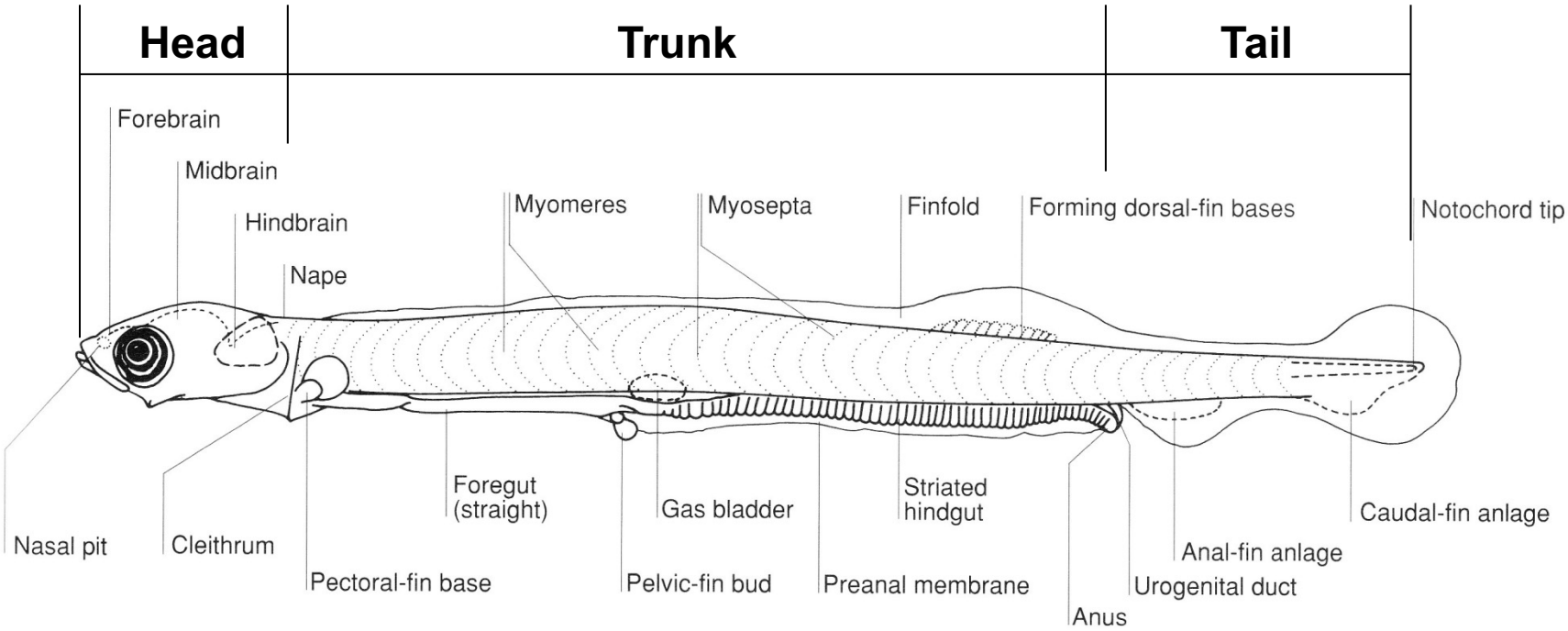
from Mito (1966)



Mito, S. 1966: Fish eggs and larvae. *In* Illustrated encyclopedia of the marine plankton of Japan., Vol. 7. Motoda, S. (ed.). Soyo-Sha, Tokyo.(in Japanese.)

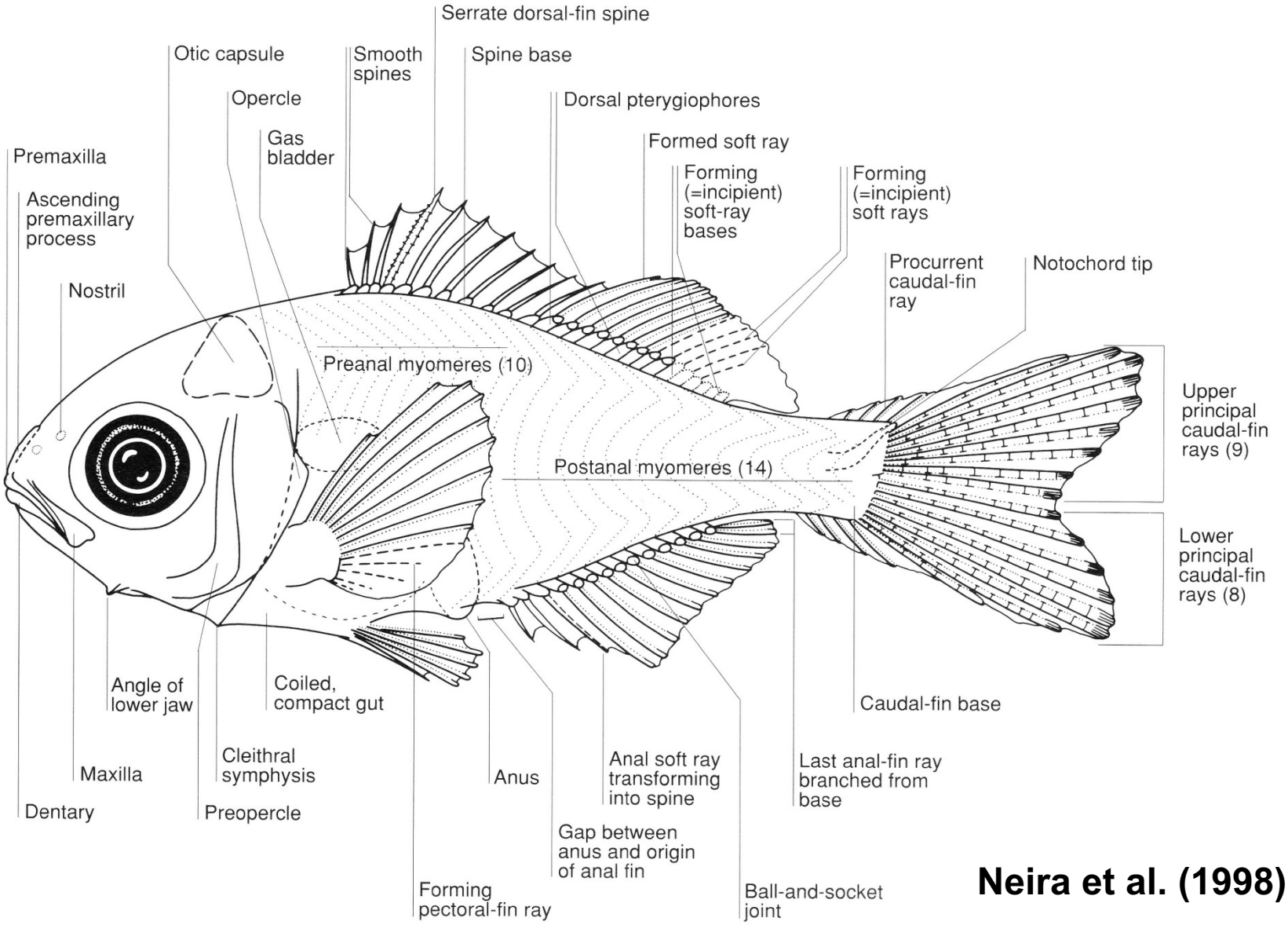
Larvae

External characters of Preflexion larva



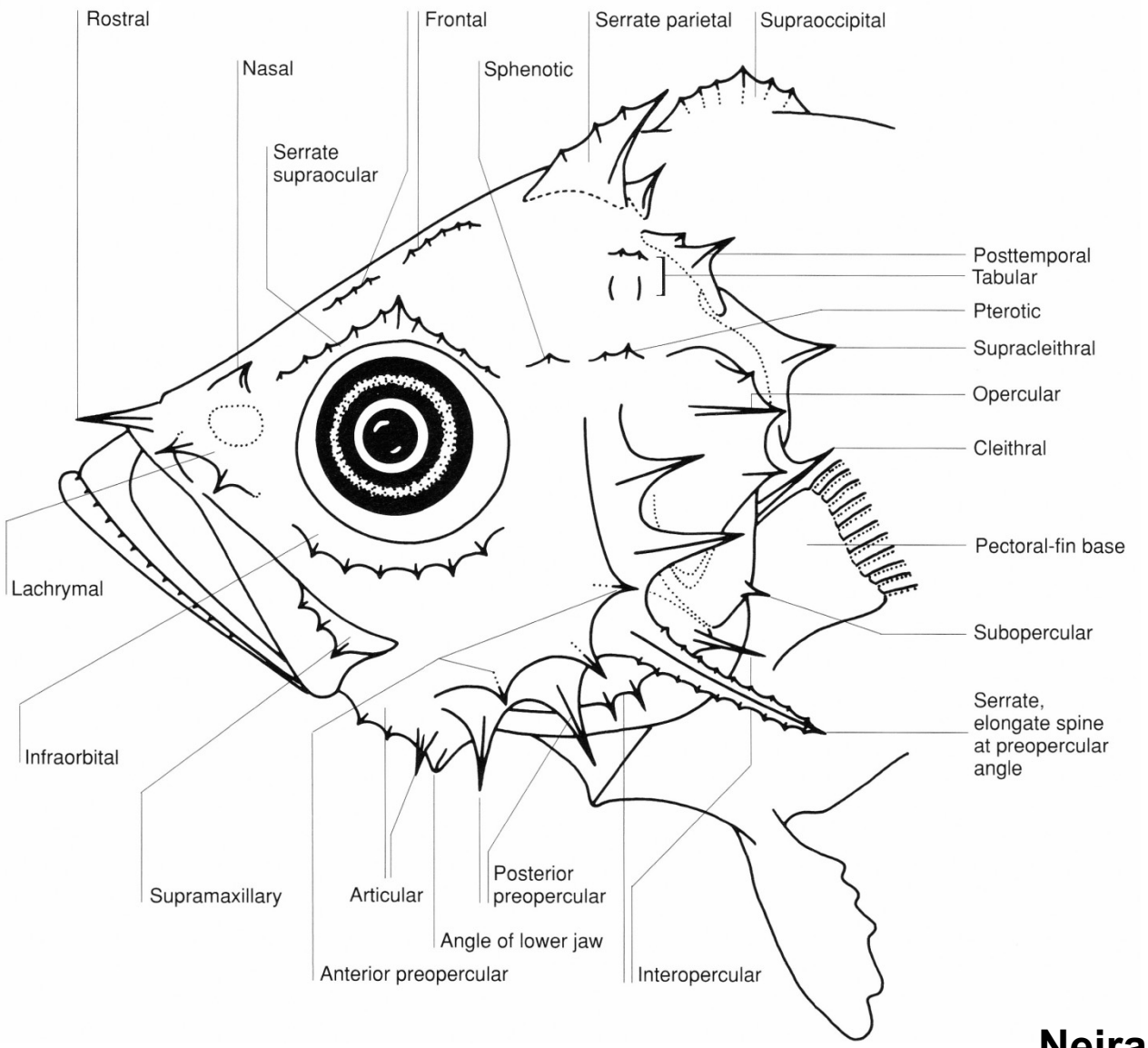
Neira et al. (1998)

External characters of Postflexion larva



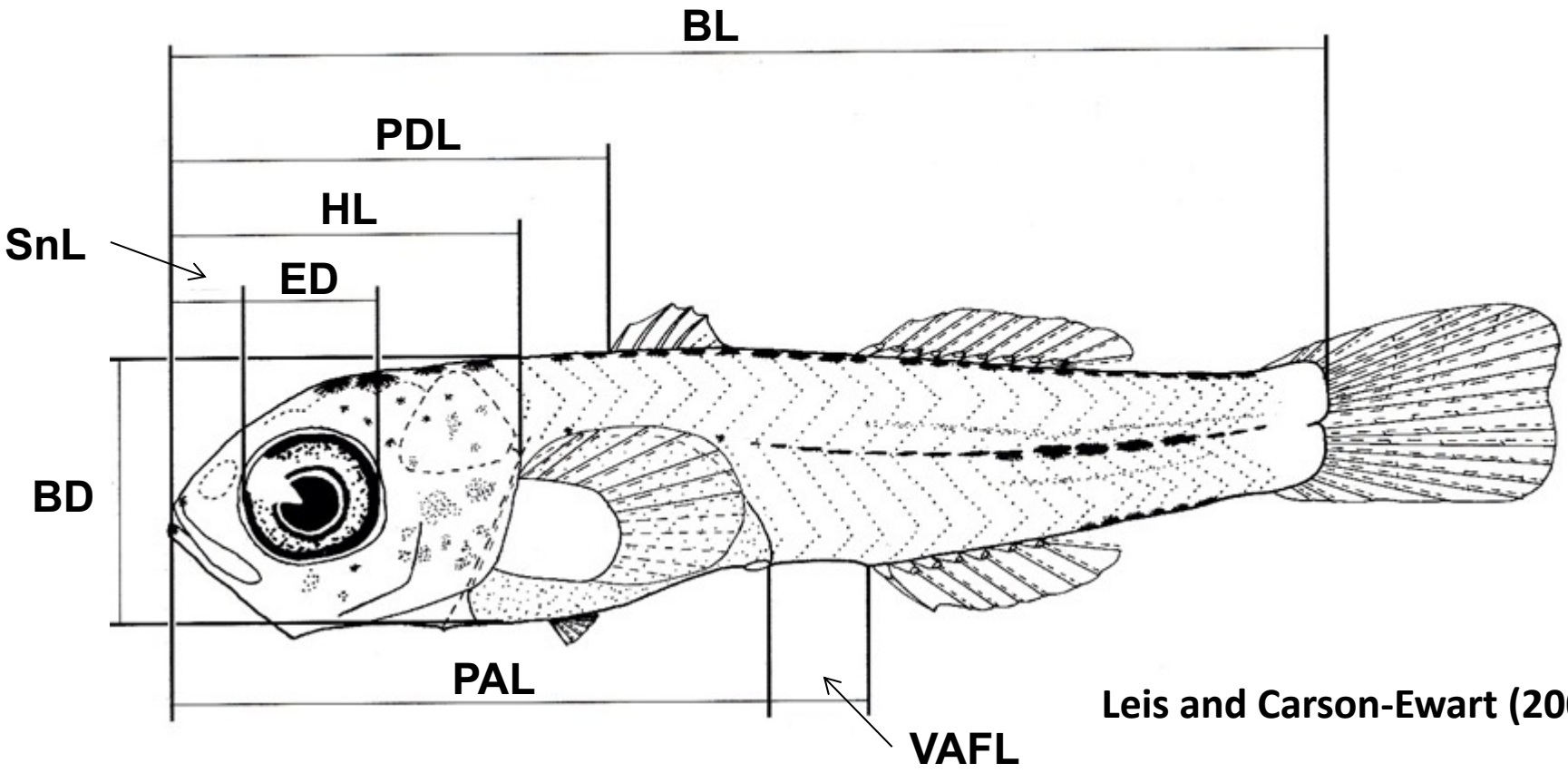
Neira et al. (1998)

Head spination



Neira et al. (1998)

Measurement



Leis and Carson-Ewart (2000)

BD: body depth; **BL:** body leng**th**; **ED:** eye diameter; **HL:** head length; **PAL:** preanal length; **PDL:** pre dorsal-fin length; **SnL:** snout length; **VAFL:** vent to anal-fin length.

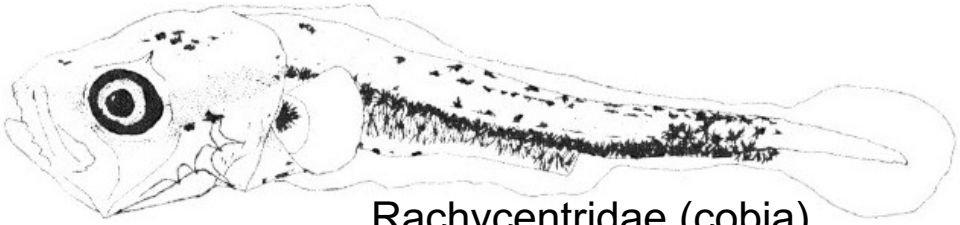
General characters useful for the identification

1. Body shape
2. Myomeres
3. Gut
4. Head
5. Snout
6. Mouth
7. Eyes
8. Head spination
9. Fin formation
10. Pigment

1. Body shape (1/2)

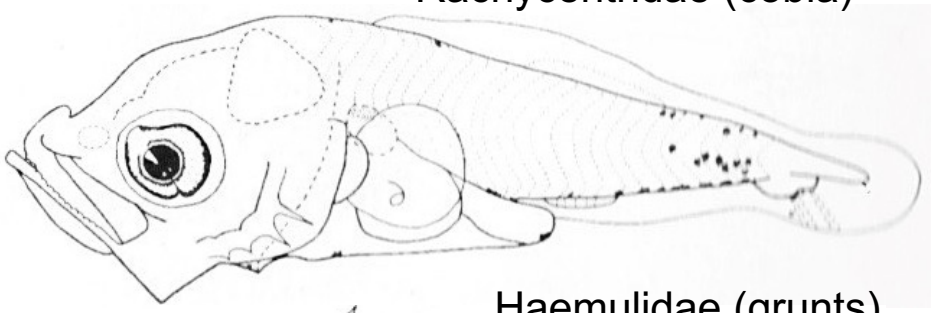
Synodontidae (lizardfishes)

Very elongate
BD < 10% BL



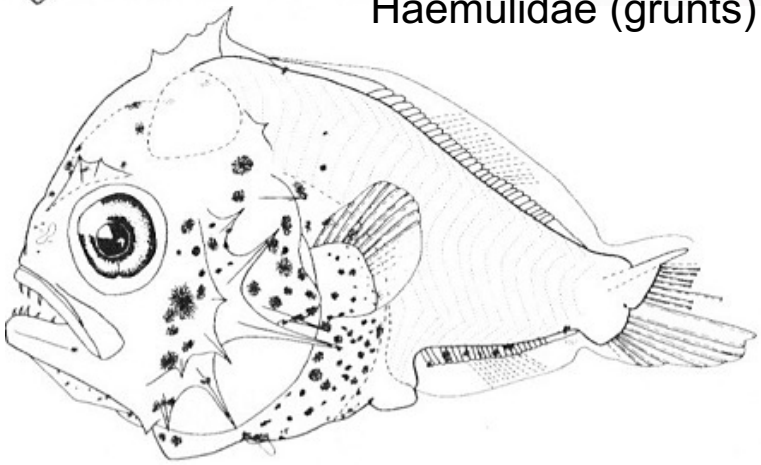
Rachycentridae (cobia)

Elongate
BD 10-20% BL



Haemulidae (grunts)

Moderate
BD 20-40% BL



Ephippidae (spadefishes)

Deep to very deep
BD > 40% BL

Figures from Leis and Carson-Ewart (2000)

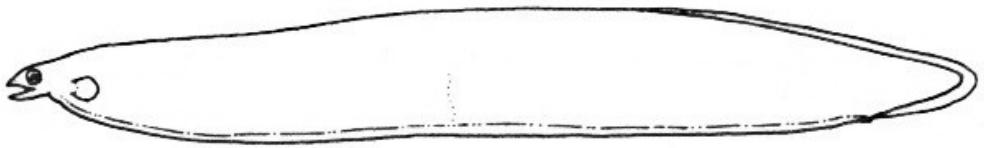
1. Body shape (2/2)

<u>Leptocephalus stage of the Anguilliformes</u> : transparent, ribbon-like and usually have a small head and fang-like teeth

Elopidae (tenpounders)

Albulidae (bonefishes)

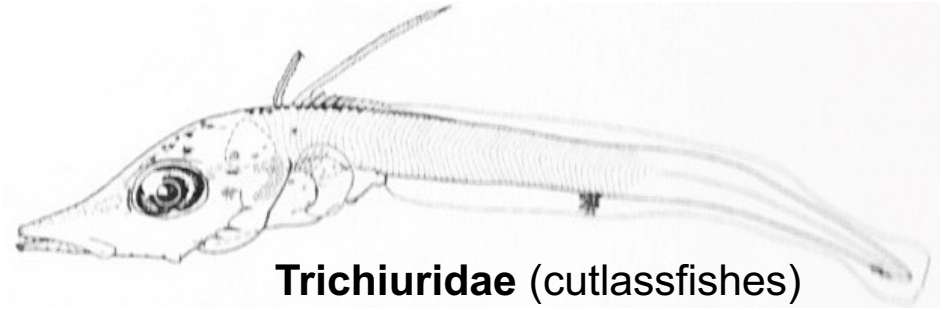
Muraenidae (morays)



Congridae (conger eels)

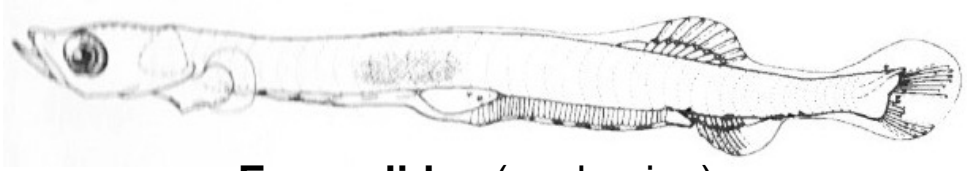
Figures from Moser (1996)

2. Myomeres



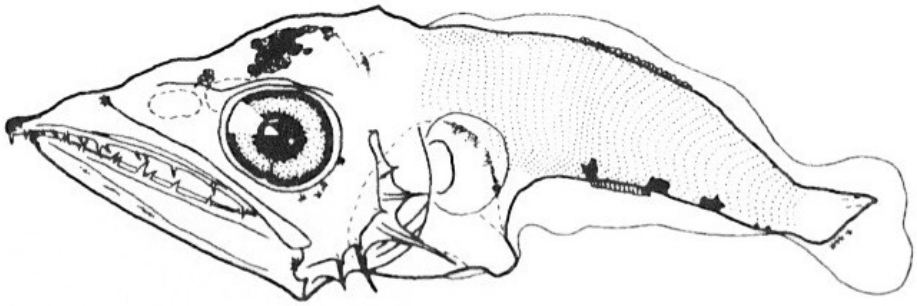
Trichiuridae (cutlassfishes)

TM ca 100 - 200



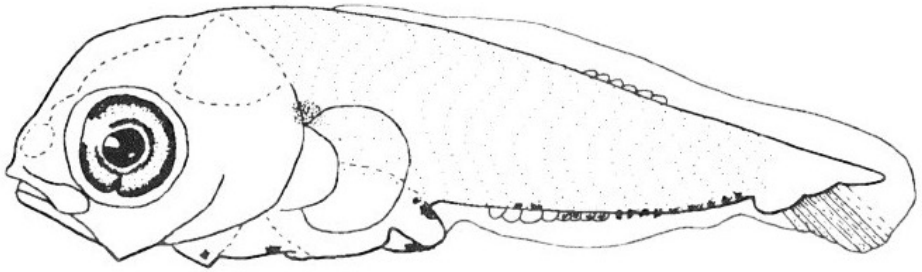
Engraulidae (anchovies)

TM ca 40 - 80



Scombridae (mackerels, spanish mackerels, bonitos, tunas)

TM ca 30 - 60



Nemipteridae (thread-fin breams)

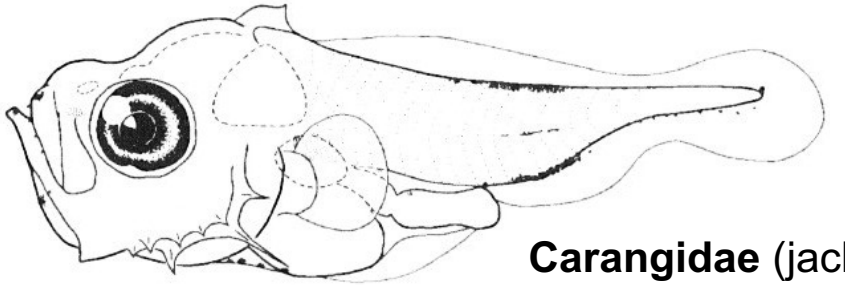
TM 24

Figures from Leis and Carson-Ewart (2000)

3. Gut

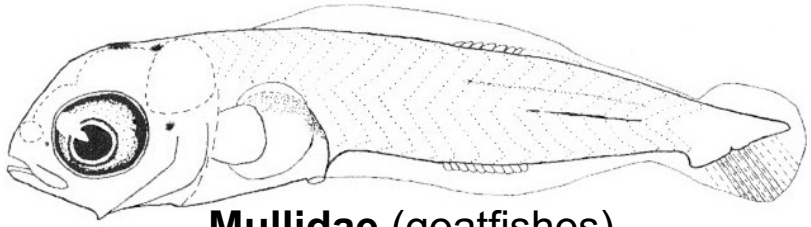
Chirocentridae (wolf herrings)

Straight
Very long



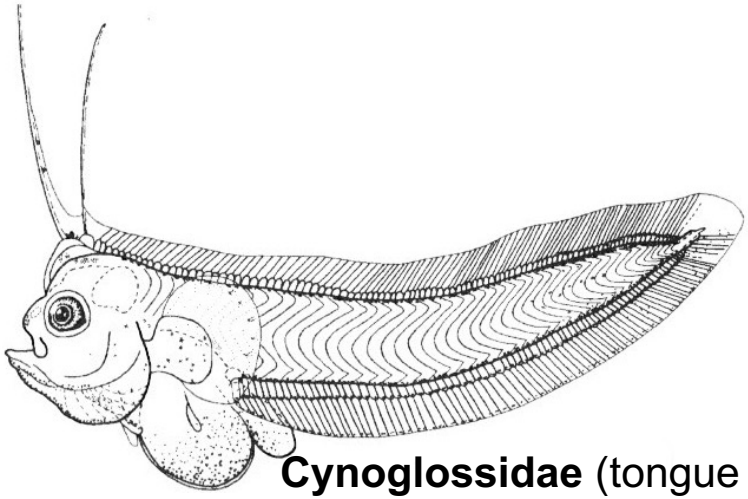
Carangidae (jacks)

Coiled
Not compact
(PAL ≧1/2 body)



Mullidae (goatfishes)

Coiled
Compact
(PAL ≦1/2 body)

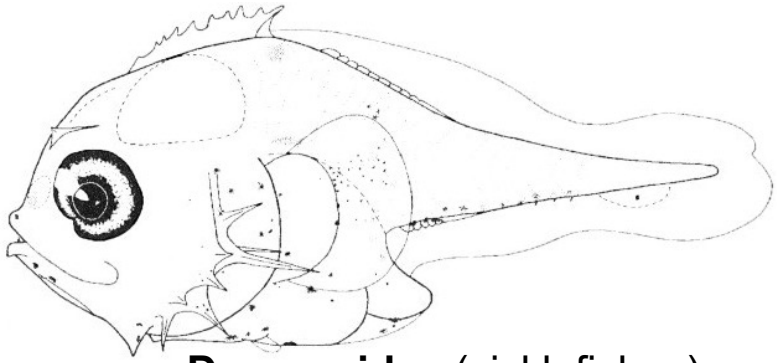


Cynoglossidae (tongue soles)

Coiled
Ventrally protrudent

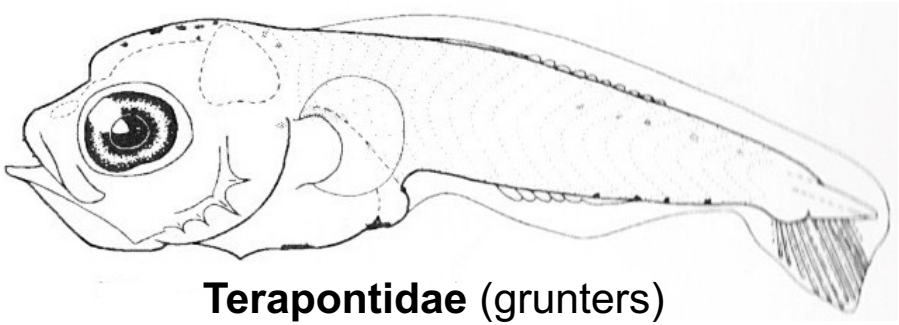
Figures from Leis and Carson-Ewart (2000)

4. Head



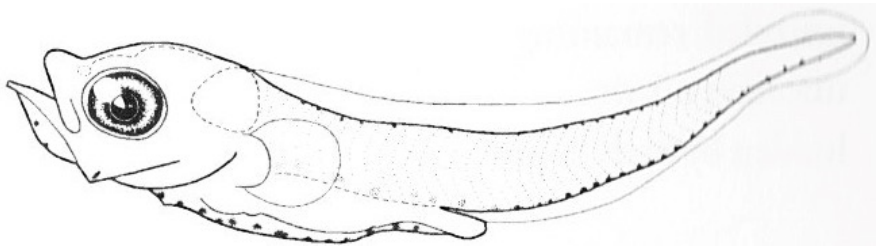
Drepaneidae (sicklefishes)

Large (deep)
HL > 33% BL



Terapontidae (grunters)

Moderate
HL 20 – 33% BL
(larger with growth in some species)

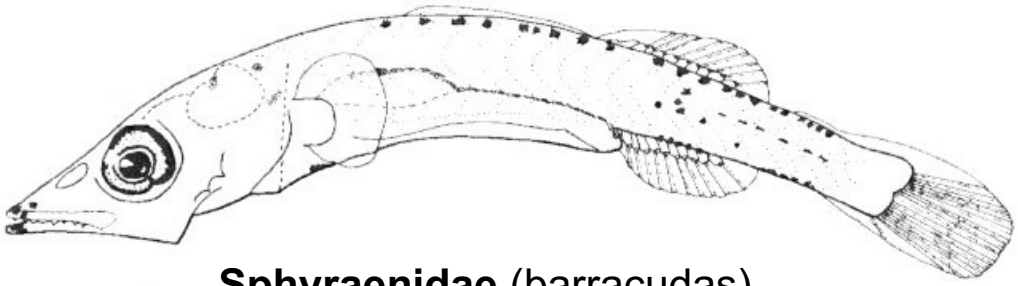


Sillaginidae (whitings)

Small
HL < 20% BL
(larger with growth in some species)

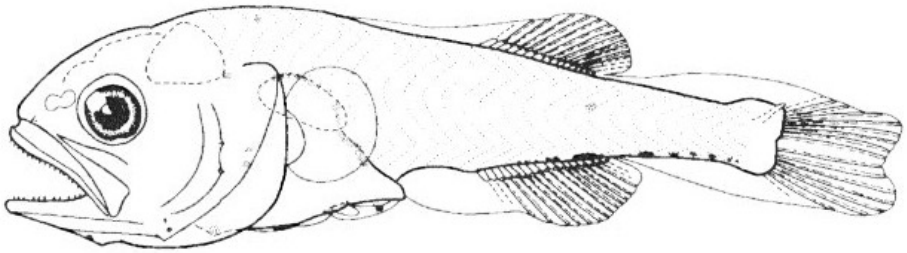
Figures from Leis and Carson-Ewart (2000)

5. Snout



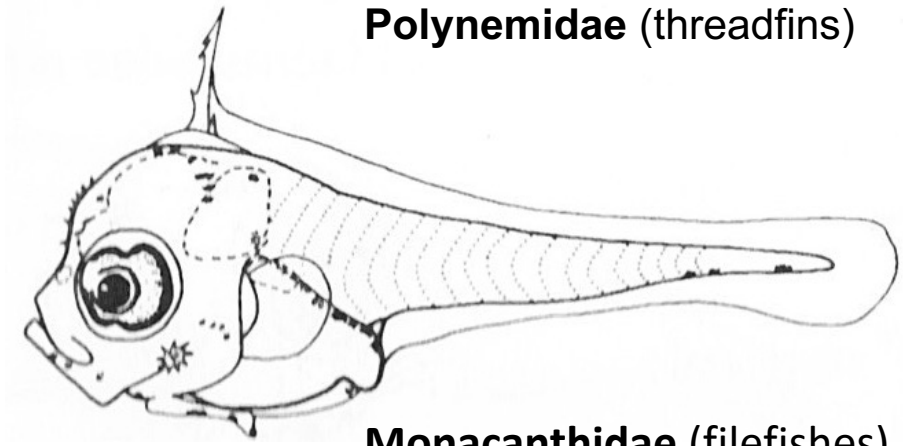
Sphyraenidae (barracudas)

Long and pointed



Polynemidae (threadfins)

Moderate and round

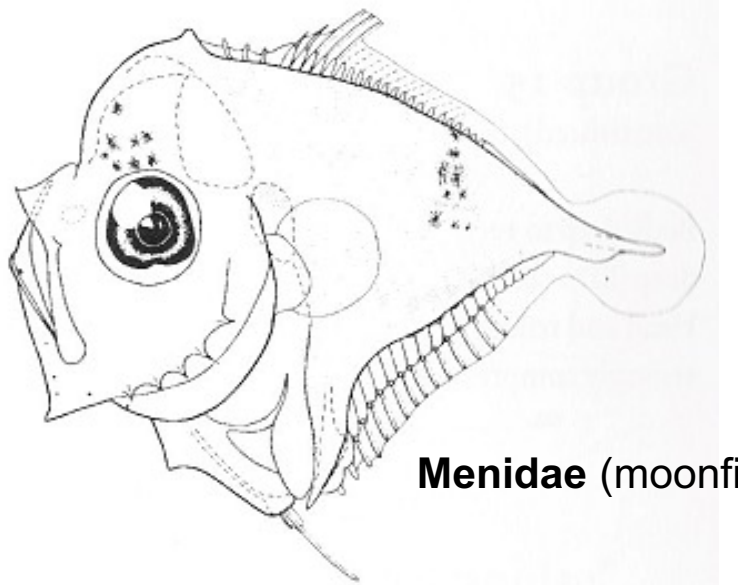


Monacanthidae (filefishes)

Short and concave in dorsal profile

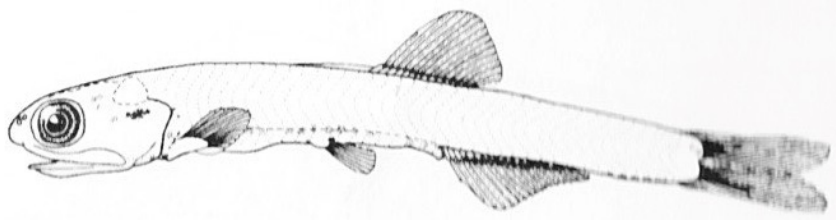
Figures from Leis and Carson-Ewart (2000)

6. Mouth



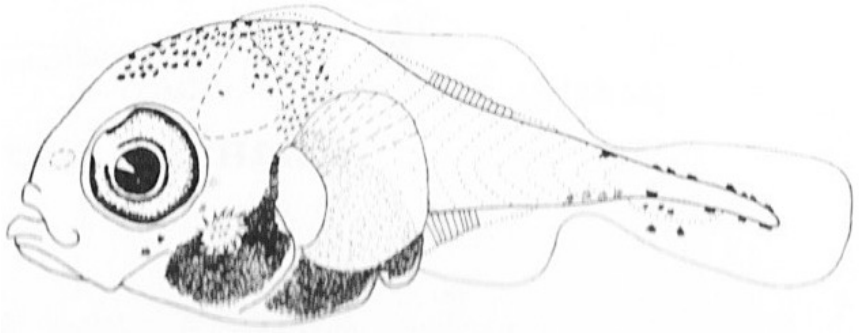
Menidae (moonfish)

Large, oblique and terminal



Engraulidae (anchovies)

Large and inferior (at large postflexion and juvenile stages)

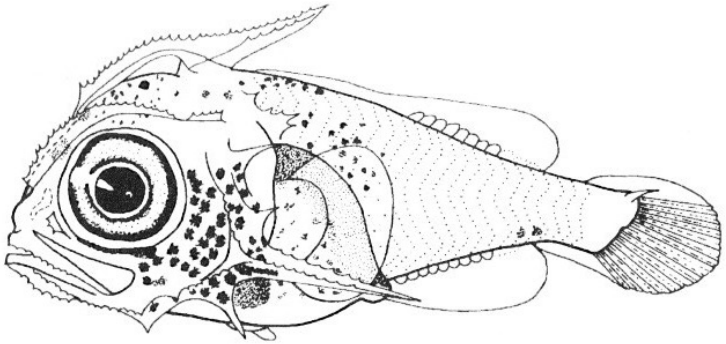


Balistidae (triggerfishes)

Small and terminal

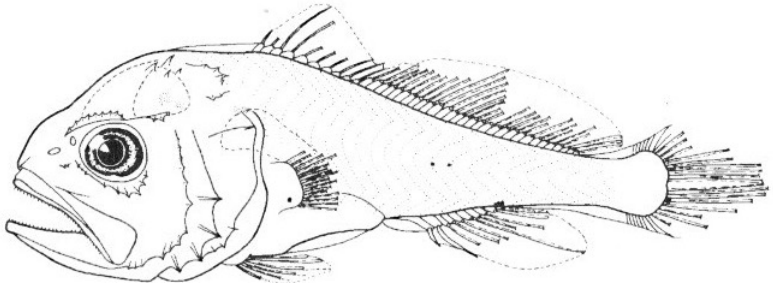
Figures from Leis and Carson-Ewart (2000)

7. Eyes



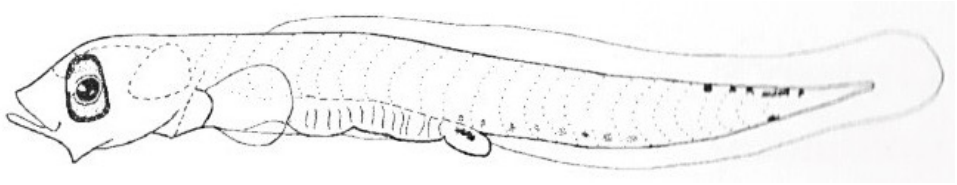
Priacanthidae (bigeyes)

Large and round
(ED > 33% HL)



Sciaenidae (croakers)

Small at postfletion stage
(ED < 25% HL) **and round**

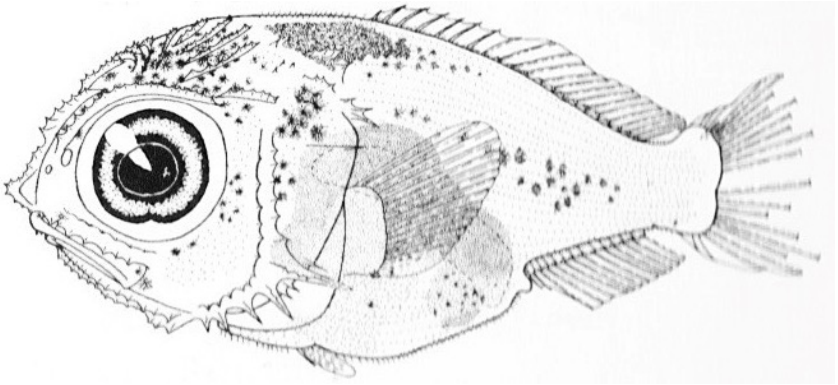


Scaridae (parrotfishes)

Elliptical in some species

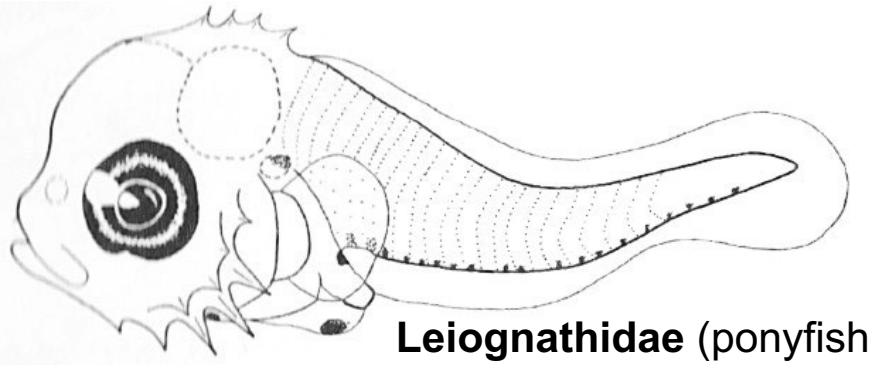
Figures from Leis and Carson-Ewart (2000)

8. Head spination



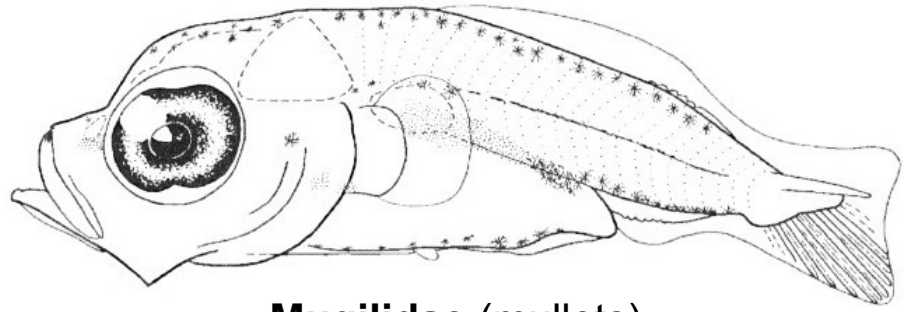
Malacanthidae (**Branchiostegidae**, tilefishes)

Well-developed



Leiognathidae (ponyfishes)

Developed



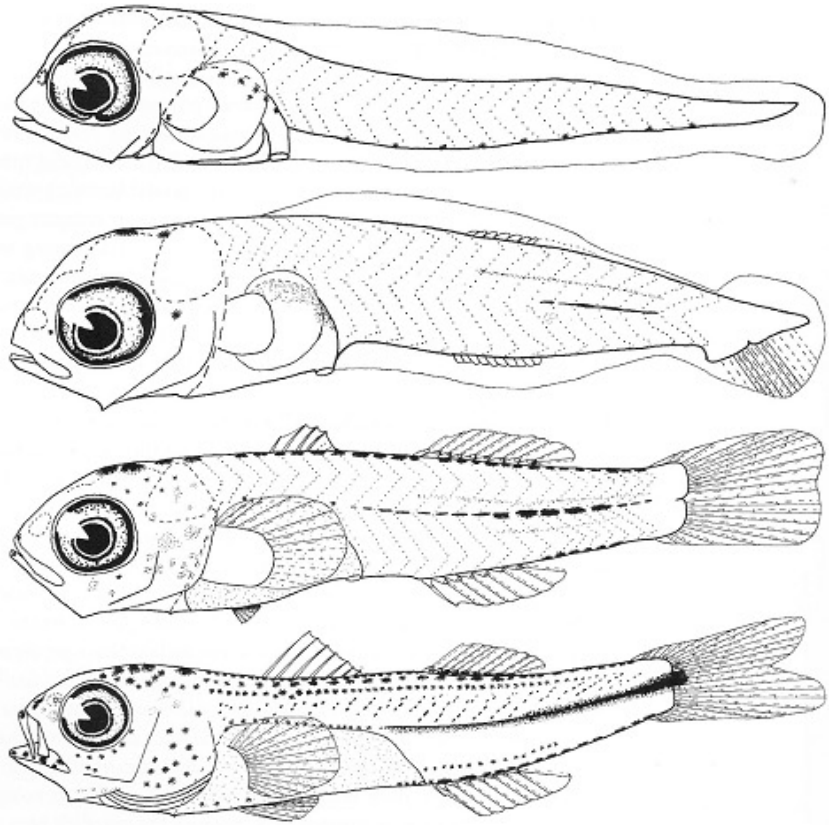
Mugilidae (mullets)

No spination

Figures from Leis and Carson-Ewart (2000)

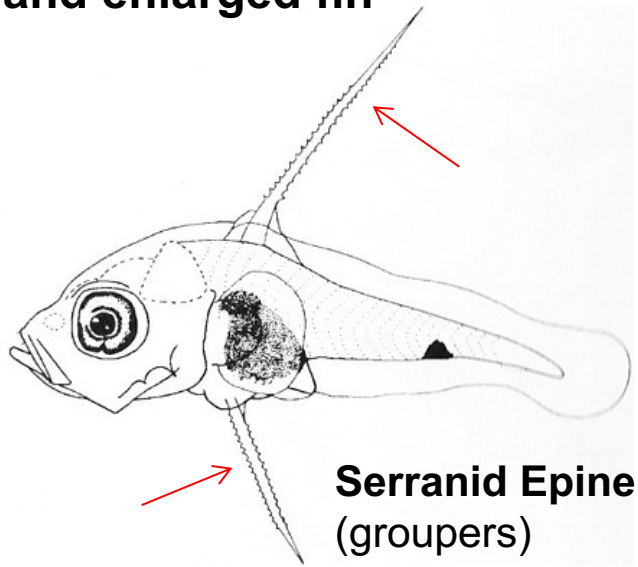
9. Fin formation

Fin development sequence
C → 2D & A → 1D → P_1 → P_2

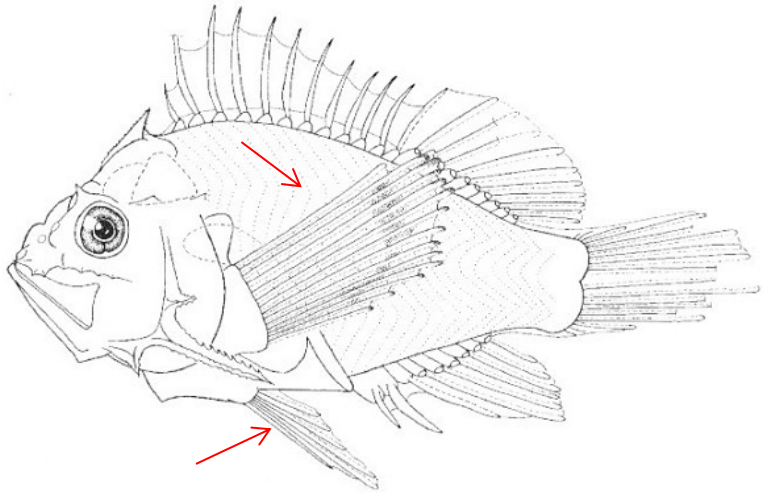


Mullid *Upeneus tragula* (goatfish)

Elongate (early forming) rays and enlarged fin



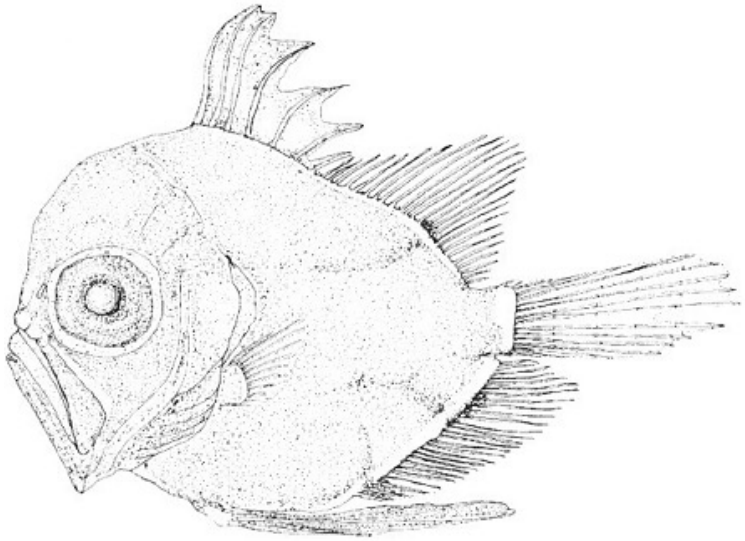
Serranid Epinephelinae (groupers)



Scorpaenidae (scorpionfishes)

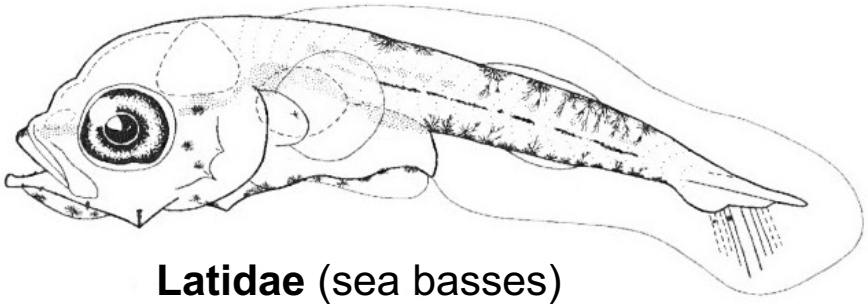
Figures from Leis and Carson-Ewart (2000)

10. Pigment



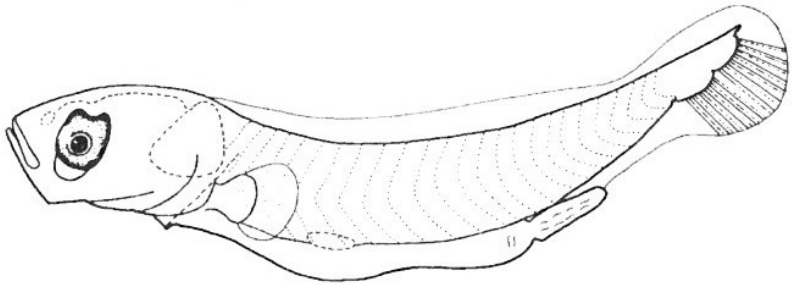
Zeidae (doory)

Well-developed



Latidae (sea basses)

Developed



Labridae (wrasses)

Poor in some species

Figures from Leis and Carson-Ewart (2000)

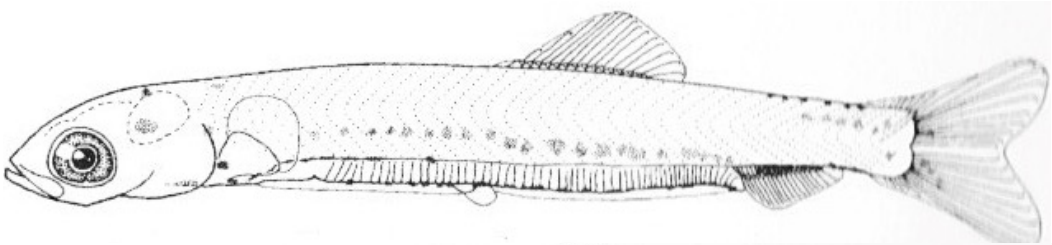
Characters useful for identification in order 1 (1/6)

Characters	Clupeiformes	Gonorynchiformes	Aulopiformes
Type of fin elements	Rays	Rays	Rays
P_1 formation	Late	Late	Often early
P_2 fin formation	Late	Late	Early to late
P_2 fin position	Abdominal	Abdominal	Abdominal
P_2 fin formula	Usually 7-10	9-12	7-11
Dorsal fin (s)	1	1	1
Anal fin	0 spine	0 spine	0 spine
Adipose fin	No	No	Usually present
Principal Caudal rays	19	19	19
Dominant body shape	Elongate, slender	Elongate, slender	Various, often elongate
Preanal length (% BL)	48-90%	77-90%	ca 20-75%
Type of gut	Straight	Straight	Straight, variously types
Vertebrae	39-76	40-61	36-121
Head spination	None	None	Usually none
Early forming fin	No	No	Occasionally P_1 rays

Leis and Carson-Ewart (2000), hereafter same

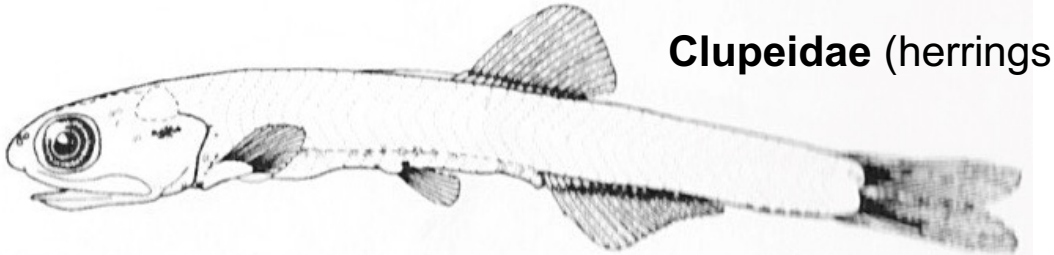
1) Clupeiformes, 2) Gonorynchiformes and 3) Aulopiformes larvae

Clupeiformes



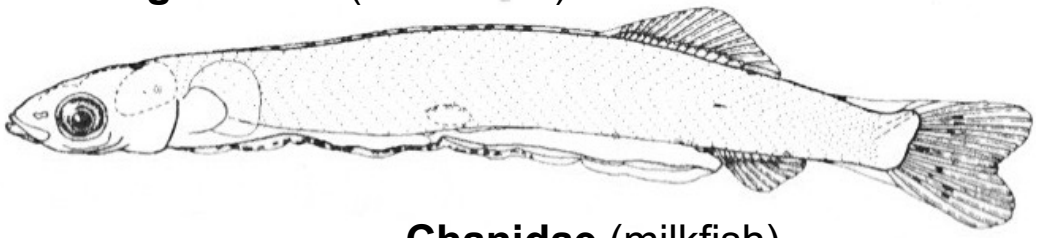
Clupeidae (herrings)

Clupeiformes



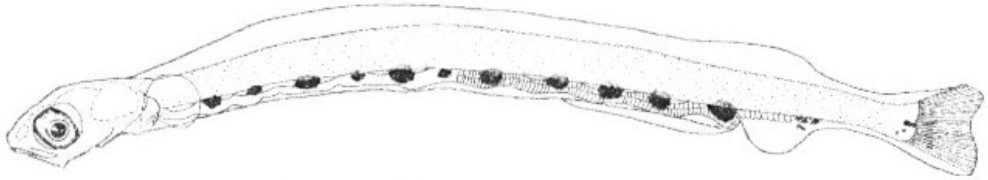
Engraulidae (anchovies)

Gonorynchiformes



Chanidae (milkfish)

Aulopiformes



Synodontidae (lizardfishes)

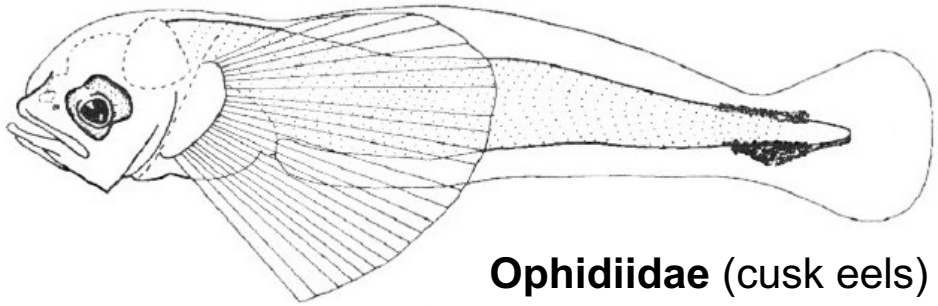
Figures from Leis and Carson-Ewart (2000)

Characters useful for identification in order 1 (2/6)

Characters	Ophidiiformes	Gadiformes	Lophiiformes
Type of fin elements	Rays	Rays	Spines and rays
P_1 formation	Sometimes early	Sometimes late	Sometimes early
P_2 fin formation	Late	Often early	Often absent, early to late
P_2 fin position	Jugular	Thoracic or jugular	Thoracic
P_2 fin formula	0-2	Various; 2-8	0 or I, 3-5
Dorsal fin (s)	1	1-3	2, anterior on head
Anal fin	0 spine	0 spine	0 spine
Adipose fin	No	No	No
Principal Caudal rays	0-14	Various numbers	8-10
Dominant body shape	Elongate	Various, elongate to deep-bodied	Globular
Preanal length (% BL)	33-55%	Usually < 50%	30-90%
Type of gut	Coiled	Usually coiled	Deep, coiled
Vertebrae	40-150	40-many	18-31
Head spination	Opercular spines	Usually none	None
Early forming fin	P_1 rays and vexillum in some	No	Varies, none to P_2 and anterior D

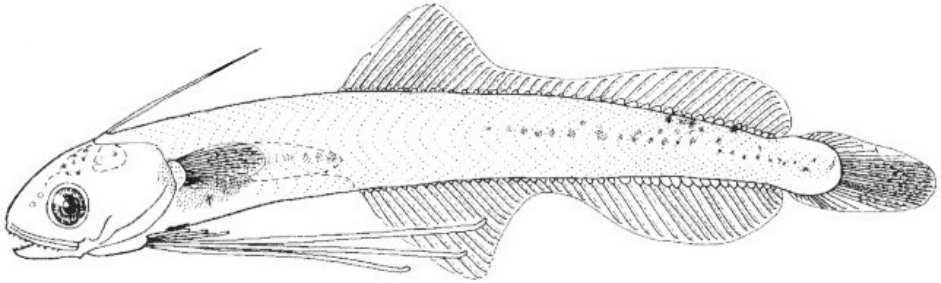
4) Ophidiiformes, 5) Gadiformes and 6) Lophiiformes larvae

Ophidiiformes



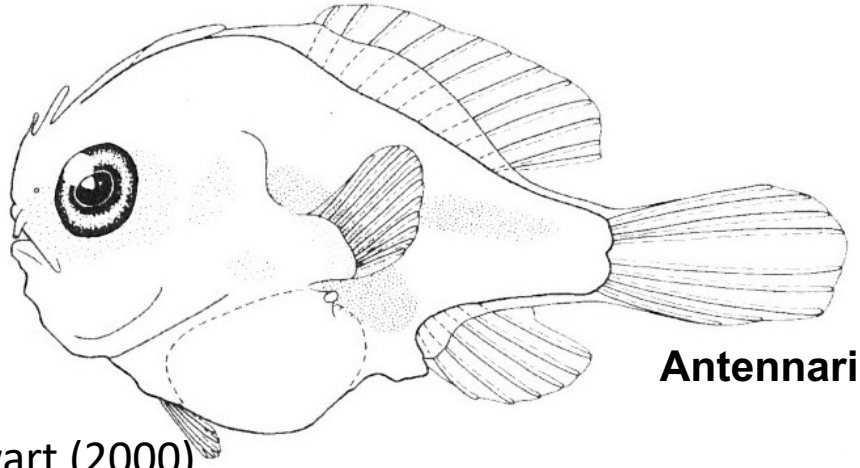
Ophidiidae (cusk eels)

Gadiformes



Bregmacerotidae (pelagic codlets)

Lophiiformes



Antennariidae (frogfishes)

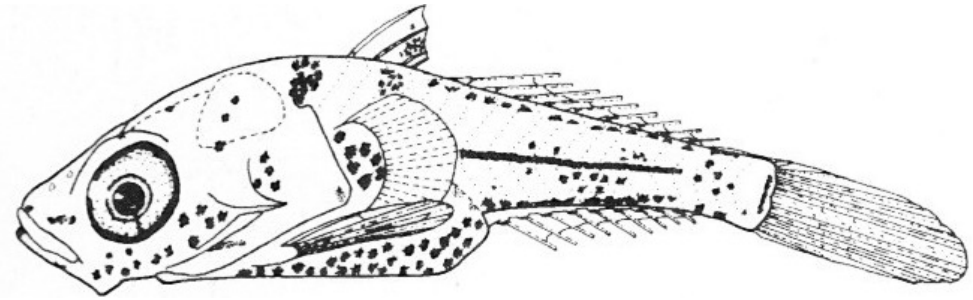
Figures from Leis and Carson-Ewart (2000)

Characters useful for identification in order 1 (3/6)

Characters	Gobiesociformes	Atheriniformes	Beloniformes
Type of fin elements	Spines, rays, or rays only	Spines and rays	Rays
P_1 formation	Late	Late	Late
P_2 fin formation	Late	Late	Late
P_2 fin position	Thoracic	Abdominal to thoracic	Abdominal
P_2 fin formula	I, 4-I, 5	I, 5	6
Dorsal fin (s)	1 or 2	2	1
Anal fin	0-1 spine	0-1 spine	0 spine
Adipose fin	No	No	No
Principal Caudal rays	8-14	17	15
Dominant body shape	Moderate to very stubbly	Elongate	Elongate
Preanal length (% BL)	50-85%	20-50%, increases ontogenetically	65-80%
Type of gut	Initially straight, later coiled	Coiled	Straight
Vertebrae	21-54	21-55	36-97
Head spination	No or 1 opercular spine	No	No
Early forming fin	No	No	C at hatching

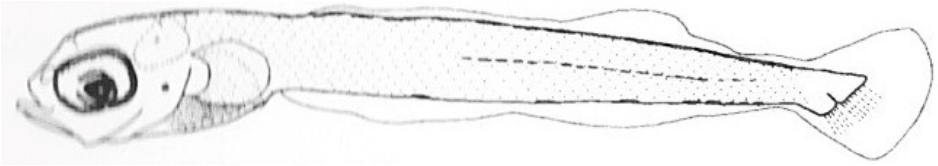
7) Gobiesociformes, 8) Atheriniformes and 9) Beloniformes larvae

Gobiesociformes



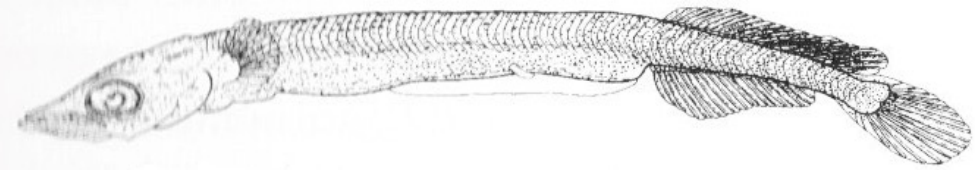
Callionymidae (dragonets)
sometimes belonging to Perciformes

Atheriniformes



Atherinidae (silversides)

Beloniformes



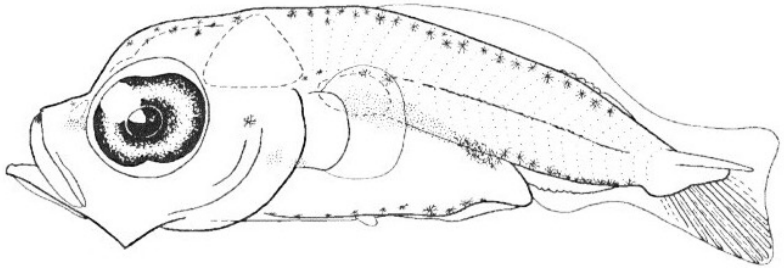
Belonidae (needlefishes)

Figures from Leis and Carson-Ewart (2000)

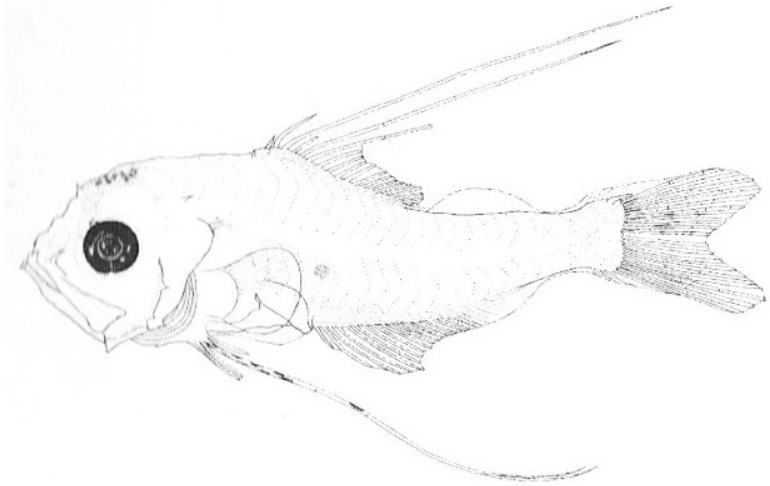
Characters useful for identification in order 1 (4/6)

Characters	Mugiliformes	Beryciformes	Zeiformes
Type of fin elements	Spines, rays	Spines and rays	Spines and rays
P_1 formation	Late	Not late	Late
P_2 fin formation	Late	Often early	Various, early to late
P_2 fin position	Subabdominal	Thoracic or abdominal	Abdominal to thoracic
P_2 fin formula	I, 5	0-I, 2-13	0-I, 3-10
Dorsal fin (s)	2	1 or 2	1
Anal fin	2-3 spines	0-4 spines	0-3 spines
Adipose fin	No	No	No
Principal Caudal rays	14-15	18-19	9-13
Dominant body shape	Slender to moderate	Slender to stubbly	Deep, compressed
Preanal length (% BL)	57-78%	ca 30-79%	50-70%
Type of gut	Coiled, underslung	Coiled	Deep, coiled
Vertebrae	24-26	24-30	21-46
Head spination	None	None to markedly heavy	None to markedly heavy
Early forming fin	None	Often P_2 and anterior D	Various, none to P_2

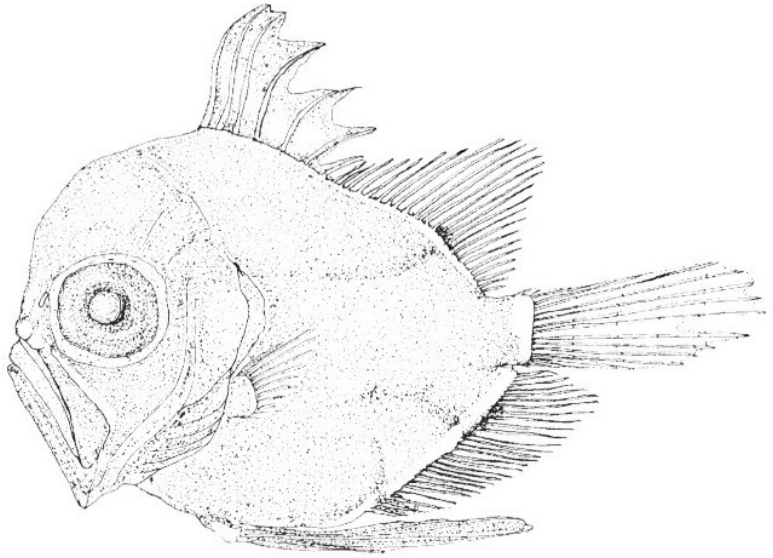
10) Mugiliformes, 11) Beryciformes and 12) Zeiformes larvae



Mugiliformes
Mugilidae (mullets)



Beryciformes
Berycidae (alfonsinos)



Zeiformes
Zeidae (doories)

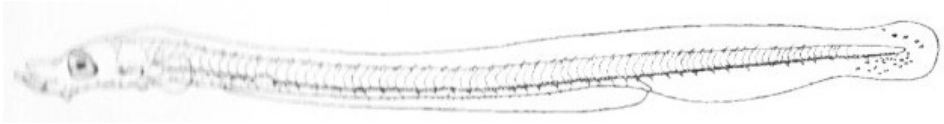
Figures from Leis and Carson-Ewart (2000)

Characters useful for identification in order 1 (5/6)

Characters	Gasterosteiformes	Scorpaeniformes	Perciformes
Type of fin elements	Spines, rays	Spines and rays	Spines and rays
P_1 formation	Late	Late	Various
P_2 fin formation	Often absent, late	Intermediate	Sometimes early
P_2 fin position	Abdominal	Thoracic	Various, usually thoracic
P_2 fin formula	0-6	I, 5 or fewer	I, 5 or fewer
Dorsal fin (s)	1 or 2	1 or 2	1 or 2
Anal fin	0-1 spine	0-3 spines	Usually 1-3 spines
Adipose fin	No	No	No
Principal Caudal rays	0-15	Variable, <18	Usually 17
Dominant body shape	Various, often elongate	Various, usually stubbly	Various, usually stubbly
Preanal length (% BL)	Various, 45-90%	ca 35-60%	Various, 20-80%
Type of gut	Usually straight	Coiled	Various, usually coiled
Vertebrae	19-87	ca 25-65	ca 20-100+, often 24-28
Head spination	None to heavy, often asso-ciated with body plates	Usually	None to markedly heavy
Early forming fin	None	P_1 can be large	Sometimes: D spine, P2 spine and rays

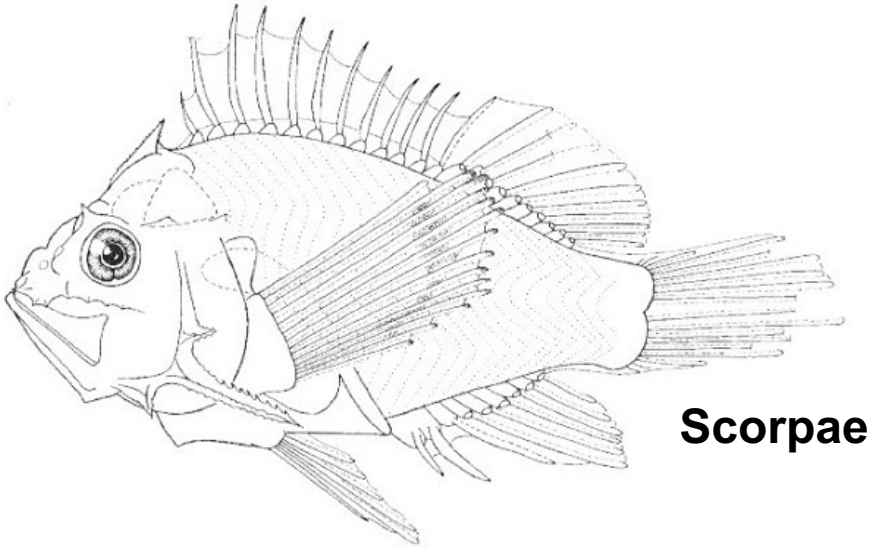
13) Gasterosteiformes and 14) Scorpaeniformes larvae

Gasterosteiformes



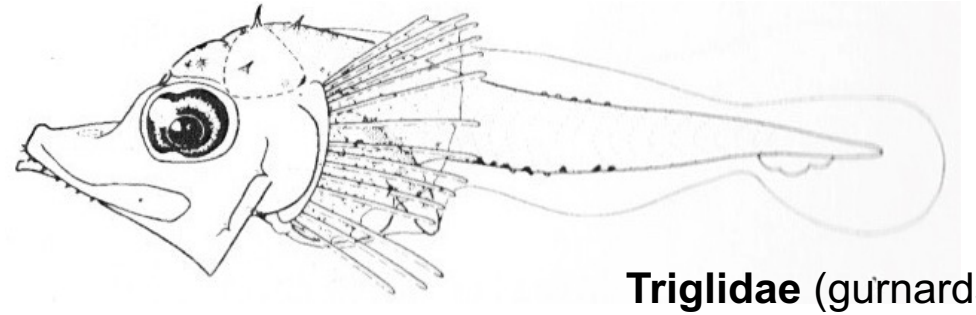
Fistulariidae (Flutemouths)

Scorpaeniformes



Scorpaenidae (scorpionfishes)

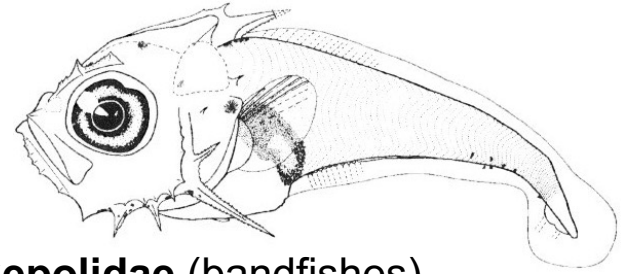
Scorpaeniformes



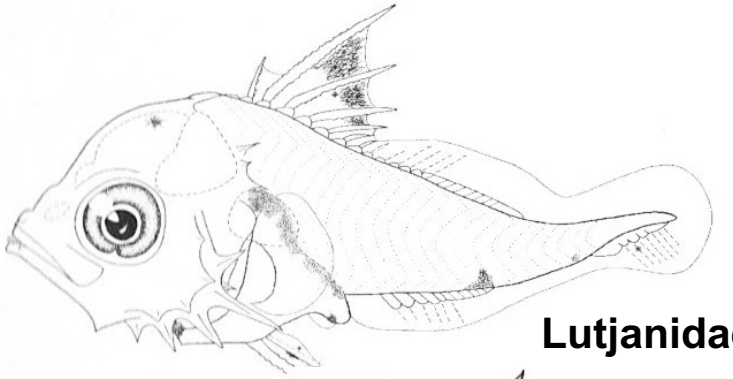
Triglidae (gurnards)

Figures from Leis and Carson-Ewart (2000)

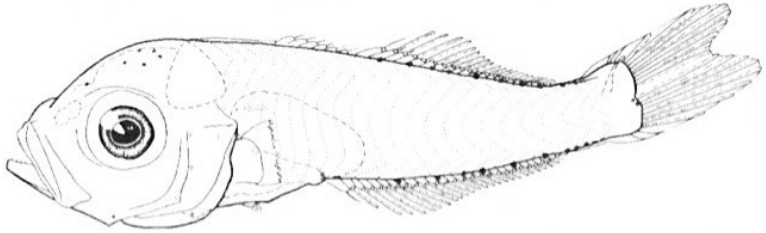
15) Perciformes larvae



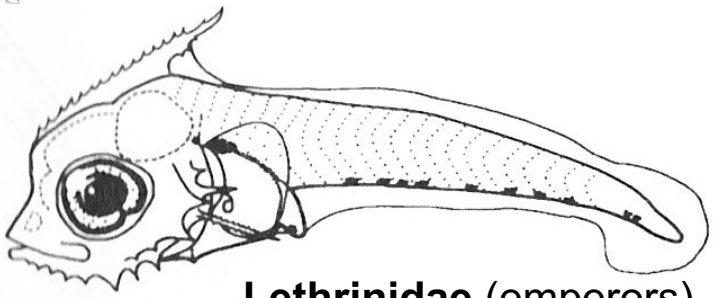
Cepolidae (bandfishes)



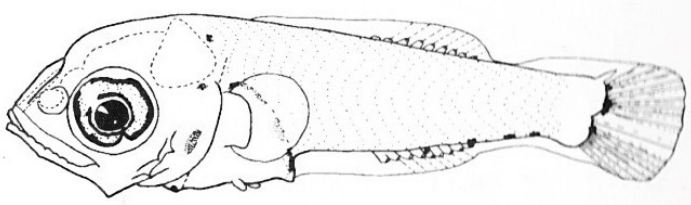
Lutjanidae (snappers)



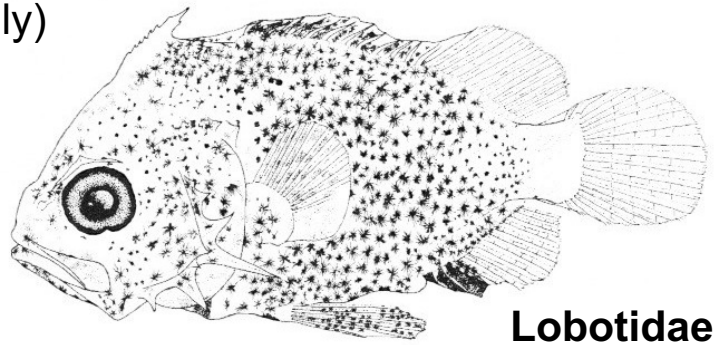
Lactariidae (False trevally)



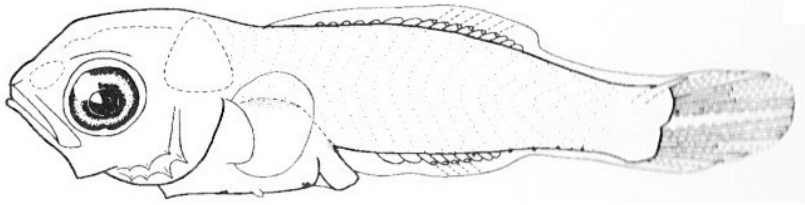
Lethrinidae (emperors)



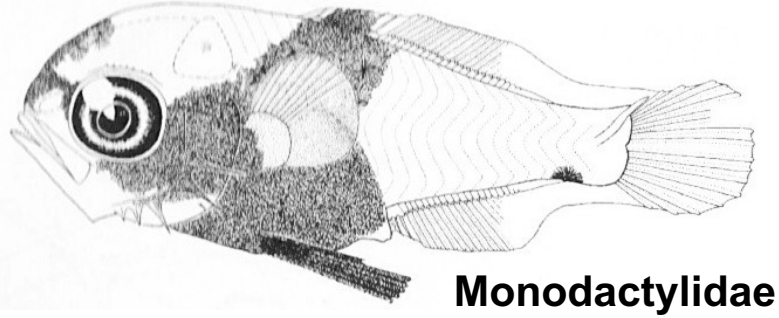
Gerreidae (silver biddies)



Lobotidae (tiger perches)



Sparidae (breams)



Monodactylidae (moonies)

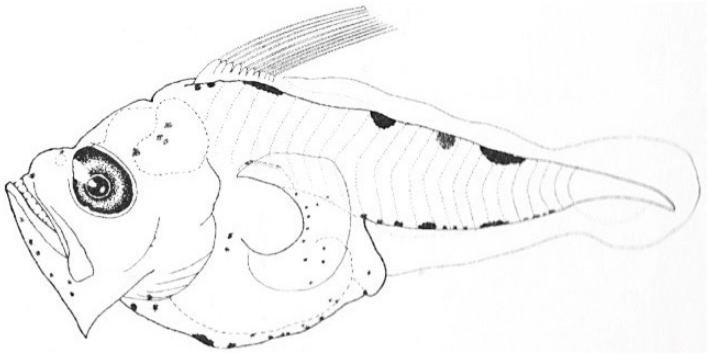
Figures from Leis and Carson-Ewart (2000)

Characters useful for identification in order 1 (6/6)

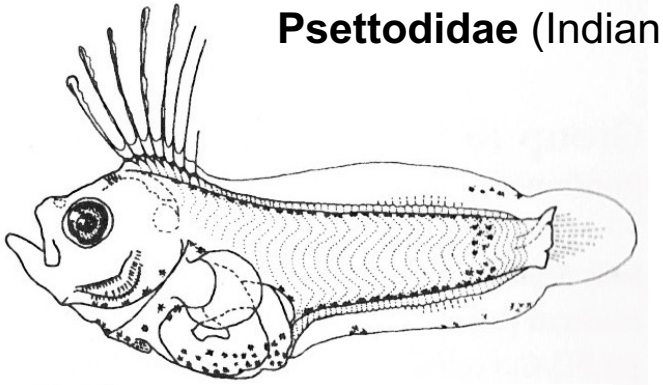
Characters	Pleuronectiformes	Tetraodontiformes
Type of fin elements	Rays except P_2 spine in some	Spines and rays or rays only
P_1 formation	Late	Sometimes early
P_2 fin formation	Sometimes early	Often absent
P_2 fin position	Thoracic to jugular	Thoracic
P_2 fin formula	I, 5 or 0, 2-6	0-I, 5
Dorsal fin (s)	1	1 or 2
Anal fin	0 spine	0 spine
Adipose fin	No	No
Principal Caudal rays	Variable	9-12
Dominant body shape	Various, markedly compressed	Various, usually moderate
Preanal length (% BL)	Usually < 40%	40-90%
Type of gut	Coiled	Coiled
Vertebrae	23-65	16-30
Head spination	None to heavy	Various
Early forming fin	Often, 1-12 anterior D rays, sometimes 2-3 P_2 rays	Sometimes P_1 rays

16) Pleuronectiformes and 17) Tetraodontiformes larvae

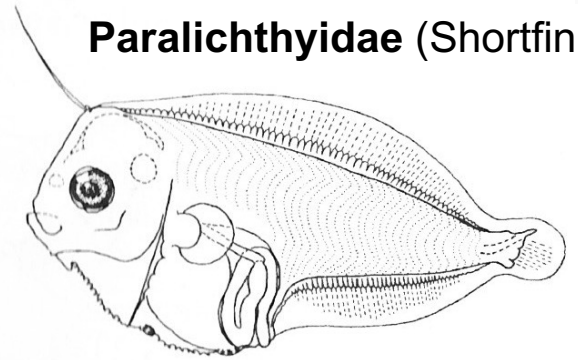
Pleuronectiformes



Psettodidae (Indian halibut)

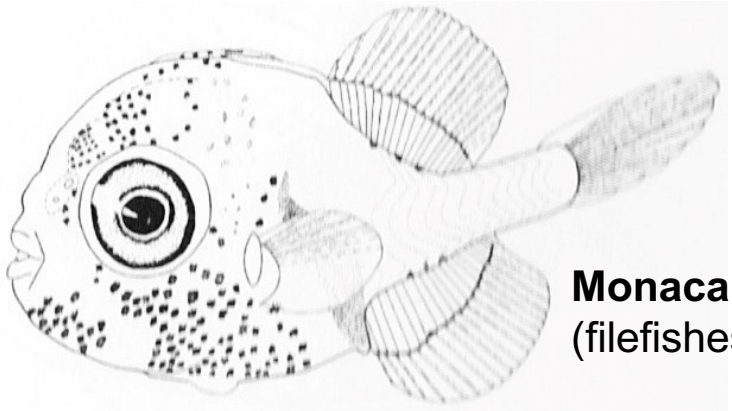


Paralichthyidae (Shortfin flounders)

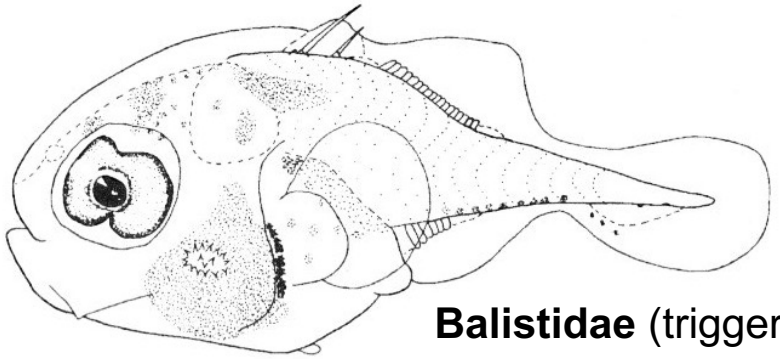


Bothidae (lefteye flounders)

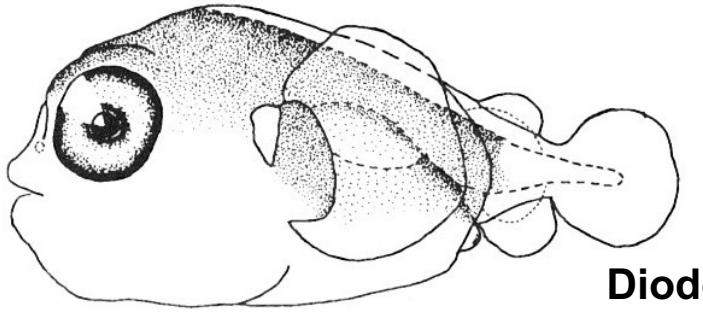
Tetraodontiformes



Monacanthidae (filefishes)



Balistidae (triggerfishes)



Diodontidae (porcupinefishes)

Figures from Leis and Carson-Ewart (2000)

Characters useful for identification in order 2 (1/3)

Characters	Elopiformes Albuliformes	Anguilliformes
Type of fin elements	Rays	Rays
P_1 formation	Late	Late
P_2 fin formation	Late	Absent
P_2 fin position	Abdominal	Absent
P_2 fin formula	10-16 (Elop.) 9-11 (Albu.)	Absent
Dorsal fin (s)	1	1
Anal fin	1	1
Adipose fin	No	No
Principal Caudal rays	19	Usually 5-11, absent in some
Dominant body shape	Leptocephalus, forked tail	Leptocephalus
Preanal length (% BL)	75-80 (Elop.), 90-95 (Albu.)	40-95
Type of gut	Straight	Straight, some with loop, rarely trailing
Vertebrae	51-82 (Elop.), 65-92 (Albu.)	97-400+ (most 100-250)
Head spination	No	No
Early forming fin	No	No

Moser (1996), hereafter same

18) Elopiformes, 19) Albuliformes and 20) Anguilliformes larvae

Elopiformes

Elopidae (tenpounders)

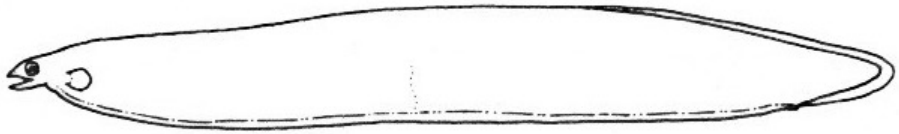
Albuliformes

Albulidae (bonefishes)

Anguilliformes

Muraenidae (morays)

Ophichthyidae (snake eels)



Congridae (conger ells)

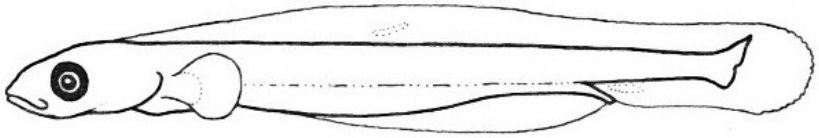
Figures from Moser (1996)

Characters useful for identification in order 2 (2/3)

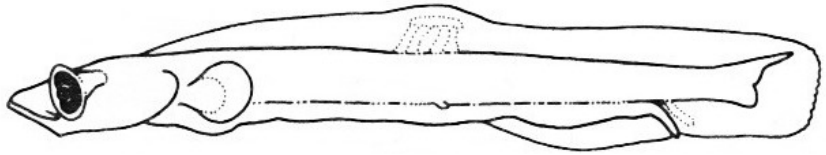
Characters	Argentiniformes	Stomiiformes
Type of fin elements	Rays	Rays
P_1 formation	Late, elongate in some	Late in most, elongate in *Ichthyococcus*
P_2 fin formation	Usually late, elongate in some	Late
P_2 fin position	Abdominal	Abdominal
P_2 fin formula	Varied, usually 8-12	Varied, usually 5-8, up to 26 in *Bathophilus*
Dorsal fin (s)	1	1
Anal fin	1	1
Adipose fin	Usually present	Often present
Principal Caudal rays	19 (10+9)	19 (10+9)
Dominant body shape	Elongate, slender, some stout	Elongate, some compressed
Preanal length (% BL)	70-95	30-95
Type of gut	Straight, folded or saccular in some	Straight, trailing and ornamented in some
Vertebrae	40-85	30-100+
Head spination	None	None
Early forming fin	No	P_1 in *Ichthyococcus*

20) Argentiniformes and 21) Stomiiformes larvae

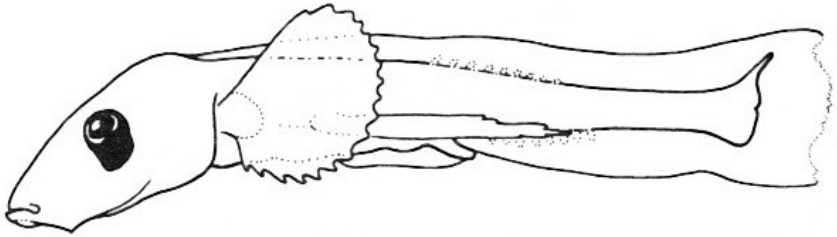
Argentiniformes



Argentinidae (argentines)



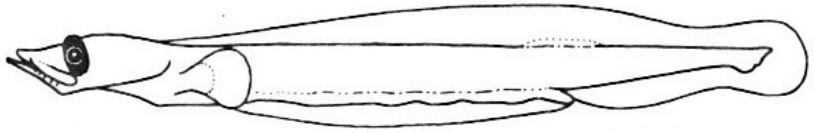
Argentinid Bathylaginae (blacksmelts)



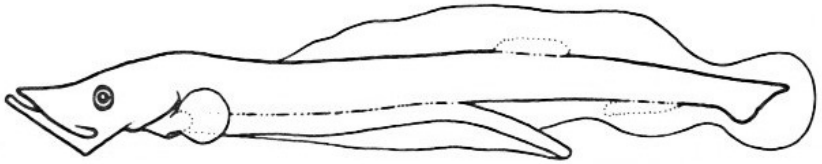
Opisthoproctidae (spookfishes)

Stomiiformes

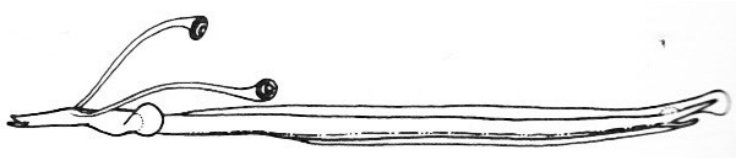
Gonostomatidae (bristlemouths)



Phosichthyidae (lightfishes)



Melanostomiidae (scaleless dragonfishes)



Idiacanthidae (blackdragons)

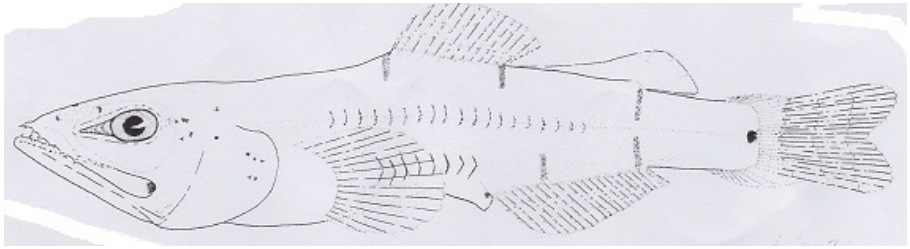
Figures from Moser (1996)

Characters useful for identification in order 2 (3/3)

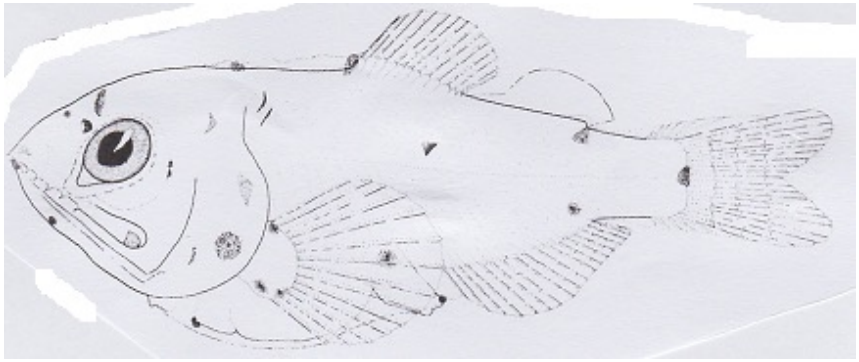
Characters	Myctophiformes	Lampridiformes
Type of fin elements	Rays	Rays
P_1 formation	Various, early and elongate in some	Late
P_2 fin formation	Various, early and elongate in some	Usually early, 1 or more elongate, usually heavily ornamented
P_2 fin position	Abdominal	Abdominal to thoracic
P_2 fin formula	Varied, usually 8-10	0-17
Dorsal fin (s)	1 fin	1 fin, 1 or more anterior rays elongate and highly ornamented
Anal fin	1	0 or 1
Adipose fin	Usually present	No
Principal Caudal rays	19 (10+9)	3-32
Dominant body shape	Various, elongate to moderately stout	Usually elongate and compressed
Preanal length (% BL)	40-70	45-90
Type of gut	Straight, varied shapes, trailing in 1 species	Coiled
Vertebrae	28-45	33-200
Head spination	Usually none	No
Early forming fin	P_1 and P_2 in some	1 or more anterior D rays and P_2

22) Myctophiformes and 23) Lampridiformes larvae

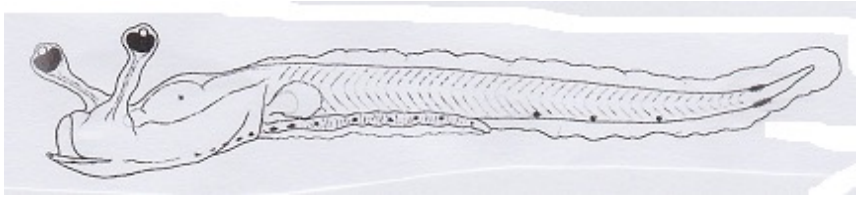
Myctophiformes
lanternfishes



Myctophid *Myctophum spinosum*

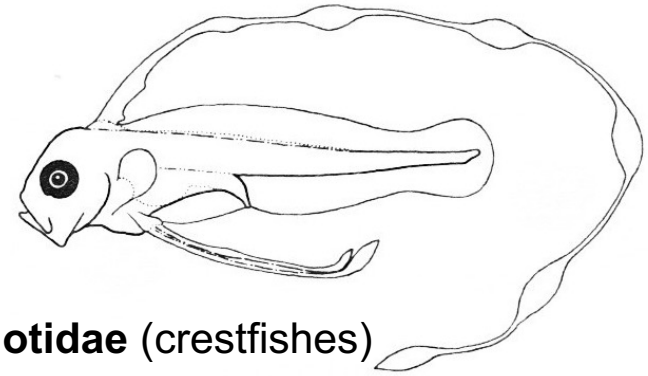


Myctophid *Myctophum asperum*

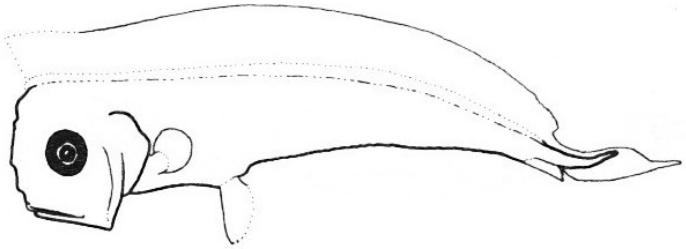


Myctophid *Myctophum aurolaternatum*

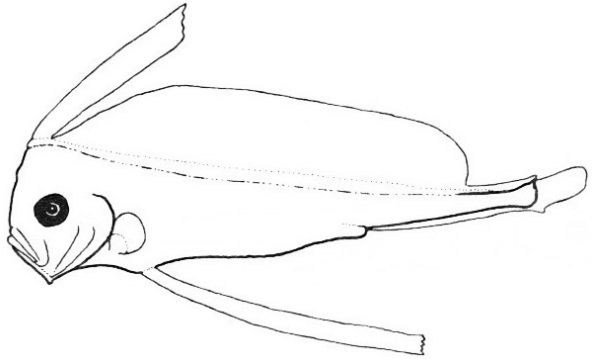
Lampridiformes



Lophotidae (crestfishes)



Radiicephalidae (tapertails)



Trachipteridae (ribbonfishes)

Figures from Moser (1996)