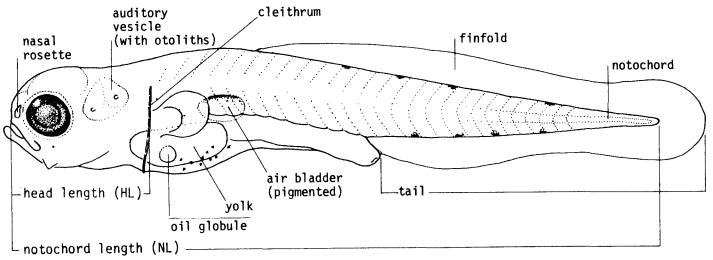
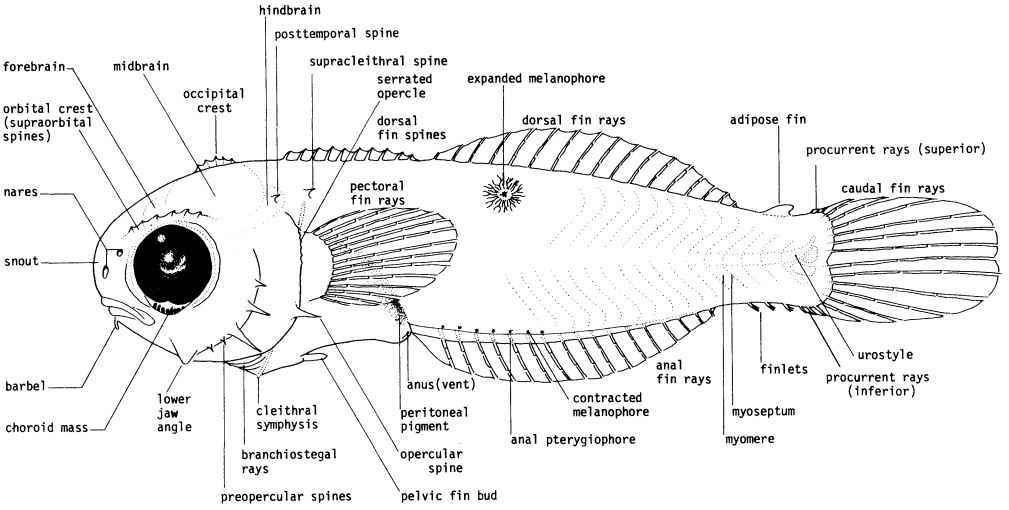
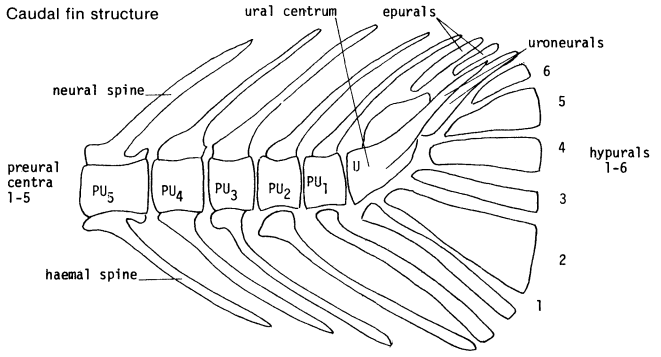
Collection Data for Previously Unpublished Material

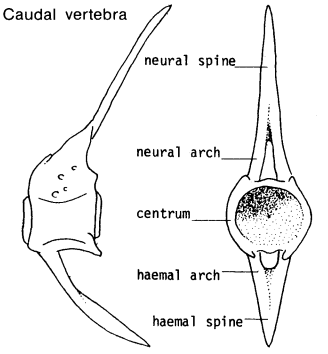
Taxon	Date	Gear	Location	Figure	Page
Bathymyrinae	16 Aug 1975	Bongo	163 km east of Atlantic City, New Jersey	—	57
Bathypterois sp.	7 May 1967	2-m hoop	26° 47'N, 79° 50'W	B	99
Enchelyopus cimbrius	(unknown)	(unknown)	Shoreham, Long Island, New York	A–F	173
Merluccius albidus	8 Jul 1978	Bongo	40° 13'N, 70° 25'W	B–C	185
Merluccius albidus	30 Sep 1979	Bongo	40° 25'N, 68° 20'W	D–E	185
Meluccius bilinearis	21 Aug 1979	Bongo	41° 04'N, 71° 42'W	B	187
Meluccius bilinearis	1 Sep 1979	Bongo	42° 15'N, 69° 43'W	C	187
Merluccius bilinearis	27 Jul 1971	Bongo	40° 54'N, 71° 47'W	D	187
Merluccius bilinearis	1 Sep 1978	Bongo	42° 17'N, 67° 48'W	E	187
Lophius americanus	28 Jun 1978	Otter trawl (egg mass)	3.5 km east of Sandy Hook, New Jersey	A	191
Sarda sarda	21 Jul 1974	Bongo	38° 27'N, 74° 05'W	F	315
Sarda sarda	18 Jul 1974	Bongo	38° 33'N, 73° 53'W	G	315
Sarda sarda	7 Aug 1966	Gulf V	39° 34'N, 72° 22.5'W	H	315
Moridae	6 Mar 1977	Bongo	40° 32'N, 71° 17'W	—	396

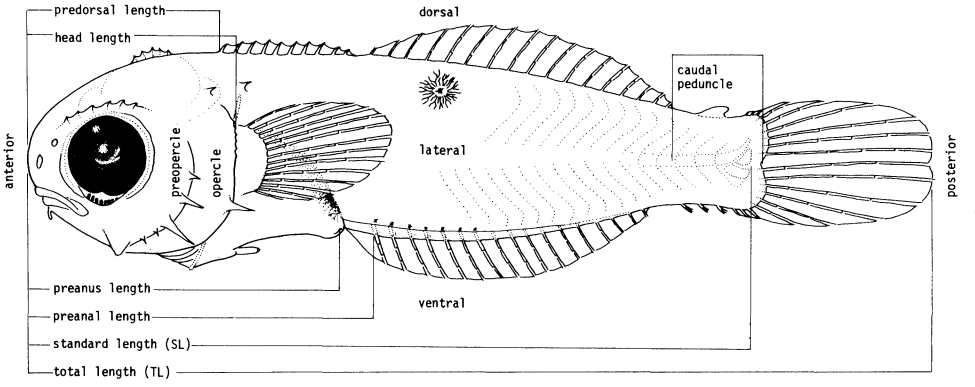
Explanatory Figures











Symbols and Abbreviations

a	—	anal
A(1-3)	—	anal fins (1st to 3rd)
ant.	—	anterior
Atl.	—	Atlantic
BD	—	body depth
ca	—	about; approximately
C	—	caudal fin
d	—	dorsal
D(1-3)	—	dorsal fins (1st to 3rd)
E	—	east; eastern
Fig.	—	Figure(s)
GR	—	gill rakers
HL	—	head length
lepto	—	leptocephalus larva
m	—	meters
mm	—	millimeter
MAB	—	Middle Atlantic Bight
N	—	north; northern
NL	—	notochord length
O.G.	—	oil globule
P	—	pectoral fin
PAL	—	preanal length
Plv	—	pelvic fin
post.	—	posterior
PrC	—	principal caudal ray
Ref.	—	references; sources of information
S	—	south; southern
S.F.	—	subfamily
SL	—	standard length
sp.	—	species
T	—	tribe
TL	—	total length
unpubl.	—	unpublished information
U.S.	—	United States
v	—	ventral
Vert.	—	vertebrae
W	—	west; western
WNA	—	Western North Atlantic
$>$	—	greater than; more than
$<$	—	less than; fewer than
$\leqslant$	—	less than or equal to
$=$	—	equal to; same as
$\simeq$	—	approximately equal to
$\sim$	—	approximately; almost
%	—	percent
$\bar{x}$	—	mean value of series of data
#	—	number

Caudal fin terminology

EP	—	epural
H(1-6)	—	hypural (1st to 6th)
HS	—	haemal spine
NS	—	neural spine
PH	—	parahypural
PU(1-2)	—	preural centra (1st to 2nd)
U(1-2)	—	ural centra (1st to 2nd)

Photophore terminology (see Myctophidae, page 103)

AO_a(1–5)	Dn	Pol	So
AO_p(1–4)	Op (1–2)	Prc(1–3)	VLO
Br (1–3)	PLO	PVO(1–2)	Vn
Bu	PO(1–5)	SAO(1–3)	VO(1–5)
Ce			

Photophore terminology (see Gonostomatidae-Sternoptychidae, page 72)

AC	IV	OP(1-3)	SO
BR(1-3)	OA	ORB	VAV

Meristic characters

Vert: (16)17+18	—	Indicates there are 17 precaudal vertebrae (rarely 16) and 18 caudal vertebrae.
D:XVI-XVII,10-11	—	Indicates there are 16 to 17 spines and 10 to 11 rays in the dorsal fin (other fin formulae are similar).
C: 12-13+9+8+11-12	—	Indicates there are 12 to 13 dorsal procurrent rays, 9 upper and 8 lower principal rays, and 11 to 12 ventral procurrent rays in the caudal fin.

Glossary

Adhesive. Sticking; clinging. An adhesive egg adheres to substrate or other eggs.

Adipose fin. Fleshy fin on the back behind the dorsal fin, as in salmons, smelts and lanternfishes.

Air bladder. Sac filled with air or other gases lying in the abdomen beneath the backbone and either attached or not to the walls of the body cavity.

Anal. Refers to anus or vent. Also a median fin situated on the ventral edge posterior to the anus (see explanatory figures, p. 12).

Anal fin origin. Point where first anal fin spine or ray joins the body.

Angle (of lower jaw). Bony prominences behind gape on ventrum of head; the angular/articular-quadrate junction (see explanatory figures, p. 12).

Anterior. Front portion; in front (see explanatory figures, p. 12).

Antrorse. Turned forward.

Aorta. Main artery carrying blood from left ventricle to other arteries.

Barbel. Slender tactile process on the lips of certain fishes (see explanatory figures, p. 12).

Basipterygium. Basal bone or process forming a support of the pelvic fins.

Bathypelagic. Living in deep waters of the oceans, especially those >1,000 m below the surface.

Bight. Curve or large embayment in a river, coastline, etc.

Branchiostegal (rays). Struts or ray-like bones attached to hyoid arch, connected by membrane (see explanatory figures, p. 12).

Bud. Base of one of the paired fins before ray formation (see explanatory figures, p.12).

Caruncles. Naked fleshy outgrowths.

Caudal fin. Median fin situated at the posterior end of the fish (see explanatory figures, p. 12).

Caudal peduncle. Narrow portion of fish's body between the posterior end of dorsal or anal fin and base of caudal fin (see explanatory figures, p. 12).

Chorion. Outer membrane of an egg: shell.

Choroid tissue. Mass of vascular tissue underlying the eye in certain myctophids and other fishes (see explanatory figures, p. 12).

Cleithral symphysis. Ventral junction of cleithral bones (see explanatory figures, p. 12).

Cleithrum. Vertical bone in pectoral girdle, considered the posterior limit of "head length" in early larvae (see explanatory figures, p. 12).

Concave. Hollow and curved, like the inside of a hollow ball.

Confluent. Flowing or running together, as in certain fishes where dorsal and anal fins are continuous with caudal fin.

Convex. Curving outwards like the surface of a hemisphere.

Convolutions. A twisting, coiling or winding together; a coiled appearance in the gut of some clupeids due to muscle bands overlying the intestine.

Crown. Dorsalmost margin of the head.

Demersal. Found on or near the bottom of the sea.

Dendritic melanophore. Branching pigment spot.

Dentary. Major long bone of lower jaw, usually bearing teeth.

Diaphanous. Translucent, veil-like.

Distal. Remote from the point of attachment or origin; opposite to proximal.

Dorsal. Back or upper part of the body; also a median fin situated on the upper part of the body (see explanatory figures, p. 12).

Dorsal fin origin. Point where the first dorsal fin spine or ray joins the body.

Dorsolateral. Of, relating to, or involving both the back and sides of the body.

Dorsum. Upper surface of the body, head, or other structure.

Duckbilled. Shaped like or terminating in something shaped like a duck's bill.

Elongate. Stretched out; having a form notably long.

Elver. Small cylindrical young eel, more advanced in development than leptocephalus.

Embryo. Organism in early stage of growth and differentiation prior to hatching.

Epibenthic. Fauna and flora of the sea bottom between low-water level and the mesobenthos down to a lower limit of about 100 m.

Eyestalks. Movable peduncles bearing the eyes at the tip.

Finfold. Median fold of integument extending along body of larva and from which the dorsal, caudal and anal fins are developed (see explanatory figures, p. 12).

Finlet. Small detached fins which follow the dorsal and anal fins (see explanatory figures, p. 12).

Flexion. Flexing of urostyle dorsally concurrent with development of hypural bones and other caudal-supporting structures.

Forebrain. Anterior of the three primary divisions of the vertebrate brain (see explanatory figures, p. 12).

Foregut. Anterior part of primitive alimentary canal.

Gape. Median margin-to-margin length of the open mouth.

Generic. Relating to or descriptive of all members of a genus.

Globoid. Sheroid.

Gut. Ventral portion of fish's body containing internal organs.

Gut loop. Loop, fold or curve found along axis of gut.

Haemal. Spine arising on ventral side of vertebral centrum; arch formed above fused distal ends of haemal spines (see explanatory figures, p. 12).

Hindbrain. Posterior of the three primary divisions of the vertebrate brain (see explanatory figures, p. 12).

Hindgut. Posterior part of the alimentary canal.

Homogeneous. Uniform composition throughout.

Hyomandibular. Bone or cartilage derived from the hyomandibular arch.

Hypurals. Bony structures, formed of expanded and/or fused haemal spines or pterygiophores of the last few vertebrae, which support the caudal fin rays.

Illicium. First dorsal fin spine of a pediculate fish migrated to the upper lip and transformed into a complex tentacle which serves as a lure to attract prey.

Insertion. Mode or place of attachment (usually posterior); opposite to origin.

Interopercle. Lower anterior (usually small) bone of the operculum lying under the preopercle.

Interorbital. Situated or extended between the orbits of the eyes.

Isthmus. Ventral fleshy area on the throat between the gills of a fish.

Juvenile stage. Young fish, fundamentally like the adult in meristic characters (excluding scalation) but smaller and reproductively inactive.

Larva. Any organism which at birth or hatching is fundamentally unlike its parent and must pass through metamorphosis before assuming adult characters.

Leptocephalus. Pelagic larvae of the orders Anguilliformes, Elopiformes and Notacanthiformes, with small heads, prominent teeth, and transparent, ribbonlike bodies.

Lunate. Crescent-shaped.

Maxillae. Longest paired bones of the upper jaw; usually associated with paired premaxillae.

Melanophore. Cell containing melanin; a black or brown pigment cell.

Meristic characters. Countable structures occurring in series (vertebrae, myomeres, fin rays, etc.).

Mesopelagic. Occurring in the open sea at middle depths, usually 100–1,000 m.

Metamorphosis. A marked change in the form or structure of an animal during postembryonic development, involving acquisition of adult characters and loss of larval characters (syn: transformation).

Midbrain. Middle of the three primary divisions of the vertebrate brain (see explanatory figures, p. 12).

Midline. The median line or median plane of the body or some part of the body.

Migration (eye). Movement of the eye from one side of the head to the other in pleuronectiform fishes.

Myomeres. Muscle segments occurring in a series along the sides of the body, the number being about equal to the number of vertebrae in adults (see explanatory figures, p. 12).

Myosepta. Dividing tissue between adjacent myomeres (see explanatory figures, p. 12).

Nape. Dorsum of "neck" area immediately posterior to the head.

Nasal organ. Rosette found on nose of larvae prior to formation of paired nostrils.

Neustonic. Occurring in surface water.

Notochord. Longitudinal flexible rod of cells forming the support axis of the body.

Notochord length (NL). A straight-line measurement from tip of snout to tip of notochord (see explanatory figures, p. 12).

Nuchal bar. Band of pigment lying in the region of the nape.

Occipital crest. Bony ridge, usually serrated, on top of head (see explanatory figures, p. 12).

Occiput. Dorsal outline of head from nape to snout.

Oil globules. Discrete spheres of fatty material with buoyant properties within the yolk of eggs of some fishes.

Opercle. Upper posterior and usually the largest bone of the operculum of a fish (see explanatory figures, p. 12).

Operculum. Bony plate of the gill cover.

Opisthonephros. The larval kidney, resembling but not identical to the embryonic mesonephros.

Orbital. Referring to the orbit or eye.

Origin. The more fixed, central or anterior point of attachment of a structure (i.e. fin).

Ossification. Process of bone formation; skeletal structures are generally considered to be ossified when they take up bone-specific stains.

Otic. Pertaining to the ear.

Ovoviviparous. Producing eggs that develop within the maternal body and hatch within or immediately after extrusion from the female parent.

Palatine teeth. Teeth lying on the palatine bones in the roof of the mouth.

Papilla. Fleshy projection or protuberance.

Papilliform hyoid barbel. Short fleshy protuberance in the hyoid area.

Pectoral fin. Paired fins behind the head (see explanatory figures, p. 12).

Pedicel. A small, short stalk or stem.

Peduncle. A narrow part (or stalk) by which some larger part of the whole body is attached or joined to a distal structure.

Pelagic. Of, relating to, or living in the open sea.

Pelvic fins. Paired fins, usually on the ventrum posterior to or under the head (see explanatory figures, p. 12).

Peritoneal pigment. Internal pigment on the peritoneum or dorsum of the abdominal cavity (see explanatory figures, p. 12).

Peritoneum. Smooth transparent serous membrane which lines the cavity of the abdomen.

Perivitelline space. Fluid-filled space between the fertilization membrane and chorion of a fish egg.

Photophores. Luminous organs on various marine (mostly deepsea) fishes.

Pigmentation. Deposition of pigment in body tissues.

Planktonic. Passively floating or weakly swimming with the prevailing currents.

Posterior. Situated toward the rear portion or tail; opposite to anterior (see explanatory figures, p. 12).

Postorbital. Situated behind the orbit.

Posttemporal spine. A sharp, externally visible, process emerging from the posttemporal bone of the skull (see explanatory figures, p. 12).

Preanal. Situated in front of the origin of the anal fin or anal finfold (see explanatory figures, p. 12).

Preanus. Situated in front of the anus (see explanatory figures, p. 12).

Premaxillae. Paired bones of upper jaw, usually containing teeth and associated with maxillae.

Preopercle. Upper anterior bone of the operculum (see explanatory figures, p. 12).

Principal caudal rays. Caudal-fin rays originating on hypural elements (see Procurrent rays).

Procurrent rays. Small (dorsal and ventral) rays of the caudal fin, not articulating with hypural elements.

Proximal. Near point of attachment or origin; opposite to distal.

Pterotic spines. Pertaining to spines in the area between the prootic and epiotic bones in the dorsal and outer part of the temporal region of a fish.

Pterygiophores. Cartilaginous or bony elements by which fin rays of a fish are supported (see explanatory figures, p. 12).

Ramus (rami). The length (usually horizontal) of the lower jaw.

Rays. Segmented fin supports, bilaterally paired, often branched (see explanatory figures, p. 12).

Reticulated. In the form of a network or web.

Retrorse. Bent backward or downward.

Sculptured. Property of egg shell bearing distinctive shapes, convolutions, or other ornamentation.

Segmented. Separated into divisions or segments.

Shell. Covering or outside of an egg; chorion.

Smooth (shell). Uniform, not rough or sculptured.

Snout. Forward part of the head, anterior to the eye (see explanatory figures, p. 12).

Spatulate. Spoon-shaped.

Sphenotic. Pertaining to a bone of the skull, situated above the prootic and often forming a part of the posterior boundary of the orbit.

Spines. Unsegmented fin supports, unpaired, unbranched, and usually stiff and sharp.

Spinous scale. Larval scale bearing spines or sharp processes (not the ctenoid scale of some adult fishes).

Stalked eye. Eye situated on stalk or peduncle.

Standard length (SL). Straight-line measurement from tip of snout to posterior edge of middle hypural elements (see explanatory figures, p. 12).

Stellate melanophore. Star-like pigment spot.

Striations. Showing narrow structural bands or lines.

Subcutaneous. Situated or occurring beneath the skin.

Subopercle. Posterior bone of the operculum, usually lying under the opercle.

Subterminal mouth. Set back from anteriormost point of snout (as in sharks, bonefish, etc.).

Supracleithral spine. Occurring above the cleithrum, with origin on the supracleithral or temporal bone.

Supraoccipital spine. Spine or crest on midline of the occiput (see explanatory figures, p. 12).

Supraorbital spine. Occurring above the eye, often in a series or crest (see explanatory figures, p. 12).

Tail. That portion of the larval body posterior to the anus (see explanatory figures, p. 12).

Telescopic eye. An eye (not on a stalk) protruding within an envelope of skin.

Terminal mouth. Located at termination of head or anterior tip of larva.

Total length (TL). Straight-line measurement from most anterior point to most posterior point of the fish (see explanatory figures, p. 12).

Transformation. (See Metamorphosis).

Tubercle. Small knobby prominence.

Urohyal. Median posterior bony element of the hyoid arch attached between the hypohyals.

Urostyle. The last vertebral element in fishes, formed by fusion or loss of several posterior centra.

Vent. Ventral opening of the alimentary canal or anus (see explanatory figures, p. 12).

Ventral. Underside; opposite to dorsal (see explanatory figures, p. 12).

Ventral fins. Pelvic fins.

Ventrum. Lower surface of the body, head or other structure.

Vertical blood vessel. Blood vessel perpendicular to the midline which connects the dorsal aorta with the gut region or the kidney in larval eels (leptocephali).

Yolk. Material stored in the ovum which provides nutrition for the developing embryo.

Yolk-sac larva. Early larva containing yolk in a sac in the gut region.

Developmental Characters

Egg and larval characters of orders (and suborders). (After Ahlstrom and Moser 1976, except Elopiformes, Lophiiformes, Atheriniformes and Tetraodontiformes.)

Character	Clupeiformes	Elopiformes	Anguilliformes	Salmoniformes (Argentinoidei)
Eggs				
Pelagic?	Yes (few demersal)	Undescribed	Yes	Yes
Shape	Spherical (most); Oval (engraulids)	Undescribed	Spherical	Spherical
Chorion (shell)	Smooth	Undescribed	Smooth	Ornamented (usually)
Yolk	Segmented	Undescribed	Segmented	Segmented
Perivitelline space	Narrow to wide	Undescribed	Wide	Narrow
Oil globules	0 or 1	Undescribed	0, 1, or more	1 to many
Larvae				
Body shape	Elongate, slender	Leptocephalus-like, forked tail	Leptocephalus	Elongate, slender
Preanus length/SL	65–95%	75–90%	40–95%	70–90%
Gut character	Straight	Straight	Straight/looped	Straight
Trailing gut?	No	No	Seldom[a]	No
Vertebrae (range)	~40–60	54–82	68–400+ 100–250 (most)	~40–85
Eyes	~Round	Round	Round to moderately narrow[b]	Round to narrow, some stalked
Head spines	No	No	No (usually)	No
Early-forming fin rays or spines	No	No	No	No
Transformation	Marked; fins migrate	Marked; shrinkage and regrowth	Marked; shrinkage and regrowth	Marked
Early (special) juvenile stage?	No	No	No	No

[a] Present in some congrids.
[b] Few telescopic; several with choroid tissue.

Egg and larval characters (cont'd)

Character	Salmoniformes (Stomiatoidei)	Myctophiformes	Gadiformes	Lophiiformes
Eggs				
Pelagic?	Yes	Yes	Yes	Yes (often in veils)
Shape	Spherical	Spherical	Spherical	Spherical; oval in few
Chorion (shell)	Smooth (usually) sculptured[c] double[d]	Smooth (usually) sculptured[e]	Smooth (usually) sculptured[g]	Smooth
Yolk	Segmented	Segmented or homogeneous	Homogeneous	Segmented or homogeneous
Perivitelline space	Wide to narrow	Narrow	Narrow	Narrow
Oil globules	0 or 1	0 or 1	0, 1 to multiple	0 or 1
Larvae				
Body shape	Elongate, slender	Varies; often elongate	Varies; elongate to stocky	Ovoid, short, plump
Preanus length/SL	30–95% (most long)	~40–70%	<50%	⩾75% (most)[h]
Gut character	Straight	Straight[f]	Coiled	Coiled, voluminous
Trailing gut?	Often	Seldom	No	No
Vertebrae (range)	~30–100+	28–45 (myctophids) 29–121 (others)	44–66 (most) 80–116 (macrourids)	18–26
Eyes	Round to narrow, some stalked	Round to narrow, seldom stalked	Round	Round
Head spines	No	No (most); Strong (some)	No (usually)	Rarely
Early forming fin rays or spines	Occasionally	Pectoral rays (occasionally)	Pelvic fins (usually)	Dorsal, pectoral, pelvic (often)
Transformation	Marked; photophores often form slowly	Varies; marked, prolonged or delayed	Gradual	Marked
Early (special) juvenile stage?	No	In some	Pelagic juveniles; several strategies	No

[c] *Maurolicus*.
[d] *Stomias* and *Chauliodus*.
[e] Synodontidae and *Aulopus japonica* (M. Okiyama, 1982, pers. comm.).
[f] Various shapes.
[g] Macrouridae.
[h] Lophiidae ~33%.

Eggs and larval characters (cont'd)

Character	Atheriniformes (Exocoetoidei)	Beryciformes	Scorpaeniformes
Eggs			
Pelagic?	Yes/no	Yes	Mostly demersal or ovoviviparous
Shape	Oval, large to about spherical	Spherical	Spherical
Chorion (shell)	Often ornamented by spines, filaments	Smooth	Smooth
Yolk	Homogeneous	Homogeneous	Homogeneous
Perivitelline space	Narrow	Narrow	Narrow
Oil globules	0	1	1 to many
Larvae			
Body shape	Elongate, slender	Slender to stocky	Stocky (most)
Preanus length/SL	65–75%	30–60%	~35–60%
Gut character	Straight	Coiled	Coiled
Trailing gut?	No	No	No
Vertebrae (range)	39–54 (exocoetids) 64–97 (others)	23–33	~25–65
Eyes	Round, large	Round	Round
Head spines	No	None to very strong	Usually
Early-forming fin rays or spines	Caudal fin formed at hatching	Pelvic (often); anterior dorsal	No (but pectoral often large)
Transformation	Gradual	Gradual (usually)	Gradual
Early (special) juvenile stage?	No	Sometimes (holocentrids)	Pelagic-juveniles in some

Egg and larval characters (cont'd)

Character	Perciformes	Pleuronectiformes	Tetraodontiformes
Eggs			
Pelagic?	Many pelagic; many demersal	Yes (few demersal)	No; demersal adhesive
Shape	Spherical (most)	Spherical	Spherical
Chorion (shell)	Smooth (most)	Smooth	Sculptured
Yolk	Homogeneous[i]	Homogeneous	Homogeneous
Perivitelline space	Narrow	Narrow[j]	Narrow to moderate
Oil globules	0, 1 or more	0, 1 or more	Multiple
Larvae			
Body shape	Moderately elongate to stocky	Varies, compressed	Deep, stocky
Preanus length/SL	20–60%	<40–50%	~50%
Gut character	Coiled (most)	Coiled	Coiled, voluminous
Trailing gut?	No	No	No
Vertebrae (range)	24–28 (most) ~20–100+	25–65	17–23
Eyes	Round (most)	Round	Round
Head spines	None to very strong	Frequently	Rarely
Early-forming fin rays or spines	Sometimes; pelvic or anterior dorsal	Often; pelvic or anterior dorsal	None, or early dorsal spine
Transformation	Gradual (usually)	Marked; eye migrates	Gradual
Early (special) juvenile stage?	In some	Can have long larval stage	No

[i] Segmented in some carangids.
[j] Wide in *Hippoglossoides*.