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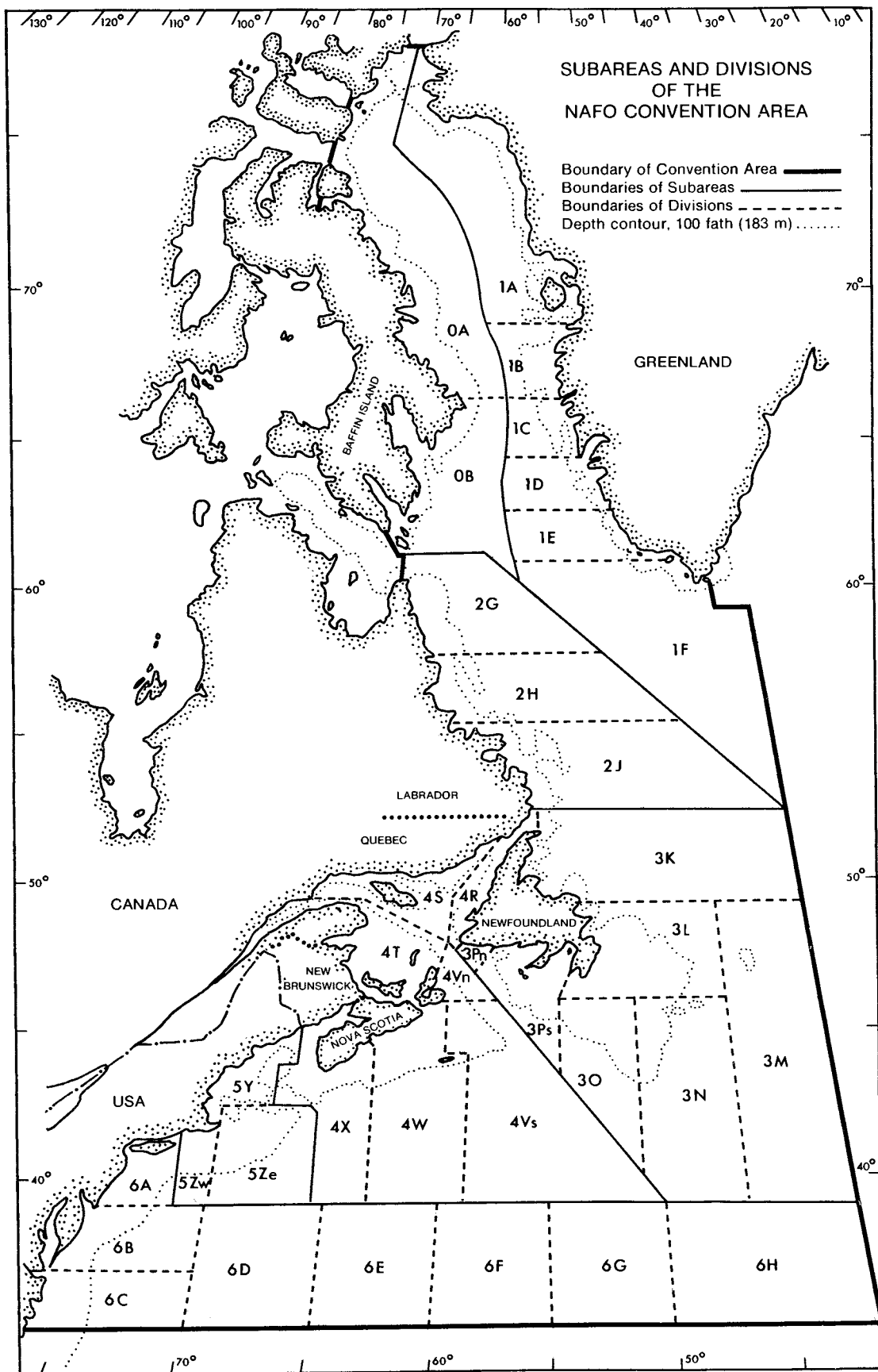


Volume 4

Guide to the Early Stages of Marine Fishes Occurring
in the Western North Atlantic Ocean, Cape Hatteras
to the Southern Scotian Shelf

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Preface

This guide presents egg and larval descriptions of 290 species of fishes (contained within 92 families, 28 suborders and 13 orders) likely to be collected in plankton and neuston sampling operations in continental shelf and oceanic waters of the western North Atlantic. Coverage is designed to emphasize species occurring between Cape Hatteras (latitude 35°N) and the southern Scotian Shelf (about 43°N) and includes oceanic mesopelagic and bathypelagic forms. Coverage is also designed to provide (a) as wide a phylogenetic survey of larval characters as today's published record allows, and (b) direct comparisons of confusing species pairs. The latter two considerations result in the inclusion of a few estuarine species or species occurring south of Cape Hatteras.

Throughout the taxonomic section of the guide, illustrations are placed on the right-hand page and the corresponding descriptions are placed on the left. Consistency in the descriptions is largely dependent on descriptive information available in the published literature. Certain meristic and morphometric characteristics of adults are included to aid in the identification of larger larvae and juveniles. Special introductory pages, which summarize and compare characters for a number of species, are provided for the families Gonostomalidae (including Sternoptychidae), Myctophidae, Paralepididae, Carangidae, Sciaenidae, Scombridae and the (sub)orders Anguilliformes, Gadiformes, Ceratioidei, Stromateoidei and Pleuronectiformes.

Many published illustrations have been redrawn, primarily to correct inconsistencies and errors in the original descriptions, but also to provide uniformity throughout the guide. Introductory material includes explanation pages, a glossary of terms widely used in ichthyoplankton work, a table of larval characters for the 13 orders, and a table of meristic characters (including presence or absence of adipose fin), arranged according to range of myomeres or vertebrae, to assist in the identification of problem larvae.

May 1983

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Introduction

Ichthyoplankton research in recent years has advanced beyond the expedition era where early developmental stages of fishes were collected solely for taxonomic and descriptive purposes or to establish locations where spawning occurred. Ichthyoplankton surveys today provide the material necessary to study many aspects of fisheries research. The abundance and distribution of eggs are used to derive estimates of the sizes of spawning populations. Collections of fishes in their larval phase provide material for various studies (including age, length and growth, feeding and starvation, predation, mortality, transport by currents during development, and impacts of pollution), which lead to an understanding of the factors determining year-class success and brood strength. Because most fish species produce pelagic eggs or larvae, use of plankton sampling gear provides information on a wide range of species and leads to a better understanding of the entire fish community, including under-utilized species. Furthermore, characters of eggs and larvae, when examined and compared above the specific level, provide insight into the related problems of systematics and phylogeny (e.g. see Moser and Ahlstrom 1970, 1974; Johnson 1974; Okiyama 1974; Okiyama and Ueyanagi 1978; Kendall 1979; Richardson 1981).

Within the area covered by this guide, the Marine Resources, Monitoring, Assessment and Prediction (MARMAP) Program of the U. S. National Marine Fisheries Service has undertaken surveys of ichthyoplankton and related parameters on an intensive basis since 1971. The area, which is completely sampled six to eight times each year, covers 260,000 km² of continental shelf waters from Cape Hatteras, North Carolina, to the Scotian Shelf. The ichthyoplankton data accruing from these surveys provide valuable scientific information leading to an understanding of population levels of fishery resources which vary seasonally and annually.

In order to utilize ichthyoplankton for fisheries-related research, it is obviously essential that eggs and larvae be correctly identified. Correct identification, in turn, depends on systematic analyses of characters which can only be undertaken after examining those characters in all related larvae of a group, whether at the level of genus, family or order, thus gaining an appreciation for the value of certain characters. Although this dependence on correct identification appears to be an obvious requirement, several gaps exist in knowledge of early life-history stages of western North Atlantic fishes, including some commercially-important species. In the western North Atlantic, more detailed and exacting descriptions are needed for commercially-important species of the families Clupeidae, Gadidae, Scorpaenidae and Pleuronectidae, as well as ecologically-important groups, including Ammodytidae, Ophidiidae, Triglidae and Anguilliformes.

Scientists studying the ichthyoplankton of the western North Atlantic must, in some cases, rely on descriptions of eastern Atlantic material. Such reliance may be dangerous when one acknowledges the vagaries of geographic variation in early fish development. Users of this guide should, where possible, be aware of the sources of material for descriptions of larval development and should also be aware that larval characters may vary between regions. For example, the characters described herein for *Scomber* pertain to specimens collected in the western North Atlantic off the northeastern United States and may not apply to *Scomber* larvae collected elsewhere. Where appropriate in this guide, instances are indicated where larval descriptions were derived from specimens collected in the eastern Atlantic, Pacific or other oceans.

Species selected for inclusion in this guide are those for which published larval descriptions are available. Some are augmented by previously unpublished observations of the author or a reviewer, but it is not the purpose of this guide to formally publish original detailed

descriptions of larval development. A more complete listing of sources of information concerning the early life histories of fishes is available in the multi-authored six-volume series entitled "Development of Fishes of the Mid-Atlantic Bight: An Atlas of Egg, Larval and Juvenile Stages", published in 1978 by the Biological Services Program of the U. S. Fish and Wildlife Service.

In the course of preparing this guide, the author has drawn freely from notes generated by several students during an excellent series of courses in ichthyoplankton taxonomy taught by the late Dr E. H. Ahlstrom and Dr H. G. Moser at the National Marine Fisheries Service Laboratory in LaJolla, California, from 1971 to 1977. One of the recurring themes in those courses was that proper identification and description of larval fishes depend on ontogenetic series rather than on character states of the individual specimen. Thus the changes in a larval structure (sequence of formation of parts, loss or acquisition of transitory features) with development becomes as much a character as the simple presence or absence of a structure.

Depending on the adequacy and completeness of published descriptions of larval development, four broad subjects were considered in preparing the accounts for this guide: (1) Osteological characters include the time and sequence of development of bony parts as well as meristic characters present at certain stages of development (which may differ from meristic characters in adults). Also considered here was the presence or absence of transitory hard parts, such as body or head spines or larval spinous scales. (2) Morphometric characters include measurements of relative body proportions in the larval stages and how these change during ontogenetic development. The size at which notochord flexion and transformation to the juvenile stage occurs is often a very important feature and is included when known. (3) Descriptions of pigmentation characters include distinctive patterns of melanophore distribution and how these may change during development. (4) Miscellaneous characters include geographic range of the adults and/or larvae, spawning times and places, vertical distribution of eggs and larvae (if appropriate), and behavioral traits associated with certain stages (i.e. egg deposition on specific substrates, habits of pelagic juvenile stages, etc.). Users of this guide should understand that the contents represent current knowledge on the development of western North Atlantic fishes. It is hoped that the gaps which are evident in the text will stimulate further, more detailed research.

Acknowledgements

As this project was beginning, many of the details of format, content, and extent of coverage were worked out after long discussions with Dr Ahlie Ahlstrom and Dr Geoff Moser of the La Jolla Laboratory of the National Marine Fisheries Service. In addition to those discussions, Dr Ahlstrom completed a thorough review of the section on Myctophiformes shortly before his death in 1979. For access to larval fish collections, literature and many ideas about fish development based on unpublished information, I thank Ahlie, Geoff and Center Director, Dr Izadore Barrett, for their gracious hospitality. I am especially grateful to the following reviewers who made valuable suggestions and corrections on early drafts of the guide and most generously provided unpublished data from their own files on larval fish development: Peter L. Berrien (eggs); John L. Butler (Perciformes); John H. Caruso (Lophiiformes); Peter H. J. Castle (Anguilliformes); Daniel M. Cohen (Gadiformes); Bruce B. Collette (Atheriniformes, Beloniformes, Scorpaeniformes); John B. Colton (draft outline); Charles R. Futch (Pleuronectiformes); Elmer J. Guthertz (Pleuronectiformes); Dannie A. Hensley (Pleuronectiformes); Edward D. Houde (Elopiformes, Clupeiformes); Robert K. Johnson (Myctophiformes); Joanne L. Laroche (Cottidae); Wayne A. Laroche (Scorpaeniformes, Perciformes, Pleuronectiformes); Barbara Sumida MacCall (Perciformes); Douglas F. Markle (Gadiformes, Blennioidea, Pleuronectiformes); H. Geoffrey Moser (Myctophidae); Anne Naplin (eggs); Muneo Okiyama (Myctophiformes); Theodore W. Pietsch (Lophiiformes); Thomas Potthoff (Scombroidei); Sally L. Richardson (Cottidae); David G. Smith (Anguilliformes, Elopiformes); John W. Tucker Jr. (Pleuronectiformes) and Louis Van Guelpen (Cottidae, Pleuronectidae).

The following reviewed the entire draft and made innumerable comments and suggestions, and I appreciate their efforts very much: Sergei Evseenko, Edward D. Houde, Arthur W. Kendall Jr., Douglas F. Markle, Muneo Okiyama, Howard Powles, T. S. Rass, William J. Richards, Kenneth L. Sherman and Wallace G. Smith. I also thank five anonymous reviewers whose comments resulted in vast improvements to the manuscript. Maureen Montone undertook not only the task of typing but also the responsibility for organizing the material on each text page, and credit for clarity and organized arrangement goes to her with sincere thanks. Errors or omissions on these pages are the author's responsibility. Mabel Trafford spent hours tracking down and obtaining copies of pertinent literature; her remarkable memory and indefatigable energy were an inspiration. My thanks also go to Doris Finan who helped greatly in locating specimens for examination, to George Nelson for consistently good photocopies of illustrations, to Donald G. McMillan for help in assembling the glossary, to Jennie Dunnington who kindly offered her time to double check the References section, to Christa Facciolla and Alyce Wells for proofreading and citation verification, and to Hanna Fidelus-Ferlas of the Plankton Sorting and Identification Center, Szczecin, Poland, for illustrating various sciaenids.

For the use of some illustrations, I thank Springer-Verlag New York Inc. and Pergamon Press Ltd. Several workers allowed me to use data from unpublished theses or manuscripts, including Thelma Brockman (Thelma Jutare), James G. Ditty, Sergei Evseenko, Susan C. Goodwin, Carolyn Griswold, Robert K. Johnson, Nuzrat Khan, Joanne Laroche, I-Hsun Ni, John Olney and Thomas Potthoff.

Methods

This guide was planned and designed to be most useful to the biologist-technician faced with the task of identifying large numbers of eggs and larvae representing a wide range of taxa. Toward that end, pertinent literature has been evaluated, oversights and errors have been corrected, and, where necessary, previous descriptions have been tempered with more recent (some unpublished) observations. The emphasis has been placed on the most diagnostic, easily-observable characters, but details of ossification sequence and changes in morphometry with growth are included, in order to facilitate comparisons between related taxa. Users who are unfamiliar with the larval morphology of major groups should consult the tables on pages 20–23 and 401–406 and the various introductory pages before attempting to identify specimens to the species level. With a few exceptions, illustrations are placed on the right-hand page and the corresponding text on the facing, left-hand page. Names of orders, suborders or families are located in the appropriate upper corner of each page to provide a “thumb index”. The phylogenetic sequence of this guide follows Nelson (1976).

Coverage. This guide contains descriptions of eggs and larvae of fishes likely to be collected in plankton and neuston sampling operations in continental shelf and adjacent oceanic waters from the southern Scotian Shelf and Gulf of Maine southward to Cape Hatteras (latitude 35°N) (NAFO Divisions 4X, 5Y–Z, 6A–D). The coverage is designed to provide (a) as wide a phylogenetic survey of larval characters as today's published records allow, and (b) direct comparisons of confusing species pairs or groups. These considerations result in the inclusion of a few primarily estuarine species or species generally occurring south of Cape Hatteras.

Introductory pages. Additional pages of information, which summarize and compare characters for a number of species, are provided for the orders Anguilliformes, Gadiformes and Pleuronectiformes, for the suborders Ceratioidei and Stromateoidei, and for the families Gonostomatidae (including Sternoptychidae), Myctophidae, Paralepididae, Carangidae, Sciaenidae and Scombridae. These pages precede the pertinent taxonomic section.

Nomenclature. The scientific name of each species is centered in bold italics at the top of each text page or midway down the page when more than one species is treated. Nomenclature follows Robins *et al.* (1980) for continental shelf species and the most recent revision for oceanic species. Exceptions are noted in the text. The grammatical form of family names follows recent general usage (see Steyskal 1980, and discussion by Robins *et al.* 1980).

Sequence of description. When morphological information was considered adequate and complete, the following sequence was used: details of spawning (season and area); characters of egg and embryo; morphometry (including at least preanus length, head length and body depth) for preflexion, flexion and postflexion stages; size ranges in which flexion and transformation (metamorphosis) occurs, presence of and size at formation of transitory spines or other larval structures; sequence of ossification of fin rays, vertebrae and teeth, if such data were available; pigmentation characters, including changes in pigment pattern with development; comments on geographic range, if pertinent; and figure credits and references consulted for text information.

Meristic characters. The myomere count (range) in larvae and the vertebral count (range) and pertinent fin-ray counts in adults are positioned in the upper right hand corner of the text page pertinent to the species. Whenever possible, the counts listed therein pertain to the western North Atlantic region encompassed by this guide.

Measurements. Linear measurements are designated NL (notochord length), SL (standard length) or TL (total length), depending on the usage of the cited author. If the author's method of measurement was unclear or indeterminable, the listed measurement is not followed by a qualifier. In a few cases (preflexion larvae), the author's original "SL" was converted to "NL" (see explanatory figures, page 12); "Preanus length" in this guide refers to a straight-line measurement from the tip of the snout to a vertical through the anus, and "preanal length" refers to a straight-line measurement from the tip of the snout to a vertical through the origin of the first anal spine or ray. In some cases, the terminology of the cited author was changed to adhere to these rules.

Figure citations. Sources of illustrations are cited after "Fig." at the bottom of each text page. If illustrations have been redrawn, the cited source is followed by "(redrawn)". A few previously unpublished illustrations are included, and the sources of this material are given on page 11. Figure citations should also be regarded as sources of information on the text page.

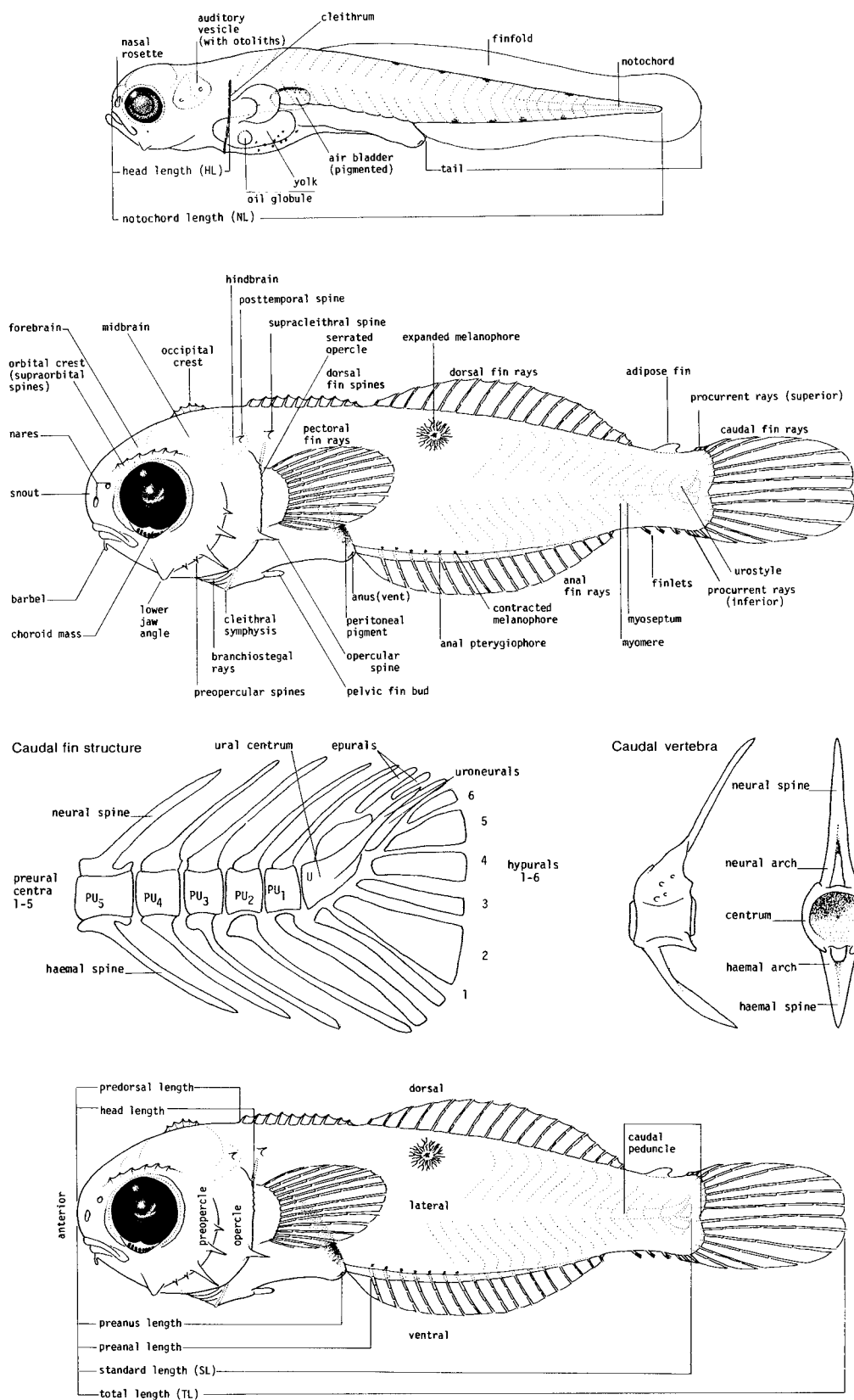
References. Citations listed after "Ref." at the bottom of the text page pertain to sources from which information other than illustrative material was obtained.

Illustrations. These generally appear on the page facing the text page. Published illustrations were examined closely for adherence to descriptions accompanying them. When redrawing was deemed necessary, extraneous pen-strokes were deleted and an attempt was made to adopt a uniform style. Fin rays have not been included in illustrations unless it was clear that they were fully ossified. In a few cases, myomeres were redrawn to bring illustrations into agreement with descriptions.

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
<i>Bathypterois</i> sp.	7 May 1967	2-m hoop	26° 47'N, 79° 50'W	B	99
<i>Enchelyopus cimbrius</i>	(unknown)	(unknown)	Shoreham, Long Island, New York	A–F	173
<i>Merluccius albidus</i>	8 Jul 1978	Bongo	40° 13'N, 70° 25'W	B–C	185
<i>Merluccius albidus</i>	30 Sep 1979	Bongo	40° 25'N, 68° 20'W	D–E	185
<i>Merluccius bilinearis</i>	21 Aug 1979	Bongo	41° 04'N, 71° 42'W	B	187
<i>Merluccius bilinearis</i>	1 Sep 1979	Bongo	42° 15'N, 69° 43'W	C	187
<i>Merluccius bilinearis</i>	27 Jul 1971	Bongo	40° 54'N, 71° 47'W	D	187
<i>Merluccius bilinearis</i>	1 Sep 1978	Bongo	42° 17'N, 67° 48'W	E	187
<i>Lophius americanus</i>	28 Jun 1978	Otter trawl (egg mass)	3.5 km east of Sandy Hook, New Jersey	A	191
<i>Sarda sarda</i>	21 Jul 1974	Bongo	38° 27'N, 74° 05'W	F	315
<i>Sarda sarda</i>	18 Jul 1974	Bongo	38° 33'N, 73° 53'W	G	315
<i>Sarda sarda</i>	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	PrC	— principal caudal ray
A(1-3)	— anal fins (1st to 3rd)	Ref.	— references; sources of information
ant.	— anterior	S	— south; southern
Atl.	— Atlantic	S.F.	— subfamily
BD	— body depth	SL	— standard length
ca	— about; approximately	sp.	— species
C	— caudal fin	T	— tribe
d	— dorsal	TL	— total length
D(1-3)	— dorsal fins (1st to 3rd)	unpubl.	— unpublished information
E	— east; eastern	U.S.	— United States
Fig.	— Figure(s)	v	— ventral
GR	— gill rakers	Vert.	— vertebrae
HL	— head length	W	— west; western
lepto	— leptocephalus larva	WNA	— Western North Atlantic
m	— meters	>	— greater than; more than
mm	— millimeter	<	— less than; fewer than
MAB	— Middle Atlantic Bight	≤	— less than or equal to
N	— north; northern	=	— equal to; same as
NL	— notochord length	≈	— approximately equal to
O.G.	— oil globule	~	— approximately; almost
P	— pectoral fin	%	— percent
PAL	— preanal length	\bar{x}	— mean value of series of data
Plv	— pelvic fin	#	— number
post.	— posterior		

Caudal fin terminology

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

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. Fleishy fin on the back behind the dorsal fin, as in salmon, 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-quadrato junction (see explanatory figures, p. 12).

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

Antorse. 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.** Spheroid.
- 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 post-embryonic 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).

Preal. 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.

Retorse. 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
Prenus 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) juv- enile stage?	No	No	No	No

^a Present in some congrid.

^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
Preamble 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 (oc- casionally)	Pelvic fins (usually)	Dorsal, pectoral, pelvic (often)
Transformation	Marked; photophores often form slowly	Varies; marked, pro- longed or delayed	Gradual	Marked
Early (special) juv- enile 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)
Preamble 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) juv- enile stage?	No	Sometimes (holo- centrids)	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) juv- enile stage?	In some	Can have long larval stage	No

ⁱ Segmented in some carangids.^j Wide in *Hippoglossoides*.

CLUPEIDAE***Brevoortia tyrannus* (Latrobe)****Spawning:** Autumn and spring in Mid-Atlantic Bight.**Meristic features**

- Eggs**
- Pelagic, spherical.
 - Diameter: 1.30-1.95 mm.
 - Shell: smooth and thin.
 - Yolk: segmented.
 - Perivitelline space: wide.
 - Oil globules: 1.
 - O.G. diameter: 0.11-0.17 mm.
 - Pigmentation: 2 rows of dorsolateral spots snout to tail on late embryo.

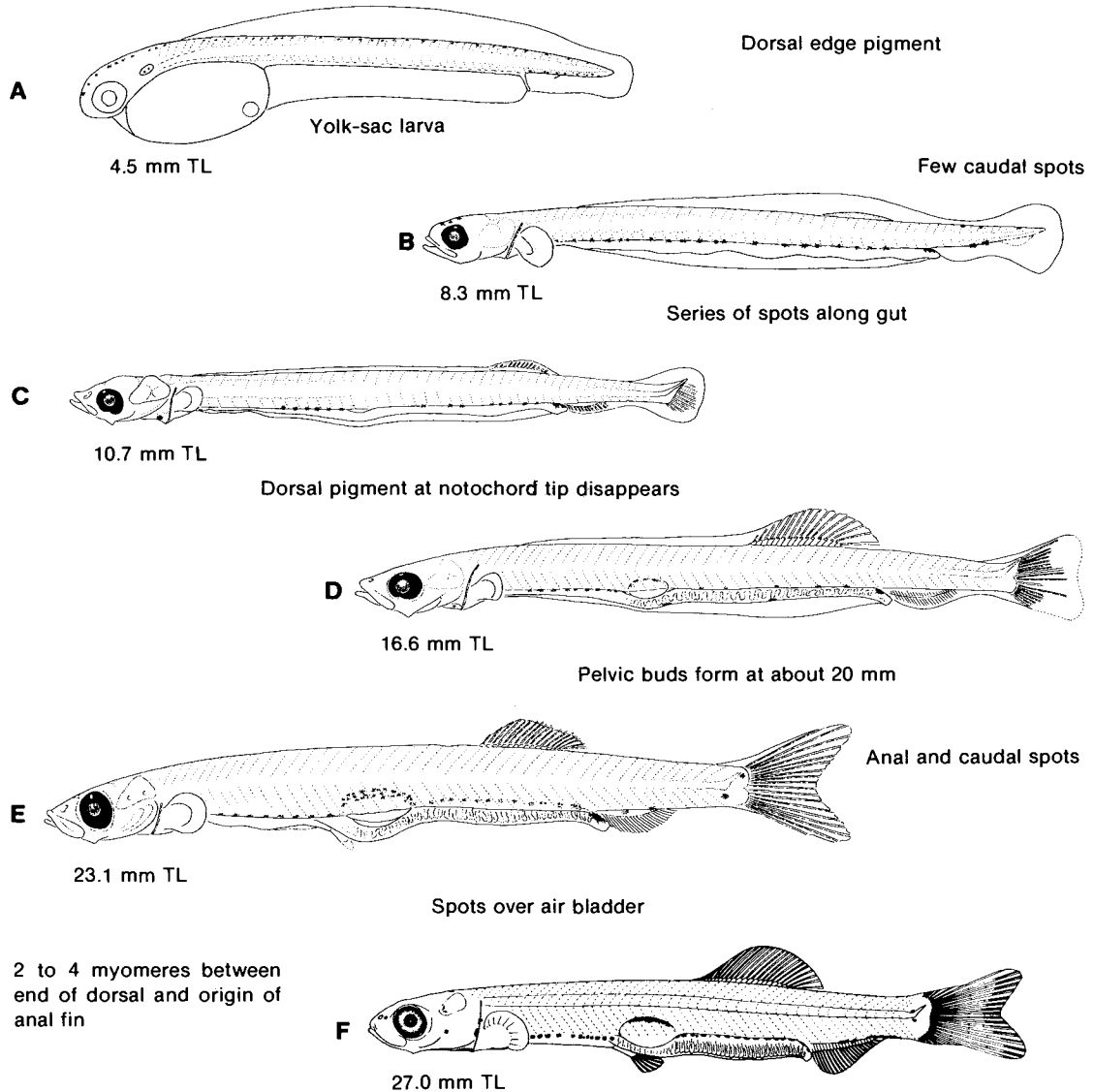
Myomeres: 45-50
 Vert : 18-19+29-30
 D : 18-24
 A : 18-24
 Plv : 7
 C : 7-9+10+9+6-7

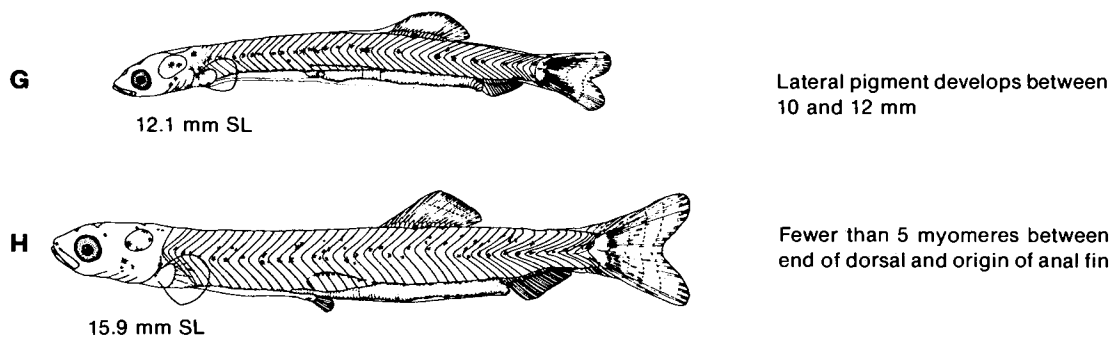
- Larvae**
- Hatching occurs at 2.4-4.5 mm; eyes unpigmented.
 - Body elongate, with straight gut 70-80% TL; vent always posterior to dorsal fin.
 - Preanal myomeres 35 at hatching and 37-40 in larger larvae.
 - Flexion occurs at 8-10 mm, and transformation at about 30 mm (in estuaries).
 - Fin formation: pectoral forms first as bud but is not complete until transformation; dorsal, anal and caudal form at about 8 mm, but not complete until near transformation; pelvic forms at about 20 mm.
 - Muscle-band striations obvious in posterior gut.
 - Air bladder evident at about 11 mm.
 - Enter estuaries after about 1 month as pelagic larvae at sizes of 10 mm and larger.
 - Pigmentation: spots along entire dorsal surface of gut and along ventral surface of posterior half of gut at 5.0 mm; dorsal spots on body disappear at about 5.7 mm (see illustrations opposite).

Important characters:

- Myomeres between dorsal and anal fins increase from 2 to 4.
- Dorsal pigment present at notochord tip in small larvae; ventral pigment also present at notochord tip.
- High dorsal and anal fin ray counts.

Note: *Brevoortia smithi* ranges from North Carolina to Louisiana; range of myomeres is 45-47, and transformation occurs at 20-24 mm.

Brevoortia tyrannus**CLUPEIDAE**

Brevoortia smithi

CLUPEIDAE***Clupea harengus* Linnaeus**

Spawning: Mostly concentrated around Gulf of Maine, mainly in autumn.

Meristic features

- Eggs**
- Demersal, adhesive.
 - Diameter: 1.0–1.4 mm.
 - Shell: smooth, transparent and thick.
 - Yolk: segmented.
 - Perivitelline space: wide
 - Oil globules: none.

Myomeres: 52–62
 Vert : 23–25+32–33
 D : (16)17–19(22)
 A : (15)17–19(21)
 Piv : 6–10
 C : 10–13+10+9+8–9

- Larvae**
- Hatching occurs at 4–10 mm TL; eyes pigmented.
 - Elongate with long straight gut; vent always posterior to dorsal fin.
 - Preanal length 80% TL; preanal myomeres 47, becoming 41–46 at sizes >20 mm.
 - Flexion occurs at 16–17 mm, and transformation at about 30 mm.
 - Fin formation: pectoral forms first as bud but is not complete until transformation; dorsal forms at about 10 mm and anal at about 16 mm, both complete at transformation; principal caudal rays complete at about 20 mm; pelvic fin forms between 20 and 30 mm, and migrates posteriorly at transformation.
 - Muscle-band striations obvious in posterior gut.
 - Air bladder forms at 10–15 mm, but not noticeable until about 30 mm.
 - Pigmentation: (see illustrations opposite).

Important characters:

- High myomere count; 8–9 myomeres between dorsal and anal fins decrease to 4 at 30 mm.
- Dorsal pigment present at notochord tip after yolk absorption, but variable; ventral pigment present at notochord tip.
- Late anal fin ray formation.

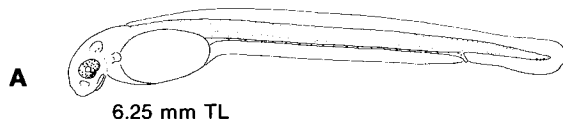
- Note:**
- (1) High myomere count and late anal fin formation are unique for Mid-Atlantic Bight clupeids.
 - (2) See *Mallotus villosus* (p. 62) for note on similar larvae.

Fig. — **A–C, E**, Krevanovsky 1956; **D**, Ehrenbaum 1909; **F**, Fage 1920 (all redrawn).

Ref. — Russell 1976; Jones *et al.* 1978.

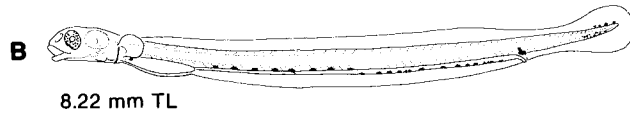
Clupea harengus

CLUPEIDAE

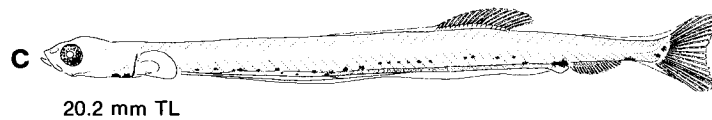


Dorsal and ventral pigment at notochord tip after yolk absorption

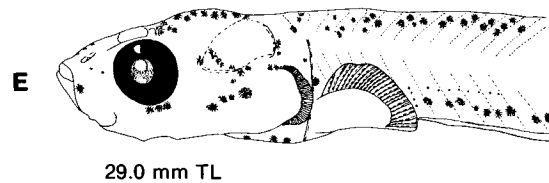
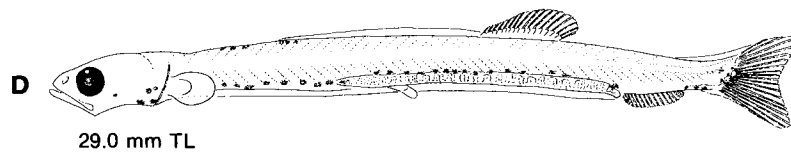
Single streak of pigment on midline of isthmus



Gut pigment: dorsal spots anterior half, ventral spots posterior half (changes later to only dorsal pigment)

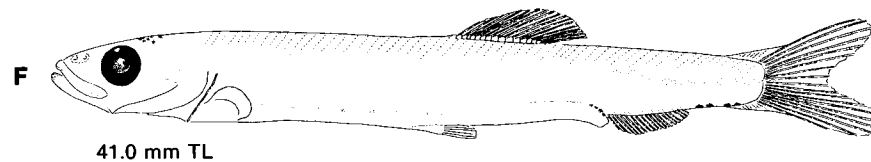


Large spots near vent and at caudal base



Pigment increasing on head and dorso-lateral region

Dorsal fin origin migrates anteriorly from myomere 33 at 26 mm to myomere 25 at 55 mm



A-E (eastern Atlantic material); **F** (Mediterranean specimen).

CLUPEIDAE***Etrumeus teres* (DeKay)****Spawning:** Winter-spring in Gulf of Mexico.**Meristic features****Eggs**

- Pelagic, spherical.
- Diameter: 1.17–1.53 mm.
- Shell: smooth, transparent and thick.
- Yolk: segmented.
- Perivitelline space: narrow (10% of diameter).
- Oil globules: none.

Myomeres: 48–50
 Vert : 15–17+32–34
 D : 16–22
 A : 10–12
 Plv : 8
 C : 6–7+10+9+6

Larvae

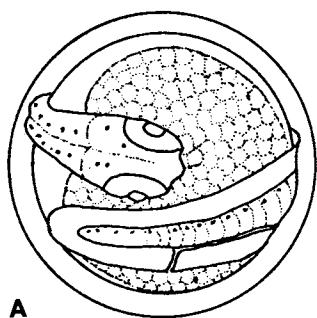
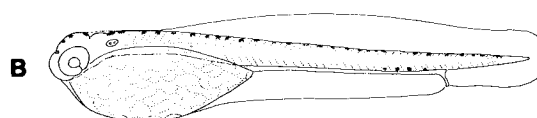
- Hatching occurs at 3.8–4.8 mm TL; eyes unpigmented.
- Body elongate with long straight-gut; vent always posterior to dorsal fin.
- Teeth apparent at about 6 mm TL; snout long and pointed in larvae >7 mm.
- Preanal myomeres 42, predorsal myomeres 25–35.
- Flexion occurs at 8–10 mm SL, and transformation at 30–33 mm TL.
- Fin formation: pectorals present as buds very early but not complete until transformation; dorsal, anal and caudal fins form next, and dorsal migrates anteriorly; pelvic fin forms late (25–30 mm) and migrates posteriorly.
- Muscle-band striations obvious in posterior gut.
- No air bladder.
- Pigmentation: (see illustrations opposite).

Important characters:

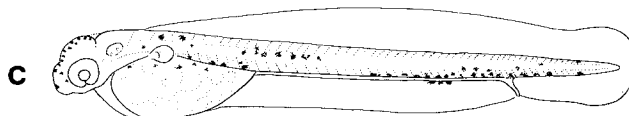
- Myomeres between dorsal and anal fins decrease from 5 in early larvae to 2 at transformation.
- Dorsal pigment at notochord tip absent after yolk absorption; ventral pigment at notochord tip forms early.
- Early teeth formation, and long pointed snout.
- Low anal fin ray count.

Fig. — **A**, O'Toole and King 1974; **B–C**, Mito 1961a; **D, F**, Uchida *et al.* 1958; **E**, Houde and Fore 1973; **G–H**, Hildebrand 1963 (**B, C, E, F** redrawn).

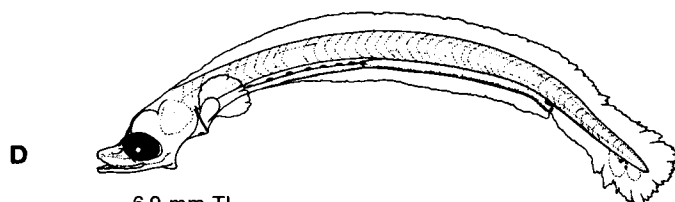
Ref. — E. D. Houde 1981 (pers. comm.).

Etrumeus teres**CLUPEIDAE****A****B**

4.8 mm TL

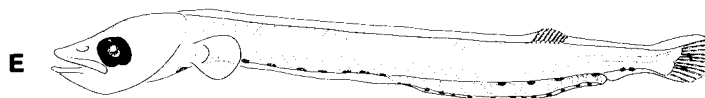
**C**

5.7 mm TL

**D**

6.9 mm TL

About 8 large spots on each side of anterior gut.

**E**

8.5 mm TL

Small spots in double row on posterior gut

Spot at tip of lower jaw in some

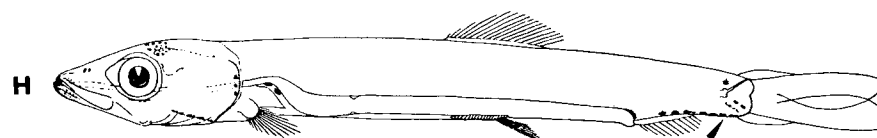
**F**

15.3 mm TL

Large spot over anus

**G**

27.5 mm TL

**H**

35.0 mm TL

Diagonal stripe of pigment distinctive

A (southeastern Atlantic); **B-D, F** (Pacific material).

CLUPEIDAE***Jenkinsia lamprotaenia* (Gosse)****Spawning:** Unknown.**Meristic features****Eggs** — Undescribed.

Myomeres: 38–(39–41)–42

Larvae — Body elongate with long straight gut >70% SL; vent always posterior to dorsal fin.

Vert : 19–21+19–21

— Preanal myomeres 32–33 at 12 mm decrease to 27 at 15 mm.

D : 10–13

A : 13–15

Plv : 8

C : 4+10+9+3

— Flexion occurs at 8–9 mm, and transformation at 12–15 mm.

— Fin formation: caudal forms first and is complete at 8–9 mm; dorsal and anal fins complete at 10 mm; pelvic fins appear at 10 mm and are complete at 15 mm; pectoral fins last to complete development.

— Muscle-band striations not well developed in hindgut.

— Pigmentation: (see illustrations opposite).

Important characters:

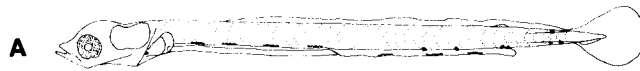
- Low myomere count; myomeres between dorsal and anal fins: 0 until transformation, and then 8–9.
- Dorsal pigment present at notochord tip; ventral pigment forms early at notochord tip.
- Low procurent ray count (4 dorsal, 3 ventral), formed at 16 mm.

- Note:** (1) Among western North Atlantic clupeids, only *Jenkinsia* and *Harengula* (p. 34) have fewer than 44 myomeres.
- (2) Ventral pigment at notochord tip forms early in *Jenkinsia* and *Etrumeus* (p. 28) but late in *Harengula* (p. 34). *Jenkinsia* lacks pointed snout and early teeth development characteristic of *Etrumeus*.
- (3) *Jenkinsia* larvae have not yet been found in Mid-Atlantic Bight samples; they may be epibenthic or semi-planktonic, floating with debris.

Jenkinsia lamprotaenia**CLUPEIDAE**

Paired, elongate pigment spots dorsal to foregut, ventral to hindgut

Dorsal peduncle pigment variable



5.8 mm SL

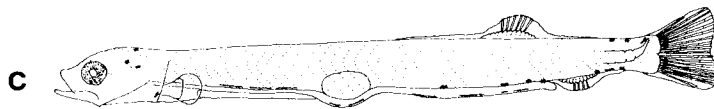
Spot at pectoral fin base remains throughout larval development

2-3 ventral spots at notochord tip develop early

Spot on hindbrain remains throughout larval development



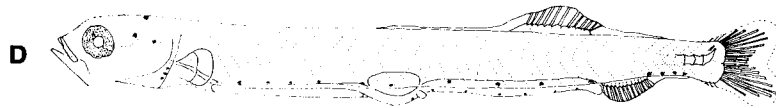
8.6 mm SL



9.4 mm SL

Spot behind eye and pair of spots on top of head remain throughout larval development

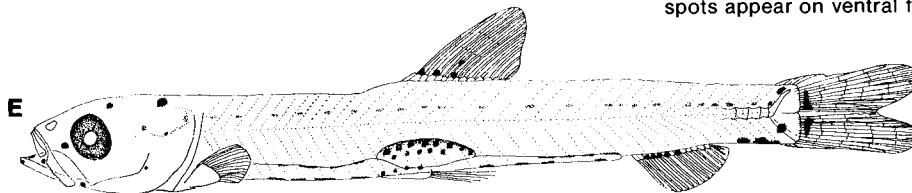
Dorsal spot at notochord tip throughout larval development



12.5 mm SL

At transformation, rapid change in position of dorsal and anal fins

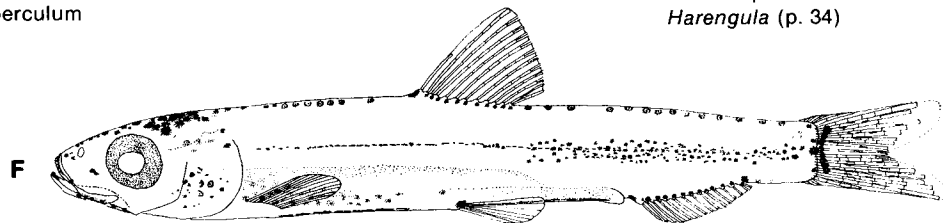
At 13 mm, air bladder pigmented dorsally, spots appear on ventral foregut



15.2 mm SL

Spots appear anterior to eye, at lower jaw angle and on operculum

See comparative note on *Harengula* (p. 34)



22.7 mm SL

Increase in pigment on head and opercle

CLUPEIDAE***Opisthonema oglinum* (Lesueur)****Spawning:** Spring–summer off North Carolina.**Meristic features****Eggs**

- Pelagic.
- Diameter: 1.08–1.31 mm.
- Shell: smooth, thin and clear.
- Yolk: lightly segmented.
- Perivitelline space: wide.
- Oil globules: 1.
- O.G. diameter: 0.12–0.16 mm.

Myomeres: 45–49
 Vert : 12–13+32–36
 D : 17–22
 A : 20–25
 Plv : 8–9
 C : 9+10+9+6–7

Larvae

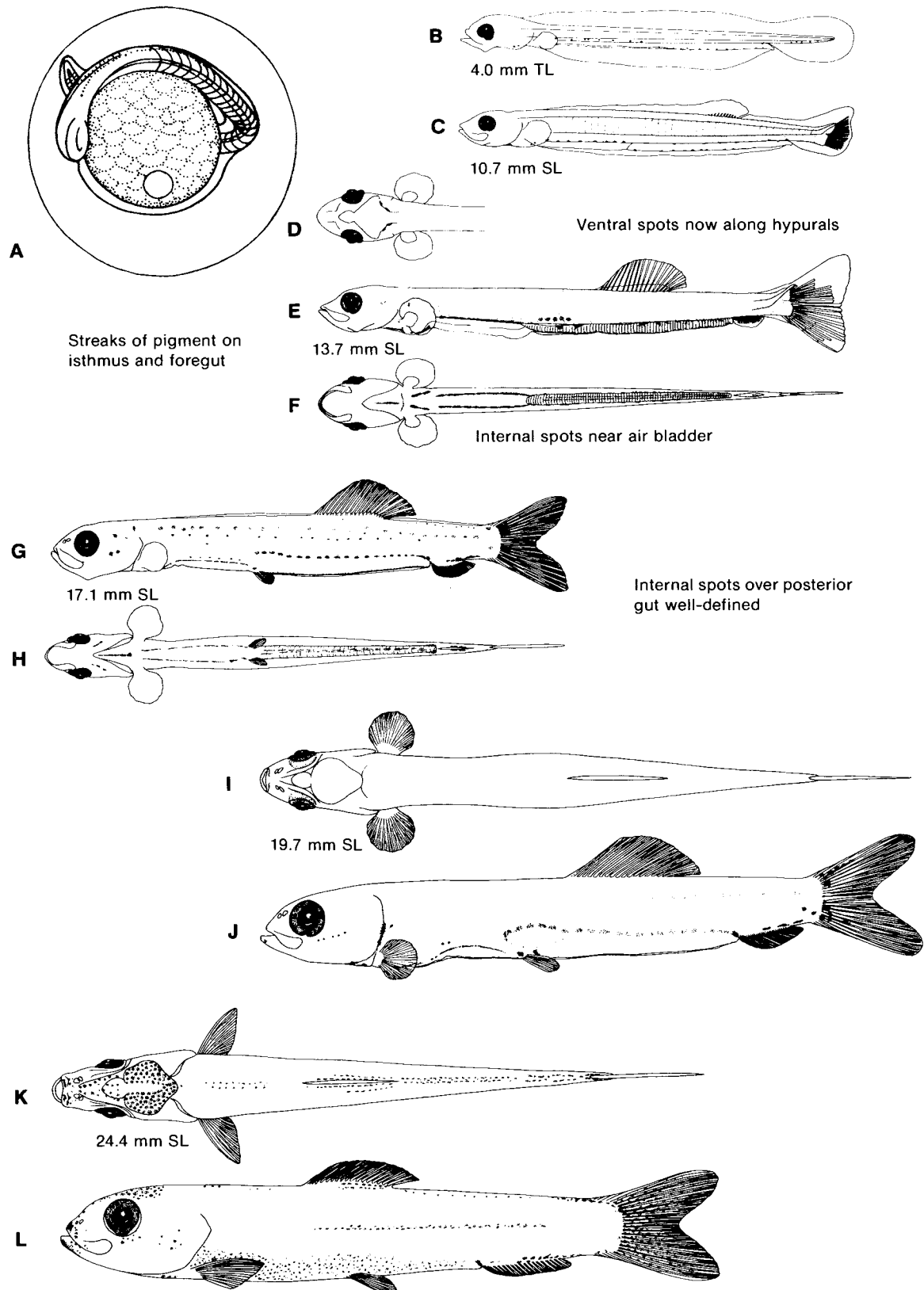
- Paired dorsolateral series of spots on embryo just before hatching; eyes unpigmented.
- Body elongate with long straight gut, 86–91% SL before flexion decreasing to 75% SL in juveniles; vent always posterior to dorsal fin.
- Preanal myomeres decrease from 38 at 15 mm to 34 at 54 mm.
- Flexion occurs at 10 mm SL, and transformation at 15–25 mm SL.
- Fin formation: pectoral forms first as bud but is not complete until 23–25 mm; caudal complete at 10 mm; dorsal and anal fins complete at 25–30 mm; pelvic fin last to form at 14 mm SL and not complete until >50 mm SL.
- Muscle-band striations obvious in posterior gut.
- Air bladder present but not obvious until transformation.
- Pigmentation: in 4.0 mm larvae, spots on ventral midline under pectoral fins and posterior to anus, double row along hindgut, and dorsolateral row on each side of foregut (see illustrations opposite).

Important characters:

- Myomeres between dorsal and anal fins decrease from 8–10 in larvae <16 mm to 5–7 at 17–25 mm.
- Predorsal myomeres decrease from 25 to 15.
- Dorsal pigment absent from notochord tip, but ventral pigment present.
- High anal fin ray count.

Opisthonema oglinum

CLUPEIDAE



CLUPEIDAE***Sardinella aurlta* Valenciennes****Spawning:** September–February off Florida.**Meristic features**

- Eggs**
- Pelagic, spherical.
 - Diameter: 0.94–1.40 mm.
 - Shell: smooth, transparent and thin.
 - Yolk: segmented.
 - Perivitelline space: moderate.
 - Oil globules: 1.
 - O.G. diameter: 0.12–0.16 mm.

Myomeres: 45–48
 Vert : 16+29–31
 D : (15)16–19(20)
 A : (14)16–17(19)
 Plv : 8–10
 C : 8+10+9+7

- Larvae**
- Hatching occurs at about 3 mm.
 - Body elongate with long straight gut; vent posterior to dorsal fin.
 - Flexion occurs at about 11 mm TL, and transformation at about 25 mm TL.
 - Last 2 anal rays become elongate in larger larvae.
 - Larvae uncommon north of Cape Hatteras.

Important characters:

- Myomeres between dorsal and anal fins 5–8; predorsal myomeres decrease from 28 to 24.
- Dorsal pigment absent from notochord tip, but ventral pigment present.
- Anal fin ray count lower than in *Opisthonema* (p. 32).

Harengula jaguana* Poey*Spawning:** February–July off Florida**Meristic features**

- Pelagic, spherical.
- Diameter: 1.55–2.00 mm (large).
- Shell: smooth and thin.
- Yolk: segmented.
- Perivitelline space: wide (58% of diameter).
- Oil globules: 1.
- O.G. diameter: 0.07–0.10 mm (small).

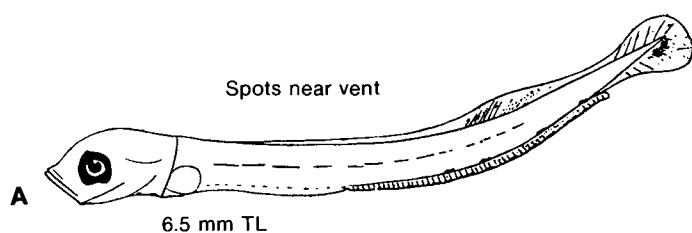
Myomeres: 39–42
 Vert : 12–14+27–29
 D : 17–19
 A : 17–18
 Plv : 7–8
 C : 8–9+10+9+7

- Larvae**
- Hatching occurs at 2.4 mm; eyes unpigmented.
 - Body elongate with long straight gut; vent posterior to dorsal fin.
 - Preanal length 90% at 12 mm SL and 75% at 32 mm SL.
 - Preanal myomeres 35 at 6 mm and 27 at 22 mm; predorsal myomeres 25 at 6 mm and 10 at 22 mm.
 - Flexion occurs at about 10–11 SL, and transformation at about 22–24 mm SL.
 - Dorsal fin complete at 14–16 mm; anal fin complete at 13–15 mm.
 - Pigmentation: (see illustrations opposite).

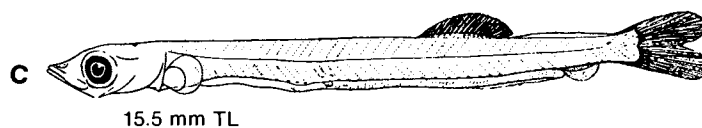
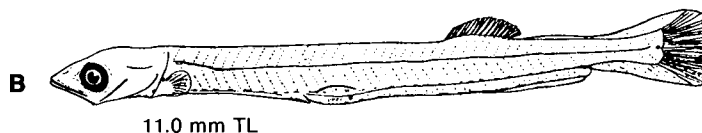
Important characters:

- Low myomere count; myomeres between dorsal and anal fins 5–7.
- Dorsal pigment present at notochord tip; ventral pigment at notochord tip usually forms late (later than in *Jenkinsia*) but is variable in early larvae and may be present.

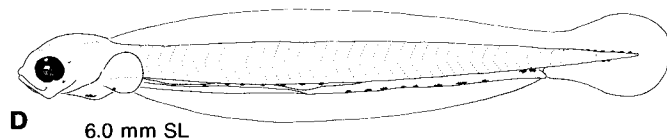
Fig. — A–C, Fage 1920; D–F, Houde *et al.* 1974 (all redrawn).**Ref.** — Simpson and Gonzalez 1967; Gorbunova and Zvyagina 1975; Matsuura 1972, 1975; E. D. Houde 1981 (pers. comm.).

Sardinella aurita**CLUPEIDAE**

In young larvae, ventral spots at notochord tip

***Harengula jaguana***

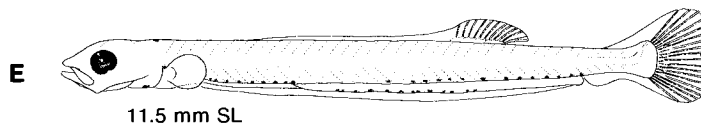
Head pigment sparse at less than 15 mm



Dorsal spots at notochord tip, lacking in *Opisthonema oglinum*, *Etrumeus teres* and *Sardinella aurita*

Spots at cleithral symphysis retained throughout larval development

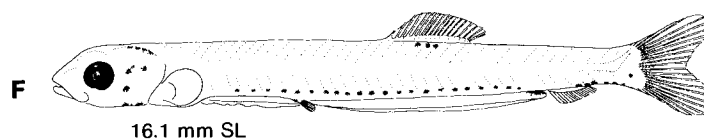
2 spots form near vent, from which an internal row of pigment develops dorsal to hindgut



Spots on caudal ray bases

Gut pigment: dorsal surface of foregut, ventral surface of hindgut

Spots on dorsal and anal bases and on postanal ventral midline, form later than similar spots in *Jenkinsia lamprotaenia* (p. 30)



Spot at base of pelvic fin

A-C (Mediterranean material)

ENGRAULIDAE***Anchoa hepsetus* (Linnaeus)****Spawning:** Spring-summer.**Eggs**

- Pelagic elliptical.
- Diameter: long axis 1.20–1.66 mm, and short axis 0.70–0.94 mm.
- Shell: smooth and transparent.
- Perivitelline space: narrow.
- Oil globules: none.

Larvae

- Hatching occurs at 3.6–4.0 mm.
- Body long and slender, with vent under dorsal fin.
- Yolk tapers posteriorly.
- Mouth large, terminal, extends to middle of eye; becomes subterminal.
- Flexion occurs between 5 and 10 mm.
- Fin formation: caudal, dorsal and anal fins develop at same time; pectoral forms early as a bud but is not complete until late; pelvic forms late.
- Gut with muscle-band striations posteriorly.
- Little pigment.
- Overlapping dorsal and anal fins (good character after ray formation).

Meristic features

Myomeres: 40–44
 Vert : 21–22+20–21
 D : 13–17
 A : 18–23
 P : 13–17
 C : 7+9+10+9+7–8

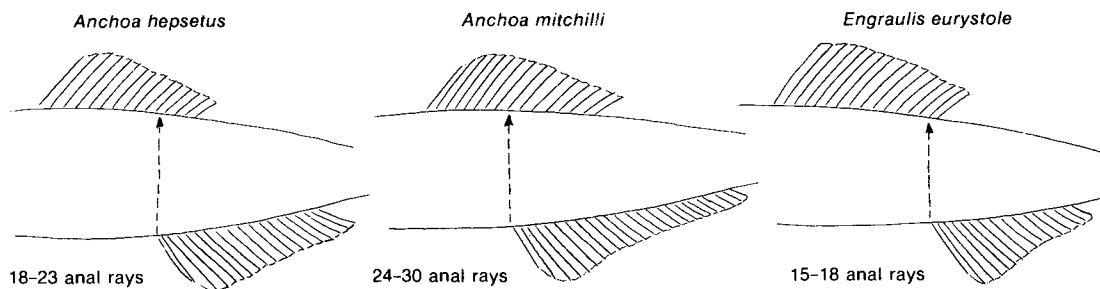
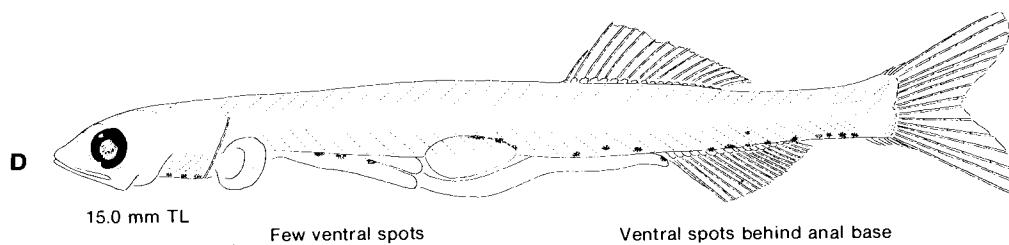
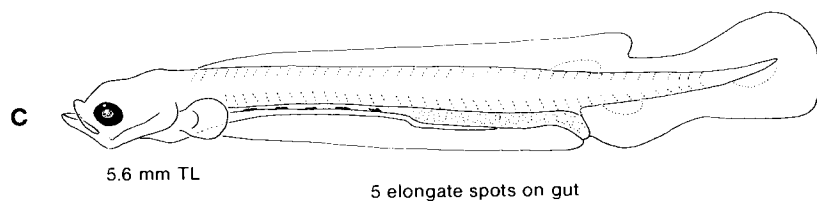
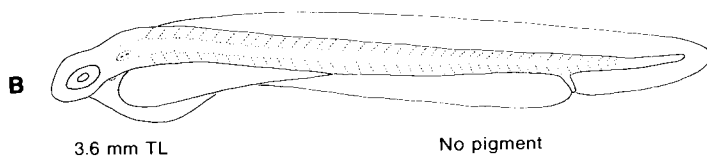
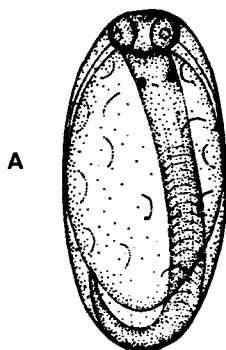


Fig. — A–C, Hildebrand and Cable 1930; **D,** Lippson and Moran 1974 (**B–D** redrawn).

Anchoa hepsetus**ENGRAULIDAE**

ENGRAULIDAE *Anchoa mitchilli* (Valenciennes)

Spawning: Late April to September in Mid-Atlantic Bight.

Meristic features

- | | |
|---|--|
| <p>Eggs</p> <ul style="list-style-type: none"> — Pelagic, barely elliptical. — Diameter: long axis 0.84–1.11 mm. — Shell: smooth and transparent. — Yolk: segmented. — Perivitelline space: narrow. — Oil globules: none. <p>Larvae</p> <ul style="list-style-type: none"> — Hatching occurs at 1.8–2.7 mm (smaller than other engraulids). — Body long and slender, with vent under dorsal fin. — Yolk tapers posteriorly. — Mouth large, terminal, extends to middle of eye; becomes subterminal. — Flexion occurs at 7–8 mm, and transformation at about 20 mm. — Fin formation: caudal, dorsal and anal fin develop at same time; pectoral forms as a bud but is not complete until late; pelvic forms late. — Gut with muscle-band striations posteriorly. — Little pigment, but somewhat more extensive than shown in illustrations opposite. — Overlapping dorsal and anal fins (good character after ray formation). | <p>Myomeres: 38–44</p> <p>Vert : 19+21–22</p> <p>D : 13–17</p> <p>A : 24–30</p> <p>P : 10–13</p> <p>C : 9+10+9+7–8</p> |
|---|--|

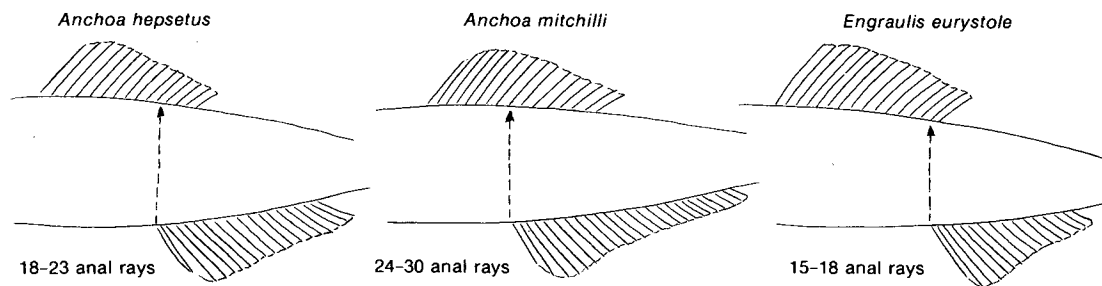
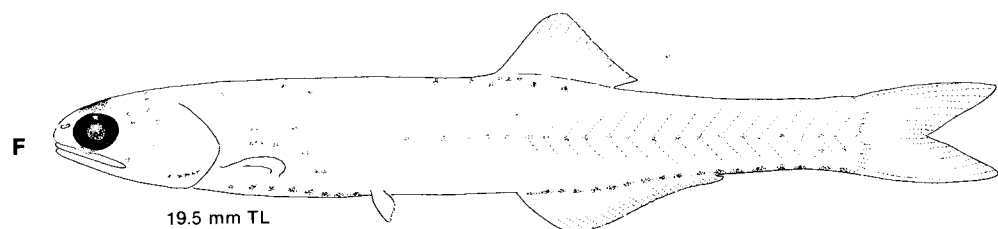
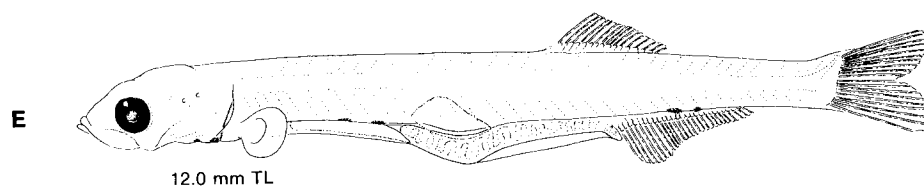
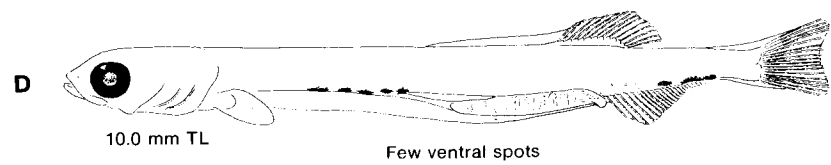
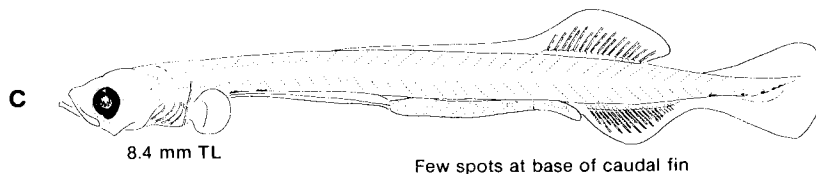
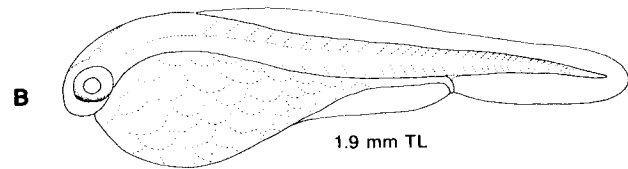
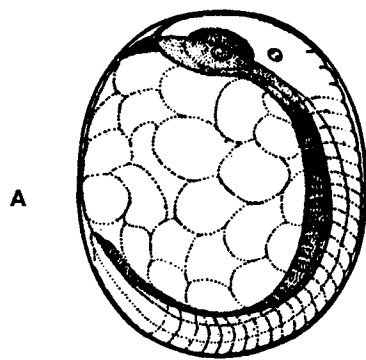


Fig. — A, B, D, Kuntz 1915; C, Lippson and Moran 1974; E, Mansueti and Hardy 1967; F, Fowler 1945 (B–F redrawn).

Ref. — E. D. Houde 1982 (pers. comm.)

Anchoa mitchilli**ENGRAULIDAE**

ENGRAULIDAE *Engraulis eurystole* (Swain and Meek)

Spawning: July and August.

Eggs

- Pelagic, elliptical.
- Diameter: long axis 1.02–1.25 mm, and short axis 0.50–0.80 mm.
- Shell: smooth and transparent.
- Yolk: segmented.
- Perivitelline space: narrow.
- Oil globules: none.

Meristic features

Myomeres: 43–45
 Vert : 26+18
 D : 13–16
 A : 15–18
 P : 14–16
 C : 10+9

Larvae

- Hatching occurs at 2–3 mm TL.
- Body long and slender, with vent under dorsal fin.
- Yolk tapers posteriorly.
- Mouth large, terminal, extends to middle of eye; becomes subterminal.
- Fin formation: caudal, dorsal and anal fins develop early and at the same time; pectoral forms early as a bud but is not complete until late; pelvic forms late.
- Gut with muscle-band striations posteriorly.
- Air bladder prominent in larger sizes (not illustrated).
- Pigment increases with development (see illustrations opposite).
- Overlapping dorsal and anal fins (good character after ray formation).

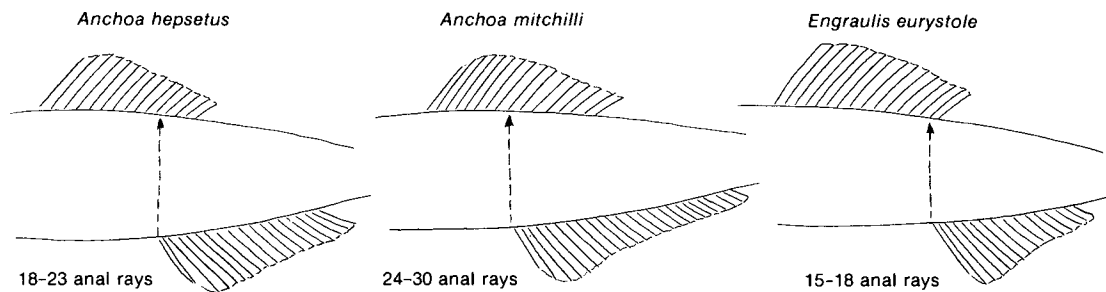
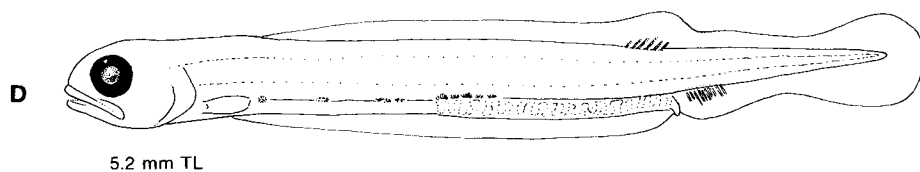
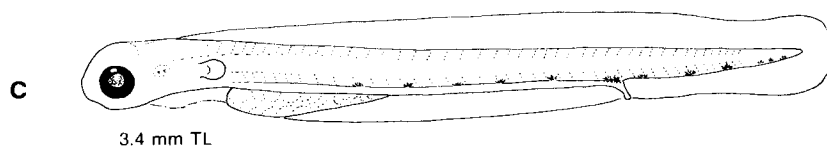
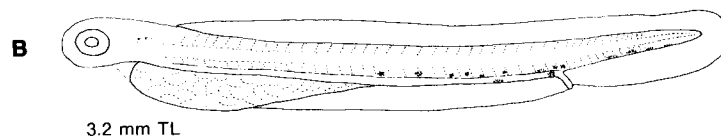
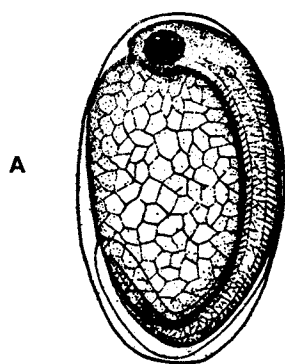
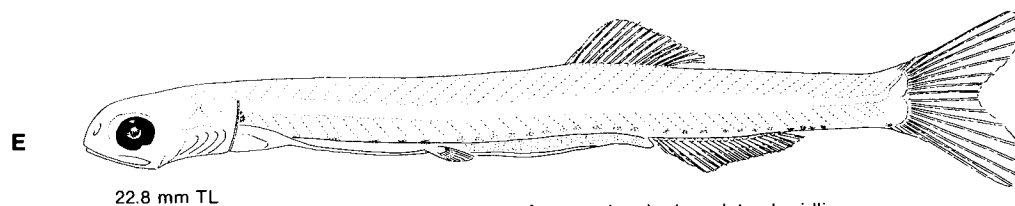


Fig. — A–D, Kuntz and Radcliffe 1917; E, Lippson and Moran 1974 (B–E redrawn).

Ref. — Markle *et al.* 1980.

Engraulis eurystole**ENGRAULIDAE**

Row of elongate spots forms medially on isthmus



In larger specimens, spots form on head, along lateral midline, on caudal rays and dorsal peritoneum.

ELOPIDAE***Megalops atlanticus* Valenciennes**

Spawning: Gulf of Mexico and Yucatan Channel in spring and summer, but locations not well known.

Eggs — Undescribed.

Larvae — Leptocephalus-like with forked caudal fin, triangular head, and ribbon-like body.
 — Gut long, about 75% TL.
 — Flexion occurs at 10–11 mm SL.
 — Air bladder conspicuous after flexion.
 — Teeth prominent in early larvae (lost at metamorphosis).
 — Note relative positions of dorsal and anal fins.
 — Period of larval growth followed by shrinkage and thickening of body during metamorphosis, and then resumption of growth up to juvenile stage.
 — Fin formation: caudal fin rays form at flexion; dorsal and anal fin rays form at about 16 mm (before metamorphosis) and are complete at 17–20 mm (after metamorphosis); pectoral and pelvic fin rays develop later.
 — Maximum size before metamorphosis is about 29 mm SL.
 — Pigmentation: dorsal edge of gut, anal base, and over eye; pigment scatters with growth.

Meristic features

Myomeres: 54–57
 Vert : 33–34+22
 D : 13–16
 A : 22–25
 C : 7+10+9+6–7

ELOPIDAE***Elops saurus* Linnaeus**

Spawning: Location unknown; season prolonged.

Eggs — Undescribed.

Larvae — Leptocephalus-like with forked caudal fin, triangular head, and ribbon-like body.
 — Gut long, 80–90% TL.
 — Flexion occurs at 10–15 mm SL.
 — Note relative positions of dorsal and anal fins.
 — Period of larval growth followed by shrinkage and thickening 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.

Meristic features

Myomeres: (72)78–80(82)
 Vert : 55–56+24
 D : 25–29
 A : 16–19
 C : 9–11+10+9+7–8

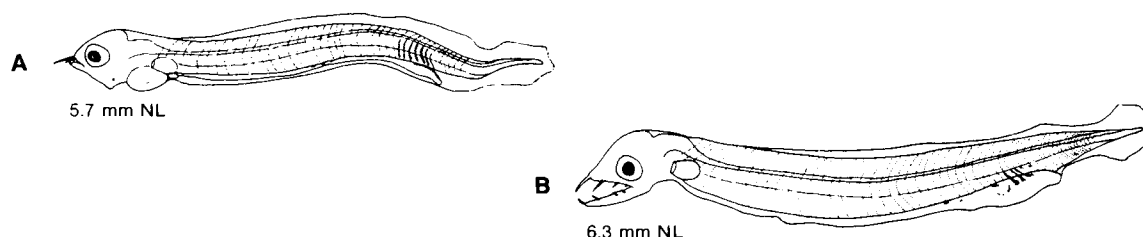
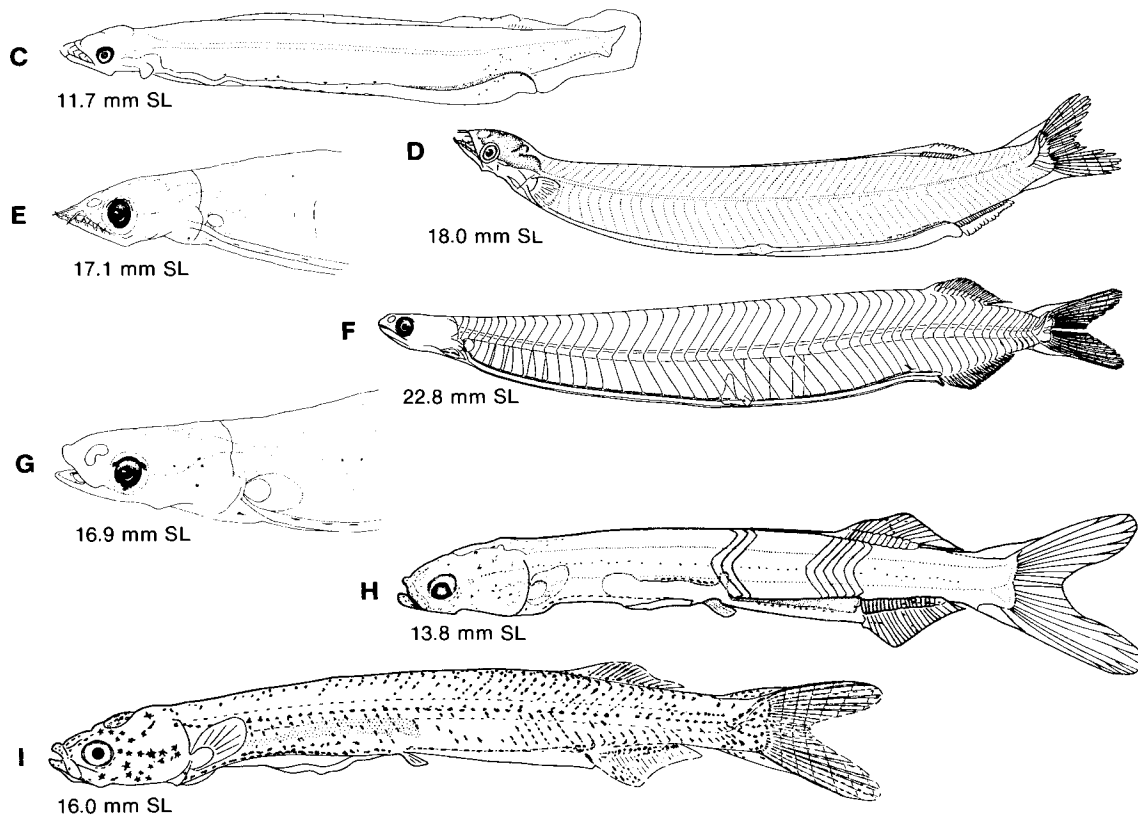
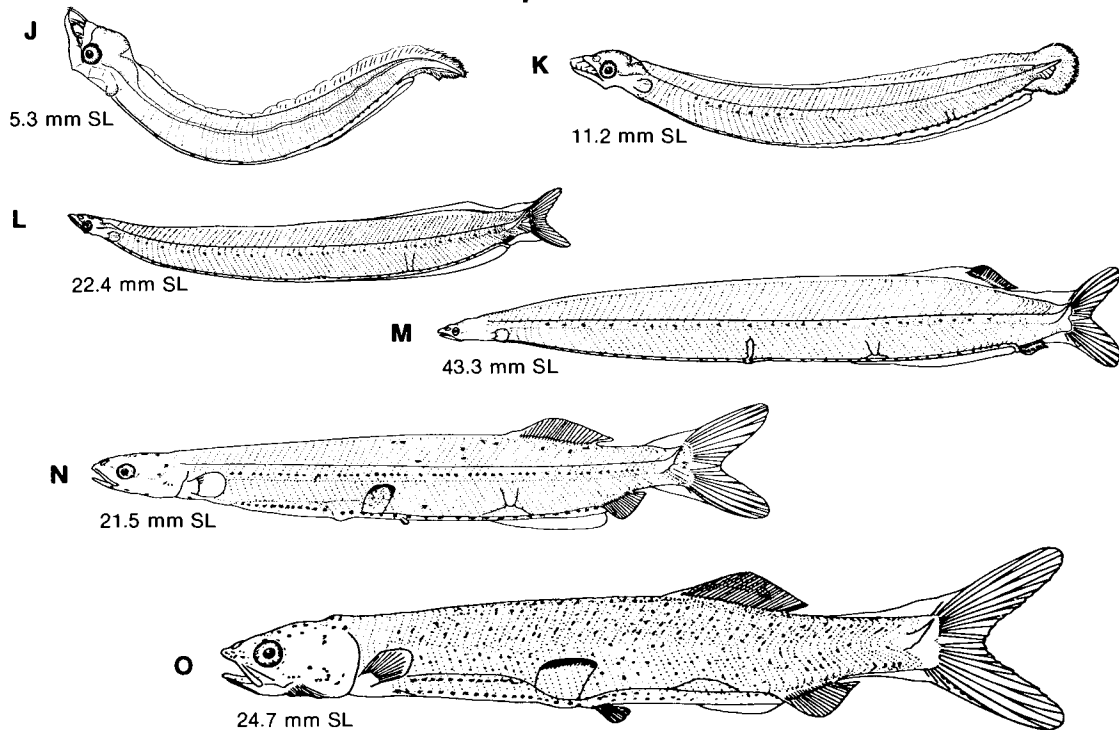
Megalops atlanticus

Fig. — A–B, Smith 1980; C, H, Wade 1962; D, Gehring 1959b; E, G, Eldred 1967b; F, Richards 1969; I, Harrington 1958; J–O, Gehring 1959a (C redrawn).

Megalops atlanticus* (cont'd)*ELOPIDAE*****Elops saurus*****F (eastern Atlantic specimen)**

ALBULIDAE***Albula vulpes* (Linnaeus)****Spawning:** Location unknown; season prolonged.**Eggs** — Undescribed.

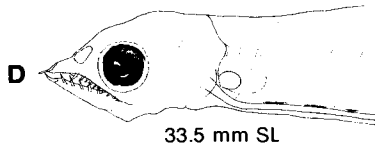
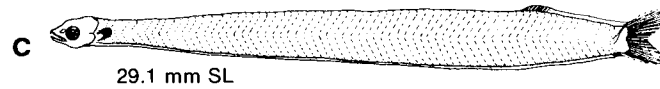
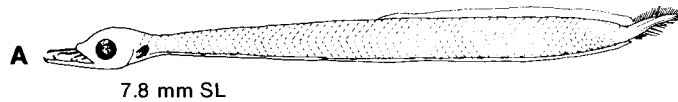
- Larvae** — Leptocephalus-like, with forked caudal fin and small head.
- Gut very long (subequal to SL).
 - Period of larval growth, followed by shrinkage and thickening of body, and then resumption of growth up to juvenile stage.
 - Teeth obvious in smaller larvae (lost at metamorphosis).
 - Flexion occurs before 17 mm SL.
 - Fin formation: dorsal and anal fins begin to form at about 30 mm and counts are complete at about 64 mm; caudal rays complete at about 43 mm; pelvic very late forming at about 65 mm.
 - Fin migration: dorsal moves from myomere 55 to 29; anal moves from myomere 66 to 57.
 - Note relative positions of dorsal and anal fins.
 - Maximum size before metamorphosis about 64 mm.
 - Pigmentation: pigment restricted to dorsal edge of gut up to metamorphosis; after metamorphosis, spots are added to caudal base, some caudal rays, and a patch over the eye.

Meristic features

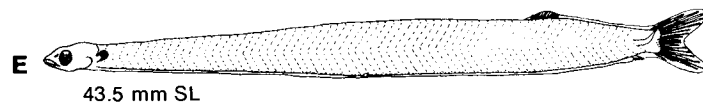
Myomeres: (65)67-69(72)
 Vert : 69-74
 D : 17-19
 A : 8-10
 C : 8+10+9+6

Best Characters for Separating Fork-tailed Leptocephalus-like Larvae

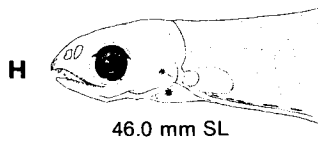
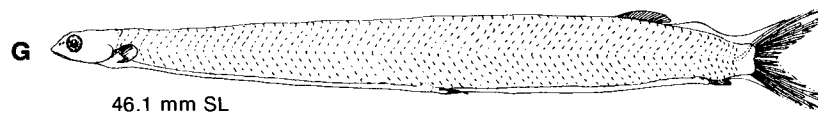
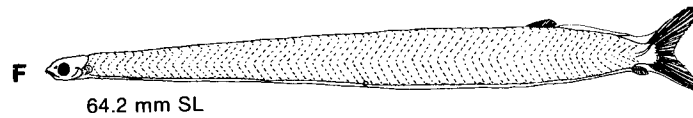
Character	<i>Megalops atlanticus</i>	<i>Elops saurus</i>	<i>Albula vulpes</i>
Myomeres	54-57	72-82	65-72
Maximum larval size	28 mm	43 mm	64 mm
Dorsal and anal fins	Opposite	Barely overlap	Separate

Albula vulpes**ALBULIDAE**

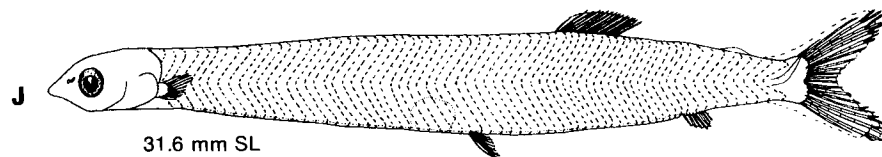
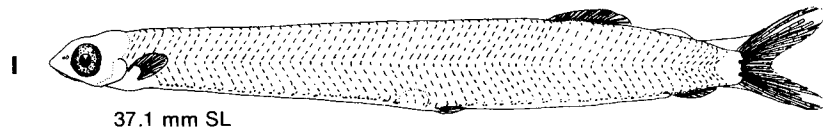
Air bladder inconspicuous at about myomere 30.



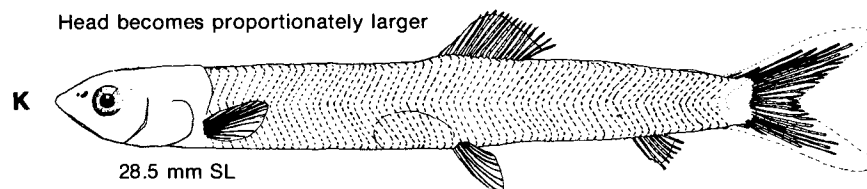
Head becomes less
leptocephalus-like



Dorsal and anal fins move anteriorly



Head becomes proportionately larger



ANGUILLIFORMES**Leptocephalus Larvae**

(Castle 1969; Smith 1979)

General features

- Body elongate, compressed, transparent, with small head.
- Myomeres visible over lateral surface.
- Gut along ventral margin of body; simple tube or with swellings or convolutions.
- Kidney elongate; lying along top of gut.
- Vertical blood vessels extend between gut and aorta at the body midline.
- No pelvic fins.
- Dorsal and anal fins short to (usually) long, always confluent with caudal.
- Pectoral fin rays late forming but fins may be reduced or absent.
- Caudal rays total 5–11, fins may be absent in Ophichthidae.
- Larval teeth fang-like (lost at metamorphosis).

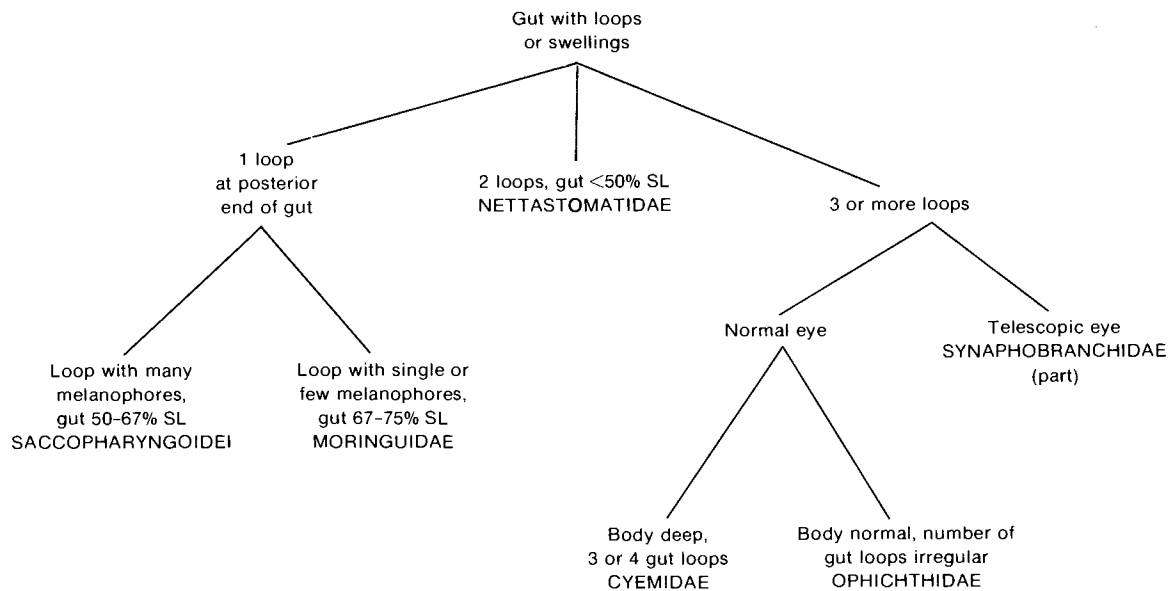
Important identifying features

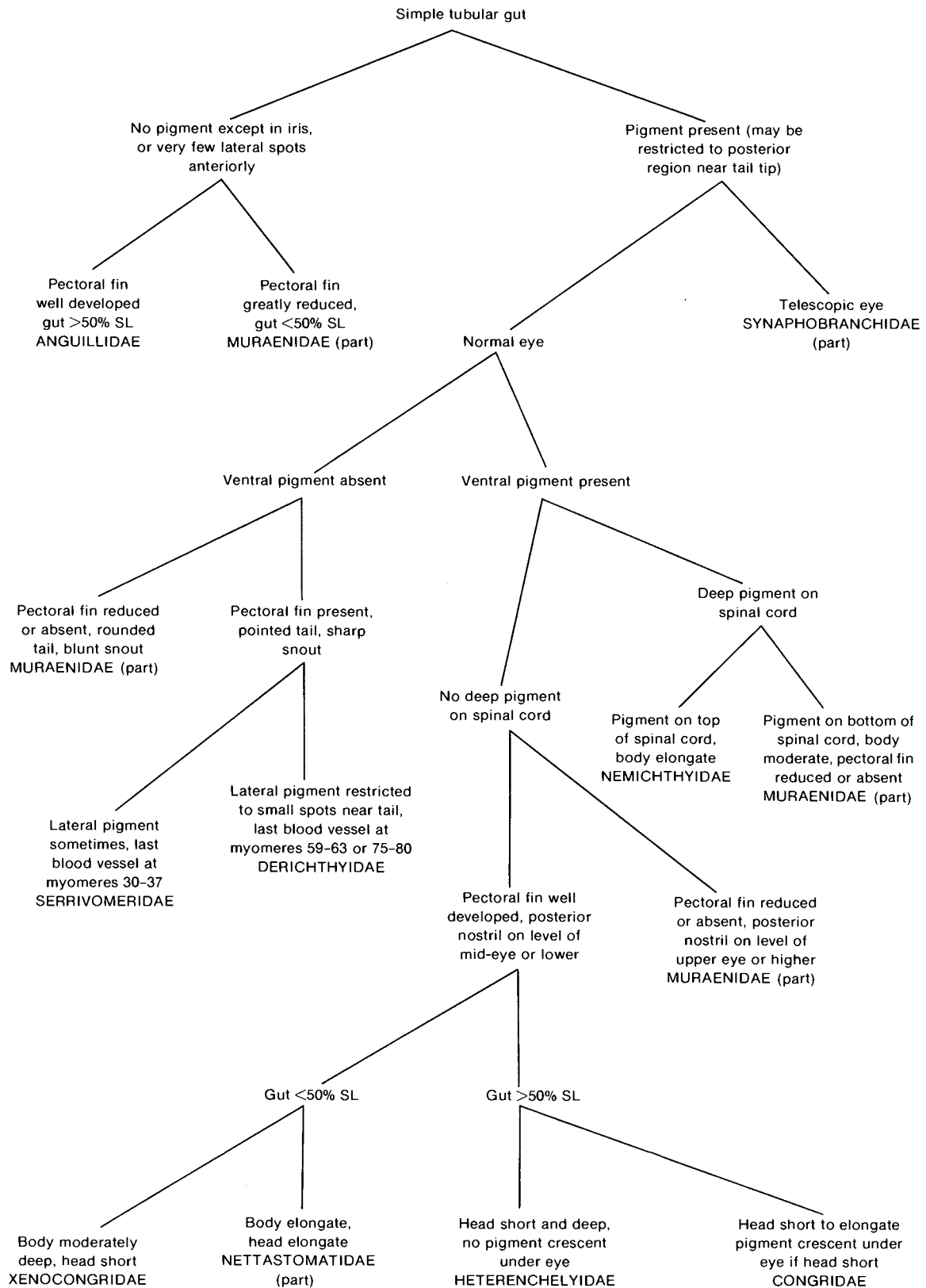
- Shape of body, head, snout, and tail tip.
- Relative length and form of gut.
- Number of myomeres, preanal, predorsal and total.
- Position of vertical blood vessels.
- Location and extent of pigment spots.
- Size and position of nasal organ.
- Maximum size before metamorphosis.

Note: Leptocephalus larvae are also found in the orders Elopiformes and Notacanthiformes. Elopiform larvae have large, forked caudal fins (see Elopidae, Albulidae). Notacanthiform larvae replace the caudal fin with a long filament and have a short, anterior dorsal fin.

Diagrammatic Family Key to Eel Leptocephali

(After Smith 1979)



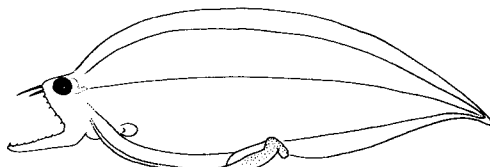
Leptocephalus Larvae**ANGUILLIFORMES**

ANGUILLIFORMES Synopsis of Family Characters

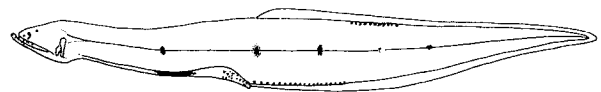
Leptocephali with Gut Loops or Swellings

Monognathidae, Eurypharyngidae, Saccopharyngidae (SACCOPHARYNGOIDEI)

- One gut swelling at posterior end of gut.
- Gut length 50–67% SL.
- Body short and deep.
- Tail pointed.
- Head short and deep with elongate hyomandibular.
- Maximum leptocephalus size 30–40 mm.
- Myomeres 100–250.
- Dorsal fin origin near level of vent.
- Ventral pigment restricted to gut swelling.
- Large lateral spots in Monognathidae, absent in other 2 families.



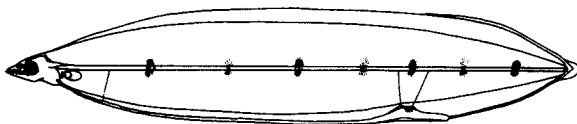
Eurypharynx pelecanoides
(Smith 1979)



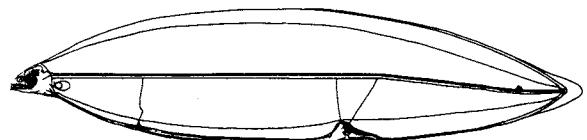
Monognathidae
(Raju 1974)

Moringuidae

- One gut swelling at posterior end of gut.
- Gut length 67–75% SL.
- Body moderately deep.
- Tail moderately blunt.
- Head moderately short.
- Maximum leptocephalus size 60–70 mm.
- Myomeres 96–122.
- Dorsal fin origin near level of vent.
- Ventral pigment restricted to gut swelling.
- One lateral spot near tail or large spots on alternate sides of body.



Moringua edwardsi
(Eldred 1968a)



Neoconger mucronatus
(Eldred 1967c)

Note: Family examples illustrated throughout this section.

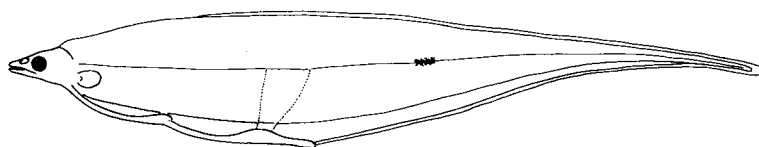
Family Characters

ANGUILLIFORMES

Leptocephali with Gut Loops or Swellings (cont'd)

Nettastomatidae (except *Facciolella*, p. 55)

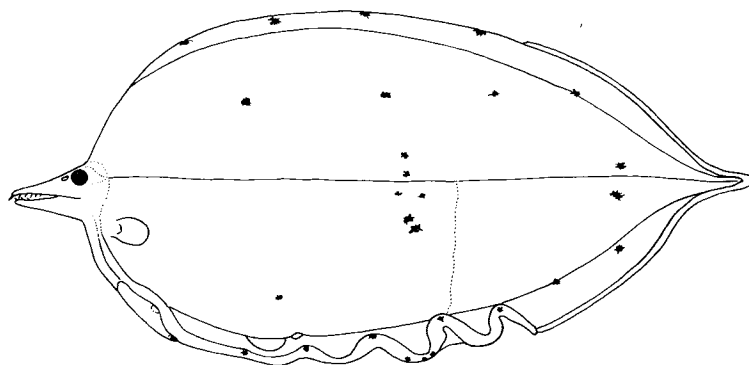
- Two swellings in gut.
- Gut length <50% SL.
- Body deep (except in *Hoplunnis*).
- Tail pointed and elongate.
- Head moderately long.
- Maximum leptocephalus size 200+ mm.
- Myomeres 190–207 in *N. melanurum*.
- Dorsal fin origin usually shortly behind head.
- Ventral, lateral pigment variable.



Nettastoma (= *Metopomycter*)
(Smith 1979; Smith *et al.* 1981
(See also *Hoplunnis* in Smith 1979)

Cyemidae

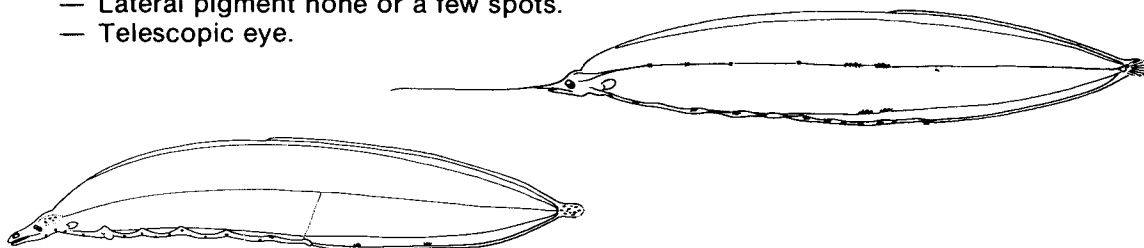
- Three or four swellings in posterior half of gut.
- Gut length about 67% SL.
- Body very deep.
- Tail pointed.
- Head long and sharply pointed.
- Maximum leptocephalus size 60–70 mm.
- Myomeres about 80.
- Dorsal fin origin near level of vent.
- Gut pigment on each swelling.
- Several lateral spots scattered or on midline.



Cyema atrum
(Smith 1979)

ANGUILLIFORMES**Family Characters****Leptocephali with Gut Loops or Swellings (cont'd)****Synphobranchidae** (Subfamily Dysommidae)

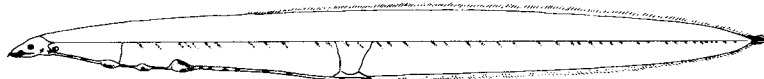
- Several swellings along gut.
- Gut length 50–67% SL.
- Body moderately elongate.
- Tail moderate.
- Head elongate (or short with rostral filament).
- Maximum leptocephalus size about 100 mm.
- Myomeres 119–204.
- Dorsal fin origin anterior to vent.
- Gut pigmented with rather large spots.
- Lateral pigment none or a few spots.
- Telescopic eye.



Dysommidae (Smith 1979)

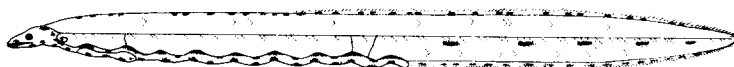
Ophichthidae (Leiby 1979a, 1979b, 1981, 1982)

- Three or more gut swellings.
- Gut length 50–67% SL.
- Body moderately elongate.
- Tail moderate to blunt (caudal fin often absent).
- Head moderate to elongate.
- Maximum leptocephalus size 80–180 mm.
- Myomeres 100+.
- Dorsal fin origin variable.
- Ventral pigment tends to concentrate on swellings.
- Lateral pigment variable.

*Myrophis punctatus*
(Fahay and Obenchain 1978)

Subfamily Myrophinae: third gut swelling
largest, kidney expanded over vent.

See note on *Acromycter alcocki*, p. 57.

Ophichthus cruentifer
(Fahay and Obenchain 1978)

Subfamily Ophichthinae: second gut swelling
largest, kidney not expanded over vent (p. 60).

Family Characters**ANGUILLIFORMES****Leptocephali with Simple Tubular Guts****Synaphobranchidae** (s.f. Synaphobranchinae)

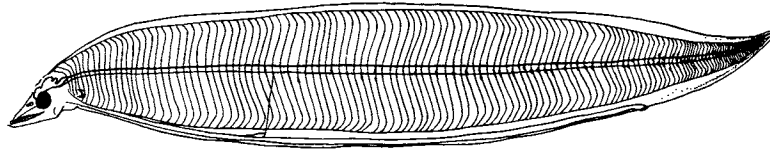
- Gut length about 75% SL.
- Body moderately elongate.
- Tail moderate.
- Head short and pointed.
- Maximum leptocephalus size 130–170 mm.
- Myomeres 126–151.
- Dorsal fin origin anterior to vent.
- No ventral pigment.
- Lateral pigment usually restricted to tail tip.
- Central portion of myomeres more opaque than dorsal and ventral portions.
- Eye telescopic.



Synaphobranchinae
(Smith 1979)

Serrivomeridae

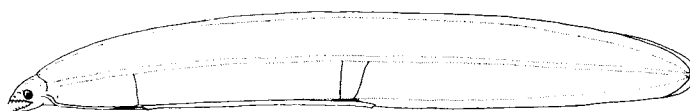
- Gut length 67–75% SL.
- Body moderate.
- Tail pointed.
- Head sharp, slightly concave.
- Maximum leptocephalus size about 60 mm.
- Myomeres 150–170.
- Dorsal fin origin anterior to vent.
- No ventral pigment.
- Lateral pigment none or few small spots on midline.
- Preanal myomeres about 89–125.
- Small nasal organ close to eye.
- Last blood vessel at myomeres 30–37.



Leptocephalus lanceolatus
(= *Serrivomer beani*)
(Bauchot 1959)

ANGUILLIFORMES**Family Characters****Leptocephali with Simple Tubular Guts (cont'd)****Muraenidae (*Anarchias*)**

- Gut length <50% SL.
- Body moderate.
- Tail blunt.
- Head short and blunt.
- Maximum leptocephalus size about 50 mm.
- Myomeres 107–114.
- Dorsal (and anal) fin origin in extreme posterior region.
- No ventral pigment.
- Few internal spots near head.
- Pectoral fin greatly reduced or absent.



Anarchias yoshiae
(Eldred 1968b)

Muraenidae

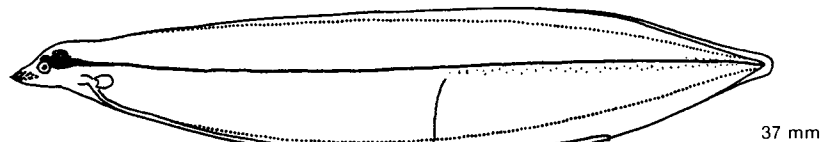
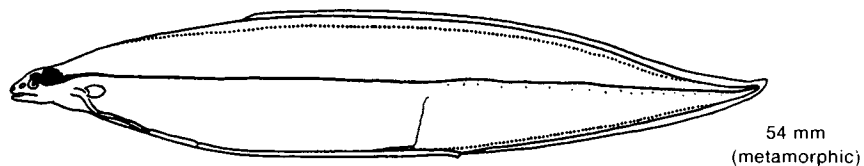
- Gut length 50–75% SL.
- Body moderately deep.
- Tail broadly rounded.
- Head short and snout blunt.
- Maximum leptocephalus size 60–70 mm.
- Myomeres about 114–174.
- Dorsal fin origin variable (confined to extreme posterior region in *Uropterygius* and *Anarchias*)
- Gut pigment present.
- No lateral pigment.
- Pectoral fin greatly reduced or absent.



Gymnothorax nigromarginatus
(Smith 1979)

Family Characters**ANGUILLIFORMES****Leptocephali with Simple Tubular Guts (cont'd)****Derichthyidae (*Derichthys*)**

- Gut length about 75% SL.
- Body moderate.
- Tail sharp.
- Head short and slightly concave.
- Maximum leptocephalus size 50–60 mm.
- Myomeres 126–134.
- Dorsal fin origin anterior to midbody.
- No ventral pigment.
- Few lateral spots near tail tip.
- Preanal myomeres 76–83.
- Last blood vessel at myomeres 59–63.



Derichthys serpentinus
(Castle 1970)

Derichthyidae (*Nessorhamphus*)

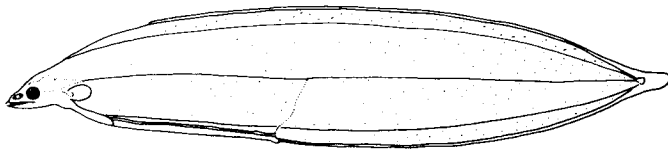
- Gut length to 90% SL.
- Body deepest behind midpoint.
- Tail sharp and pointed.
- Head rather long.
- Maximum leptocephalus size 70–80 mm.
- Myomeres 149–159.
- Dorsal fin origin at midbody.
- No ventral pigment.
- Few lateral spots near tail tip.
- Preanal myomeres >100.
- Last blood vessel at myomeres 75–80.



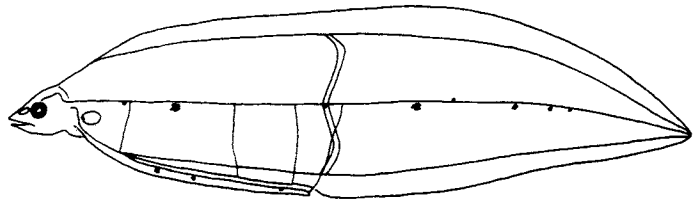
Nessorhamphus ingolfianus
(Smith 1979)

ANGUILLIFORMES**Family Characters****Leptocephali with Simple Tubular Guts (cont'd)****Xenocoagridae**

- Gut length $\leq 50\%$ SL.
- Body moderately deep.
- Tail moderate.
- Head moderately short.
- Maximum leptocephalus size about 90 mm.
- Myomeres 98–141.
- Dorsal fin origin 1–2 head lengths behind head.
- Gut pigment variable.
- Lateral pigment variable.
- Crescentic pigment sometimes under eye.



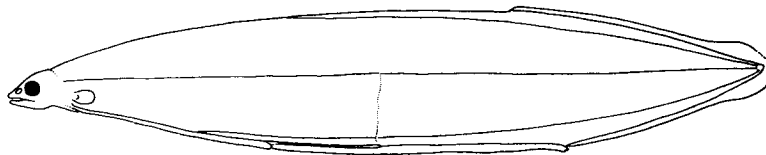
Kaupichthys hyoprорoides
(Smith 1979)



Robinsia catherinae
(Smith 1969)

Anguillidae

- Gut length about 67% SL.
- Body moderately deep.
- Tail moderate.
- Head with rather short snout.
- Maximum leptocephalus size about 80 mm.
- Myomeres 104–111 or 111–119.
- Dorsal fin origin anterior to vent.
- No pigment.



Anguilla rostrata (p. 58)
(Smith 1979)

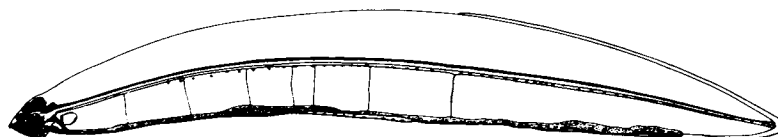
Family Characters

ANGUILLIFORMES

Leptocephali with Simple Tubular Guts (cont'd)

Heterenchelyidae

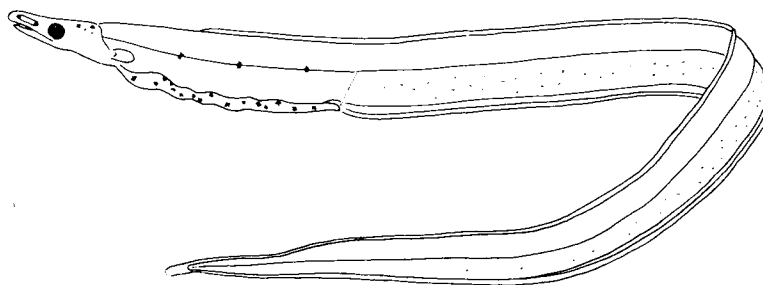
- Gut length 80-90% SL.
- Body moderately elongate.
- Tail moderately blunt.
- Head short and deep, snout becomes blunt with growth.
- Maximum leptocephalus size 60-70 mm.
- Myomeres about 108-109.
- Dorsal fin origin at about midbody.
- Gut pigment present.
- Single row of lateral spots.
- Larva of the single western Atlantic species, *Pythonichthys sanguineus*, undescribed.



Pythonichthys microphthalmus
(Blache 1977)

Nettastomatidae (*Facciolella*)

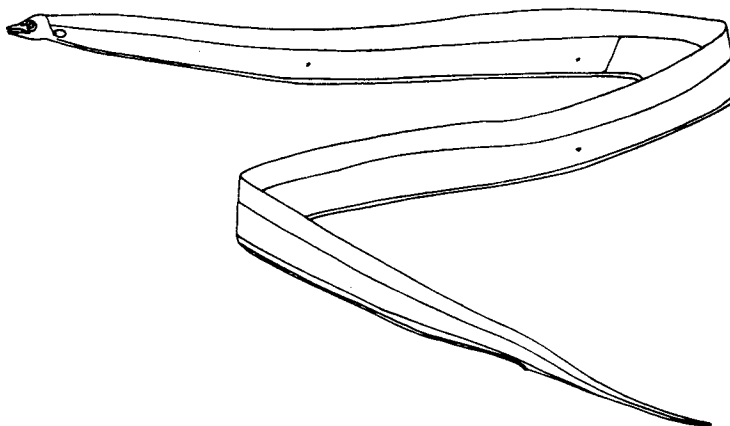
- Gut simple and thick.
- Gut length <50% SL.
- Body elongate.
- Tail sharp.
- Head long and pointed.
- Maximum leptocephalus size about 200 mm.
- Myomeres 235-250 (?)
- Dorsal fin origin shortly behind head.
- Pigment scattered over gut.
- Lateral pigment scattered over lower side.
- Nasal organ large, not near the eye.



Facciolella sp.
(Smith 1979)

ANGUILLIFORMES**Family Characters****Leptocephali with Simple Tubular Guts (cont'd)****Nemichthyidae**

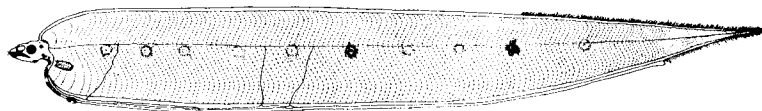
- Gut length about 90% SL.
- Body elongate.
- Tail moderate to sharp.
- Snout sharp, profile concave.
- Maximum leptocephalus size 300–400 mm.
- Myomeres 170–300+.
- Dorsal fin origin anterior to vent.
- Gut pigment on bottom of gut anteriorly, top of gut posteriorly.
- Lateral pigment none or few widely-spaced spots below midline.
- Spots along top of spinal cord.
- Small nasal organ close to eye.



Nemichthys scolopaceus
(Smith 1979)

Muraenesocidae

- Closely related to Congridae.
- Larvae similar to congrid larvae.



Paraxenomystax sp.
(Fahay 1976)

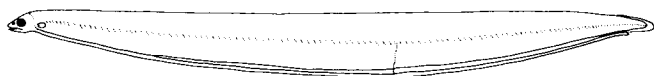
Family Characters

ANGUILLIFORMES

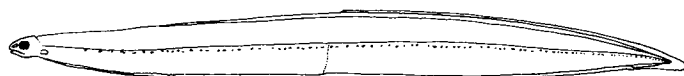
Leptocephali with Simple Tubular Guts (cont'd)

Congridae

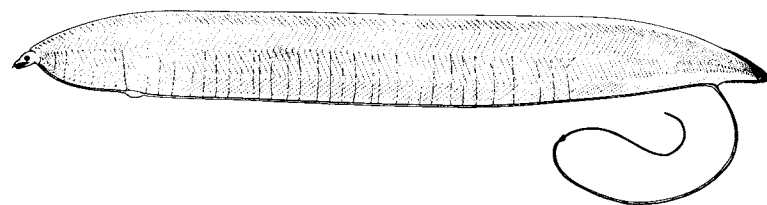
- Gut length 75% SL or more.
- Body moderate to elongate.
- Tail moderate.
- Head moderately elongate.
- Maximum leptocephalus size about 100 mm in most but 200–300 mm in some.
- Myomere range wide.
- Dorsal fin origin variable.
- Gut pigment always present.
- Lateral pigment variable, sometimes absent.



Ariosoma balearicum
(Smith 1979)



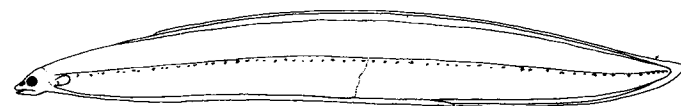
Uroconger syringinus
(Smith 1979)



Bathymyrinae
(M. P. Fahay, see p. 11)



Pseudophichthys splendens
(Smith 1979)



Heterocongrinae
(Smith 1979)

- Note:** (1) See also *Paraconger*, *Conger*, *Rechias* and *Hildebrandia* in Smith (1979).
 (2) See Smith and Leiby (1980) for description of larval *Acromycter alcocki*, a congrid leptocephalus with swellings along the gut as in ophichthids; this species has been collected near Bermuda, the Bahamas, and in the Gulf of Mexico.

ANGUILLIDAE***Anguilla rostrata* (Lesueur)**

Spawning: January–July, presumably in the Sargasso Sea or farther south.

Meristic features

Myomeres: 102–111

Eggs — Undescribed.

Larvae — 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.
- Elvers arrive in Mid-Atlantic Bight estuaries during the spring.
- Pigmentation: none, except in eye, until glass eel stage.

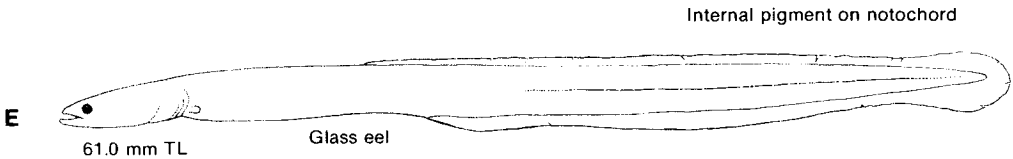
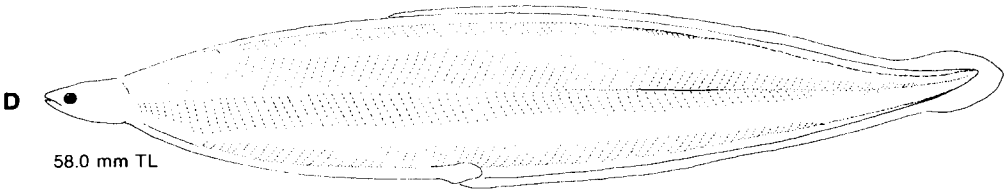
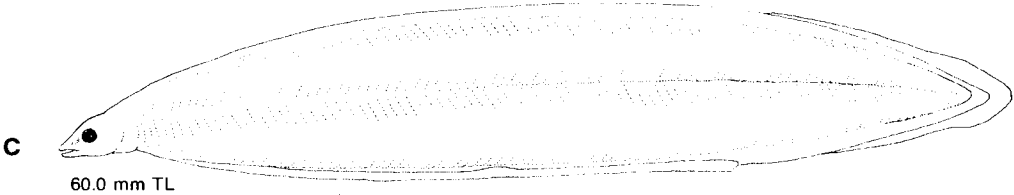
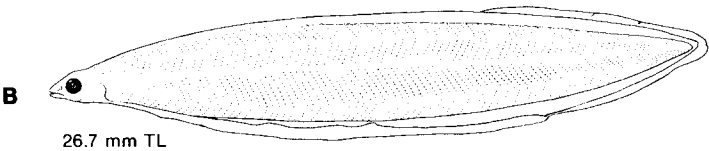
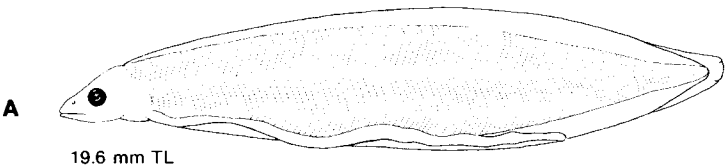
- Note:**
- (1) *Anguilla anguilla* (Linnaeus), the European eel, is similar and may be collected in the western North Atlantic; myomeres 111–119 (Vladykov and March 1975).
 - (2) The only other unpigmented leptocephalus reported from the western North Atlantic is *Anarchias yoshiae* (Fig. F opposite), a muraenid with 107–114 myomeres, the posterior nostril near upper margin of eye, pectoral fin totally lacking, gut about 50% TL, and a blunt tail. Leptocephali may have a few internal pigment spots near the brain (Smith 1979), and inconspicuous spots along the ventral margin of the spinal cord.

Fig. — **A–B**, Vladykov 1955; **C–E**, Schmidt 1916; **F**, Eldred 1968b (**A–E** redrawn).

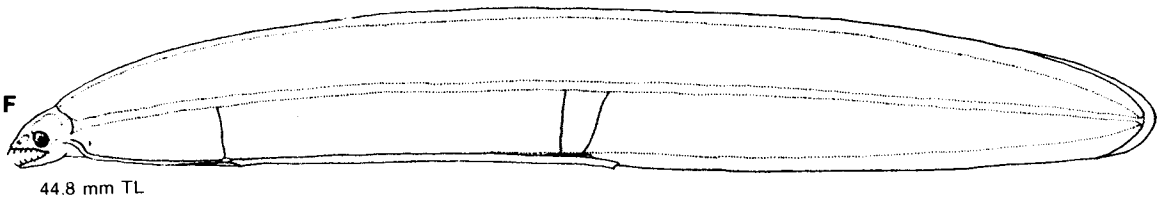
Ref. — Eldred 1968c.

Anguilla rostrata

ANGUILLIDAE



Anarchias yoshiae



OPHICHTHIDAE *Ophichthus cruentifer* (Goode and Bean)

Spawning: This is the only ophichthid eel which spawns in the Mid-Atlantic Bight, in summer near edge of continental shelf.

Meristic features
Myomeres: 142–162

Eggs

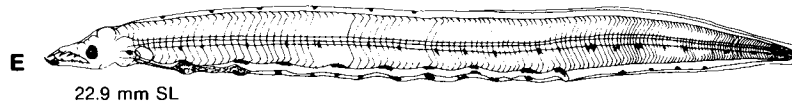
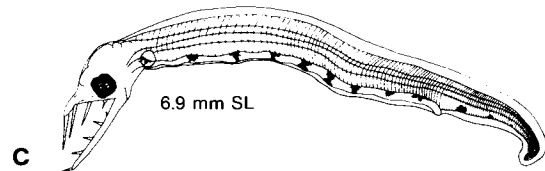
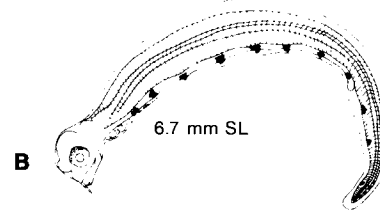
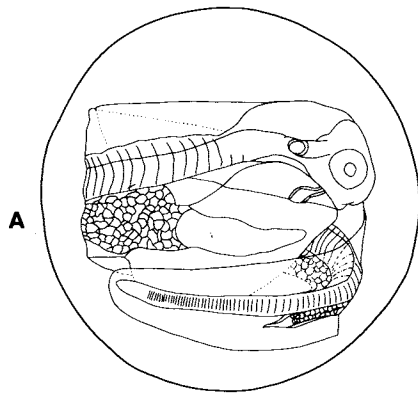
- Pelagic, large, no pigmentation.
- Diameter: 1.90–2.89 mm (smallest newly spawned).
- Shell: smooth and clear.
- Perivitelline space: wide.
- Yolk: segmented.
- Oil globules: 1.
- O.G. diameter: 0.26–0.65 mm.

Larvae

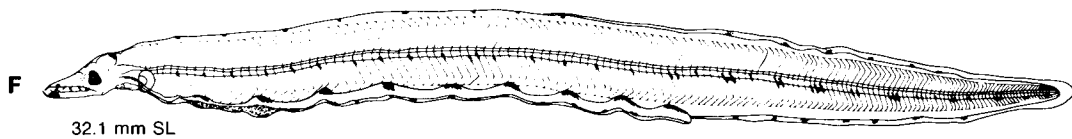
- Leptocephalus; hatching size 6.5 ± 0.8 mm.
- Gut long and undulating with 9 peaks or loops; length decreases from 76% SL at 5.8 mm to 53% SL at 83.5 mm.
- Preanal myomeres 66–75; predorsal myomeres 44–57.
- Predorsal length decreases from about 50% SL at 30 mm to 38% SL at 80 mm.
- Pectoral fin late forming; pelvic fin absent.
- Maximum size before metamorphosis 83.5 mm.
- Larvae caught off Long Island and New Jersey average 154 myomeres; those caught off Virginia Capes average 148 myomeres.
- Pigmentation: tip of lower jaw, top of head, snout; dorsal edge of body; dorsal patches on gut loops, ventral patches added after about 20 mm, and spots develop between loops in larger larvae; myosepta sporadically pigmented along midline; 5–7 subcutaneous spots ventral to midline on tail; few spots on flank on upper and lower angles of some myosepta; anal base pigment in short linear clusters.

Ophichthus cruentifer

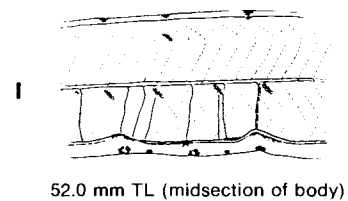
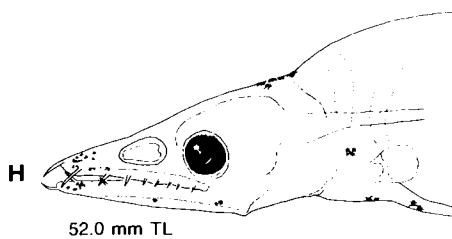
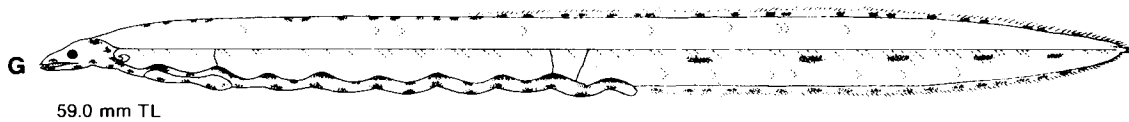
OPHICHTHIDAE



Tip of lower jaw pigmented



Spots along dorsal edge of body



OSMERIDAE***Mallotus villosus* (Müller)**

Spawning: Spring-summer, near bottom in river mouths and coastal waters.

Meristic features

- Eggs**
- Demersal, adhesive, spherical.
 - Diameter: 0.90–1.16 mm.
 - Shell: transparent and thick.
 - Perivitelline space: moderately wide.
 - Oil globules: many (tiny).

Myomeres: 62–73
 Vert : 64–70
 D : 12–14
 A : (17)19–21(22)
 Plv : 8
 P : 18–20

- Larvae**
- Hatching occurs at 6–7 mm; eye unpigmented.
 - Long and slender; preanus length about 75% TL; preanal myomeres 48–51 (at hatching).
 - Flexion occurs at 11–16 mm TL.
 - Sequence of fin formation: C–A, D, Ad.–Plv–P.
 - Adipose fin present.
 - Sizes (TL) at beginning of ossification and completion of fin rays:

Principal caudal rays	7 mm	16 mm
Anal and dorsal rays	11	21
Adipose fin	13	16
Pelvic rays (bud at 21 mm)	29	40
Pectoral rays	40+	

- Pigmentation: double, ventral row of spots anterior to yolk sac but posterior to pectoral fin base and large spot over anus; single row of spots from yolk-sac to caudal fin base; row of spots added to each lateral surface, dorsal to gut.

Similar larvae

- *Clupea harengus* (p. 26): no adipose fin; medial streak of pigment on isthmus; preanus length about 83% TL; front of yolk-sac near pectoral fin base (well posterior to pectoral fin base in *Mallotus*); yolk-sac larvae (7–10 mm) larger than in *Mallotus* (<7 mm).
- *Argentina* sp. (p. 64): pelvic fins farther posterior (i.e. under posterior dorsal fin) and mouth much smaller.
- *Pholis gunnellus* (p. 294) and *Ammodytes* sp. (p. 298): preanus length only about 50% TL; long dorsal and anal fin bases.
- Engraulidae (p. 36–41): dorsal and anal fins overlap.
- *Osmerus mordax* : (see below).

***Osmerus mordax* (Mitchill)**

Spawning: Late winter-early spring in brackish to fresh water.

Meristics features

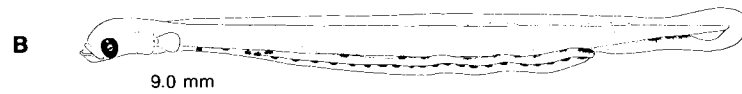
- Eggs**
- Demersal, adhesive, in clusters.
 - Diameter: 0.6–1.2 mm.

Myomeres: 62–64
 Vert : 62–64
 D : 10–11
 A : 15–17
 Plv : 8
 P : 11–12

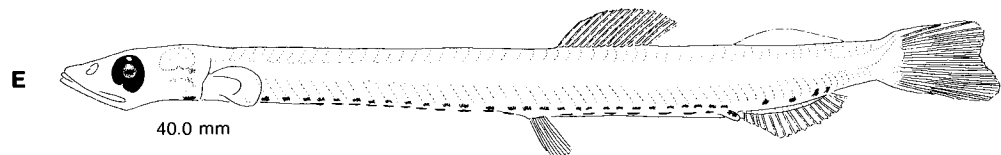
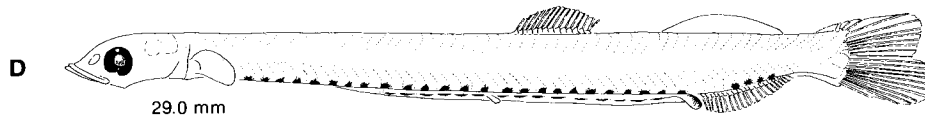
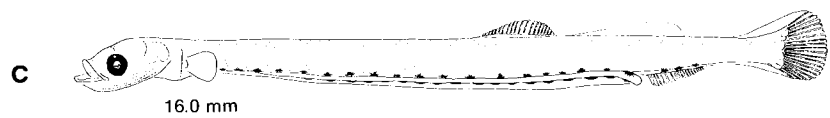
- Larvae**
- Hatching occurs at about 5–6 mm; preanal myomeres 38–43.
 - Adipose fin present.
 - Fins well developed at about 15 mm.
 - Air bladder obvious in sizes greater than 15 mm.
 - Pigmentation: up to 15 mm, may have ventral pair of spots anterior to pectoral fins.

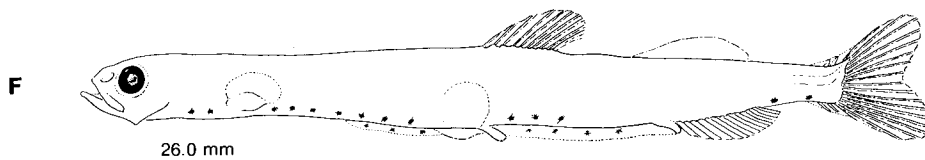
Fig. — **A** and **F**, Bigelow and Schroeder 1963; **B–E**, Templeman 1948 (all redrawn).

Ref. — Rice 1878; McKenzie 1964; Serebryakov MS 1980; H. Powles 1982 (pers. comm.).

Mallotus villosus**OSMERIDAE**

One or more pairs of elongate spots
laterally on isthmus

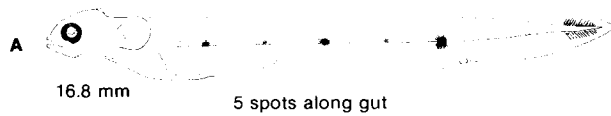


Osmerus mordax

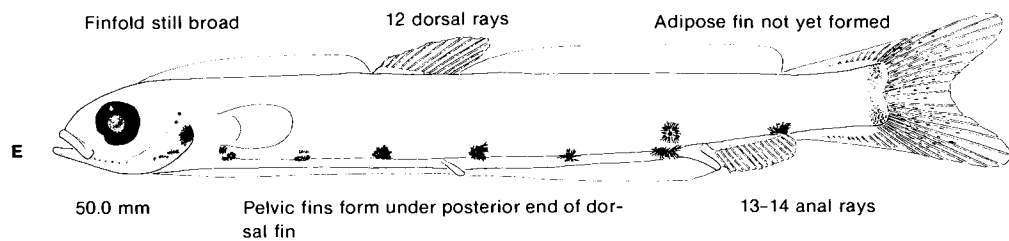
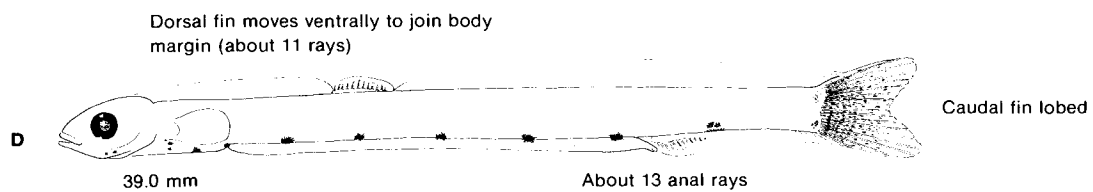
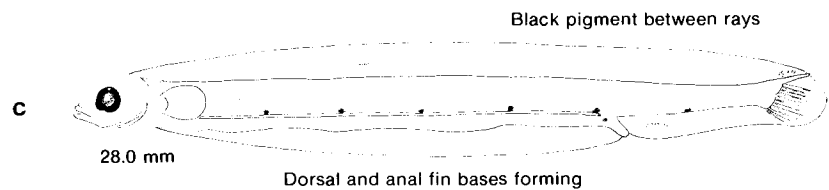
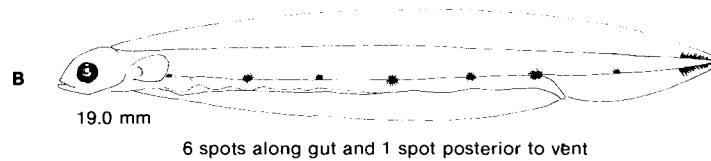
ARGENTINIDAE***Argentina silus Ascanius***

(North Atlantic)

- | | | |
|---------------|--|---|
| Eggs | <ul style="list-style-type: none"> — Pelagical, spherical. — Diameter: 3.0–3.5 mm. — Shell: smooth. — Yolk: segmented. — Oil globules: 1. — O.G. diameter: 0.95–1.16 mm. — Perivitelline space: narrow. | Meristic features |
| | | Myomeres: 64–67
Vert : 64–67
D : 11–13
A : 13–17
Plv : 12–13
P : 15–18 |
| Larvae | <ul style="list-style-type: none"> — Hatching occurs at 6–9 mm; eyes unpigmented; no body pigment; broad fin fold; preanal myomeres 46–48. — Long and slender, with long straight gut. — Low number of branchiostegal rays (6). — Adipose fin present after transformation. — Flexion occurs at 28–35 mm, and transformation at >50 mm. — Dorsal and anal fins form distally in finfold. — Caudal fin begins to ossify at about 28 mm. — Pectoral and pelvic fins form late. — Pigmentation: (see illustrations opposite). | |
| Note: | <ul style="list-style-type: none"> (1) Large postlarvae superficially resemble <i>Trachinocephalus myops</i> (Synodontidae, p. 94); they differ in position of pelvic fin relative to dorsal fin and absence of adipose fin pigment (Markle <i>et al.</i> 1980). (2) <i>Argentina striata</i> Goode and Bean (from western North Atlantic) may differ in pigmentation and sequence of fin development; meristic features are: myomeres = 47–51, D = 10–12; A = 11–13, Plv = 12–15, and P = 18–21 (Cohen and Atsides, 1969). | |

Argentina silus**ARGENTINIDAE**

Spots dorsal and ventral to notochord tip

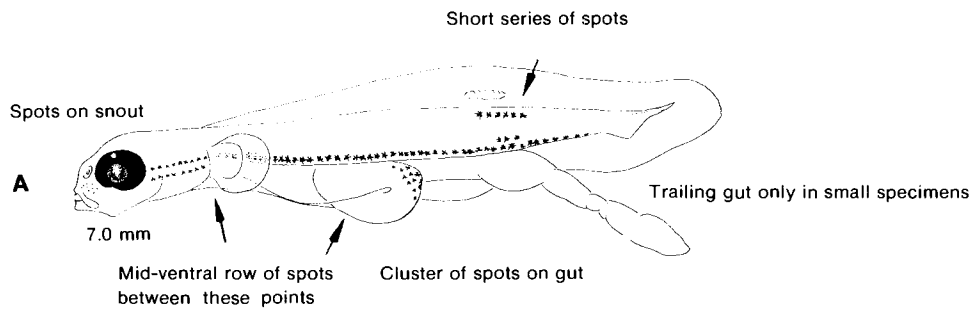


ARGENTINIDAE *Microstoma microstoma* (Risso)

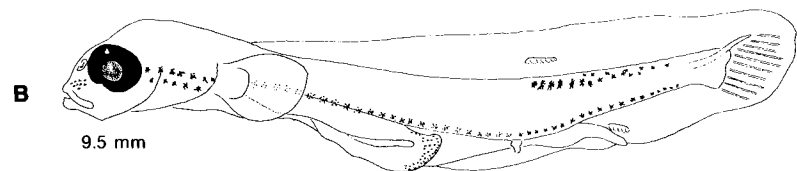
Eggs	— Pelagic, spherical and transparent.	Meristic features
	— Diameter: 1.60–1.72 mm.	
	— Shell: sculptured with internally-directed projections.	
	— Yolk: segmented.	
	— Oil globules: 1.	
	— O. G. diameter: 0.48–0.52 mm.	
Larvae	— Perivitelline space: narrow.	Myomeres: 45–46
	— Fairly slender with swollen trailing gut.	Vert : 29–30+15–17
	— No adipose fin.	D : 11–12
	— Low number of branchiostegal rays (3–4).	A : 8–9
	— Flexion occurs at about 7–11 mm, and transformation at about 17–20 mm.	Plv : 9–11
	— Dorsal and anal fins form distally in finfold.	P : 8
	— Pectoral and pelvic fins form late.	
	— Pigmentation: (see illustrations opposite).	

Fig. — **A–D**, Schmidt 1918 (redrawn).

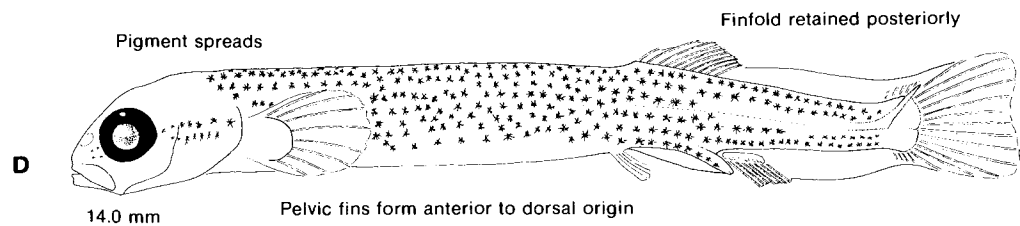
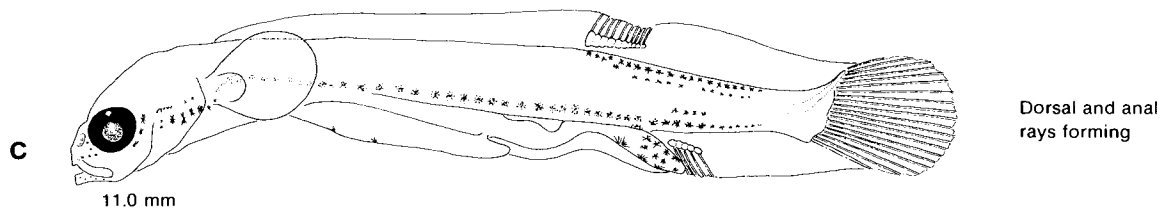
Ref. — Sanzo 1931a.

*Microstoma microstoma***ARGENTINIDAE**

Conspicuous row of spots from eye along ventral edge



Dorsal and anal fin bases forming in finfolds; dorsal fin origin at about myomere 30-31



A-D (Mediterranean material)

ARGENTINIDAE *Nansenia groenlandica* (Reinhardt)**Eggs** — Undescribed.**Larvae** — Fairly slender, with long thick gut.
— Low number of branchiostegal rays (3–4).
— Adipose fin forms before transformation.
— Flexion complete at about 10–13 mm; and transformation occurs at >20 mm.
— Dorsal and anal fins form distally in finfold.
— Pelvic fin forms late.
— Dorsal fin origin anterior to pelvic fins.
— Oblong eye in early larvae.
— Small terminal mouth.
— Wide finfold.
— Pigmentation: (see illustrations opposite).**Meristic features**

Myomeres: 43–44

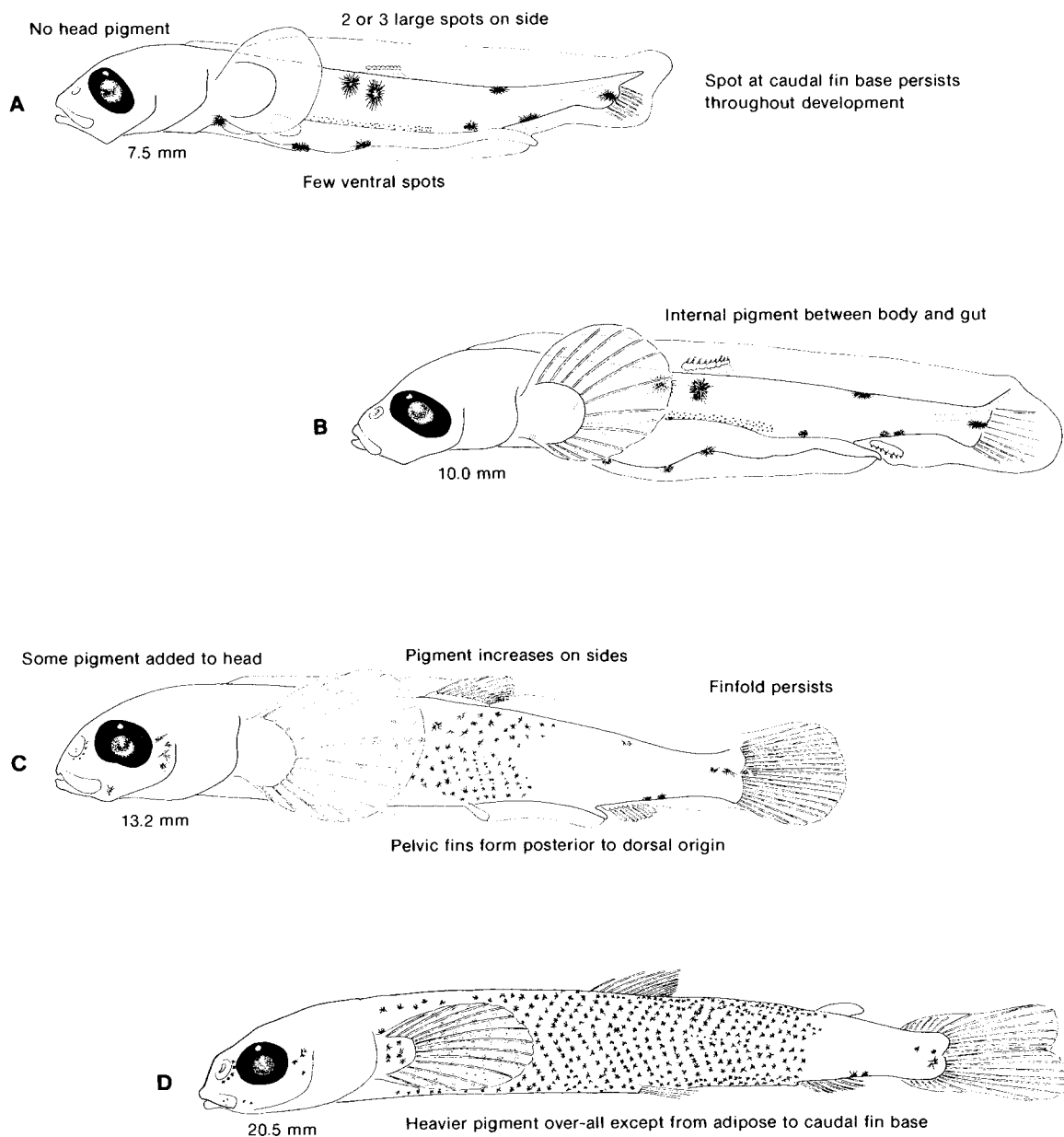
Vert : 43–44

D : 10–11

A : 9–11

Plv : 9–11

P : 14–15

Nansenia groenlandica**ARGENTINIDAE**

A-D (eastern North Atlantic material).

BATHYLAGIDAE***Bathylagus* sp.****General features of genus**

- Larvae** — Slim-bodied with stalked eyes variously developed between species (some species without stalked eyes)
 — Pectoral and pelvic fins form late; pelvic fins form under dorsal fin.
 — Adipose fin present (reduced in some species).
 — Meristic features as follows:

Western Atlantic species	Vert.	D	A	P	Plv
<i>Bathylagus greyae</i> Cohen	...	11-13	13	12-13	10-11
<i>Bathylagus compsus</i> Cohen	51	10-11	19-20	9	9-10
<i>Bathylagus longirostris</i> Maul	48	11-12	19-21	9-12	9-10
<i>Bathylagus euryops</i> Goode & Bean	44-46	9-11	16-19	7-12	7-9
<i>Bathylagus berycoides</i> Borodin	48-49	10-11	18-22	10-12	9-10

Note: Cohen (1964) concluded that either *Bathylagus benedicti* described by Tåning (1931) or *B. benedicti* described by Beebe (1933) represented larvae of *B. euryops*. Two species are possibly involved, because Beebe's larva lacks distinctive pigmentation and stalked eyes.

"*Bathylagus benedicti*" (Fig. A-C)

- Larvae** — Series included postlarvae to transforming specimens.
 — 47 myomeres.
 — Flexion occurs at 15-22 mm, and transformation at about 27-30 mm.
 — Dorsal fin forms at margin of finfold at about 22 mm.
 — Three (rarely 4 or 5) large dendritic spots laterally on body.
 — Large spot on intestine under pectoral fin; few spots along gut to anus.

"*Bathylagus benedicti*" (Fig. D)

- Larvae** — Series included 8 transforming specimens 18-22 mm.
 — All fin rays formed by 18 mm: D = 10, A = 18.
 — Upper edge of opercle ends behind middle of eye (not lower, as shown in Fig. D).

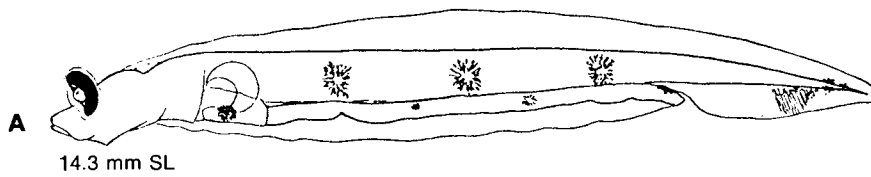
***Bathylagus compsus* Cohen (Fig. E-G)**

- Larvae** — Small eyes on stalks in postlarvae, but eyes normal in transforming specimens.
 — Row of spots above and below midline.
 — Row of spots along ventral edge from pectoral fins to anus in postlarvae.

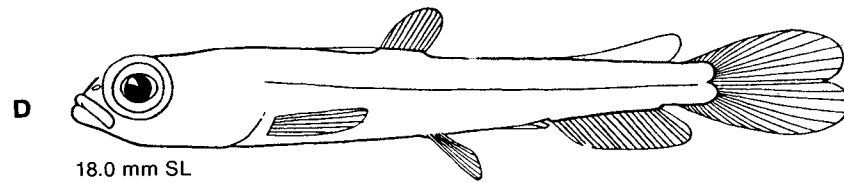
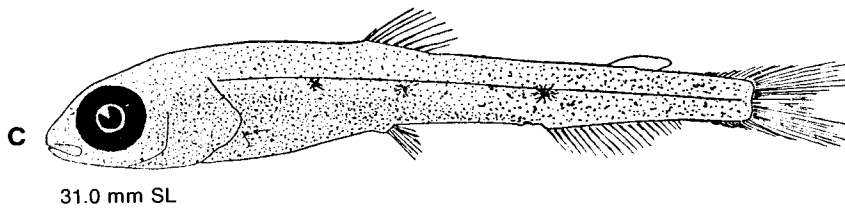
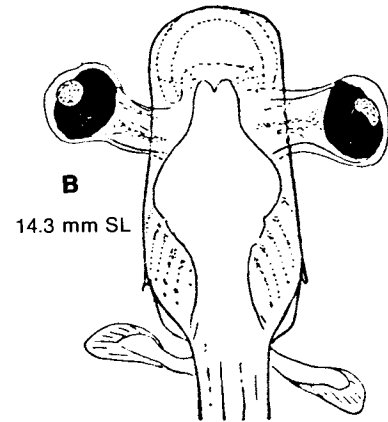
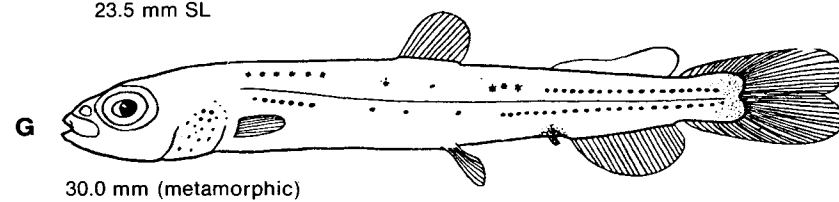
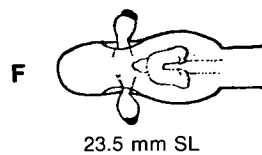
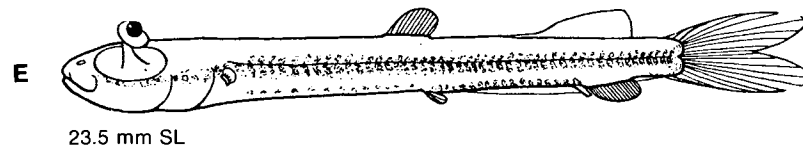
Note: Beebe (1933) referred this species to *B. glacialis*.

Fig. — A-C, Tåning 1931, D-G, Beebe 1933.

Ref. — Cohen 1964.

Bathylagus (euryops)**BATHYLAGIDAE**

Central spot at myomeres 18-21;
dorsal fin forms over middle spot

***Bathylagus compsus* Cohen**

GONOSTOMATIDAE Family Characters

(including STERNOPTYCHIDAE)

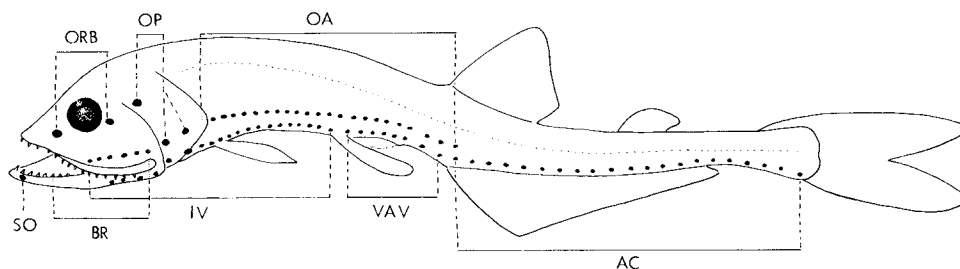
General: Larval descriptions available for 12 of 16 genera in the western North Atlantic; very abundant in oceanic collections; *Cyclothone* (adults) may be most abundant genus; *Vinciguerria* and *Maurolicus* larvae very abundant.

Eggs — Most are undescribed; characteristics in 4 genera are as follows:

Character	<i>Maurolicus muelleri</i>	<i>Ichthyococcus ovatus</i>	<i>Vinciguerria attenuata</i>	<i>Argyropelecus hemigymnus</i>
Diameter	1.32–1.58 mm*	0.80 mm	0.84–0.92 mm	0.92–1.04 mm
Shell	Sculptured	Smooth (orange)	Smooth	Smooth
Yolk	Segmented	Segmented	Segmented	Segmented
Oil globules	One	One	One	One
O.G. diameter	0.26–0.28 mm	0.24 mm	0.18–0.20 mm	0.26–0.28 mm
Perivitelline space	Narrow	Narrow	Narrow	Narrow

* Mediterranean specimens; may be larger (up to 1.65 mm) in western North Atlantic.

- Larvae** — Elongate body in most genera.
- Preanal length ranges from fairly short (in *Argyripnus*) to about 95% SL; trailing gut occurs in *Ichthyococcus*.
 - Head shape varies; eye round to narrow (especially in *Argyropelecus*.)
 - Teeth on maxilla and premaxilla (only on premaxilla in myctophids and neoscopelids).
 - Anal fin base usually long, occupying most of postanal distance.
 - Fins form in adult position, except in *Pollichthys* where anterior shift occurs at metamorphosis; adipose fin may be present or absent.
 - Transformation either gradual or marked (see table on opposite page).
 - Myomeres 28–42 in most, but about 85 in *Diplophos*.
 - Principal caudal rays 10+9 in all; pectoral fins often on peduncle.
 - Dorsal and anal fin-ray counts important, i.e. higher dorsal-ray counts in *Gonostoma*, *Bonapartia* and *Margrethia*.
 - Photophores form in stages. (Terminology as in Ozawa 1976; compare to Myctophidae, p. 103.)



Ref. — Sanzo 1931a; Grey 1964; Ahlstrom 1974; Bond 1977.

Family Characters

GONOSTOMATIDAE

Summary of important characters in gonostomatid-sternoptychid genera with described larvae:

Genus	Anteriormost fin origin	Dorsal fin base length	Transformation	Photophores
<i>Vinciguerria</i>	Dorsal	Long	Most or all ventral photophores form simultaneously	Separate
<i>Cyclothone</i> ¹	Dorsal≈Anal	Long	during late postlarval stage	Separate
<i>Ichthyococcus</i> ²	Dorsal	Short		Separate
<i>Pollichthys</i> ³	Dorsal	Short		Separate
<i>Diplophos</i> ⁴	Dorsal	Short		Separate
<i>Gonostoma</i> ¹	Anal	Long	Gradual, protracted; OP and posterior IV first to form	Separate
<i>Bonapartia</i> ^{1,5}	Anal	Long		Separate
<i>Margrethia</i> ^{1,5}	Anal≈Dorsal	Long		Separate
<i>Maurolicus</i>	Dorsal	Short	Gradual, protracted; BR and posterior IV first to form	Most in clusters with common bases
<i>Valenciennellus</i>	Anal	Short		
<i>Argyripnus</i>	Anal	Short		
<i>Argyropelecus</i> ⁶	Dorsal	Short	Striking change in body form	

¹ These genera lack photophores on isthmus, have low numbers of photophores in ventral series, and have pelvic and anal fins separated by short gap.

² Trailing gut present.

³ Very long gut; anus shifts anteriorly before metamorphosis.

⁴ Very high myomere count (~85); very elongate body.

⁵ OA photophores lacking.

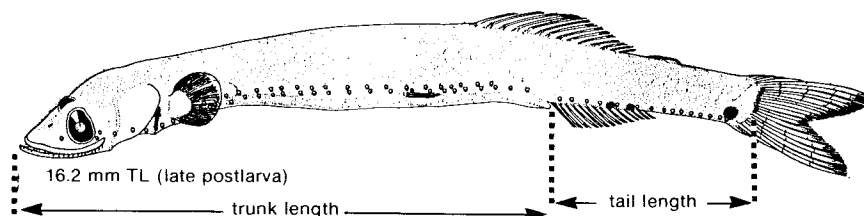
⁶ The very similar and common *Sternoptyx* sp. is characterized by a much shorter gut before transformation, normal eyes after transformation (telescopic in *Argyropelecus*), and transformation occurring at smaller sizes.

GONOSTOMATIDAE *Vinciguerrria* (3 species)

- Larvae** — Slender elongate body; long straight gut; preanal length about 75% SL, decreases at transformation.
- Concave occiput and snout; head length about 20% SL, increases at transformation; eyes oval and semi-stalked.
- Pigment light; prominent caudal spot.
- Transformation marked: body deepens, head and eyes increase in relative size, photophores develop almost simultaneously (some AC and OA slightly later).
- Fin formation: caudal forms first, followed by dorsal and anal; pelvic buds and true pectoral rays form at transformation; adipose fin present, but small and late forming.

Distinguishing characters:

		<i>V. poweriae</i> (Cocco)	<i>V. nimbaria</i> (Jordan and Williams)	<i>V. attenuata</i> (Cocco)
Meristic	Vert	38-39	40-42	40-41
	D	13-15	14-15	13-15
	A	12-14	13-15	14-16
	Plv	7	7	7
	P	9-10	9-10	9-10
Pigment	Caudal spot	Median (small but visible through transformation)	Ventral peduncle (lost at transformation)	Median (sometimes lost at transformation)
	Air bladder	None	None	Present
	Over anal fin	None	2-3 spots	None
	Caudal fin base	None	2-3 vertical lines	None
	Isthmus-body junction	None	Narrow line	None
Others	Anal fin origin	Under posterior dorsal rays	Under middle of dorsal fin	Under middle of dorsal fin
	Eye (juvenile)	Round	Round	Tubular
	SO photophore	Absent	Forms at transformation	Absent
Ratio of trunk length to tail length	Early larva	3	3	2.75
	Late larva	3	2.75	2+
	Transforming	2.5+	2.5+	1.75
	Juvenile	2.5	2	1.5+



Vinciguerrria nimbaria (Indian Ocean specimen, Silas and George, 1969)

Fig. — A-B, D-H, Jespersen and Tåning 1926; C, Ahistrom and Counts 1958.

Ref. — Jespersen and Tåning 1919; Jespersen 1933; Grey 1964.

Vinciguerrria poweriae**GONOSTOMATIDAE**

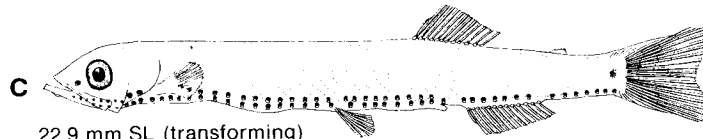
11.3 mm SL (postlarva)

Small round organ sometimes visible in body above anal papilla



20.0 mm SL (late postlarva)

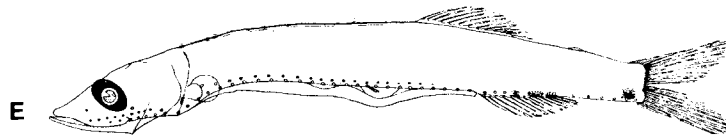
Generic features: gape does not extend as far back as in engraulids; spots larger than in clupeids or engraulids; oval eye



22.9 mm SL (transforming)

Vinciguerrria nimbaria

7.3 mm SL (postlarva)



14.3 mm SL (late postlarva)

Vinciguerrria attenuata

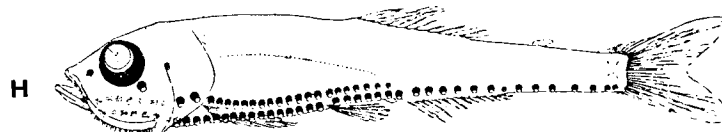
9.7 mm SL (postlarva)

At all stages, relative tail length is greatest in *V. attenuata*



18.3 mm SL (late postlarva)

Air bladder pigmented



20.8 mm SL (juvenile)

Note: See *Pollichthys* (p. 78).

GONOSTOMATIDAE *Cyclothone braueri* Jespersen and Tåning

- Eggs** — Undescribed. **Meristic features***
- Larvae** — Body slender, elongate; preanal length about 50% SL; eye round; air bladder present; no adipose fin. Myomeres: 29–33
 — Flexion occurs at about 4.5–5.5 mm SL. Vert : 29–33
 — Transformation: sudden at about 14 mm SL; body shrinks, head changes shape, vent moves anteriorly from anal fin origin, most photophores become pigmented simultaneously. D : 12–15
 A : 16–21
 Plv : 6–7
 P : 9–13
 — Fin formation: caudal and dorsal fins complete at about 10 mm, and anal fins soon after; pelvic bud forms near air bladder at about 12 mm; pectoral fin rays begin to form dorsally at about 12 mm. * Counts pertain to range for genus
 — Photophores: most form (unpigmented) at about 11–12 mm; only a few (i.e. OA) are late forming; AC does not form in 2 groups.
 — Pigmentation: 2–3 spots along gut (posteriormost at anus) plus 1 spot which forms at cleithral symphysis; air bladder pigmented; lateral series of spots posterior to pectoral fin; about 11 evenly-spaced spots over anal base; after anal fin formation, 14–15 spots form on pterygiophores; 1 spot under urostyle and 3 spots laterally over urostyle.
- Note:** (1) Larvae very similar to *Vinciguerrria* (p. 74) before photophores pigmented, but *Cyclothone* has rounded eyes, shorter preanus length, and more spots along anal fin base.
 (2) Other species also present in western North Atlantic (see *C. microdon* in Jespersen and Tåning, 1926).

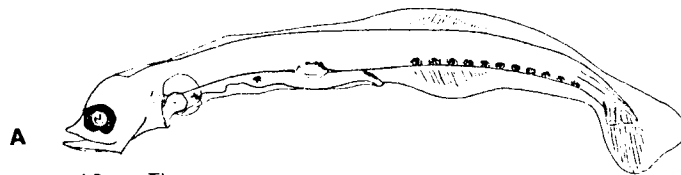
***Ichthyococcus ovatus* (Cocco)**

- Eggs** — See table on p. 72. **Meristic features**
- Larvae** — Body slender, elongate and round; trailing gut; adipose fin present. Myomeres: 38–42
 — Snout pointed and depressed; eye elliptical. Vert : 38–42
 — Preanal length about 70% SL; preanal myomeres 32 at hatching and 26 in later larvae (about 10 mm). D : 11–12
 A : 15–17
 Plv : 7
 P : 7
 — Transformation: body shrinks and deepens (largest larvae 18–28 mm, smallest juveniles 11–14 mm); head becomes shorter and deeper; upper pectoral rays disappear.
 — Fin formation: caudal fin complete at 11 mm; dorsal and anal fins begin to ossify at about 14 mm, anal complete at 21 mm, dorsal at 28 mm (maximum larval size); pelvic buds form at about 14 mm; pectoral and pelvic fins complete after transformation.
 — Photophores first to form: IV, VAV, last 2 or 3 AC.
 — Pigmentation: (see illustrations opposite).

General note: In the two species above and *Pollichthys maui* (p. 78–79), photophores are separate, and most ventral photophores form simultaneously during late larval stage.

Fig. — A–D, Jespersen and Tåning 1926.

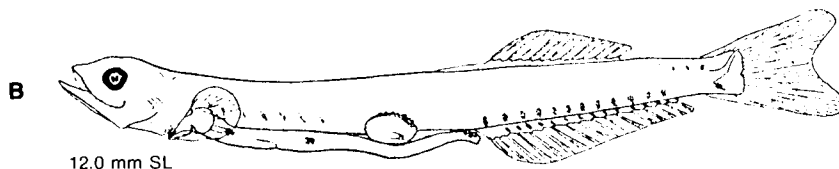
Ref. — Sanzo 1913, 1930; Ahlstrom 1974.

Cyclothone braueri**GONOSTOMATIDAE**

4.8 mm TL

Anal origin under dorsal;
dorsal fin base relatively long

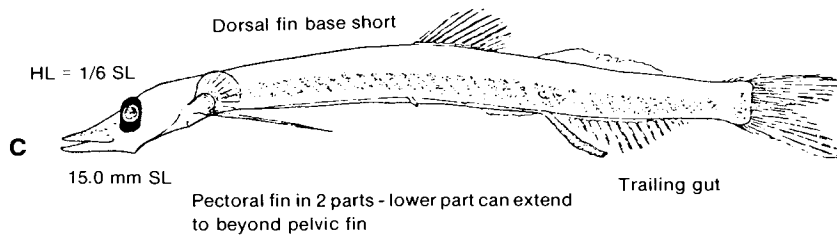
No adipose fin



12.0 mm SL

Pelvic and anal fins
separated by short gap

No photophores on isthmus; low number in ventral series (AC 12-16, VAV 4-5)

Ichthyococcus ovatus

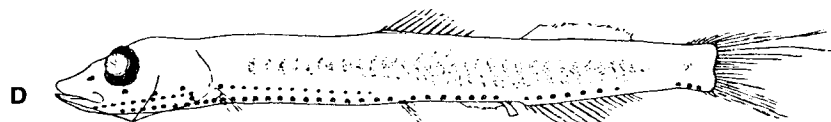
HL = 1/6 SL

15.0 mm SL

Dorsal fin base short

Pectoral fin in 2 parts - lower part can extend
to beyond pelvic fin

Trailing gut

Anal fin origin well posterior to dorsal origin,
pelvic under dorsal origin

13.0 mm SL (transforming)

Pigment on snout and pectoral fin

Broad, lateral stripe of diffuse pigment

A-D (eastern Atlantic material)

GONOSTOMATIDAE *Pollichthys maui* (Poll)**Eggs** — Undescribed.

- Larvae** — Elongate body with long gut; adipose fin present.
 — Preanal length about 80% SL at 3.0 mm; anus at myomere 34, moving to myomere 39–43 at about 4–6 mm.
 — Snout short, upturned, becomes sharply pointed.
 — Eyes oval, on short stalks, with underlying choroid tissue (not present in other gonostomatids).
 — Eye diameter decreases early in development (from about 45% HL at 3.4 mm to about 20% HL in juveniles).
 — Head depth about 62% HL at 3.0 mm, decreasing to about 42% HL in late post larvae, and becoming deep again in juveniles.
 — Flexion occurs at 3.6–7.0 mm, and transformation at 16–18 mm.
 — Morphological changes from larval to juvenile stages:

Meristic features

Myomeres: 45–48
 Vert : 45–47
 D : 10–12
 A : 25–26
 Plv : 6–7
 P : 8

Preanal length % SL	80–88	55
Head length % SL	20–15	25
Maximum body depth % SL	7	12
Head depth % HL	42	60
Anal fin base length % SL	5–10	25–30

- Sizes at beginning of ossification and completion of fin rays and vertebrae:

Principal caudal rays	7.6 mm	14.0 mm
Dorsal rays	9.1	13.1
Anal rays	14.8	18.0 (juvenile)
Pelvic rays (buds at 10 mm)	16.0	18.0–20.0
Pectoral rays	~20.0 (metamorphic)	18.0 (juvenile)
Vertebrae	17.2	21.3

- Most photophores (unpigmented) form between 16 and 25 mm; become pigmented simultaneously; all photophores separate.
 — Pigmentation: none (except eyes) until metamorphosis.

Note: (1) Closely related to *Vinciguerria* (p. 74): transforming stages similar, but *Pollichthys* (a) lacks pigment at peduncle end, (b) has longer tail, (c) has longer anal fin base, (d) has anteriorly-directed eyes in early stages, and (e) shows more anterior movement of anus at transformation.

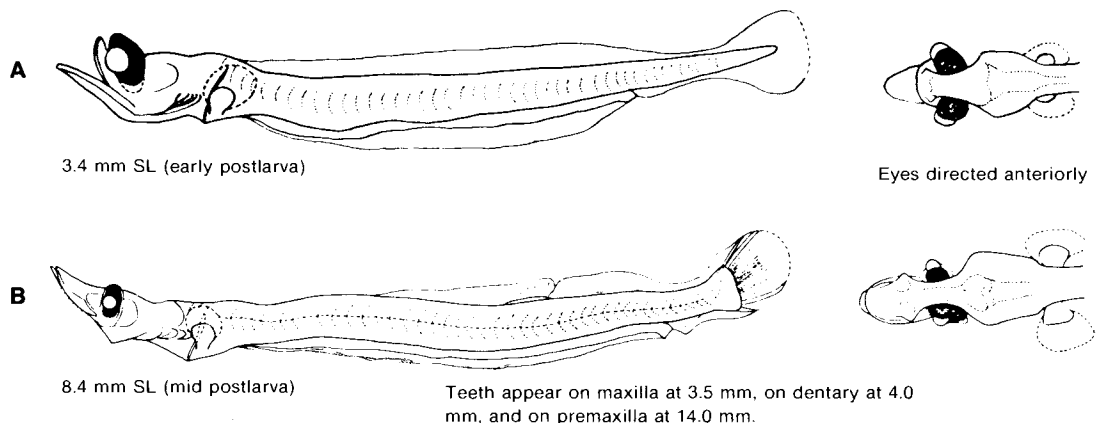
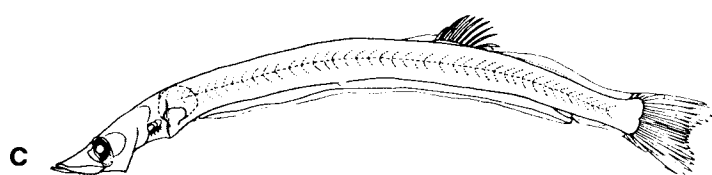
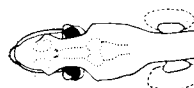


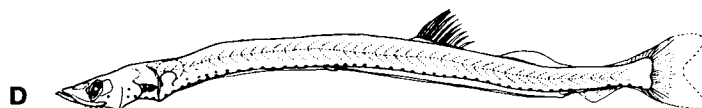
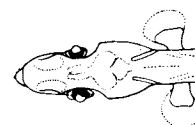
Fig. — A-E, H, Ozawa 1976; F-G, Grey 1964.

Ref. — Ahlstrom 1974.

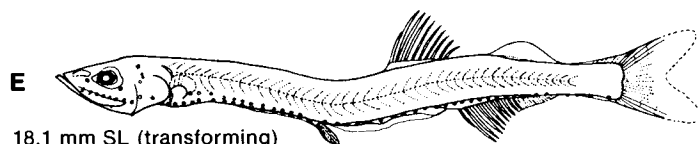
Pollichthys maui**GONOSTOMATIDAE****C**
12.7 mm SL (mid postlarva)

Pectorals fan-shaped

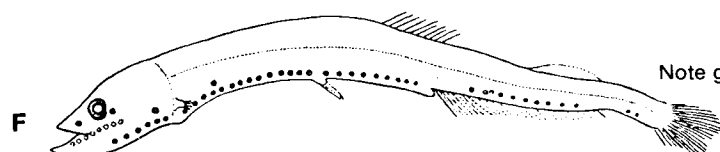
Pelvic bud at myomere 18–20, dorsal fin origin at myomere 26–29, and anus at myomere 39–43 (dorsal and anal shift anteriorly at transformation)

**D**
21.3 mm SL (late postlarva)

OA series late forming;
AC group incomplete initially (similar to *Gonostoma* and *Margrethia*)

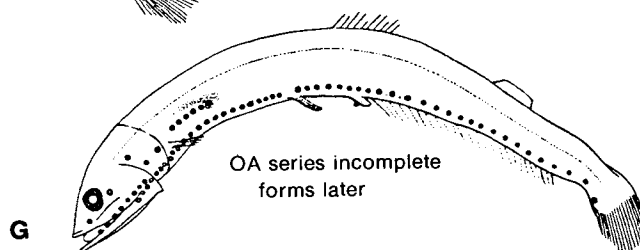
**E**
18.1 mm SL (transforming)

Sudden transition in body shape at transformation; anal fin origin moves from behind dorsal fin to under anterior dorsal fin

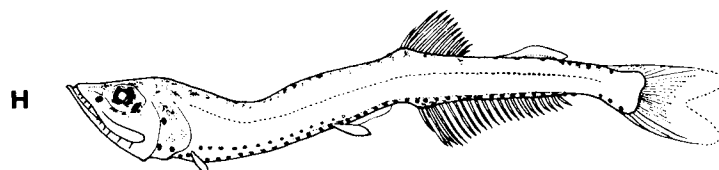
**F**
17.0 mm SL (transforming)

Lacks body pigment

Note gap in developing AC photophores

**G**
16.5 mm SL (transforming)

OA series incomplete
forms later

**H**
18.1 mm SL (juvenile)

Finfold retained from pelvic fin to anus;
anus separate from anal fin origin after transformation

A–E, H (Pacific material)

GONOSTOMATIDAE *Diplophos taenia* Günther**Eggs** — Undescribed.

Larvae — Elongate, with flat head and very small mouth.
 — Anal fin origin behind dorsal fin origin.
 — Dorsal fin base short.
 — No adipose fin.
 — Transformation gradual, beginning at about 46 mm; body shrinks to one-third TL; photophores added gradually, but most ventral photophores form simultaneously; dorsal and anal fins move anteriorly.
 — Pigmentation: spots along dorsal and ventral edges from head to tail.

Meristic features

Myomeres: ~85
 Vert : ~85
 D : 10-11
 A : 68
 Piv : 7
 P : 8-9



Note: *Diplophos maderensis* (Johnson), whose larvae are undescribed, also occurs in the western North Atlantic.

Fig. — A, Jespersen and Tåning 1919.

Ref. — Grey 1964.

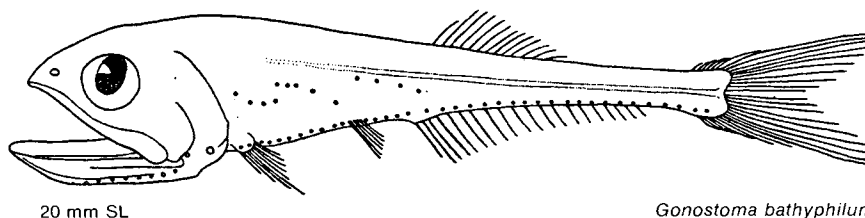
Characteristics of Four Species

GONOSTOMATIDAE

- Larvae**
- Gradual transformation.
 - All photophores separate; none on isthmus.
 - Anal fin origin about at the level of the dorsal fin origin.
 - Dorsal fin base relatively long.
 - Pectoral fin forms on peduncle.
 - Sequence of photophore formation in four species; first number in each range is size (mm) at which formation begins and second number is size at which adult complement is attained.

Photophore group	<i>Gonostoma atlanticum</i>	<i>Gonostoma elongatum</i>	<i>Bonapartia pedaliota</i>	<i>Margrethia obtusirostra</i>
OP	12.0–18.8	6.0–22.5	9.5–20.5	5.8–15.0
IV (posterior)	13.0–18.8	7.5–22.5	9.5–18.0	5.8–11.3
BR	18.8–18.8	10.2–22.5	9.5–24.5	8.0–15.0
VAV	18.8–18.8	10.2–22.5	13.5–15.5	6.4–8.0
ORB	18.8–18.8	14.0–14.0	12.5–15.5	15.0–15.0
AC	18.8–18.8	14.0–22.5	12.5–18.5	6.4–?
SO	After metamorphosis	22.5	>25	>19
OA		22.5	Lacking	Lacking

- Note:**
- (1) *Gonostoma atlanticum* occurs off the southern United States coast, but records of its occurrence off New England may be the result of misidentification.
 - (2) *Gonostoma elongatum* is the most abundant member of the genus off northeastern United States; it is more abundant than *G. atlanticum* in Slope and Gulf Stream waters and in the northern Sargasso Sea.
 - (3) *Gonostoma bathyphilum* (below) is reportedly common in deep water (>2,000 m). Larvae are undescribed, but a 20 mm SL juvenile (described by Koefoed 1958) is characterized by an oval eye, lack of adipose fin, pectoral fin on peduncle, and 21–24 anal rays (lower than in the other two species).



Gonostoma bathyphilum
(Koefoed 1958)

GONOSTOMATIDAE *Gonostoma atlanticum* Norman

- Larvae** — Anal fin origin slightly anterior to dorsal fin origin.
 — No adipose fin.
 — Photophores form more suddenly than in *G. elongatum*; AC photophores develop together.
 — Sequence of photophore formation (see table on preceding page).

Meristic features

Myomeres: ~38
 Vert : ~38
 D : 16–18
 A : 28–30
 Plv : 6–7
 P : 10

***Gonostoma elongatum* Günther**

- Larvae** — Anal fin origin slightly anterior to dorsal fin origin.
 — Adipose fin present (develops at about 20 mm).
 — Flexion occurs at about 4–6 mm.
 — Round eye; no caudal pigment (compare with *Bonapartia*).
 — Lower OP photophore is first to develop; OA series last to form at about 22.5 mm.
 — Sequence of photophore formation (see table on preceding page).

Meristic features

Myomeres: 39–40
 Vert : ~39
 D : 12–14
 A : 29–32
 Plv : 8
 P : 10–12

***Bonapartia pedaliota* Goode and Bean**

- Larvae** — Anal fin origin anterior to dorsal fin origin; anterior anal rays elongate.
 — No adipose fin.
 — Oval eye (becomes round at about 25 mm).
 — Peritoneal pigment and caudal spot in smallest larvae.
 — Lower OP, middle BR and posterior IV are first photophores to develop.
 — Sequence on photophore formation (see table on preceding page).

Meristic features

Myomeres: ~37
 Vert : ~37
 D : 17–20
 A : 29–31
 Plv : 7–8
 P : 14–16

***Margrethia obtusirostra* Jespersen and Tåning**

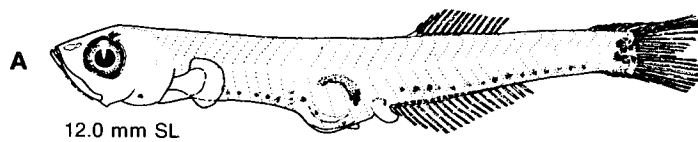
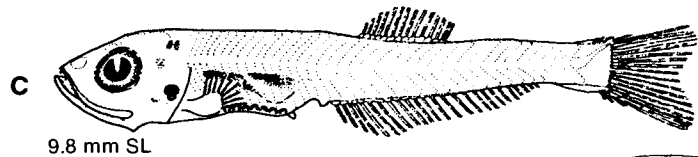
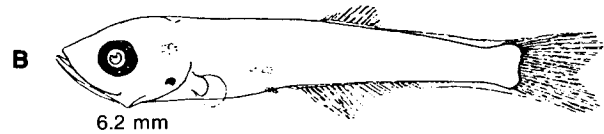
- Larvae** — Anal and dorsal fin origins about the same level or anal slightly posterior; anterior dorsal and anal rays longer.
 — Pelvic fin origin slightly anterior to dorsal fin origin.
 — Adipose fin present (develops early).
 — Oval eye (becomes round).
 — Lower OP, posterior IV, VAV, posterior and middle AC, and middle BR photophores develop early.
 — Sequence on photophore formation (see table on preceding page).

Meristic features

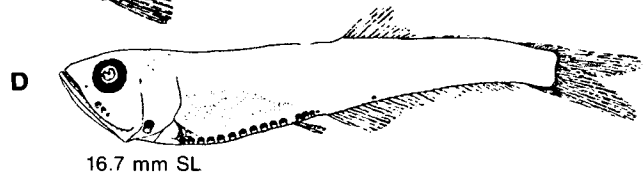
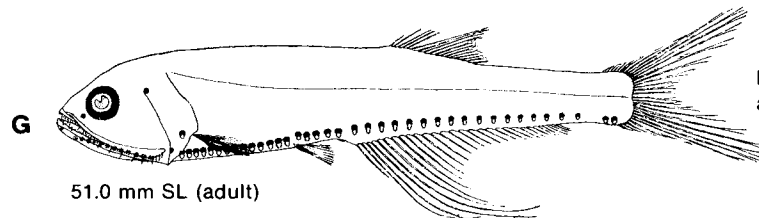
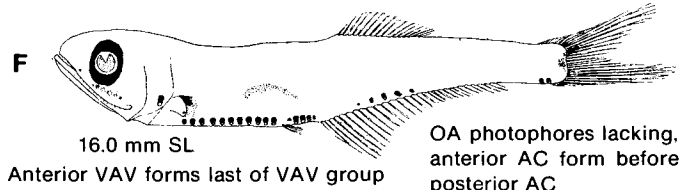
Myomeres: ~34
 Vert : ~34
 D : 15–16
 A : 21–26
 Plv : 8
 P : 13–15

Fig. — **A, C**, Ahlstrom 1974; **B, D, F–I**, Jespersen and Tåning 1919; **E**, Badcock 1977 (redrawn). (Fig. **A**, and **C** reproduced through the courtesy of Springer-Verlag, New York, Inc.; Fig. **E** reproduced through the courtesy of Pergamon Press Inc., New York.)

Ref. — Grey 1964; Jahn and Backus 1976.

Gonostoma atlanticum* GONOSTOMATIDAE**Gonostoma elongatum***

Pigment behind eye and
on gut above pelvic

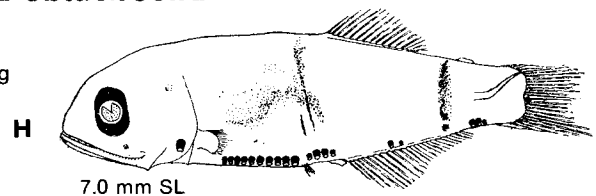
***Bonapartia pedaliota***

Posterior IV forms first, added to
anteriorly (see E)

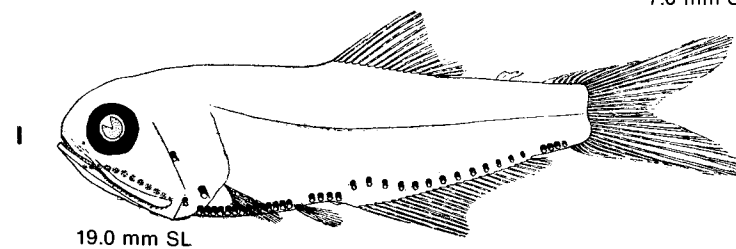
Margrethia obtusirostra

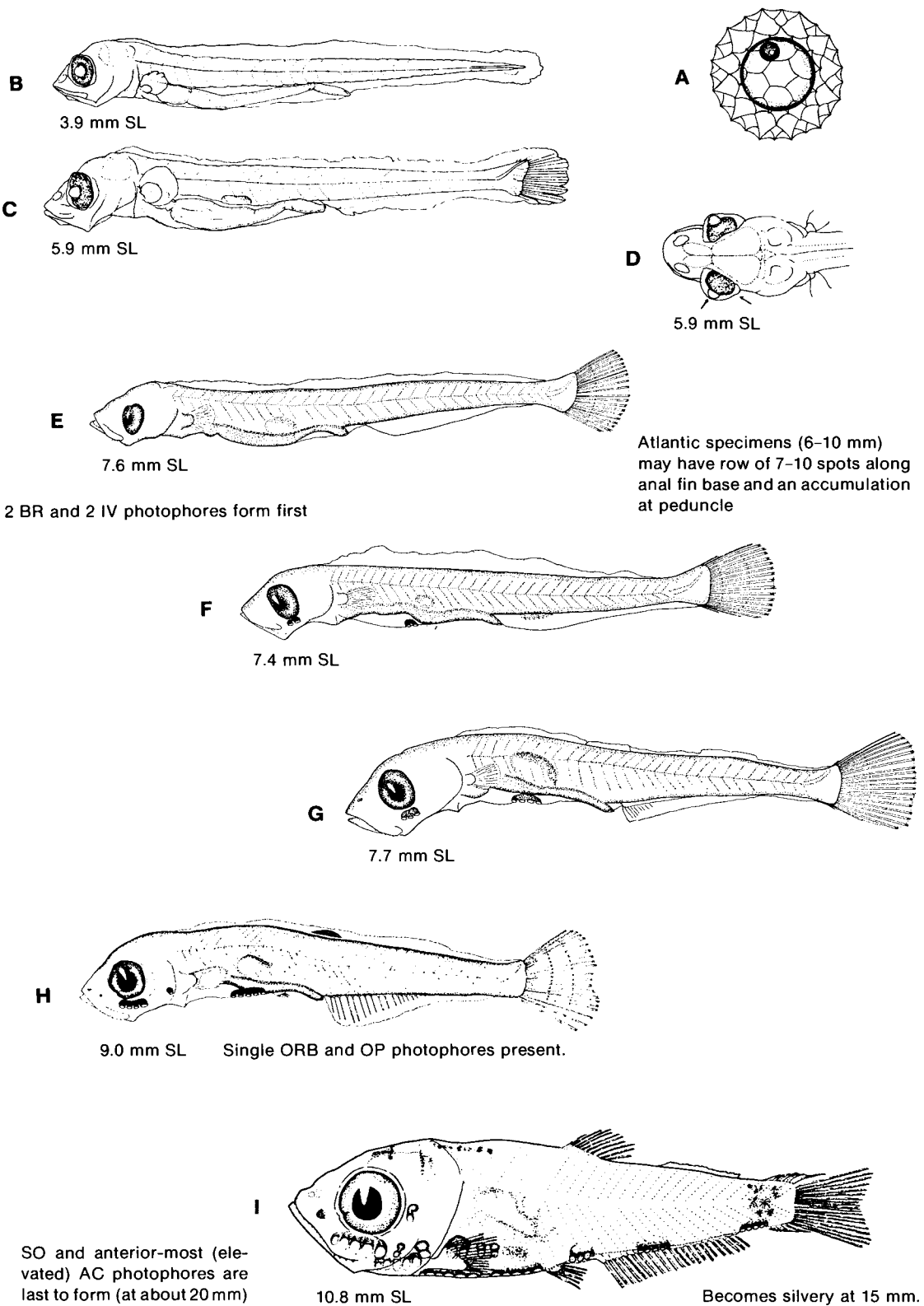
OA photophores lacking

Peritoneal pigment



Pigment bars not typical



Maurolicus muelleri**GONOSTOMATIDAE**

A, E–H (New Zealand material); **B–D** (Japan Sea material); **I** (Pacific specimen).

GONOSTOMATIDAE *Valenciennellus tripunctulatus* (Esmark)

- Larvae** — Oval eye, short dorsal fin base.
 — Adipose fin present.
 — Anal fin origin slightly anterior to dorsal fin origin.
 — Photophore development (length range over which one or some photophores of group form): none up to 9 mm, BR about 8 mm, posterior IV at 9–11 mm, VAV at 10.5–12.0 mm, ORB at 11.5–12.0 mm, anterior IV at 11.0–14.5 mm, OA at 13.5–15.0 mm, OP at 14.5–15.0 mm, posterior AC at 15–16 mm.
 — Pigment aggregation over each photophore.
- Meristic features**
 Myomeres: 32–33(–35?)
 Vert : 32–33
 D : 7–8
 A : 23–25
 Plv : 6–8
 P : 12–13

***Argyripnus atlanticus* Maul**

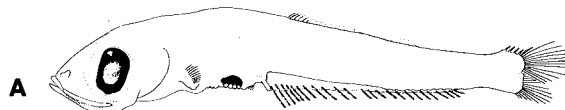
- Larvae** — Maxillary extends to posterior eye margin.
 — Adipose fin present.
 — Gap in developing anal fin (see Fig. D).
 — Anal fin origin under or slightly anterior to dorsal fin origin.
 — Preanal length about 43% SL, increases to about 50% SL in juveniles.
 — Head length 25–28% SL, eye diameter 11–13% SL.
 — BR, ORB, OP₂ and OP₃ photophores appear early (about 16 mm).
 — Pigment only around crown and some photophores (each photophore not accompanied by pigment as in *Valenciennellus tripunctulatus*).
- Meristic features**
 Myomeres: 45–46
 Vert : 45–46
 D : 11–12
 A : 13–15+9
 Plv : 6–7
 P : 17–19

STERNOPTYCHIDAE *Argyropelecus hemigymnus* Cocco

- Larvae** — Premetamorphic larvae range 4–9 mm.
 — During transformation, body (especially anterior part) shrinks 2–3 mm, gut shortens, head deepens, and eyes become telescopic.
 — Photophores develop after shrinkage stage (6–10 mm); in larger larvae, gap forms in anal rays (where photophores develop).
 — Photophore development sequence: lower OP, BR, posterior IV, anterior IV, posterior AC, anterior AC, OA, ORB and VAV.
 — Preanal myomeres 16–18 before and about 10 after transformation.
- Meristic features**
 Myomeres: 37–38
 Vert : 14–15+22–23
 D : 8
 A : 6+5
 Plv : 6
 P : 9–11
- Note:** (1) Striking change in body form of *A. hemigymnus* during transformation (see Badcock and Baird (1980) for description of rapid transformation in *Sternoptyx diaphana*).
 (2) Other genera and species are present in the western North Atlantic.

Fig. — **A**, Badcock 1977 (redrawn); **B**, Jespersen and Tåning 1919; **C**, Ahlstrom 1974; **D**, Badcock and Merrett 1972, **E**, Jespersen and Tåning 1926. (Fig. **A** reproduced through the courtesy of Pergamon Press, Inc., New York; and Fig. **C** through the courtesy of Springer-Verlag, New York, Inc.).

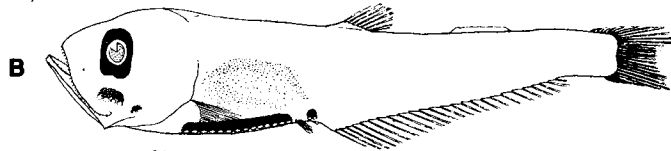
Ref. — Tåning 1918; Jespersen 1933; Grey 1964, Schultz 1964; Weitzman 1974.

***Valenciennellus tripunctulatus* GONOSTOMATIDAE**

10.5 mm SL

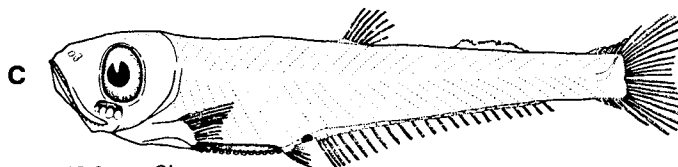
Peritoneal pigment

Common characters for 3 species: gradual transformation; most or all photophores in clusters with common bases; BR photophore forms early.

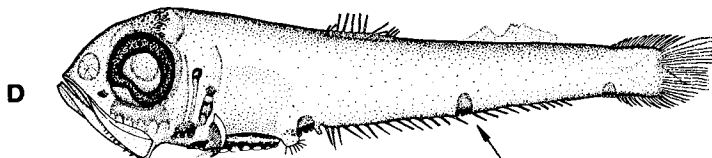


11.0 mm SL

Lateral pigment over abdomen at 10-12 mm



13.2 mm SL.

Argyripnus atlanticus

18.7 mm SL

OP₃ photophore enlarged and doubleGap in anal fin between ray 13 and 15
(under developing middle AC photophores)***Argyropelecus hemigymnus* STERNOPTYCHIDAE**

9.0 mm SL

A-B (eastern Atlantic material); C (Pacific specimen)

CHAULIODONTIDAE *Chauliodus sloani* Bloch and Schneider

- Eggs** — Pelagic, spherical.
 — Diameter: 2.24–2.52 mm
 — Shell: smooth, double.
 — Yolk: segmented.
 — Oil globules: none.
 — Perivitelline space: wide.
- Larvae** — Hatching occurs at about 7.2 mm.
 — Body slender and elongate; depth about 8% SL.
 — Eye oval, snout pointed; head flexed ventrally.
 — Long gut (not trailing); preanal length about 90% SL.
 — Fin formation (see table below).
 — Transformation: shrinks from about 44 mm (maximum larval size) to about 27 mm, then growth resumes; unpigmented photophores form simultaneously at about 40 mm, and acquire pigment and structure later.
 — Very little (or no) pigment.

Meristic features

Myomeres: 57–58
 Vert : 54–62
 D : 5–7
 A : 10–13
 Plv : 6–8
 P : 11–14

Note: Larval *Chauliodus danae* (51–58 vert.) are presumably similar. Sanzo's (1914) specimen of 41.6 mm and Belyanina's (1977) specimens of 35.2 and 32.0 mm all show the dorsal fin origin in the more posterior position characteristic of *C. danae*.

STOMIATIDAE *Stomias ferox* Reinhardt

- Eggs** — Undescribed; spawning occurs in spring.
- Larvae** — Elongate with long head and prominent jaws (relative head length decreases).
 — Slightly trailing gut (intestine hangs outside body until transformation).
 — Dorsal finfold long.
 — Fin formation:

Meristic features

Myomeres: 81–84
 Vert : 77–83
 D : 17–21
 A : 19–23
 Plv : 5
 P : 6

	Begin to ossify		Complete	
	<i>C. sloani</i>	<i>S. ferox</i>	<i>C. sloani</i>	<i>S. ferox</i>
Caudal rays	~13 mm	~17 mm	~20 mm	44 mm
Pelvic (bud)	~22 mm	early adult	41 mm	adult
Dorsal rays	~23 mm	~17 mm	41 mm	44 mm
Anal rays	~41 mm	~17 mm	35 mm(adult)	44 mm
Pectoral rays	(After tranformation)		35 mm(adult)	adult

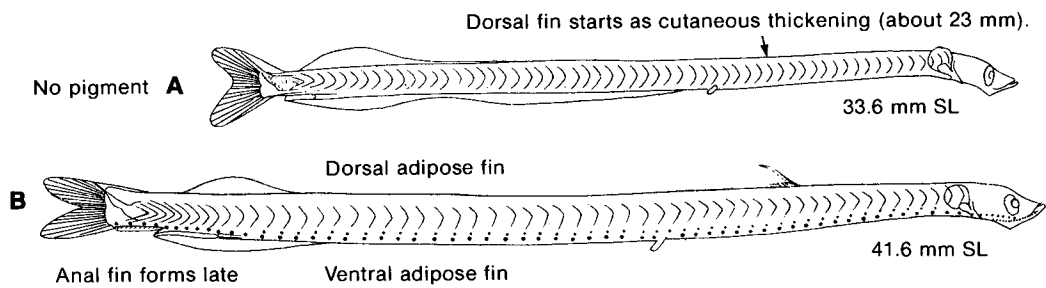
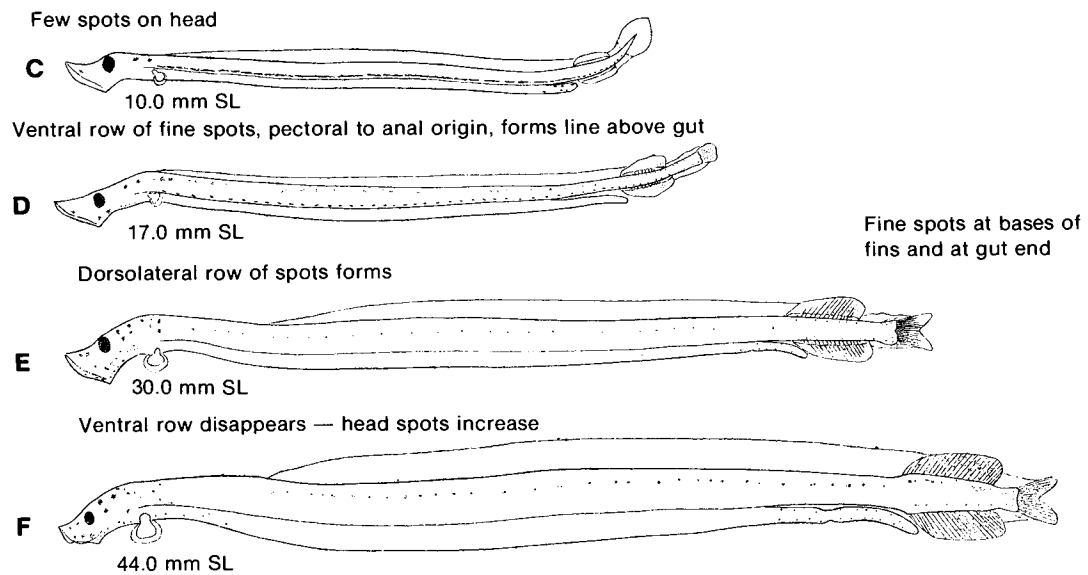
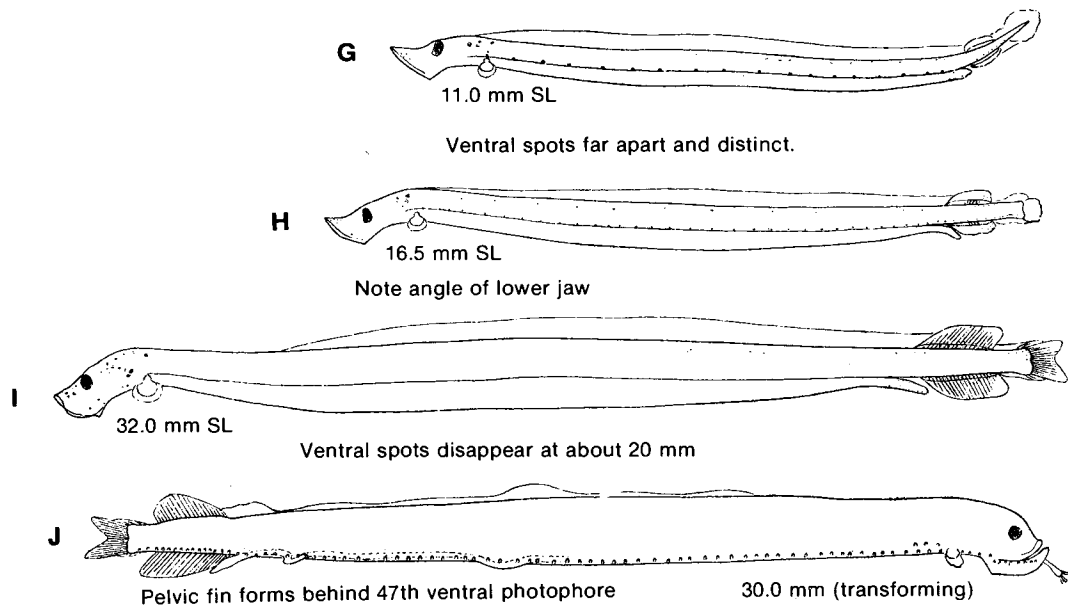
- Transformation: shrinks from about 44 mm (maximum larval size) to about 23 mm, then growth resumes and photophores form.

Note: (1) Vertebral counts in other Atlantic species are: 75–78 in *S. boa*, 66–71 in *S. affinis*, 64–68 in *S. brevibarbus*, 66–72 in *S. colubrinus*; myomere counts average 2 more.

(2) Both *S. ferox* and *S. boa* (see illustrations opposite) have very light pigment, and lack widely-spaced dorsal spots as in *Eustomias* (p. 90).

Fig. — A–B, Sanzo 1914; C–J, Ege 1918.

Ref. — Sanzo 1918; Morrow 1964; Belyanina 1977.

Chauliodus sloani**CHAULIODONTIDAE*****Stomias ferox*****STOMIATIDAE*****Stomias boa***

G-J (eastern Atlantic material)

MELANOSTOMIATIDAE Five Genera

(=Melanostomiidae)

Morphological features

Eggs — Undescribed.

Larvae — Well-developed finfolds, including preanal finfold.
 — Snout profile concave; oval eye.
 — Trailing gut; long preanal length.
 — Dorsal and anal fins opposite each other on posterior part of body; slight anterior shift of anal fin origin at transformation.
 — Caudal, dorsal and anal fins form early; pectoral and pelvic fins form late.
 — Lower caudal lobe longer than upper; no adipose fin.
 — Transformation: unpigmented photophores form simultaneously and then acquire pigment and structure; finfolds reduced; lower jaw barbel develops.

Meristic characters (Counts in bold type are diagnostic)

	<i>Bathophilus</i> sp.	<i>Eustomias</i> sp.	<i>Flagellostomias</i> <i>boureei</i> (Zugmayer)	<i>Leptostomias</i> <i>gladiator</i> (Zugmayer)	<i>Photonectes</i> <i>parvimanus</i> Regan & Trewavas
Myomeres (1) ^a	38-46	72-78	67-78	75-78	64-67
Myomeres (2) ^a	19-21	32-37	32-33	42-44	39-41
Myomeres (3) ^a	11-17	14	14-16	16-18	12-13
Vertebrae ^b	38-45	55(?) - 78	~65	75-83	49-64
Dorsal rays ^b	9-18	20-30	14-17	16-22	15-22
Anal rays ^b	9-18	32-46	21-26	20-29	15-24
Pelvic rays ^b	4-26	6-8	7	7-8	7
Pectoral rays ^b	1-47	0-13	9-12	10-11	0-3

^a Myomeres: (1) = nape to end of anal fin; (2) = nape to pelvic bud; (3) = pelvic bud to anal origin.

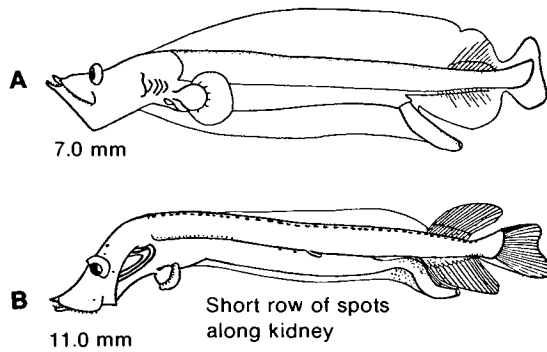
^b Range of counts within genera.

Other characters

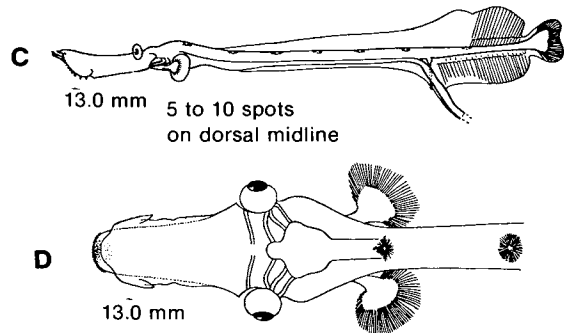
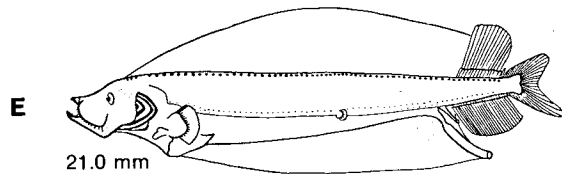
- Bathophilus* : Anal and dorsal origins about even; head flexed ventrally; dorsal finfold huge, pelvic fin forms high on body (near midline); flexion occurs at 8-11 mm; pelvic fin count can be high.
- Eustomias* : Anal fin longer than dorsal and origin more anterior; elongate body with long snout and small terminal mouth; pectoral fin absent in some species; finfolds low anteriorly and high posteriorly.
- Flagellostomias*: Anal fin longer than dorsal and origin more anterior (although origins about even in larvae <18 mm); finfolds huge, lower pectoral ray becomes isolated.
- Leptostomias* : Anal and dorsal origins about even; highest myomere count in family.
- Photonectes* : Anal and dorsal origins about even; snout concave; maxillary curved; finfolds moderate.

Fig. — A-J, Beebe and Crane 1939.

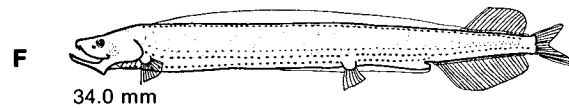
Ref. — Sanzo 1914, 1918.

***Bathophilus* sp.**

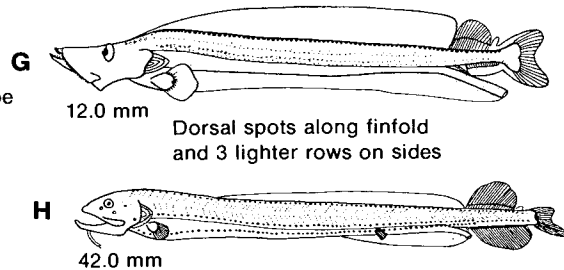
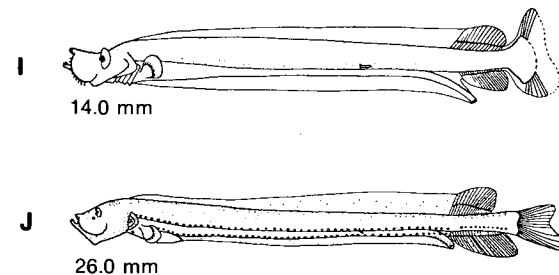
Parallel rows of spots along base of dorsal finfold

MELANOSTOMIATIDAE***Eustomias* sp.*****Flagellostomias boureei***

Dorsal spots (about 1 per myomere) to side of dorsal midline; ventral spots — same number but lighter



Short row of spots on each side of nape

Leptostomias gladiator***Photonectes parvimanus***

3 to 6 dorsal spots on each myomere; 3 to 4 spots per myomere laterally below midline; finfolds and anal fin sprinkled with fine spots.

IDIACANTHIDAE***Idiacanthus fasciola* Peters****Eggs** — Undescribed.**Meristic features**

- Larvae** — Elongate and slender with long head, long flat snout, small mouth, and eyes on long stalks.
 — Gut long, straight and trailing.
 — No opercle; gill arches exposed.
 — Row of midlateral spots and about 6 spots along midline of isthmus.
 — Large larval pectoral fin; dorsal finfold high and anal finfold low; dorsal rays begin forming at posterior end at about 16 mm; no adipose fin.
 — Postlarval changes: body shrinks and deepens; fins and photophores begin to form; eyestalks gradually shorten, supporting cartilaginous rod coils; sexes differentiate.
 — Transformation: eyestalks disappear; opercle forms; gape increases; fin rays complete; general pigment appears; pectoral fins disappear; gut included in body.
 — Male: no barbel or pelvic fin; large postorbital photophore forms.
 — Female: lower jaw barbel develops; small postorbital photophore forms; small pelvic fin completes development.

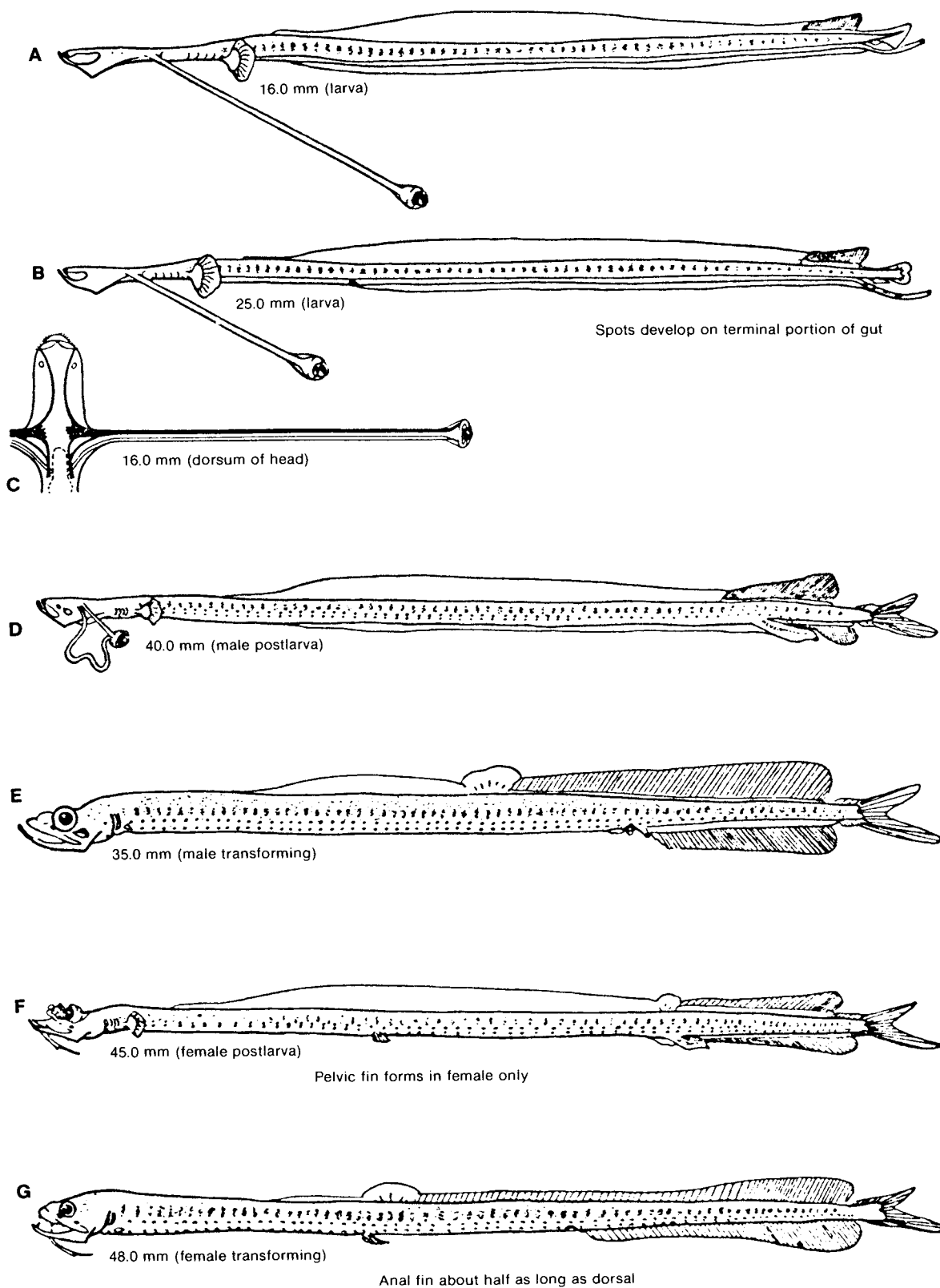
Myomeres: ~78
 Vert : ~78
 D : 54-74
 A : 38-49
 Piv : 6 (female)
 P : None

Length (mm)	Stage	Sex
16-28	Larvae	Both
36-50	Postlarvae	Both
28-40	Transforming	Male
32-44	Adult	Male
43-161	Transforming	Female
190-318	Adult	Female

Fig. — A-G, Beebe 1934.**Ref.** — Gibbs 1964.

Idiacanthus fasciola

IDIACANTHIDAE



SYNODONTIDAE**3 Genera, 10 Species****General features**

- Eggs** — Spherical, pelagic.
 — Sculptured with hexagonally-arranged points.
 — Yolk: unsegmented.
 — Perivitelline space: narrow.
- Larvae** — Elongate with long gut and large mouth.
 — Adipose fin present.
 — Transformation occurs at a large size.
 — Myomere number may be helpful:

Meristic features

D : 10-13
 A : 9-12 (except 2 species)
 C : 9-16+10+9+9-14

<i>Synodus poeyi</i> Jordan	44-46
<i>Saurida brasiliensis</i> Norman	46-50
<i>Synodus intermedius</i> (Agassiz)	47-50
<i>Saurida normani</i> Longley	49-52
<i>Saurida suspicio</i> Breder	49-52
<i>Saurida caribbea</i> Breder	52-58
<i>Synodus synodus</i> (Linnaeus)	54-57
<i>Trachinocephalus myops</i> (Forster)*	54-57
<i>Synodus saurus</i> (Linnaeus)	55-58
<i>Synodus foetens</i> (Linnaeus)	56-61

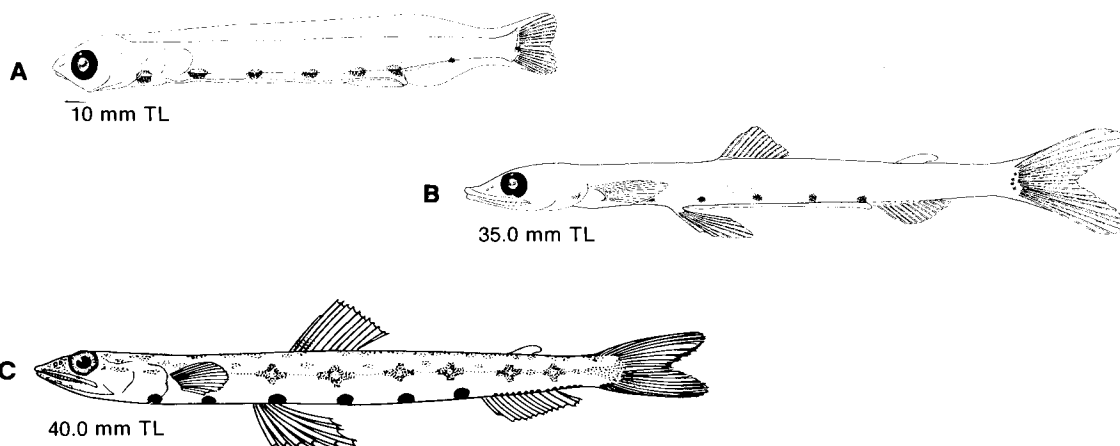
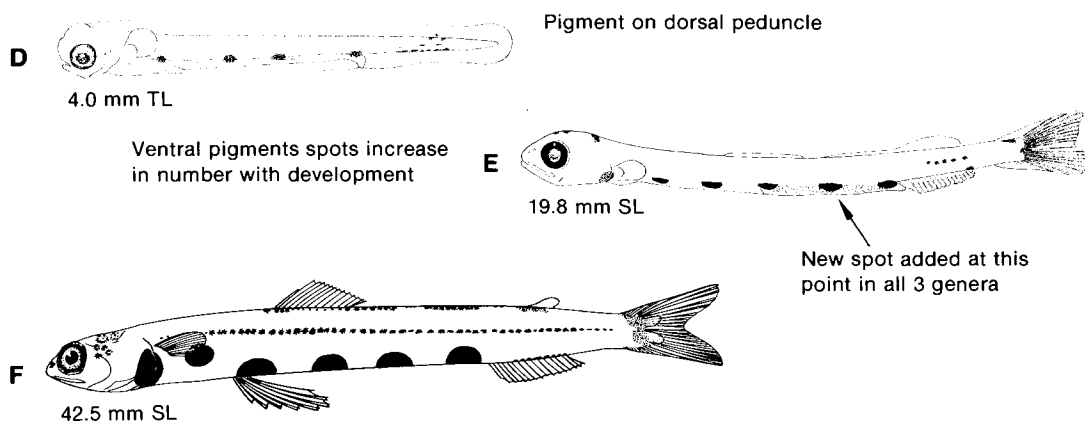
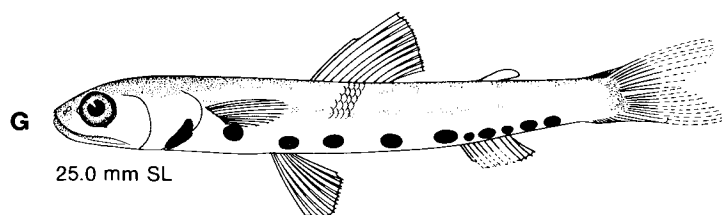
* See comparative note on *Argentina silus* (p. 64).

- Anal rays 8-9 in *S. synodus* and 14-15 in *T. myops*.
 — Pigmentation: prominent ventrolateral spots, in pairs.

Note: Preanal finfold persists in larvae of *Synodus* and *Trachinocephalus* (M. Okiyama, 1981, pers. comm.).

Fig. — **A-B**, Mansueti and Hardy 1967; **D**, Mito 1961a; **E**, Okiyama 1974 (all redrawn); **C, F-G**, Anderson *et al.* 1966. (Fig. **E** reproduced through the courtesy of Springer-Verlag, New York, Inc.)

Ref. — Gibbs 1959; Rudometkina 1980; Zvyagina 1965.

Synodus foetens**SYNODONTIDAE*****Trachinocephalus myops******Saurida brasiliensis***

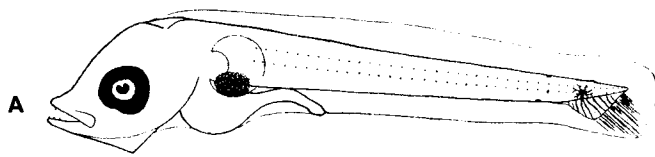
D-E (Pacific material).

CHLOROPHTHALMIDAE *Chlorophthalmus agassizi* Bonaparte

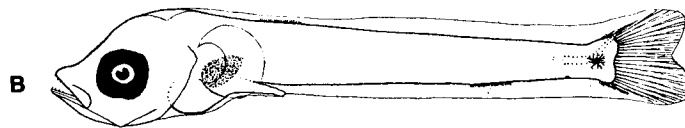
- | | | |
|---------------|---|---|
| Eggs | — Undescribed. | Meristic features |
| Larvae | <ul style="list-style-type: none"> — Body slightly elongate, round and segmented (not compressed as in paralepidids). — Snout "duckbilled"; eyes round. — Preamble length about 45% SL throughout development; long gap between anus and anal fin origin. — Fin formation sequence: caudal, dorsal, anal, pectoral, and pelvic (last). — Adipose fin present. — Transformation gradual at about 25 mm. — Pigmentation: large spot at caudal base (or several in juveniles); 2 small spots on dorsal and ventral edges of peduncle in early larvae; 1 internal peritoneal pigment patch on gut under pectoral fin; juveniles develop a "checkered" pattern. | <ul style="list-style-type: none"> Myomeres: 46-48 Vert : 17+30 D : 10-11 A : 7-9 Piv : 8-9 P : 15-17 |
- Note:**
- (1) Eye, head, gut and trunk similar to larval myctophids, but in *C. agassizi* anal fin is more posterior and dorsal fin more anterior; most myctophids lack prominent spot on caudal peduncle (p. 102-143)
 - (2) The larvae of the chlorophthalmid *Parasudis truculentis* (Goode and Bean), which occurs with *C. agassizi* along the continental slope off eastern United States, are undescribed; the species has 38 vertebrae.

Fig. — A-G, Tåning 1918.

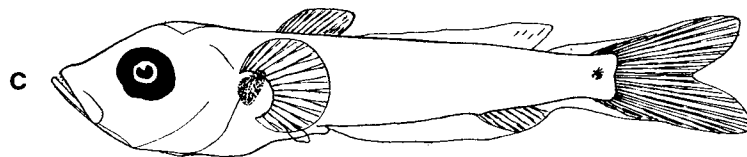
Ref. — Mead 1966a.

***Chlorophthalmus agassizi* CHLOROPHTHALMIDAE**

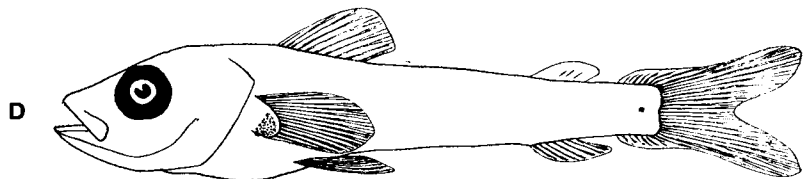
6.5 mm SL



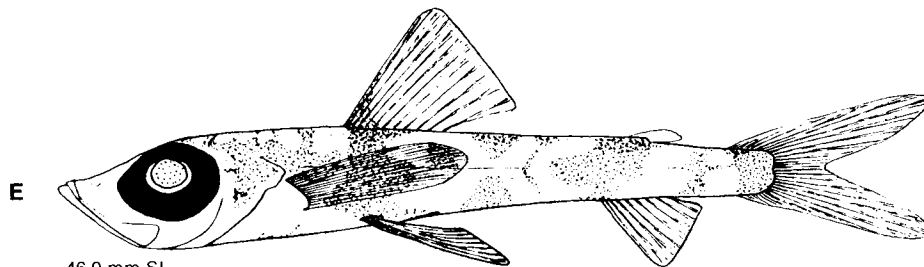
"Duckbilled" 9.5 mm SL



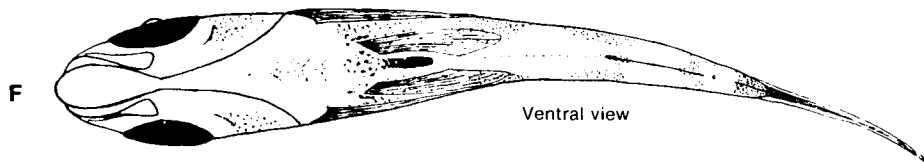
13.0 mm SL



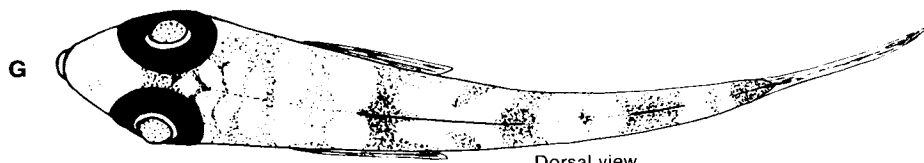
25.0 mm SL



46.0 mm SL



Ventral view



Dorsal view

A-G (Mediterranean material)

BATHYPTEROIDAE***Bathypterois* sp.****Eggs** — Undescribed.**Larvae** — Moderately slender, with protruding gut in some species.

— Eye slightly telescopic.

— Body proportions: body depth about 20% SL; pre-anal length about 66% SL; head length about 24% SL; eye diameter about 5% SL; premaxilla length about 10% SL.

— After transformation, body slims as gut is pulled in, eye shrinks, mouth grows larger, and posterior body lengthens.

— Adipose fin present in most species.

— Pectoral fin large, extending posteriorly to dorsal fin insertion; note relative origins of pelvic, dorsal and anal fins (Fig. A, B).

— Pigmentation: no body or peritoneal pigment.

Meristic features*
(western Atlantic)

Myomeres: 49-61

Vert : 49-61

D : 12-16

A : 7-13

Piv : 8-9

P : 7-15 (visible externally)

* Range in genus

Note: (1) Meristic characters and relative positions of dorsal and anal fins indicate larva in Fig. B is *Bathypterois viridensis* (Roule).

(2) This family included in Chlorophthalmidae, as defined by Sulak (1977).

NEOSCOPELIDAE***Scopelengys tristis* Alcock****Eggs** — Undescribed.**Meristic features****Larvae** — Deep, laterally compressed body; large head with long pointed snout.

Myomeres: 29-32

Vert : 29-32

— Eyes small and round; no choroid tissue.

D : 11-13

— Body proportions: body depth 22-28% SL; preanal length 58-67% SL; head length 35% SL; eye diameter 6-8% SL.

A : 12-14

Piv : 8

— Flexion occurs at 5-7 mm.

P : 15-16

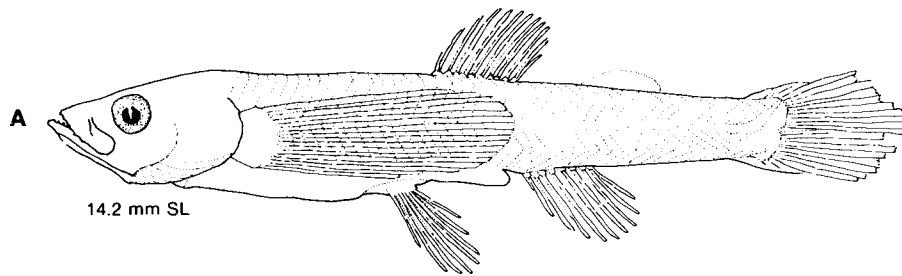
— Adipose fin present.

— Large pectoral fin (30-36% SL) forms at about 3.5 mm.

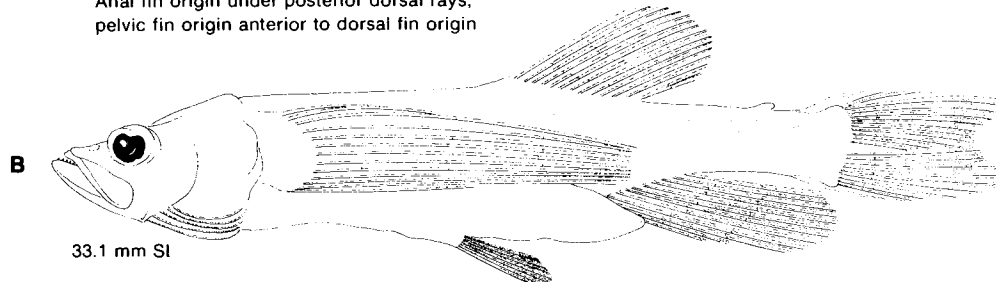
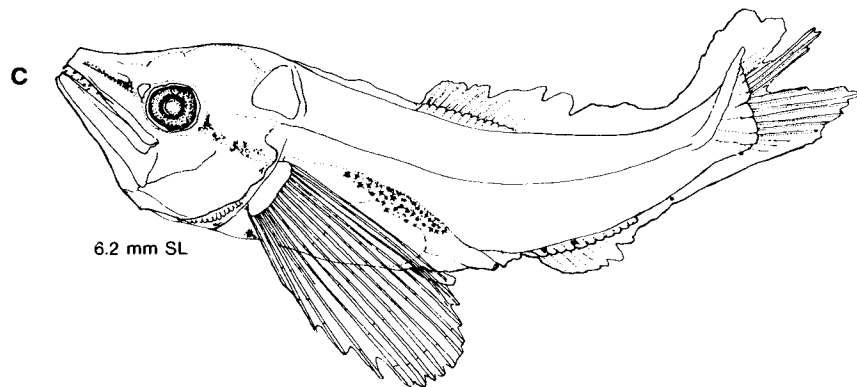
— Dorsal and anal fins form at flexion; pelvic buds form at 6.5-7.0 mm; all fins complete at 10 mm.

— Pigmentation: bar forms from snout to opercle, through eye; may have internal spots on air bladder, but no peritoneal gut pigment as in other myctophiform families; few spots along anal fin base and ventral spots on gut and peduncle (disappear in later larvae).

Note: This species is rare in the western Atlantic; smallest Atlantic specimen is 69.5 mm.**Fig.** — A, Okiyama 1974 (reversed); B, M. P. Fahay (see p. 11); C, Okiyama 1974; D, Butler and Ahlstrom 1976. (Fig. A and C reproduced through the courtesy of Springer-Verlag, New York, Inc.)**Ref.** — Mead 1966b; Sulak 1977.

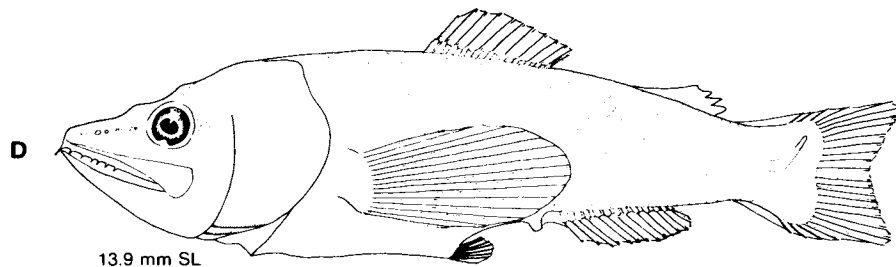
Bathypterois* sp.*BATHYPTEROIDAE**

Anal fin origin under posterior dorsal rays;
pelvic fin origin anterior to dorsal fin origin

***Scopelengys tristis*****NEOSCOPELIDAE**

Superficially similar to some *Lampanyctus*
(Myctophidae), p. 135

Anal fin origin posterior to dorsal fin; pelvic fin under or
slightly anterior to dorsal fin



Photophores lacking in *Scopelengys*, but present in
neoscopelid genus *Neoscopelus*

Note: Larvae in both families have large pectoral fins, lack peritoneal pigment on gut and have anus immediately anterior to anal fin origin.

A, C (Pacific material; **D** (Indian Ocean specimen)

SCOPELOSAURIDAE Five Western Atlantic Species (=Notosudidae)

General characteristics

Eggs — Undescribed.

Meristic features*

- Larvae** — Body long, slender, cylindrical and compressed in tail region; brain with posterior "wings".
 — Eyes narrowed horizontally, on very short stalks; choroid tissue posteriorly; snout "duckbilled".
 — Body depth 5–6% SL; preanal length 73–80% SL; head length 15–25% SL (changes with growth).
 — Preanus length increases slightly early in development, varies with species.
 — Flexion occurs at about 10–12 mm; transformation at 27–45 mm.
 — Pectoral fin forms early; caudal, anal and adipose fins form soon after flexion; pelvic and dorsal fins form late (>20 mm).
 — Pigmentation: best distinguishing character (usually restricted to tail region); no pigment on head or peritoneum until transformation.
- Myomeres: 47–61
 D : 10–13
 A : 16–21
 Piv : 9
 P : 10–15
- * Range for western Atlantic species.

Ahliesaurus berryi Bertelsen, Krefft and Marshall.

- Myomeres 47–50; 1–1.5 myomeres between pelvic and dorsal fin origins at >20 mm; preanus length 57–60% SL.
- Broad band of many small spots on peduncle; about 6 large internal spots spaced along midline (4th above anus); spots on anal and adipose fins.

Scopelosaurus smithli Bean

- Myomeres 53–56; 4–5 myomeres between pelvic and dorsal fin origins at >20 mm; preanus length 43–45% SL.
- Broad band of many small spots on peduncle and vertical line of spots on caudal base (weak or no pigment between these groups); clump of small spots on middle caudal rays (>10 mm); no lateral spots, and anal fin unpigmented.

Scopelosaurus lepidus Krefft and Maul

- Myomeres 58–61; 5–6 myomeres between pelvic and dorsal fin origins at >20 mm; preanus length 40–44% SL.
- Middorsal and midventral lines of spots on finfold of peduncle (become embedded in body); vertical line of 2–10 spots on caudal base; few spots may occur at tips of caudal and anal fins.

Scopelosuarus argenteus (Maul)

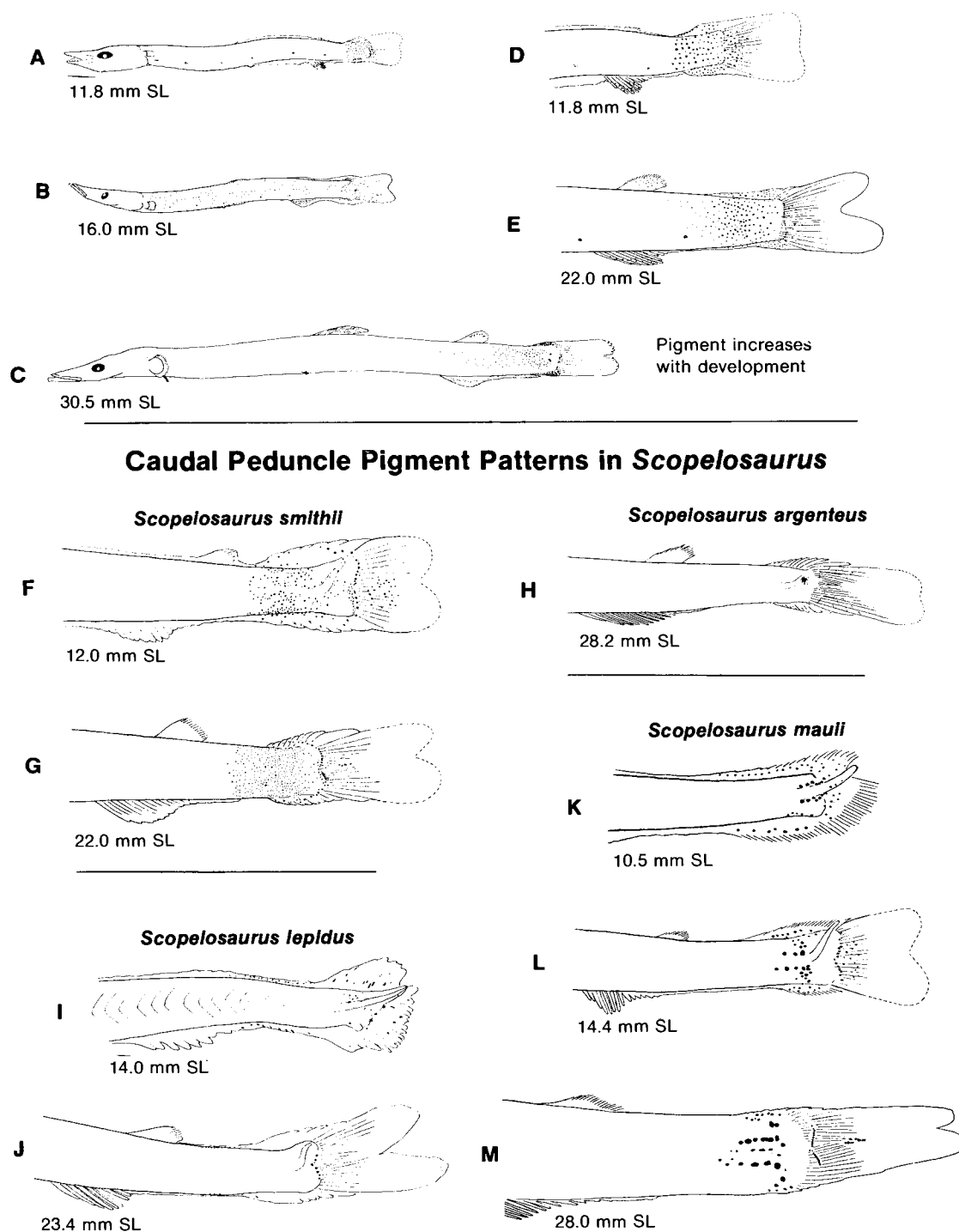
- Myomeres 54–57; 5 myomeres between pelvic and dorsal fins origins at >20 mm; preanus length 40–45% SL.
- Most larvae 10–29 mm are totally without pigment; some larvae 15–34 mm have single spot on peduncle (may occur on one side only).

Scopelosaurus mauli Bertelsen, Krefft and Marshall

- Myomeres 55–57; 6–7.5 myomeres between pelvic and dorsal fin origins at >20 mm; preanus length 38–40% SL.
- Two short lateral lines of 3–5 large spots above and below midline of peduncle; internal vertical band of spots under posterior ends of lateral lines; groups of spots on upper and lower procurrent caudal rays; vertical line of spots on caudal base; group of spots on middle caudal rays.

Fig. — A–M, Bertelsen *et al.* 1976.

Ref. — Marshall 1966; Ozawa 1978.

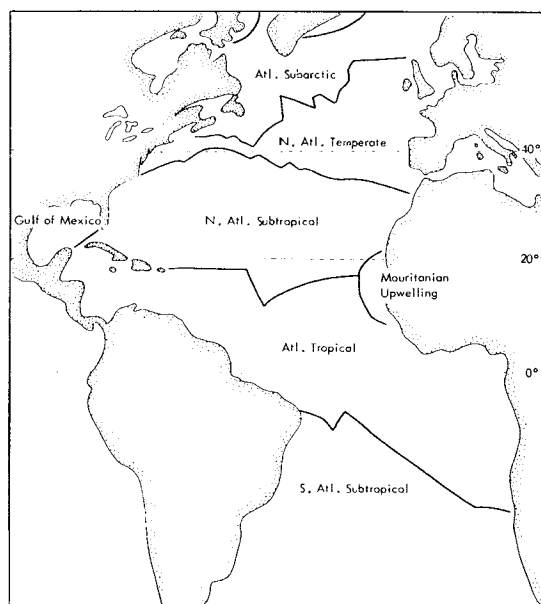
Ahliesaurus berryi**SCOPELOSAURIDAE**

Note: All 5 species occur in western North Atlantic between 20° N and 40° N and *S. lepidus* to 60° N or farther north.

MYCTOPHIDAE**Introduction**

Eight-two species in 20 genera occur in the North Atlantic (Nafpaktitis *et al.*, 1977). Since the larvae of only 33 species have been described (many from Pacific collections), it is clear that many Atlantic larvae cannot be identified to species at this time. However, the larvae of some species in all 20 genera have been described (see table, p. 105-107).

The most abundant myctophid species in five Atlantic Ocean regions (see map below), based on catches of adults in the upper 200 m are listed (at right) as percentages of all myctophids represented by the species within each region (map and table from Backus *et al.*, 1977).

**Atl. Subarctic**

<i>Benthosema glaciale</i>	96
----------------------------	----

N. Atl. Temperate

<i>Benthosema glaciale</i>	45
<i>Ceratoscopelus maderensis</i>	21
<i>Lobianchia dofleini</i>	12
<i>Lampanyctus pusillus</i>	6

N. Atl. Subtropical

<i>Notolychnus valdiviae</i>	18
<i>Diogenichthys atlanticus</i>	14
<i>Ceratoscopelus warmingii</i>	10
* <i>Bolinichthys indicus</i>	7
<i>Lobianchia dofleini</i>	7
<i>Lampanyctus pusillus</i>	7
<i>Benthosema suborbitale</i>	6

Atl. Tropical

<i>Lepidophanes guentheri</i>	17
<i>Diaphus dumerili</i>	12
<i>Ceratoscopelus warmingii</i>	12
<i>Notolychnus valdiviae</i>	12
<i>Benthosema suborbitale</i>	7
* <i>Lampanyctus alatus</i>	4
* <i>Diaphus vanhoeffeni</i>	4

Gulf of Mexico

<i>Notolychnus valdiviae</i>	27
* <i>Lampanyctus alatus</i>	24
<i>Benthosema suborbitale</i>	22
<i>Ceratoscopelus warmingii</i>	6
* <i>Diaphus mollis</i>	4
<i>Lepidophanes guentheri</i>	3
<i>Notoscopelus resplendens</i>	3

* Larvae undescribed.

Egg Characteristics

With the exception of one species, myctophid eggs are virtually unknown. Characteristics of *Lampanyctodes hectoris* eggs, taken in a surface plankton tow near New Zealand, have been described (Robertson, 1977).

- Shell: weakly oval, fragile.
- Long diameter: 0.74-0.83 mm.
- Short diameter: 0.65-0.72 mm.
- Yolk: strongly segmented.
- Oil globule: single, 0.21-0.23 mm.
- Perivitelline space: narrow.

Larval Characteristics**MYCTOPHIDAE**

(Ref: Moser and Ahlstrom 1970, 1972, 1974)

Morphology

- Body ranges from slender and elongate to deep and big-headed.
- Head varies from deep and narrow to short and slender.
- Eye round or narrow; some choroid tissue may be present under either type, but more developed under narrow eyes; several species have narrow eyes on short stalks (*Symbolophorus* and *Myctophum*).
- Gut length varies; in most species, preanal length increases relative to SL during larval development; in some species, a gap is present between anus and anal fin origin.
- Size at transformation ranges from about 10 mm (*Electrona*) to more than 20 mm (*Notolychnus*).

Pigmentation

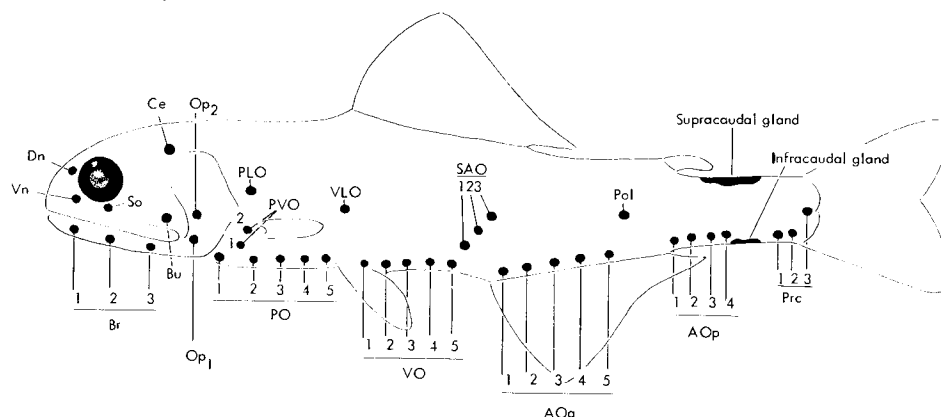
- Variable among species within a genus.
- Important series of spots on ventral midline of tail; if series present, the number of spots increases or decreases during development.
- Pigment pattern usually changes during development.

Fin development

- Adipose fin present.
- Pectoral: rays develop early; often the first to begin ossifying; ossification immediately follows formation of caudal rays in some species; more rays may be present in larvae than in adults.
- Caudal: usually the first fin to develop ossified rays.
- Anal: forms in the adult position; usually begins ossifying after pectoral and caudal rays.
- Dorsal: forms in the adult position; usually begins ossifying after anal.
- Pelvic: Usually the last to form; 8 rays (rarely 6 or 7).
- In most genera, the anal rays exceed the dorsal in number and the difference is greatest in the subfamily Myctophinae; exceptions are *Lobiancha*, *Lampadena* and *Notoscopelus* where the dorsal rays outnumber the anal rays, and *Diaphus*, *Lepidophanes*, *Taaningichthys* and *Ceratoscopelus* where the dorsal and anal rays are about equal in number.

Photophores

- Photophore group terminology (Moser and Ahlstrom 1972).



MYCTOPHIDAE**Larval Characteristics****Photophore development**

- Br₂ is the first to form in all species except *Notolychnus valdiviae*.
- Other photophores may form sequentially before transformation.
- See table below.

Other larval structures

- Lower jaw barbel (*Diogenichthys*).
- Elongate lower pectoral rays (*Loweina*).
- Enlarged dorsal finfold (*Loweina* and *Benthosema*).
- Stalked eyes (*Symbolophorus*, some *Hygophum* and *Myctophum*).

Similar larvae

- *Scopelengys* (Neoscopelidae) (p. 98): similar to *Lampanyctus*.
- *Chlorophthalmus* (Chlorophthalmidae): eye, head, gut and trunk similar, but dorsal origin farther anterior and anal (p. 96) farther posterior.

Subfamily Differences

Subfamily Myctophinae	Subfamily Lampanyctinae
Eyes: elliptical, some with choroid tissue, some with stalks.	Eyes: round, may have small sliver of choroid (<i>Lobianchia</i> and <i>Notolychnus</i> may have slightly narrowed eyes).
Larval photophores: only Br ₂ formed in most; 3 species develop other photophores.	Larval photophores: sequential development of 3 or 4 pairs in most.
1. <i>Diogenichthys atlanticus</i> : Br ₂ , PO ₂ , PO ₅ and AOa ₁ .	1. <i>Notoscopelus</i> : Br ₂ , PO ₅ , and Vn form in sequence followed by PLO later.
2. <i>Benthosema suborbitale</i> : Br ₂ , PO ₁ , PO ₂ , Br ₁ and Br ₃ .	2. <i>Bolinichthys</i> (with exceptions), <i>Ceratoscopelus</i> and <i>Lepidophanes</i> : Br ₂ , Vn, PLO and PO ₅ form in sequence; photophores very small.
3. <i>Myctophum asperum</i> : Br ₂ , Dn and PLO.	3. <i>Lampadena</i> : Br ₂ , PLO and PO ₅ form early.
	4. <i>Diaphus</i> , <i>Lobianchia</i> : Br ₂ , PO ₅ , and PO ₁ form early.
	5. <i>Lampanyctus</i> : only Br ₂ in larvae.
	6. <i>Notolychnus</i> and <i>Taaningichthys</i> : no photophores in larvae, except <i>Taaningichthys</i> may form Br ₂ just before transformation.

North Atlantic Species

MYCTOPHIDAE

The 82 myctophid species occurring in the North Atlantic (Nafpaktitis *et al.* 1977) are listed below, with sources of larval descriptions and meristic counts for vertebrae, gillrakers and fin rays. Tribal organization in the subfamily Lampanyctinae is after Moser and Ahlstrom (1974). Vertebral counts followed by an asterisk (*) are from Tåning (1918), based on Mediterranean material.

	Source of descriptions ^a	Vert – ebrae	Gill rakers	Fin rays		
				D	A	P
Subfamily Myctophinae						
Tribe Myctophini						
<i>Protomyctophum arcticum</i>	1	...	4-5+1+14-15	11-13	21-24	15-17
<i>Electrona risso</i>	1,2	32-34	8-9+1+17-20	13-14	18-19	13-16
<i>Hygophum benoiti</i>	1,6	35-36*	4-5+1+13-14	12-14	19-21	13-15
<i>Hygophum hygomii</i>	1,4,5	36-37*	5+1+13-15	13-15	20-22	15-16
<i>Hygophum macrochir</i>	4	...	5+1+13-15	12-14	18-20	13-15
<i>Hygophum reinhardtii</i>	2,4	38-39	4-5+1+12-14	13-14	22-24	13-15
<i>Hygophum taaningi</i>	4	...	4+1+11-13	13-14	19-20	13-14
<i>Myctophum affine</i>	—	...	5-6+1+12-15	12-13	18-20	13-14
<i>Myctophum asperum</i>	4,5	35-38	4-5+1+9-11	12-14	17-18	14-15
<i>Myctophum nitidulum</i>	2,4,5	37-39	5-6+1+12-15	13-14	19-20	13-14
<i>Myctophum obtusirostre</i>	4	...	6-7+1+15-17	12-13	17-19	16-18
<i>Myctophum punctatum</i>	1,4,9	40*	6-8+1+16-18	13-14	20-22	13-14
<i>Myctophum selenops</i>	4,5	...	6-7+1+14-16	12-14	17-18	16-18
<i>Symbolophorus rufinus</i>	—	...	5-6+1+14-15	14-16	20-21	14-16
<i>Symbolophorus veranyi</i>	1,8	39-40*	5-6+1+12-14	12-14	21-23	12-13
<i>Diogenichthys atlanticus</i>	1,2,5	32-35	2+1+9-11	11-12	15-16	12-13
<i>Bethosema glaciale</i>	1,4,7,11	34-36*	4-5+1+10-12	12-14	17-19	11-13
<i>Bethosema suborbitale</i>	4,5,13	34	3+1+9-11	11-14	16-17	12-14
Tribe Gonichthyini						
<i>Loweina rara</i>	2,4	37-39	2+1+5-6	11-13	15-16	10-12
<i>Loweina interrupta</i>	—	...	3+1+7-10	11-12	15-16	11-12
<i>Gonichthys cocco</i>	1	40-41*	3-4+1+5-6	11-12	20-23	13-15
<i>Centrobranchus nigroocellatus</i>	—	...	None	10-11	16-19	13-15
Subfamily Lampanyctinae						
Tribe Notolychnini						
<i>Notolychnus valdiviae</i>	1,4	28-30	2+1+7-8	10-12	12-14	12-13
Tribe Lampanyctini						
<i>Lampanyctus alatus</i>	—	...	3-4+1+9-10	11-13	16-18	11-13
<i>Lampanyctus ater</i>	—	...	5+1+10-12	13-15	18-19	...
<i>Lampanyctus crocodilus</i>	1	36-37*	4-5+1+10-12	13-15	17-18	14-16
<i>Lampanyctus cuprarius</i>	—	...	5+1+11-12	16-18	17-19	11-12
<i>Lampanyctus festivus</i>	—	...	4+1+8-9	13-14	18-20	15-17
<i>Lampanyctus intracarius</i>	10	...	4+1+10-11	14-16	18-20	13-14
<i>Lampanyctus isaacsi</i>	—	...	5-6+1+12-13	14-16	17-19	11-13

MYCTOPHIDAE

North Atlantic Species

	Source of descriptions ^a	Vert-ebrae	Gill rakers	Fin rays		
				D	A	P
<i>Lampanyctus lineatus</i>	—	...	5-6+1+11-13	16-18	19-22	12-14
<i>Lampanyctus macdonaldi</i>	—	...	6-8+1+14-18	13-15	15-18	12-13
<i>Lampanyctus nobilis</i>	—	...	3-4+1+9-10	14-16	17-20	13-15
<i>Lampanyctus photonotus</i>	—	...	3-5+1+8-10	12-14	16-17	12-14
<i>Lampanyctus pusillus</i>	1	32-34*	3+1+7-9	12-13	14-16	13-15
<i>Lampanyctus tenuiformis</i>	—	...	4+1+9	13-14	17-18	13-14
Tribe Diaphini						
<i>Lobianchia dofleini</i>	1,4	33-35*	5-6+1+12-15	15-17	13-15	11-13
<i>Lobianchia gemellarii</i>	1,4	36*	4-6+1+10-14	17-18	13-15	11-12
<i>Diaphus dumerilii</i>	—	...	5-9+1+13-18	14-15	14-15	11-12
<i>Diaphus garmani</i>	—	...	6-8+1+12-15	14-16	15-17	11-12
<i>Diaphus problematicus</i>	—	...	4+1+8-9	16-17	16-18	11-12
<i>Diaphus adenomus</i>	—	...	5+1+11	14-15	15-16	11-12
<i>Diaphus splendidus</i>	—	...	5-6+1+11-13	14-15	15-17	11-12
<i>Diaphus taaningi</i>	—	...	6-8+1+12-14	14	14-15	11
<i>Diaphus bertelseni</i>	—	...	5+1+12	14-15	15	11
<i>Diaphus luetkeni</i>	—	...	6-7+1+13-15	15-17	14-16	11
<i>Diaphus termophilus</i>	—	...	7-9+1+14-16	13-14	15	11-12
<i>Diaphus minax</i>	—	...	5-6+1+11-14	13-14	13-14	11
<i>Diaphus lucidus</i>	—	...	5-6+1+10-12	17	17-18	11-12
<i>Diaphus fragilis</i>	—	...	5-6+1+11-12	17-19	17-18	11-13
<i>Diaphus perspicillatus</i>	—	...	9-10+1+16-18	15-17	14-16	11-12
<i>Diaphus effulgens</i>	—	...	6-7+1+12-14	15-16	14-15	11-12
<i>Diaphus roei</i>	—	...	6-8+1+15-16	15	13-14	11-12
<i>Diaphus metopoclampus</i>	12	...	7-9+1+13-16	15-16	14-16	10-11
<i>Diaphus vanhoeffeni</i>	—	...	7-8+1+14-15	13-14	14-15	10-11
<i>Diaphus rafinesquii</i>	1	33-34*	7-8+1+14-16	13-14	13-15	10-11
<i>Diaphus mollis</i>	—	...	4-5+1+10-12	13	12-13	10-11
<i>Diaphus holti</i>	1	32-34*	5-6+1+11-13	13-14	12-14	10-12
<i>Diaphus subtilis</i>	—	...	6-7+1+13-15	12-13	13	10-12
<i>Diaphus brachycephalus</i>	—	...	5-7+1+12-14	12-13	13-14	10-12
<i>Diaphus anderseni</i>	—	...	5+1+11	12-13	12	10-11
Tribe Gymnoscopelini						
<i>Lampadena anomala</i>	—	36	5+1+10-12	14-16	13-14	16-18
<i>Lampadena chavesi</i>	—	37-38	6-7+1+12-14	13-15	12-14	15-17
<i>Lampadena luminosa</i>	4	36-37	4+1+8-10	14-15	13-15	15-17
<i>Lampadena speculigera</i>	—	38-40	6-7+1+12-14	13-15	14-15	13-15
<i>Lampadena urophaos atlantica</i>	3	36-38	3-4+1+8-9	15-16	14	16-17
<i>Taaningichthys bathyphilus</i>	—	34-36	2-4+1+5-9	11-14	12-14	12-14
<i>Taaningichthys minimus</i>	3	40-41	4-5+1+10-13	11-13	11-14	15-17
<i>Taaningichthys paurolychnus</i>	—	35-36	3-4+1+8-11	11-13	11-14	13-15
<i>Bolinichthys distofax</i>	—	...	5-6+1+11-12	12-14	13-15	12-13
<i>Bolinichthys indicus</i>	—	...	3-4+1+10-12	11-13	12-14	12-14
<i>Bolinichthys photothorax</i>	—	...	5-7+1+13-15	12-14	13-15	12-14
<i>Bolinichthys supralateralis</i>	4	...	5-6+1+12-13	13-15	13-15	13-14
<i>Lepidophanes guentheri</i>	3	...	4+1+9-10	13-15	14-15	12-13

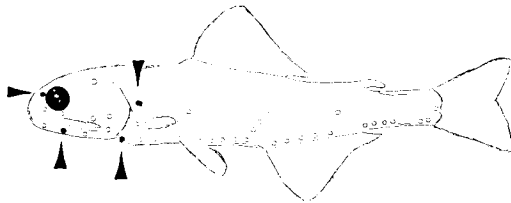
North Atlantic Species

MYCTOPHIDAE

	Source of descriptions ^a	Vert – ebrae	Gill rakers	Fin rays		
				D	A	P
<i>Lepidophanes gaussi</i>	4	...	3+1+8	13–14	13–15	12–13
<i>Ceratoscopelus maderensis</i>	1,3	35–38	5–6+1+12–15	13–14	13–15	13–14
<i>Ceratoscopelus warmingii</i>	14	...	3–4+1+8–10	13–15	13–15	13–15
<i>Notoscopelus bolini</i>	—	37–38	8–10+1+17–19	23–26	19–20	12–14
<i>Notoscopelus caudispinosus</i>	—	36	4+1+9–10	25–27	20–21	11–13
<i>Notoscopelus resplendens</i>	3,4,13	36–37	5–7+1+12–15	21–23	18–20	12–13
<i>Notoscopelus elongatus kroeyeri</i>	—	39–40	8–9+1+17–20	21–22	18–20	13

- ^a Sources:
- | | |
|---|--|
| 1. Tåning 1918 (Med.) | 8. Mazzealli 1912 (Med.) |
| 2. Moser and Ahlstrom 1970 (Pac.) | 9. Sanzo 1915 (Med.) |
| 3. Moser and Ahlstrom 1972 (most Pac.) | 10. Legendre 1934 (E. Atl.) |
| 4. Moser and Ahlstrom 1974 (all oceans) | 11. Sparta 1951 (E. Atl.) |
| 5. Pertseva-Ostroumova 1974 (Pac. & Ind.) | 12. Sparta 1952 (E. Atl.) |
| 6. Shiganova 1974 (Atl.) | 13. Badcock and Merrett 1976 (E. Atl.) |
| 7. Holt 1898 (E. Atl.) | 14. Miller <i>et al.</i> 1979 (Pac.) |

Note: Hypothetical figure at the bottom of each text page of the myctophid section shows location of the pertinent photophores. Photophores discussed in the larval development section are indicated by a solid circle and pointer. Open circles indicate photophores which do not appear until after transformation. The almost-universally first-forming Br₂ photophore originates below and slightly behind the eye, and then migrates to its adult position on the middle of the lower jaw.



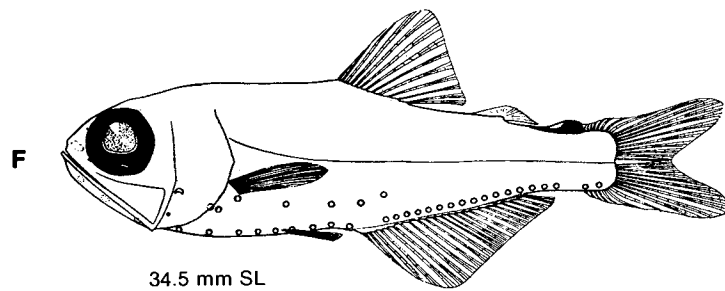
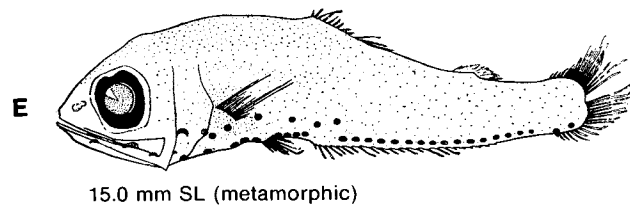
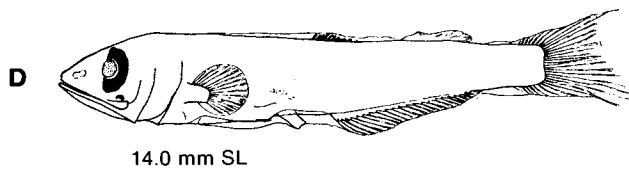
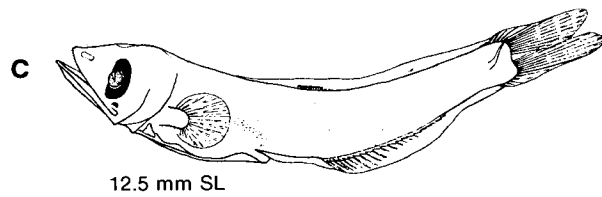
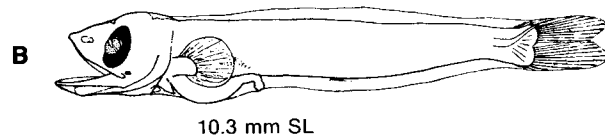
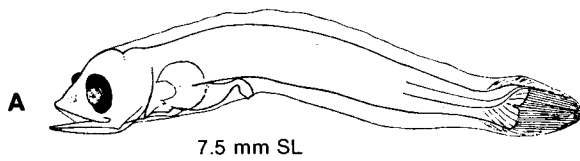
In this example, Br₂, PLO, Dn and PO₁ photophores are indicated.

MYCTOPHIDAE *Protomyctophum arcticum* (Lütken)
Myctophinae

Morphology	— Body slender.	Meristic features
	— Short gut in early larvae, lengthens in late larvae.	
	— Marked space between anus and anal fin origin.	
	— Eye oblong, with no choroid tissue.	
Photophores	— Transforms at about 15 mm.	
		Vert: 36–41 (genus)
		D : 11–13
		A : 21–24
Pigmentation		P : 15–17
	— Br ₂ forms early in larval stage; all other photophores form after metamorphosis.	
	— Unpigmented, except Tåning (1918) noted faint internal pigment in abdomen and in some specimens faint internal melanophores in caudal region, ventral to urostyle.	
Distribution		
	— Subpolar-temperate.	



Fig. — A-F, Tåning 1918.

Protomyctophum arcticum**MYCTOPHIDAE**

MYCTOPHIDAE
Myctophinae

***Electrona risso* (Cocco)**

- Morphology** — Body more robust than *P. arcticum* (p. 108).
 — Unique gut shape, broad anteriorly and narrows in posterior third; gut length about 50% SL at 3.4 mm, 53–58% SL during flexion, and 57–62% during later stages.
 — Head large and broad, its length 26–27% SL during preflexion and about 30% SL during postflexion.
 — Dorsal snout concave during preflexion and rounded during postflexion.
 — Eye moderately narrow, with small choroid mass.
 — Slight space between anus and anal fin origin.
 — Flexion occurs at 6.2–7.0 mm, and transformation at about 10 mm (small).
- Ossification** — Sizes at beginning of ossification and completion of fin rays and vertebrae:

Meristic features

Vert : 32–34
 D : 13–14
 A : 18–19
 P : 13–16

Primary caudal rays	5.7 mm	7.5 mm
Pectoral rays	5.0	~7.8
Anal rays	7.0	~9.0
Dorsal rays	9.0	10.0
Pelvic rays (bud at 6.2 mm)	9.0	10.0
Vertebrae	8.2	9.0

- Photophores** — Br₂ forms early in larvae (5.8 mm) at posteroventral margin of orbit.
- Pigmentation** — Very scant; some spots on pectoral rays beginning at about 6 mm; one spot at symphysis of lower jaw; possibly on snout tip; embedded in dorsal surface of air bladder.
- Distribution** — Eastern Atlantic; collected occasionally in western Atlantic (Nafpaktitis *et al.* 1977).

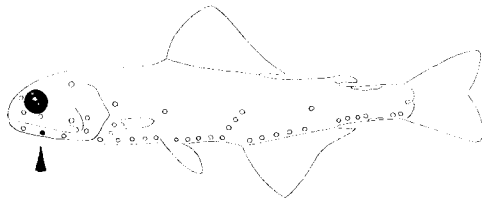
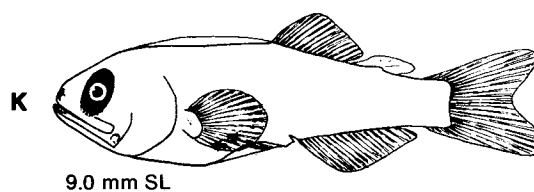
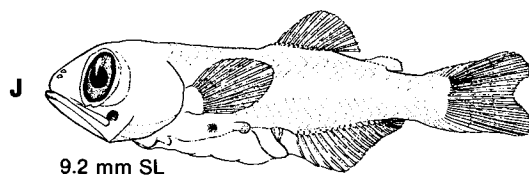
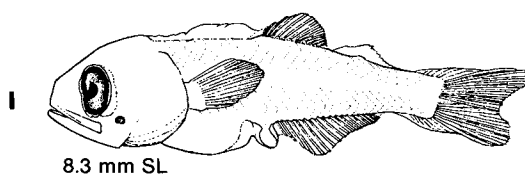
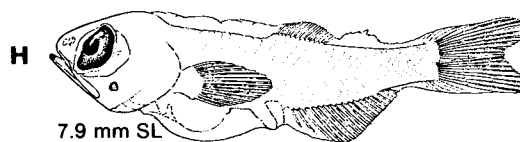
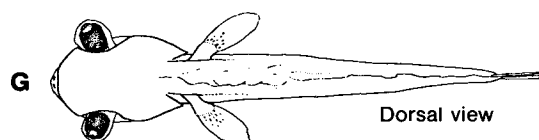
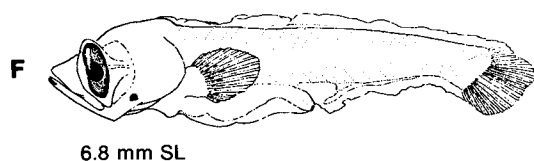
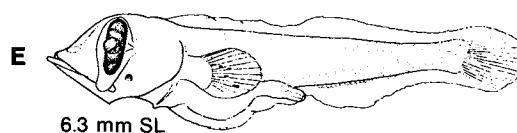
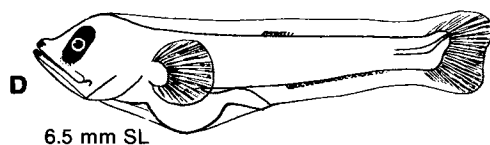
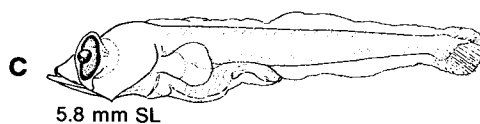
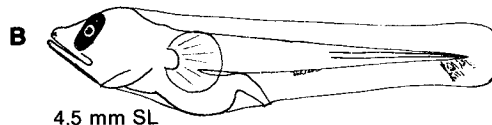
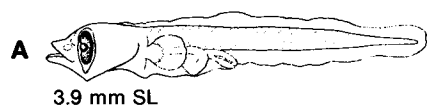


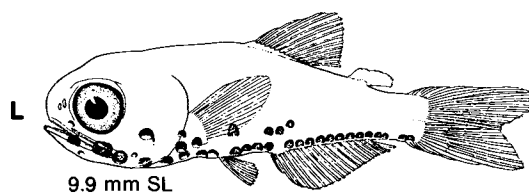
Fig. — A, C, E–J, L, Moser and Ahlstrom 1970; B, D, K, Tåning 1918.

Electrona risso

MYCTOPHIDAE



One larva (9.5 mm) reported with pairs of PO_2 , PO_3 and PO_4 developed (Moser and Ahlstrom, 1970).



MYCTOPHIDAE

Myctophinae

Hygophum benoiti (Cocco)

- | | | |
|---------------------|---|--|
| Morphology | <ul style="list-style-type: none"> — Snout more rounded than in <i>H. hygomii</i>, and eye slightly wider. — Body depth increases from 12% NL to 28–29% SL. — Preanus length increases from 50% NL to 62% SL. — Head length increases from 17% NL to 30% SL. — Transformation occurs at 10.0–12.5 mm (11.0–13.6 mm, Shiganova 1974). | Meristic features |
| | | Vert: 35–36
D : 12–14
A : 19–21
P : 13–15 |
| Ossification | <ul style="list-style-type: none"> — Fins develop at smaller size than in <i>H. hygomii</i>; all dorsal rays formed at 8 mm (10 mm, Shiganova 1974). | |
| Pigmentation | <ul style="list-style-type: none"> — Spots at posterior margin of jaw, tip of snout and lower jaw. — Spots at caudal base and anus, and 8–9 spots anterior to anus. | |

Hygophum hygomii (Lütken)

- | | | |
|---------------------|---|--|
| Morphology | <ul style="list-style-type: none"> — Snout more pointed than in <i>H. benoiti</i>, and eye narrower. — Transformation occurs at 13.0–14.5 mm. | Meristic features |
| | | Vert: 36–37
D : 13–15
A : 20–22
P : 15–16 |
| Ossification | <ul style="list-style-type: none"> — Development of fins later than in <i>H. benoiti</i>; only anterior dorsal ray base formed at 8 mm. | |
| Pigmentation | <ul style="list-style-type: none"> — Spots rarely found on snout tip, lower jaw, and caudal rays. — Spot present at anus. | |

Common Characters for Both Species

- | | |
|---------------------|---|
| Morphology | <ul style="list-style-type: none"> — Body moderately slender, with anus at anterior margin of anal fin (no gap). — Eyes unstalked, moderately narrow with prominent choroid tissue. |
| Ossification | <ul style="list-style-type: none"> — Dorsal fin forms late in larval period. |
| Photophores | <ul style="list-style-type: none"> — Br₂ usually the only photophore to form in the larval stage. |
| Pigmentation | <ul style="list-style-type: none"> — Pigment decreases through larval development; most pigment on head and gut; melanophores present on isthmus (see illustration at right). |
| Distribution | <ul style="list-style-type: none"> — Temperate-semisubtropical |



(Badcock and Merrett 1976)

Note: Larvae somewhat similar to *Benthosema suborbitale*, (p. 124), but choroid tissue more extensive in *Hygophum*. Compare ventral views of head in both genera.

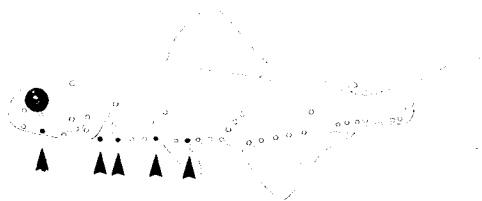
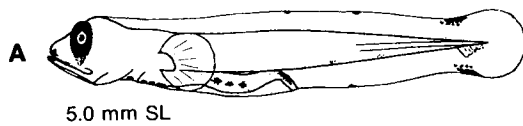
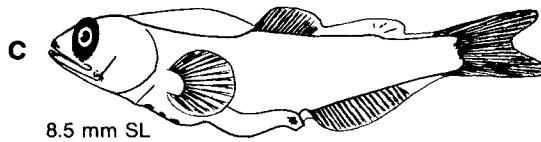
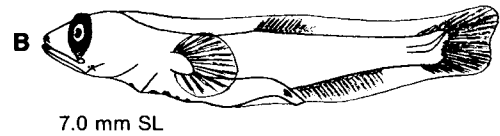


Fig. — A–E, H–J, Tåning 1918; F, Pertseva-Ostroumova 1974; G, Moser and Ahlstrom 1974.

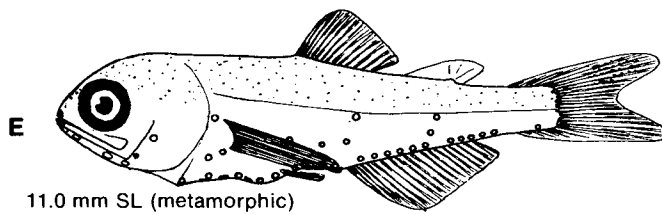
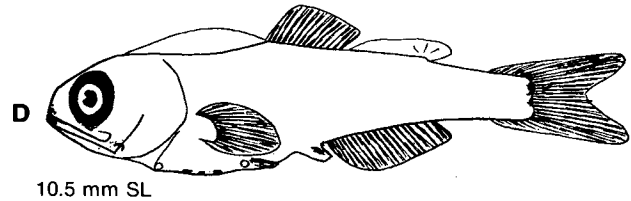
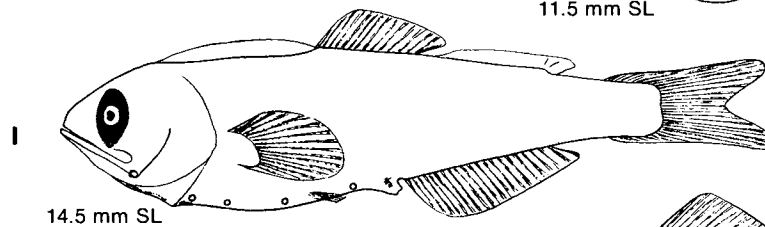
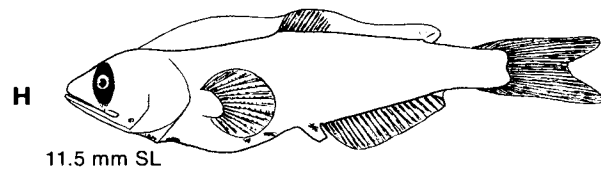
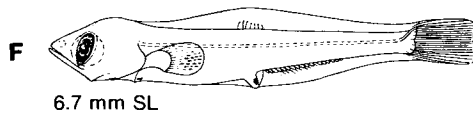
Ref. — Shiganova 1974.

Hygophum benoiti

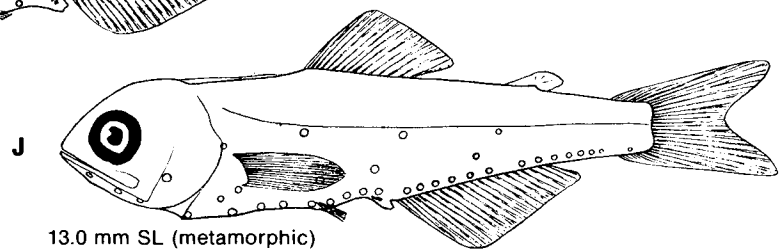
MYCTOPHIDAE

Br₂ forms about 6.0 mm SL

One or two PO photophores
may develop just before
transformation

*Hygophum hygomii*

Two or three PO and one VO
photophore may develop
just before transformation



MYCTOPHIDAE
Myctophinae
***Hygophum reinhardtii* (Lütken)**

Morphology	— Body elongate, with very long gut.	Meristic features
	— Very narrow eye on short stalk, prominent choroid tissue.	
	— Flexion occurs at 8.8–10.3 mm, and transformation at 15.0–16.4 mm.	Vert: 38–39
Ossification	— Sizes at beginning of ossification and completion of fin rays:	D : 13–14
		A : 22–24
		P : 13–15

Primary caudal rays	8.0 mm	9.0 mm
Pectoral rays	9.0	12.0
Anal rays	10.0	13–14
Dorsal rays (form late)	14.0	15+ (at transformation)
Pelvic rays (buds at 11.0 mm)	14.4	15.2

Pigmentation	— Pigment increases through development; median spot at midpoint of isthmus; 9–10 bars of pigment form on tail myosepta; no spots on tip of jaw; 4 pairs of spots on gut increase to 10–11 in larvae >10 mm.
Distribution	— Subtropical.

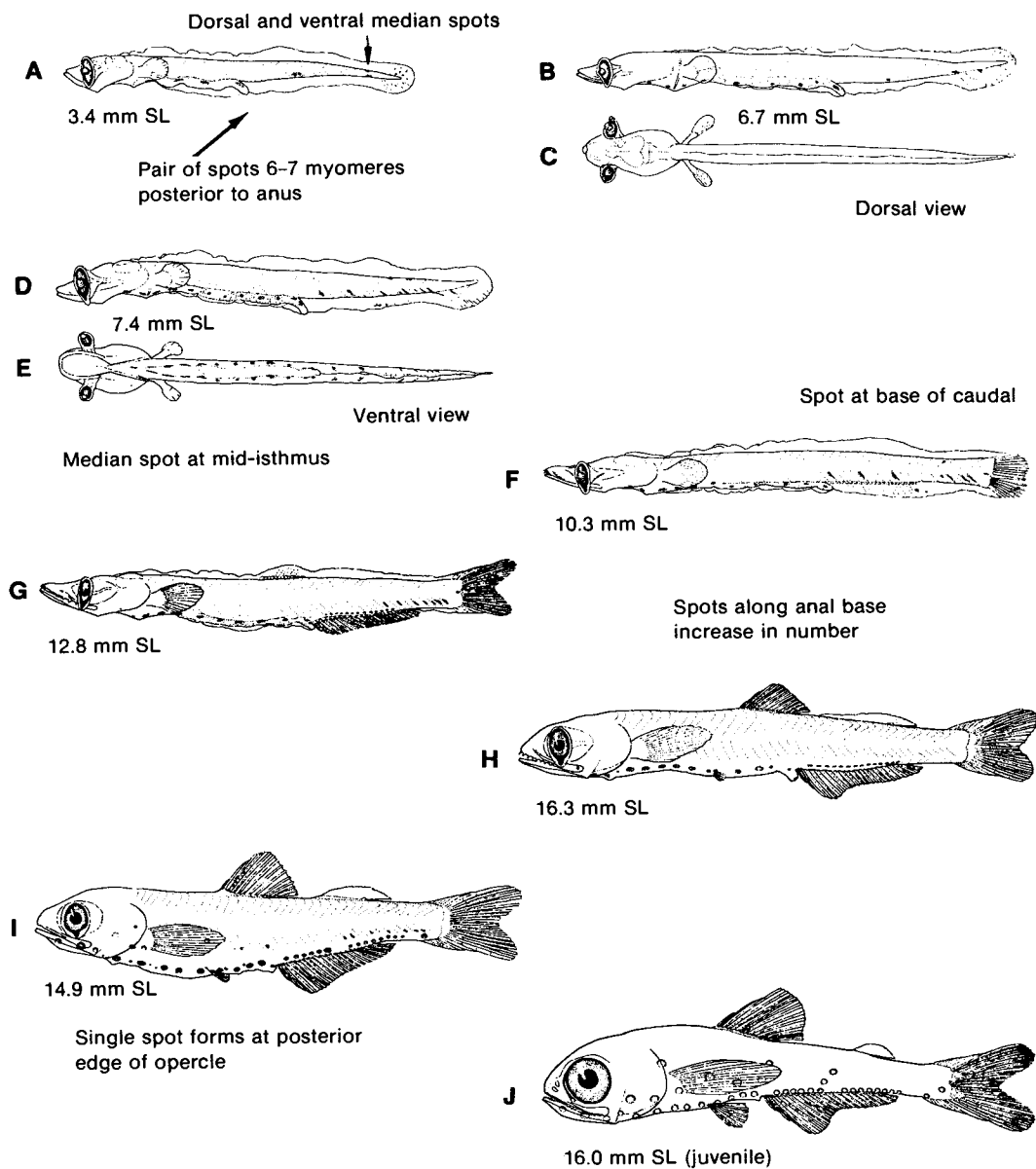
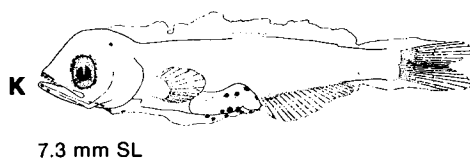
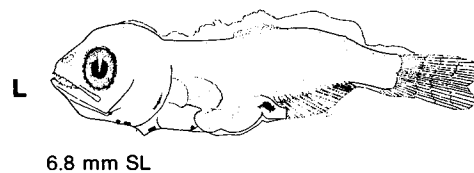
***Hygophum macrochir* (Günther) and *H. taaningi* Bekker**

Morphology	— Body deeper than <i>H. reinhardtii</i> .	Meristic features	
	— Eyes large and relatively wide; little or no choroid tissue.	<i>macrochir</i>	<i>taaningi</i>
	— Gut narrow anteriorly, and enlarged posteriorly; the enlarged part in <i>H. macrochir</i> covered with melanophores.	D: 12–14	13–14
		A: 18–20	19–20
		P: 13–15	13–14
Distribution	— <i>H. macrochir</i> tropical, and <i>H. taaningi</i> subtropical.		

Note: In all three species above, only Br₂ photophore forms during larval stage.



Fig. — A–J, Moser and Ahlstrom 1970; K–L, Moser and Ahlstrom 1974.

Hygophum reinhardtii**MYCTOPHIDAE*****Hygophum macrochir******Hygophum taaningi***

MYCTOPHIDAE *Myctophum punctatum* Rafinesque
Myctophinae

- | | | | |
|---------------------|---|--------------------------|---|
| Morphology | — Body elongate.
— Snout pointed, flat and broad.
— Eyes narrow, stalked, with tapered choroid mass.
— Large, broad pectoral fins on fan-shaped base.
— Pelvic fin buds form at about 10 mm.
— Flexion occurs at about 7.0 mm, and transformation at 21–22 mm. | Meristic features | Vert: 40
D : 13–14
A : 20–22
P : 13–14 |
| Photophores | — Only Br ₂ forms during larval stage; others form at metamorphosis. | | |
| Pigmentation | — Melanophores in caudal region are characteristic.
— Preanal series of spots from anus to head.
— Pigment often on posterior rays of dorsal, anal and adipose fins; spots at base of pectoral fin and a few along the rays.
— Rows of spots on edges of upper and lower jaws, and spots on upper edge of opercle. | | |
| Distribution | — Subpolar-temperate. | | |
- Note:**
- (1) There is evidence that *M. punctatum* does not reproduce in the western Atlantic (Zurbrigg and Scott, 1972).
 - (2) *Myctophum affine* is similar to *M. punctatum* and *M. nitidulum* (p. 118), but larvae undescribed.



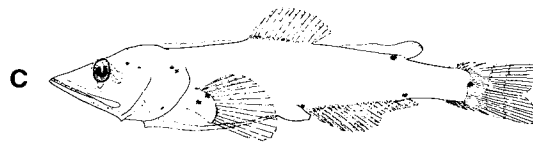
Fig. — A-B, D-F, Tåning 1918; **C,** Moser and Ahlstrom 1974.

Myctophum punctatum**MYCTOPHIDAE**

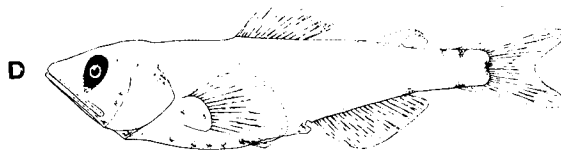
5.7 mm SL

Ventral spots disappear
in later stages

10.5 mm SL

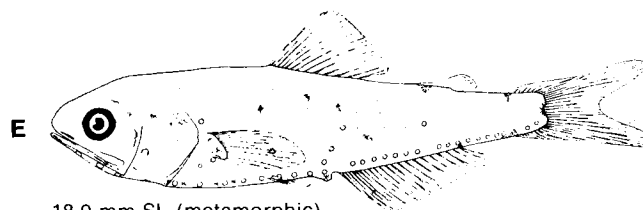
Dorsal edge pigment
near adipose fin

13.6 mm SL



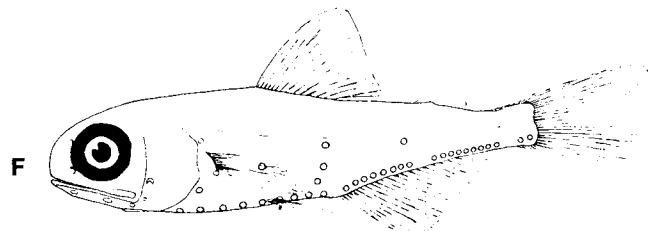
16.0 mm SL

Prominent spot at mid-caudal base

Spots on dorsal and ventral
edge of peduncle

18.0 mm SL (metamorphic)

Eye round, but much larval pigment remains



Adult

MYCTOPHIDAE

Myctophinae

Myctophum nitidulum Garman

- Morphology** — Body deeper than *M. punctatum*, but slimmer than other Atlantic *Myctophum* species.
 — Head massive and broad; eyes stalked with large cone of choroid tissue (53–56% of eye length).
 — Large, broad pectoral fin on fan-shaped base.
 — Anterior two-thirds of gut large and posterior one-third small; gut length 50% SL, increasing to 60–68% SL at flexion.
 — Flexion occurs at 6.5–7.0 mm, and transformation at 11.7–14.7 mm.
- Meristic features**
 Vert: 37–39
 D : 13–14
 A : 19–20
 P : 13–14
- Ossification** — Sizes at beginning of ossification and completion of fin rays and vertebrae:
- | | | |
|------------------------------|--------|--------|
| Pectoral rays | 4.0 mm | 5.0 mm |
| Primary caudal rays | 5.0 | 6.0 |
| Anal rays | 6.9 | 8.2 |
| Dorsal rays | 6.9 | 11.3 |
| Pelvic rays (buds at 6.0 mm) | 8.4 | 11.3 |
| Vertebrae | ... | 11.3 |
- Photophores** — Only Br₂ forms during larval stage (at about 7.0 mm).
- Pigmentation** — Spots on dentaries, branchiostegals, head, opercle, pectoral fins, tail, base of caudal fin, and ventral gut surface.
- Distribution** — Tropical-subtropical.

Comparison of Three Other *Myctophum* Species

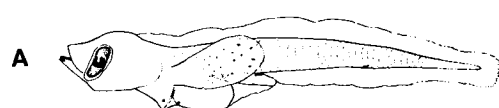
Species	Body	Head	Eyes	Choroid mass	Photophore formation
<i>M. asperum</i> ^a Richardson	Rotund	Broad	Large, unstalked	Short	Dn at 4.6 mm PLO at 9.8
<i>M. obtusirostre</i> ^a Tåning	Rotund	Broad	Large, unstalked	Short	Dn at 4.0 mm PLO at 7.1 PO ₁ at 8.9
<i>M. selenops</i> ^b Tåning	Rotund	Longer and narrower	Slightly stalked	Narrower and more	Dn at 5.1 mm PLO at 6.2 PO ₁ at 7.5

^a Tropical

^b Tropical-subtropical



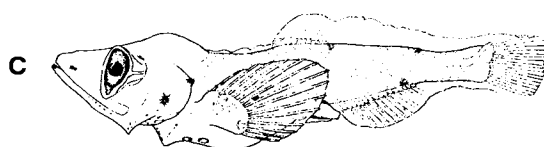
Fig. — A–H, Moser and Ahlstrom 1970; I–J, Pertseva-Ostroumova 1974; K–M, Moser and Ahlstrom 1974.

Myctophum nitidulum**MYCTOPHIDAE**

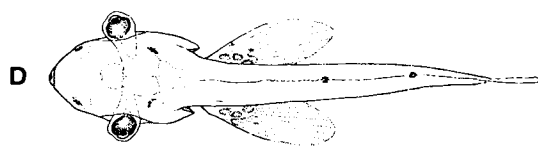
3.3 mm SL



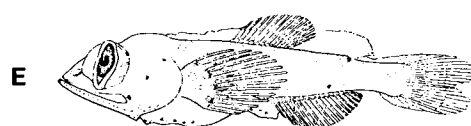
5.8 mm SL

Full complement of
pectoral rays by 5 mm

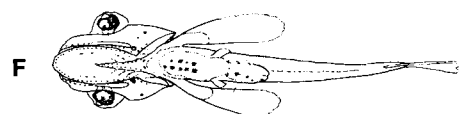
7.0 mm SL



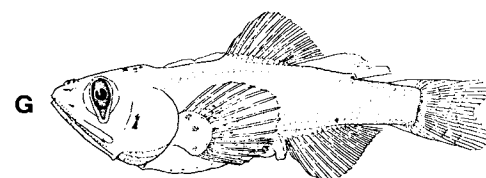
Dorsal view



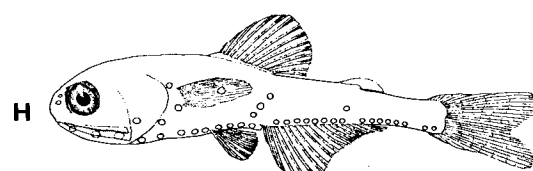
8.2 mm SL



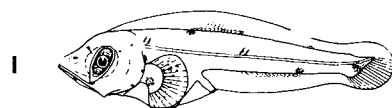
Ventral view



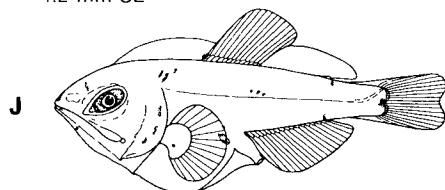
11.7 mm SL



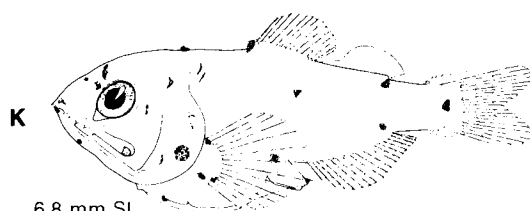
18.8 mm SL (juvenile)

Myctophum asperum

4.2 mm SL

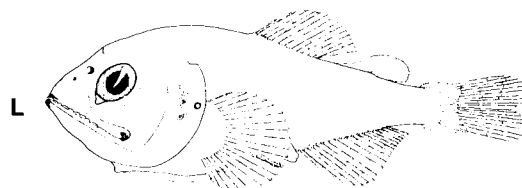


7.0 mm SL



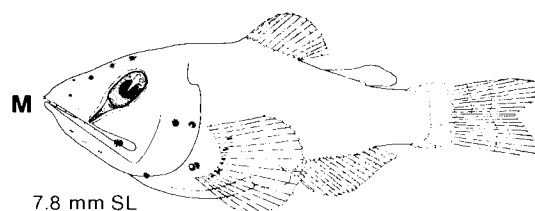
6.8 mm SL

Heavily-pigmented, especially on body

Myctophum obtusirostre

7.6 mm SL

Pigment confined to head

Myctophum selenops

7.8 mm SL

Pigment on head and pectoral rays

MYCTOPHIDAE ***Symbolophorus veranyi* (Moreau)**
Myctophinae

Morphology	<ul style="list-style-type: none"> — Moderately elongate body. — Narrow eyes on short stalks; small cone of choroid tissue. — Snout pointed; flat in small larvae. — Large pectoral fins with elongate bases; fins extend beyond anus. — Transforms at about 20 mm. 	Meristic features
		Vert: 39–40
		D : 12–14
		A : 21–23
		P : 12–13
Ossification	— Dorsal rays not yet completely ossified at 17 mm.	
Photophores	— Only Br ₂ forms during larval stage (at about 12 mm).	
Pigmentation	<ul style="list-style-type: none"> — Few preanal ventral spots. — Large spot on posterior edge of opercle; spots on tip of snout and lower jaw. — Pigment on pectoral rays (heavier at bases). — Pigment decreases toward end of larval period. 	
Distribution	— Temperate.	

Note: *Symbolophorus rufinus* (Tåning), larvae undescribed, also occurs in the western North Atlantic. Larvae of the two species may differ in sequence of pelvic fin-ray formation.

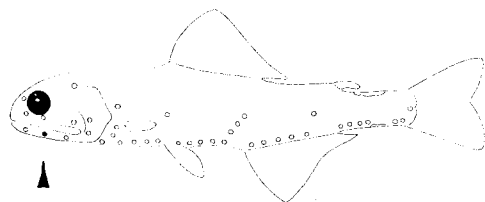
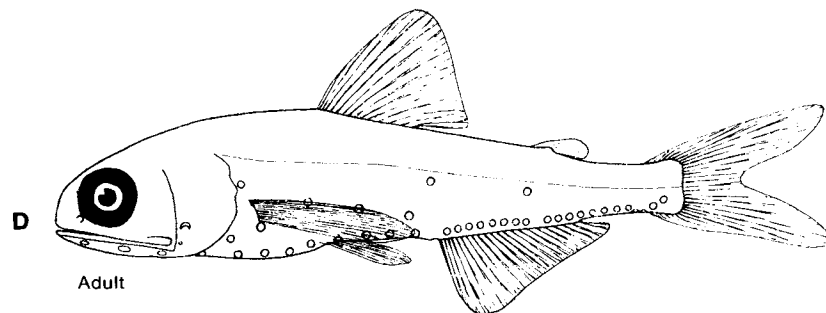
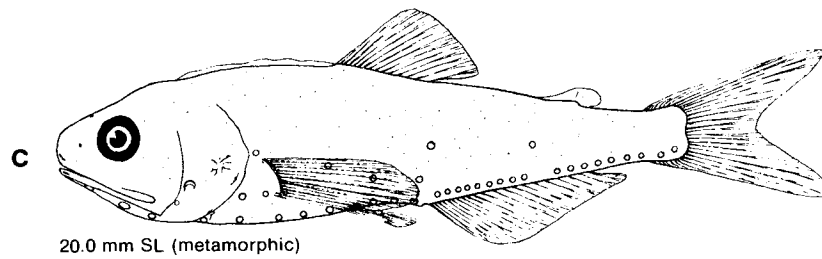
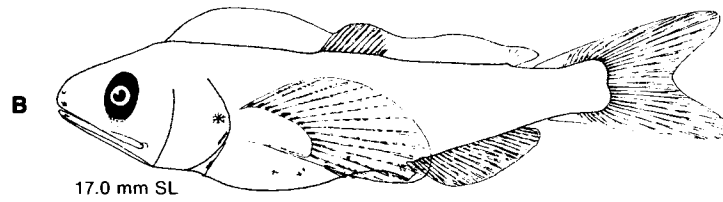
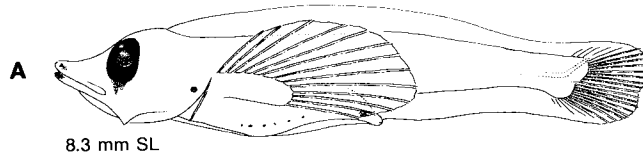


Fig. — A-D, Tåning 1918 (A, redrawn), described as *Myctophum humboldti*.

Symbolophorus veranyi**MYCTOPHIDAE**

MYCTOPHIDAE *Diogenichthys atlanticus* (Tåning)
Myctophinae

- Morphology** — Body slender in small larvae: body depth increases from 11–13% SL during preflexion to 28% SL in late larvae.
 — Eye slightly oval, with no opaque choroid mass.
 — Head wedge-shaped; length increases from 21–22% SL at 3 mm to 33% SL at 8–9 mm, and then decreases to 28% SL at 14 mm.
 — Gut uniform in diameter when small, conical in older larvae; length increases from 50% SL to 60% SL after flexion.
 — Gap between anus and anal fin origin until about 9 mm.
 — Barbel on lower jaw present from about 5 mm until transformation.
 — Flexion occurs at 6–7 mm, and transformation at 14–15 mm.
- Meristic features**

Vert: 32–35
 D : 11–12
 A : 15–16
 P : 12–13

- Ossification** — Sizes at beginning of ossification and completion of fin rays:

Pectoral rays	6.0 mm	9.0 mm
Primary caudal rays	6.0	7.0
Anal rays	6.0	7.6
Dorsal rays	8.0	10.0
Pelvic rays (buds at about 7 mm)	8.0	12.0

- Photophores** — Size of larvae when formation begins and location:

Br ₂	~6.0	Postero-ventral margin of orbit
PO ₂	7.0	Under pectoral base.
PO ₅	8.5	Anterior to pelvic fins.
AO _{a1}	~11.0	Posterior to anus.
Br ₃ , PO ₁ , PO ₃	...	(May begin to form just before transformation)

- Pigmentation** — Spots on anal rays, at base of pectoral rays, and at base of caudal rays.
 — Large spot on side of trunk over end of gut.
 — Spots on ventral midline of tail and along anal fin base increase in number during larval development.
 — Single spots form on dorsal midline, posterior to dorsal fin and posterior to adipose fin, at about 7 mm.

- Distribution** — Tropical-subtropical.

Note: Differences in developmental rates of 5 mm larvae (Fig. C, K and N) due to geographic variation.

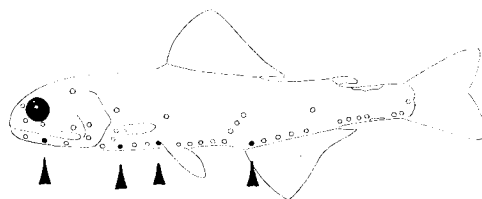


Fig. — **A–J**, Moser and Ahlstrom 1970; **K–M**, Tåning 1918; **N–O**, Pertseva-Ostroumova 1974.

Diogenichthys atlanticus

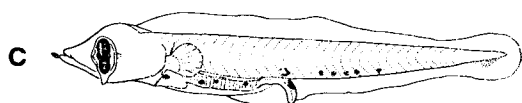
MYCTOPHIDAE



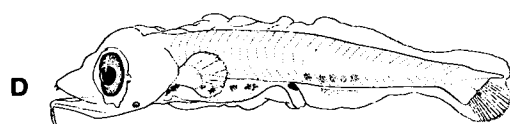
3.6 mm SL



4.3 mm SL



5.1 mm SL



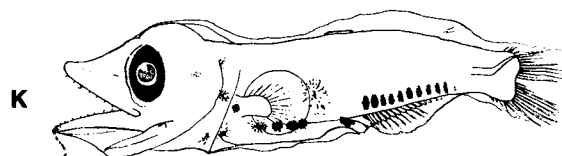
6.0 mm SL

Spots along side of gut

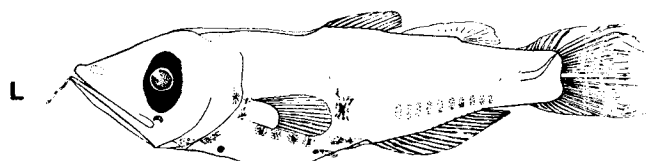


7.2 mm SL

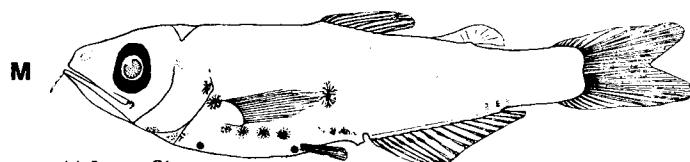
Barbel pigmented



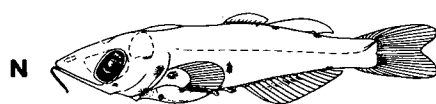
About 5.0 mm SL



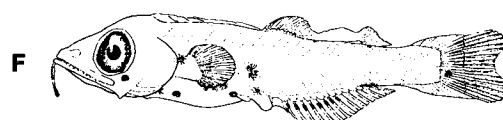
7.0 mm SL



11.0 mm SL



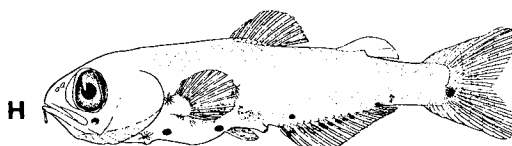
5.0 mm SL



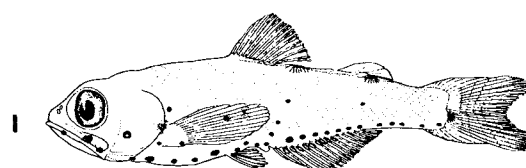
8.8 mm SL



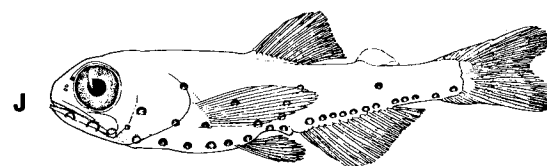
Dorsal view



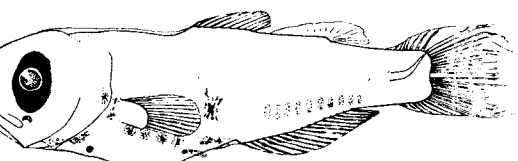
12.8 mm SL



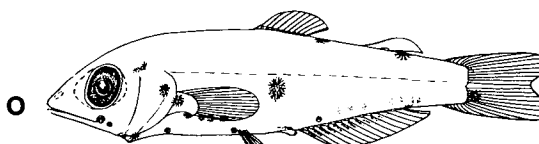
14.5 mm SL



16.0 mm SL (juvenile)



7.0 mm SL



9.0 mm SL

MYCTOPHIDAE Myctophinae

Benthosema glaciale (Reinhardt)

Morphology	— Gap between anus and anal fin origin closes at about 8 mm.	Meristic features
	— Flexion occurs at 5–7 mm, and transformation at about 11 mm.	Vert : 34–36
Ossification	— Dorsal and anal fin rays complete at about 11 mm.	D : 12–14
		A : 17–19
Photophores	— In addition to Br ₂ , late larvae develop Br ₁ , OP ₂ and PO photophores; AO _a may develop before transformation.	P : 11–13
Pigmentation	— Spot at posterior edge of opercle; spots at tip of snout and lower jaw.	
	— Three ventral spots from cleithral symphysis to anus.	
	— Ventral spots on tail reduce to 1 faint spot over middle of anal fin at 11 mm; pectoral rays pigmented.	
	— Spot near developing Br ₂ .	
Distribution	— Subpolar-temperate.	

Benthosema suborbitale (Gilbert)

Morphology	— Anus-anal fin gap and size at transformation similar to <i>B. glaciale</i> .	Meristic features
		Vert : 34
Photophores	— Sequence of development: Br ₂ , PO ₁ , PO ₂ , Br ₁ and Br ₃ .	D : 11–14
		A : 16–17
Pigmentation	— No ventral pigment. — See note on <i>Hygophum hygomii</i> (p. 112) regarding pigment on ventral surface of head, and illustration at right.	P : 12–14
Distribution	— Tropical-subtropical.	



Badcock and
Merrett 1976

Generic Characters

Larvae	— Some photophore development in larvae.
	— Oval eye with lunate choroid mass.
	— Gap between anus and anal fin origin.
	— Transformation occurs at relatively small size.

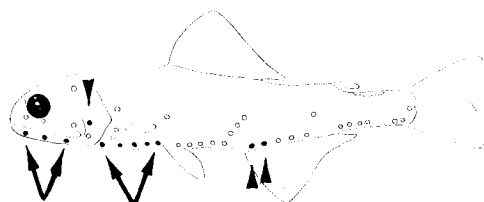
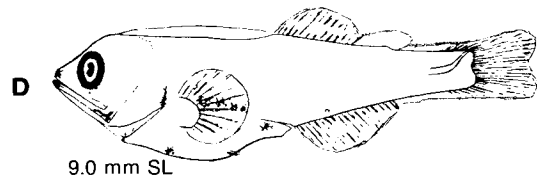
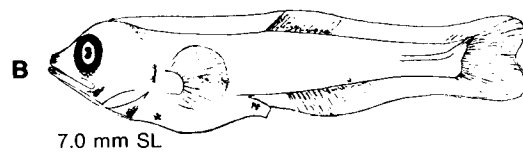
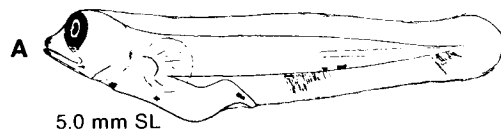
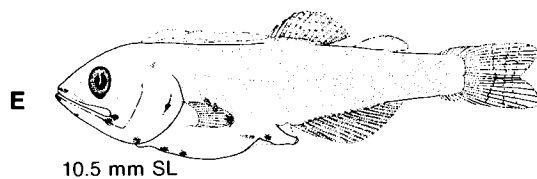


Fig. — A–B, D, F–G, Tåning 1918; C, E, K, Moser and Ahlstrom 1974; H–J, Pertseva-Ostroumova 1974 (redrawn).

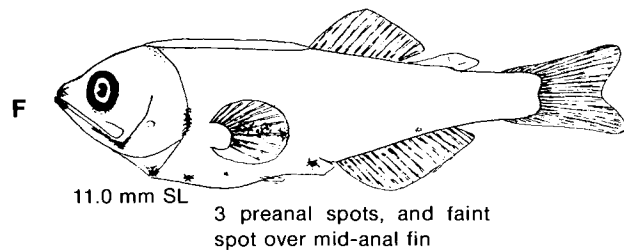
Benthosema glaciale**MYCTOPHIDAE**

Pigmented pectoral rays

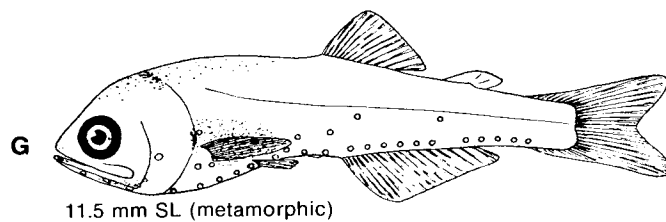
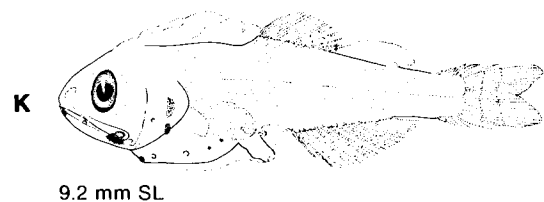
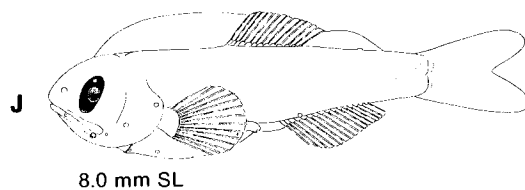
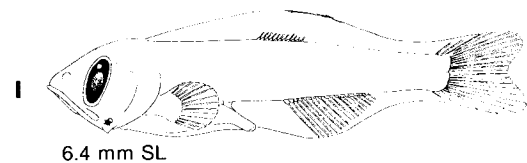
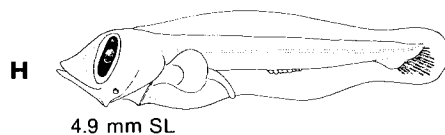
Spot at posterior edge of opercle



Pigment at tips of snout
and lower jaw



3 preanal spots, and faint
spot over mid-anal fin

***Benthosema suborbitale***

MYCTOPHIDAE

Myctophinae

Loweina rara (Lütken)

- Morphology**
- Large oval eyes, no opaque choroid mass.
 - Posteriorly-placed median fins and large finfold.
 - Elongate lower pectoral fin rays, with pigmented spatulate process on distal end.
 - Long gut, increasing from 54–57% SL in small larvae to 70% SL at flexion and to 80% SL prior to transformation.
 - Flexion occurs at 8–11 mm, and transformation at about 20 mm (large).
- Ossification**
- Sizes at beginning of ossification and completion of fin rays:
- | | | |
|---------------------------------------|--------|--------|
| Pectoral rays (6 more than in adults) | 4.6 mm | 8.4 mm |
| Primary caudal rays | 7.5 | 8.8 |
| Anal rays | 8.8 | 11.0 |
| Dorsal rays | 9.3 | 11.0 |
| Pelvic rays (buds at 8.5 mm) | 15.7 | >20 |
- Meristic features**
- Vert: 37–39
D : 11–13
A : 15–16
P : 10–12
- Photophores**
- Br₂ forms at corner of jaw in 11 mm larvae; other photophores form after transformation.
- Pigmentation**
- Transverse band across brain between eyes.
 - Spot medial to pectoral base and one on mid-isthmus (2 spots may join in some larvae 7 to 12 mm).
- Distribution**
- Tropical-subtropical.

Gonichthys cocco (Cocco)

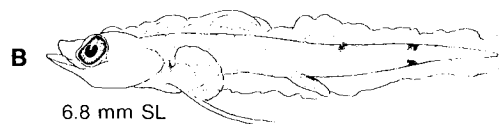
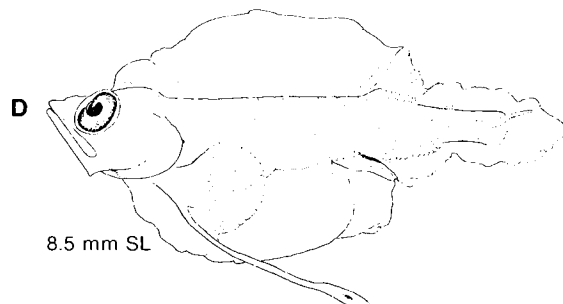
- Morphology**
- Head and body deep and laterally-compressed.
 - Small narrow eyes, with elongate choroid tissue.
 - Snout flat at 5 mm (becomes rounded).
 - Flexion occurs at 5.0–7.5 mm.
- Ossification**
- All median fin rays formed by 7.5 mm.
- Photophores**
- Only Br₂ forms during larval stage.
- Pigmentation**
- Large spot at base of caudal fin, and some pigment on caudal rays and pectoral rays.
 - Few small ventral spots anterior to anus.
 - See illustrations for other pigment.
- Distribution**
- Tropical-subtropical.
- Meristic features**
- Vert: 40–41
D : 11–12
A : 20–23
P : 13–15



Fig. — A–H, Moser and Ahlstrom 1970; I–K, Tåning 1918.

Loweina rara**MYCTOPHIDAE**

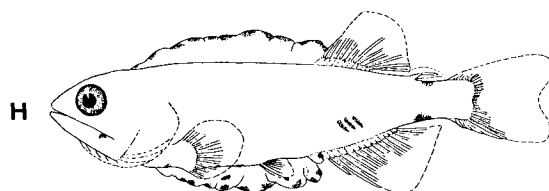
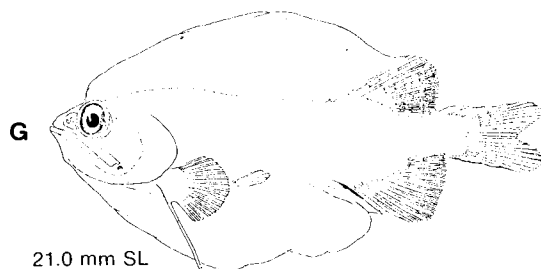
Gut ends in free, terminal section



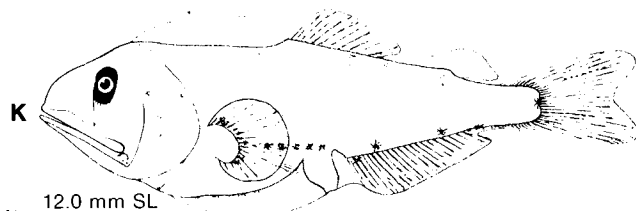
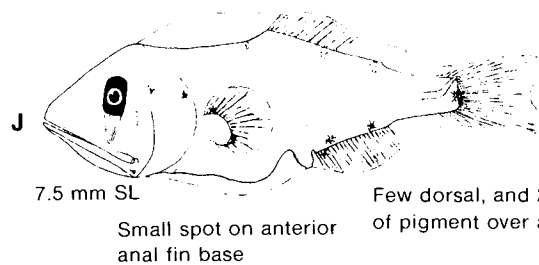
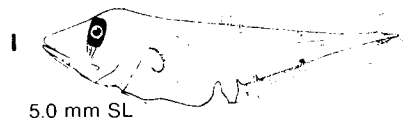
2 dorsal, 1 ventral blotch on tail



Finfold often pigmented and pigment on dorsal, terminal end of gut



20.0 mm SL (metamorphic)

Gonichthys cocco

Diffuse internal abdominal pigment and row of external spots anterior to anus

Few dorsal, and 2-3 ventral accumulations of pigment over anal fin

MYCTOPHIDAE *Lampadena urophaos atlantica* Maul
Lampanyctinae

- Morphology** — Body moderately slender.
- Photophores** — Develop early in the larval stage, with Br₂, PLO and PO₅ appearing first, followed by Vn and PO₁.
- Pigmentation** — Dorsal row of spots from dorsal fin origin to peduncle; ventral row of spots from anal fin origin to peduncle.
- Distribution** — Subtropical.

Meristic features

Vert : 36–38
 D : 15–16
 A : 14
 P : 16–17

Lampadena luminosa (Garman)

- Morphology** — Body shape similar to *L. urophaos atlantica*.
- Photophores** — Development similar to *L. urophaos atlantica*.
- Pigmentation** — Dorsal and ventral pigment similar to *L. urophaos atlantica* but originates at posterior ends of dorsal and anal fins.
- Distribution** — Tropical-semisubtropical.

Meristic features

Vert : 36–37
 D : 14–15
 A : 13–15
 P : 15–17

Taaningichthys minimus (Tåning)

- Morphology** — Body more slender than *Lampadena*.
- Photophores** — No photophores in larvae until Br₂ forms just before transformation (about 18 mm); PO₅ forms at about 19.3 mm.
- Pigmentation** — Pigment similar to that in *Lampadena*; internal pigment above vertebral column in small larvae.
- Distribution** — Subtropical; larvae are neustonic.

Meristic features

Vert : 40–41
 D : 11–13
 A : 11–14
 P : 15–17

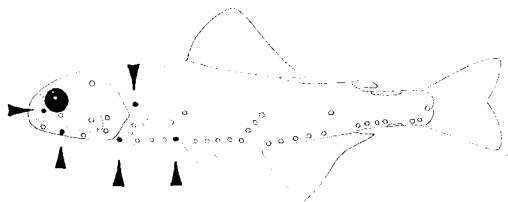
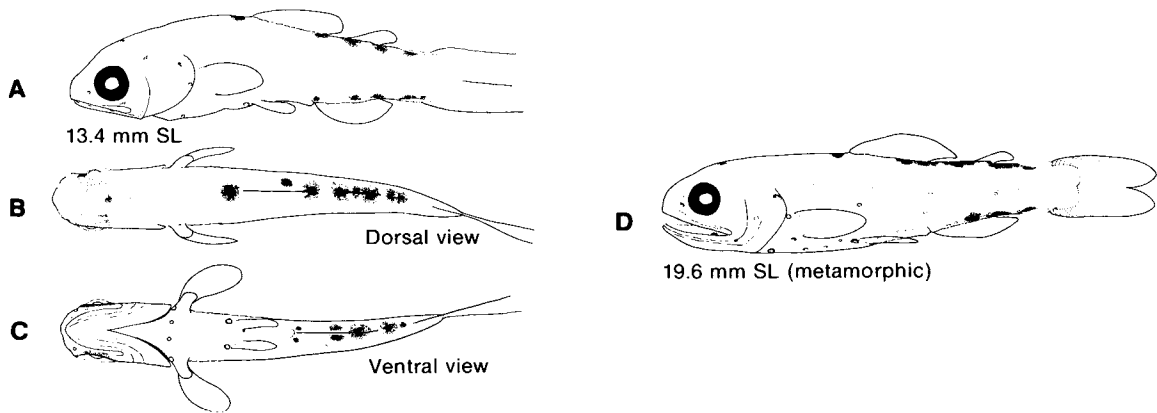
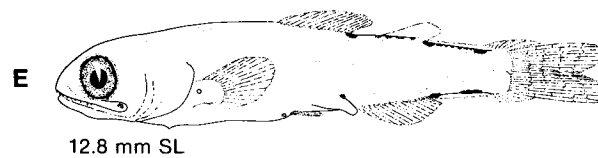
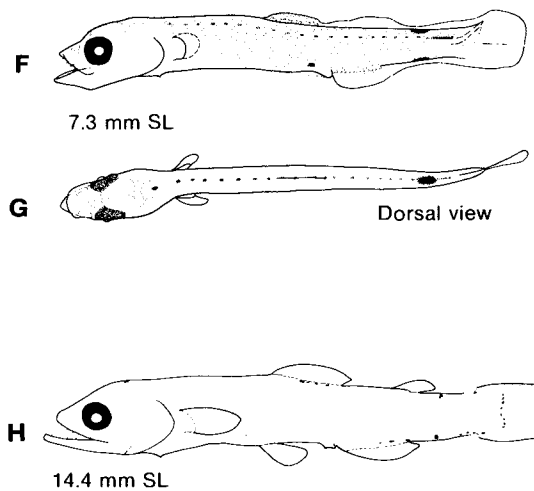


Fig. — A–D, F–H, Moser and Ahlstrom 1972; E, Moser and Ahlstrom 1974.

Lampadena urophaos atlantica**MYCTOPHIDAE*****Lampadena luminosa******Taaningichthys minimus***

MYCTOPHIDAE ***Bolinichthys supralateralis* (Parr)**
Lampanyctinae

Morphology	— Body rather stubby and deeper than <i>Lepidophanes</i> .	Meristic features
Photophores	— Very small; Br ₂ , Vn, PLO and PO ₅ form sequentially in some species of the genus whereas only Br ₂ forms in others.	Vert : ? D : 13-15 A : 13-15 P : 13-14
Pigmentation	— Sparse.	
Distribution	— Tropical-subtropical.	

***Lepidophanes guentheri* (Goode and Bean)**

Morphology	— Body elongate.	Meristic features
Photophores	— Br ₂ forms first, followed by Vn, PLO and PO ₅ which form about simultaneously; OP ₁ and OP ₂ form just before transformation.	Vert : ? D : 13-15 A : 14-15 P : 12-13
Distribution	— Tropical.	

***Lepidophanes gaussi* (Brauer)**

Morphology	— Body elongate.	Meristic features
Photophores	— Very small; Br ₂ forms first, followed by Vn, PLO and PO ₅ which form about simultaneously; OP ₁ and OP ₂ form just before transformation.	Vert : ? D : 13-14 A : 13-15 P : 12-13
Pigmentation	— Present on nape, on dorsal and ventral midlines of peduncle, and internally on posterior half of vertebral column.	
Distribution	— Subtropical.	

Note: *L. guentheri* and *L. gaussi* are superficially similar to *Ceratoscopelus maderensis* (p. 132), but they develop more quickly and transform at smaller size.

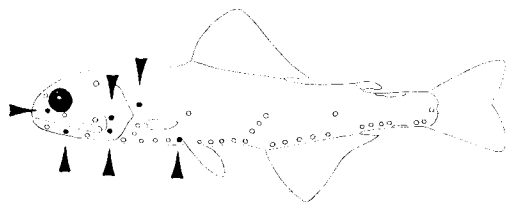
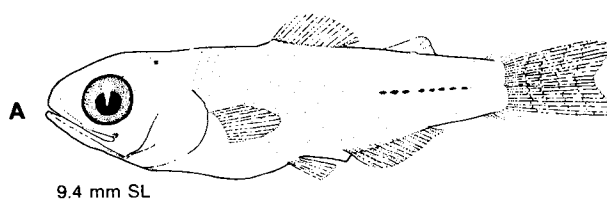
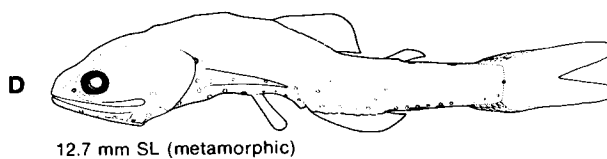
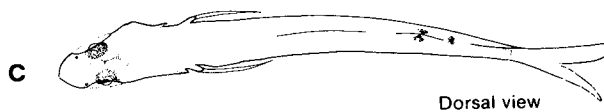
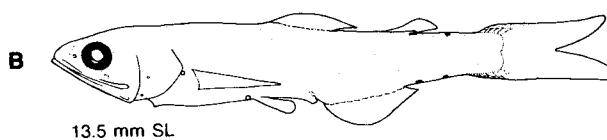
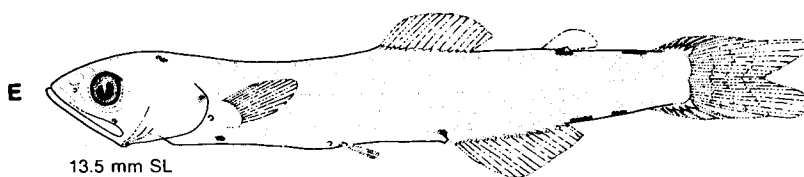


Fig. — **A, E**, Moser and Ahlstrom 1974; **B-D**, Moser and Ahlstrom 1972.

Bolinichthys supralateralis**MYCTOPHIDAE**

Lepidophanes guentheri

Lepidophanes gaussi

MYCTOPHIDAE *Ceratoscopelus maderensis* (Lowe)
Lampanctinae

Morphology	— Body elongate. — Sliver of choroid tissue under eye. — Flexion occurs at about 6 mm, and transformation at about 16 mm.	Meristic features Vert : 35–38 D : 13–14 A : 13–15 P : 13–14
Ossification	— All fin rays formed by about 16.5 mm.	
Photophores	— Very small; Br ₂ , Vn, PLO and PO ₅ formed between 7 and 11 mm.	
Pigmentation	— At 5 mm, a series of small spots extends from anus to the larger spots on the ventral peduncle. — There are 3 or 4 larger spots on dorsal and ventral midlines of peduncle. — Few faint spots on occipital, abdomen and sides of anus.	
Distribution	— Temperate-semisubtropical.	
Note:	<i>Ceratoscopelus warmingi</i> (Lütken) is similar but lacks dorsal pigment on peduncle except a few spots possibly embedded near tip of notochord; distribution is tropical-subtropical. (See Fig. H opposite.)	

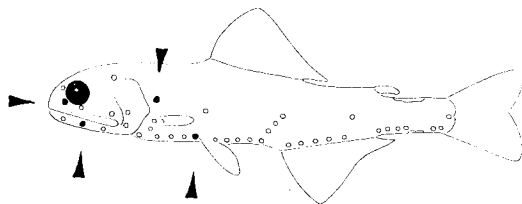
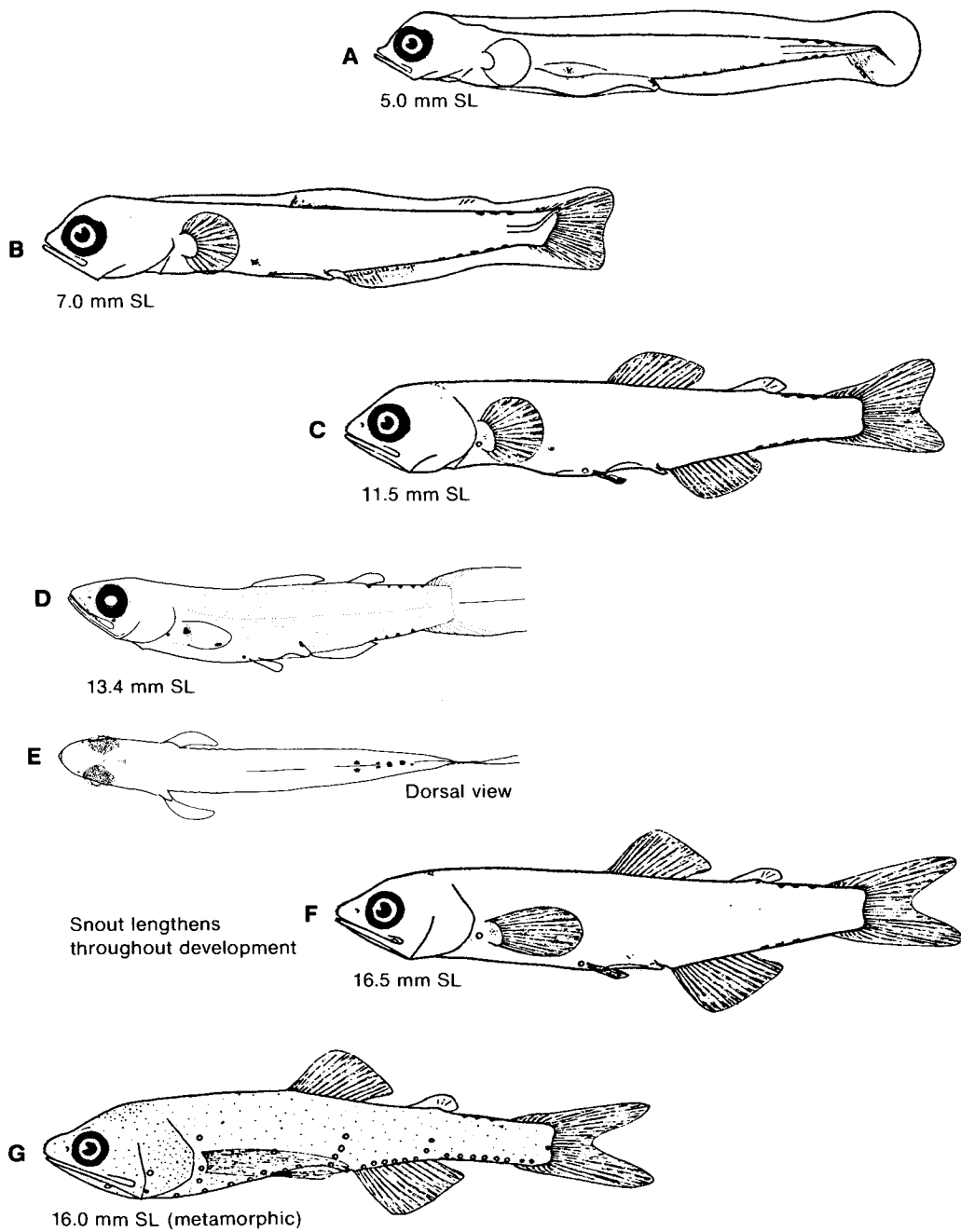
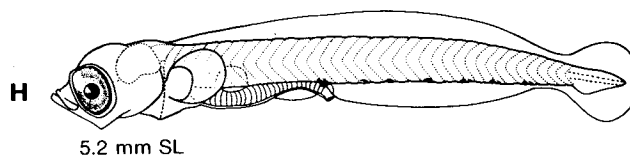


Fig. — A–C, F–G, Tåning 1918; D–E, Moser and Ahlstrom 1972; H, Miller *et al.* 1979.

Ceratoscopelus maderensis**MYCTOPHIDAE*****Ceratoscopelus warmingi***

H (Pacific specimen)

MYCTOPHIDAE ***Lampanyctus pusillus* (Johnson)**
Lampanyctinae

Morphology	— Body short and stocky. — Eyes round, with no choroid tissue. — Transformation occurs at about 12 mm.	Meristic features Vert : 32-34 D : 12-13 A : 14-16 P : 13-15
Ossification	— All fin rays formed by 10 mm.	
Pigmentation	— Occipital spots (1 or 2) not distinct in figures. — Spots on gill cover, snout and lower jaw tip, and small spots (some internal) over abdomen. — Row of dorso-lateral spots and row of preanal spots develop.	
Distribution	— Temperate-semisubtropical.	

***Lampanyctus crocodilus* (Risso)**

Morphology	— Body more elongate than <i>L. pusillus</i> . — Eyes round, with no choroid tissue. — Transformation occurs at 19-22 mm.	Meristic features Vert : 36-37 D : 13-15 A : 17-18 P : 14-16
Ossification	— All fin rays formed by 19 mm.	
Pigmentation	— Pigment follows myosepta above pectoral base. — Spot on anus and occiput remain through larval development.	
Distribution	— Temperate-semisubtropical.	

Generic Characters

Morphology	— Deep-bodied with large head; jaws in some species elongate with prominent teeth. — Abrupt transformation from larvae to juveniles.
Photophores	— Br ₂ only photophore formed in the larval period.
Pigmentation	— Pigment in older larvae may develop in several locations: lower jaw tip, between eyes, back of head, side of head, adipose fin, pectoral fin, along myosepta, and in cleithral region (internal).

Note: (1) There are 13 species of *Lampanyctus* in the western North Atlantic.
(2) *L. pusillus* was described as *L. alatus* by Tåning (1918).

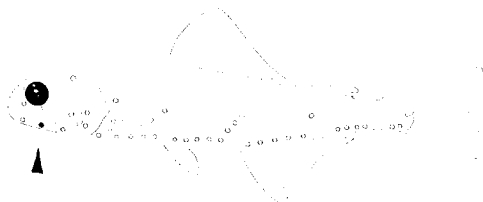
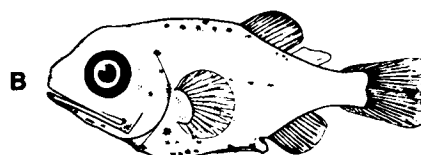


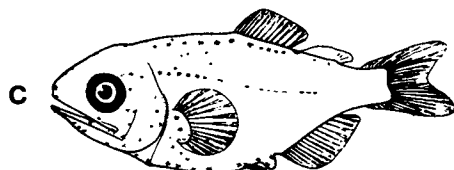
Fig. — A-K, Tåning 1918.

Lampanyctus pusillus**MYCTOPHIDAE**

5.0 mm SL

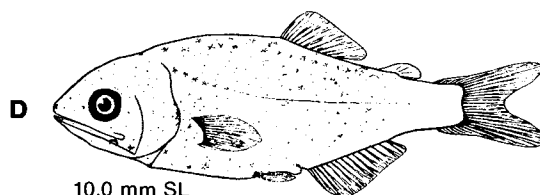


6.5 mm SL



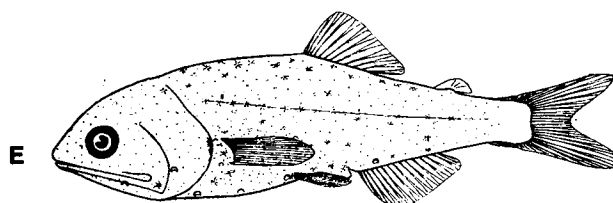
8.5 mm SL

Midlateral line of spots

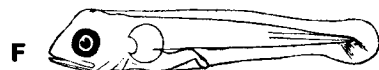


10.0 mm SL

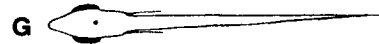
Usually a large spot between dorsal and adipose fins



12.0 mm SL (metamorphic)

Lampanyctus crocodilus

5.5 mm SL

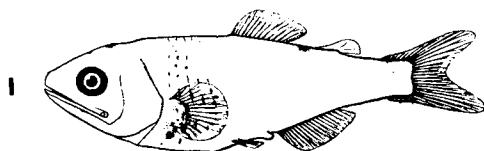


Dorsal view

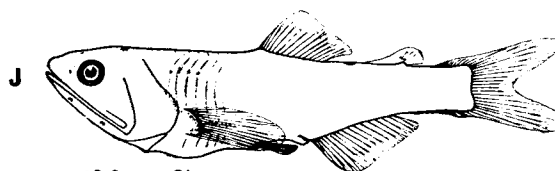


8.0 mm SL

Large spot between dorsal and adipose fins

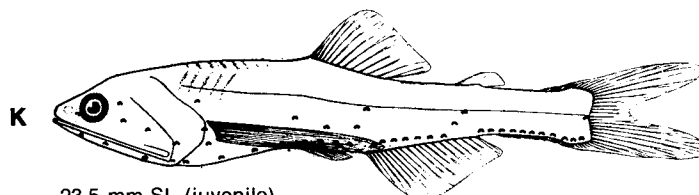


14.0 mm SL



19.0 mm SL

Several spots on pectoral base and rays



23.5 mm SL (juvenile)

MYCTOPHIDAE
Lampanyctinae

***Lobianchia dofleini* (Zugmayer)**

Morphology	— Body short and stocky; large pectoral fin.	Meristic feature
	— Eyes small, slightly oval, with some choroid tissue.	
	— Flexion occurs at about 5–6 mm, and transformation at 10–11.	
Ossification	— All fin rays complete by 11.5 mm; larvae have 17–19 pectoral fin rays, adults have 11–13.	Vert : 33–35
		D : 15–17
		A : 13–15
Photophores	— PO ₁ may form at about 7 mm.	P : 11–13
Pigmentation	— Several scattered spots preanally and on anus.	
	— Spots scattered below dorsal fin and above bases of pectoral and anal fins.	
	— Several spots on pectoral fin base and along the rays.	
Distribution	— Temperate-semisubtropical.	

***Lobianchia gemellarii* (Cocco)**

Morphology	— Body short and stocky; long upper pectoral rays.	Meristic features
	— Eyes round.	
	— Flexion occurs at about 5–6 mm, and transformation at about 14 mm.	
Ossification	— All fin rays complete by 10 mm.	Vert : 36
		D : 17–18
		A : 13–15
Photophores	— Br ₂ , PO ₁ , and PO ₅ are discernible at about 8 mm.	P : 11–12
Pigmentation	— Spot on anus and often at cleithral symphysis.	
	— Spot at posterior anal fin base and two prominent spots at caudal base.	
	— Spots at pectoral base, more prominent in smaller larvae.	
Distribution	— Tropical-subtropical.	

Generic Characters

Morphology	— Deep-bodied with large head.
	— Characteristic pectoral fin shape.
Pigmentation	— Heavily pigmented in pectoral fin area.
Photophores	— Br ₂ , PO ₁ and PO ₅ develop in the larval period.

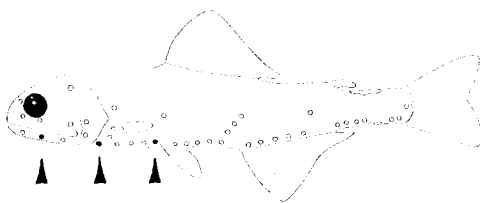
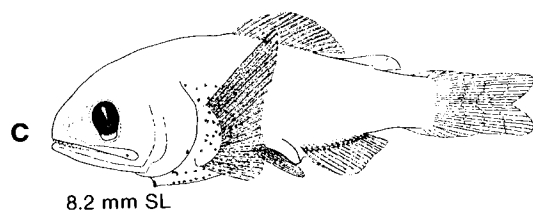
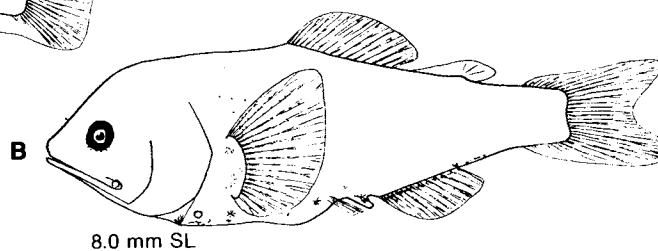
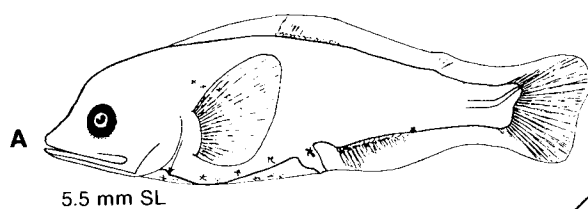
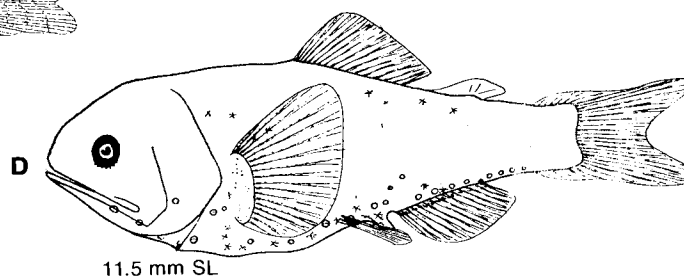


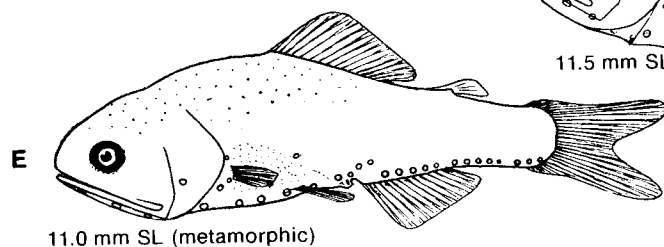
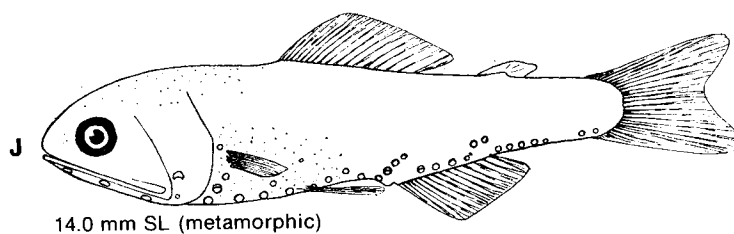
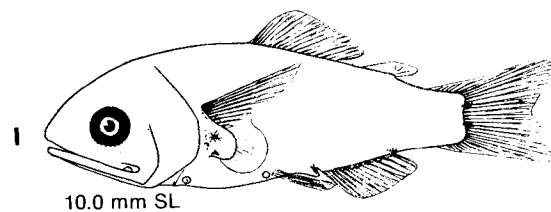
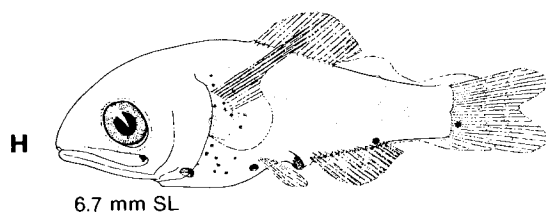
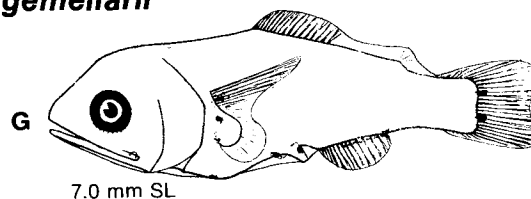
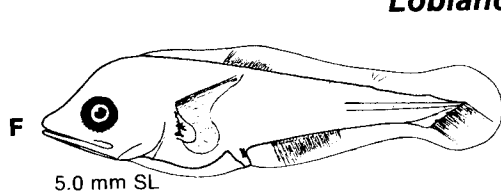
Fig. — A–B, D–G, I–J, Tåning 1918; C, H, Moser and Ahlstrom 1974.

Lobianchia dofleini**MYCTOPHIDAE**

Reduction in pectoral fin size and
ray number at metamorphosis



Spots at cleithral symphysis

***Lobianchia gemellarii***

MYCTOPHIDAE
Lampanyctinae

***Diaphus rafinesquii* (Cocco)**

- Morphology** — Body slender, with round eye.
 — Flexion occurs at 4.5–6.0 mm, and transformation at about 10 mm.
- Ossification** — All fin rays complete by 9.5 mm.
- Photophores** — Br₂ and PO₅ visible at about 7 mm.
- Pigmentation** — Faint spot at anus; strong spot at posterior anal-fin base; two spots at caudal base.
- Distribution** — Temperate-semisubtropical.

Meristic features

Vert: 33–34
 D : 13–14
 A : 13–15
 P : 10–11

***Diaphus holti* Tåning**

- Morphology** — Body slender, with round eye.
 — Flexion occurs <5 mm, and transformation at 10–11 mm.
- Ossification** — All fin rays complete by 10 mm.
- Photophores** — Br₂, PO₁ and PO₅ begin formation at about 7 mm and are complete at 10 mm.
- Pigmentation** — Spot at anus and cleithral symphysis; row of spots along anal fin base and ventral midline of tail.
 — Single, large spot on lower half of caudal fin base.
- Distribution** — Eastern Atlantic.

Meristic features

Vert: 32–34
 D : 13–14
 A : 12–14
 P : 10–12

Generic Characters

- Morphology** — Two types: (1) slender body, small head, and series of melanophores on ventral midline of tail; (2) deeper body, bulbous head, and single persistent tail spot (or none).
- Photophores** — More photophores develop in larval period than in any other myctophid genus (i.e. Br₂, PO series, VO₁, VO₅, OP₂, VLO and PVO).
- Pigmentation** — Embedded spots common at base of caudal fin; pigment rarely on head and never between eyes.

Note: There are 23 species of *Diaphus* in western North Atlantic.

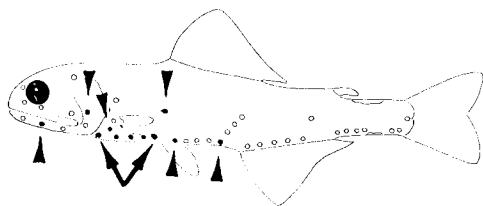
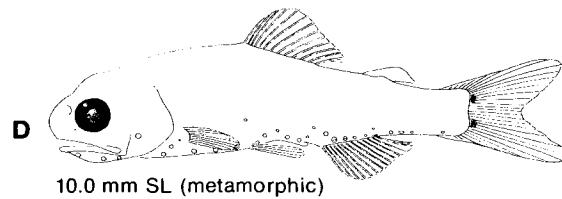
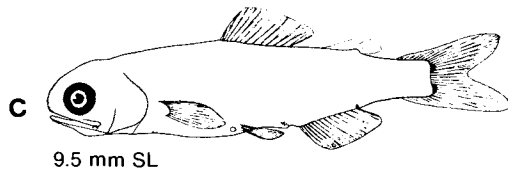
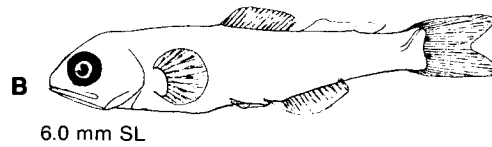
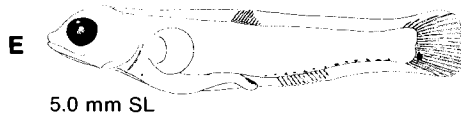


Fig. — A–H, Tåning 1918 (D, E and F redrawn).

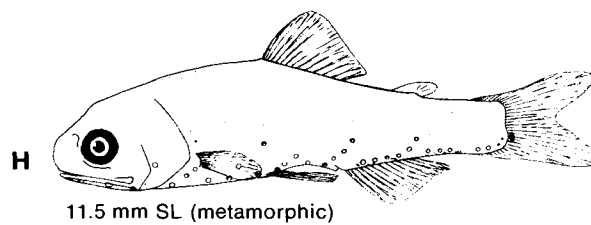
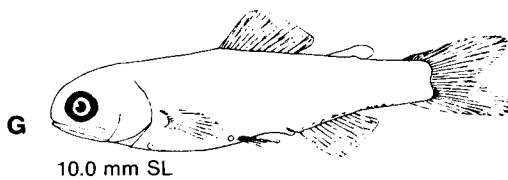
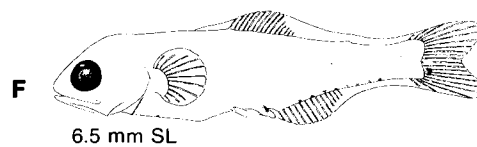
Ref. — Moser and Ahlstrom 1974.

Diaphus rafinesquii**MYCTOPHIDAE**

Pigment spots more prominent in smaller larvae

***Diaphus holti***

Pigment spots more prominent in smaller larvae



MYCTOPHIDAE *Notoscopelus resplendens* (Richardson)
Lampanyctinae

Morphology	— Body stout and tapering posteriorly; head blunt after flexion. — Dorsal fin base longer than anal fin base. — Flexion occurs at about 5 mm NL to 6 mm SL.	Meristic features Vert: 36-37 D : 21-23 A : 18-20 P : 12-13
Ossification	— Dorsal and anal fin bases visible before flexion; 3-4 more dorsal rays than anal rays (equal number in most lampanyctines). — Pelvic rays begin forming at about 7 mm, and all fin rays complete at 9.8 mm SL.	
Photophores	— Br ₂ forms before flexion, PO ₅ appears by 7 mm SL, Vn forms at about 9.8 mm SL, followed by PLO.	
Pigmentation	— Formed before flexion (retained during larval development): spots on tips of lower jaw and snout; spot embedded on forehead, on anus, under opercle edge (near pectoral fin base), on posteroventral surface of brain; few spots on anterior lateral midline; peritoneum pigmented. — Formed during flexion: spots along dorsal fin base, and along anal fin base. — Formed after flexion: spots on head increase; vertical pigment at caudal fin base at about 11 mm SL; dorsal pigment may extend from nape to caudal peduncle. — Note difference in dorsal melanophores in larvae caught day and night (Fig. I and J).	
Distribution	— Tropical-subtropical.	

Note: Distribution of *Notoscopelus caudispinosus* (larvae undescribed) in the western North Atlantic is similar to that of *N. resplendens*.

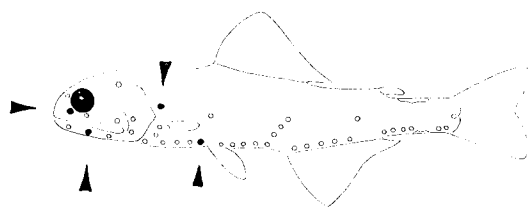
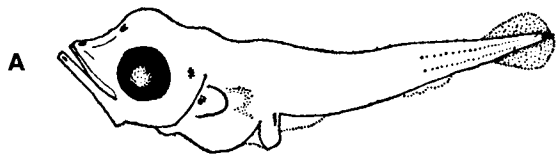
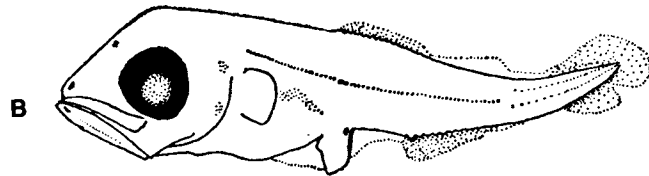


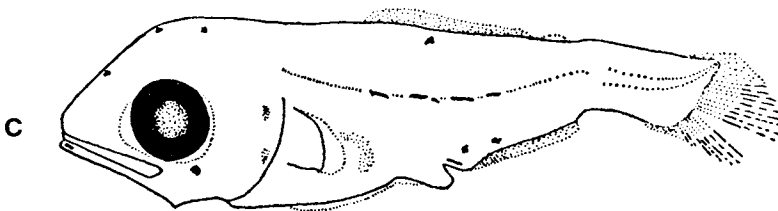
Fig. — A-D, I-J, Badcock and Merrett 1976; E, Moser and Ahlstrom 1974; F-H, Moser and Ahlstrom 1972.

Notoscopelus resplendens**MYCTOPHIDAE**

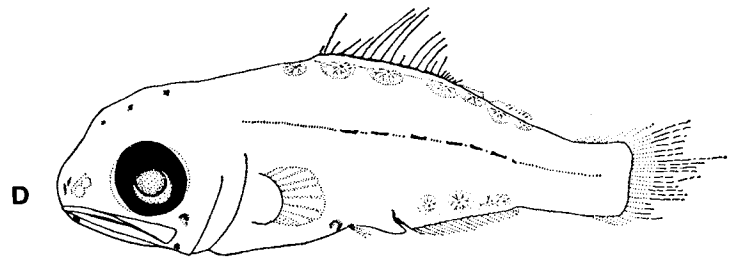
3.8 mm NL



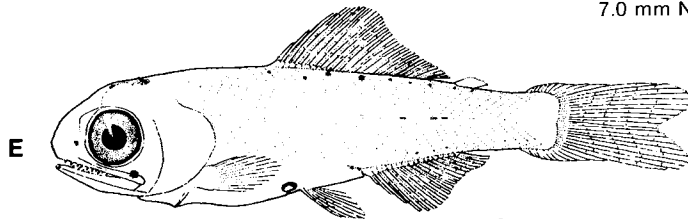
4.7 mm NL



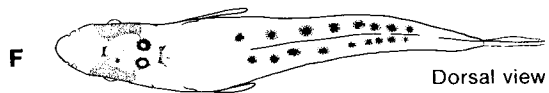
5.4 mm NL



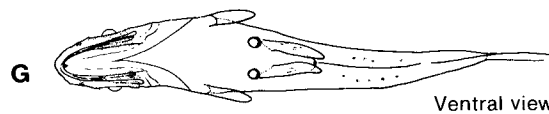
7.0 mm NL



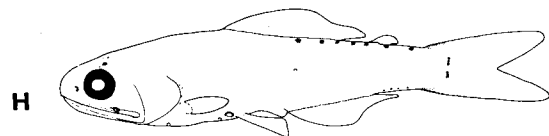
11.2 mm SL



Dorsal view



Ventral view



21.0 mm SL (metamorphic)

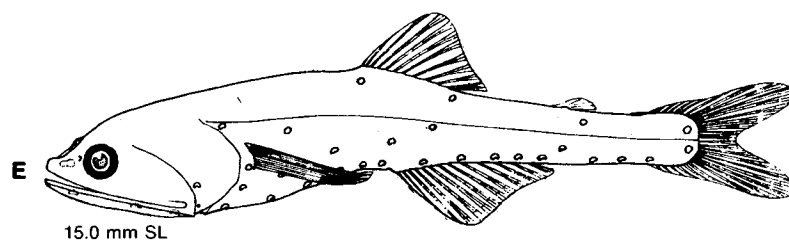
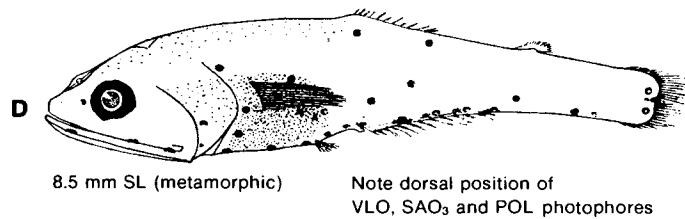
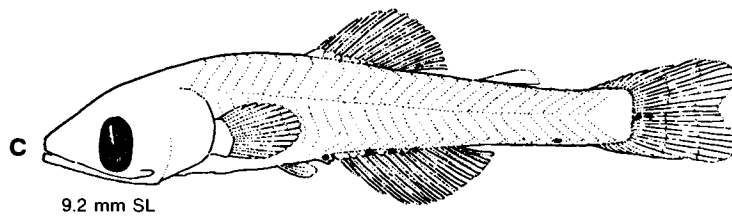
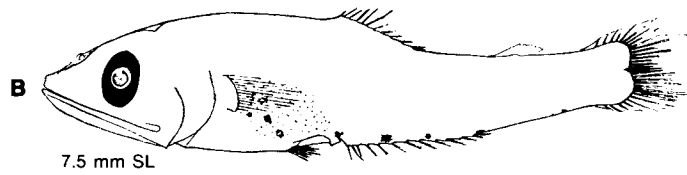
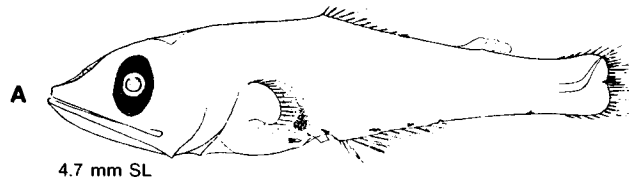


MYCTOPHIDAE
Lampanyctinae***Notolychnus valdiviae* (Brauer)**

- Morphology** — Shapes of head, body and gut are unusual and distinctive.
— Eye shape varies among specimens, from narrow to nearly round.
— Larvae develop early and transform at small size (9–10 mm).
- Photophores** — All photophores formed after transformation.
- Distribution** — Tropical-subtropical.

Meristic features

Vert: 28–30
D : 10–12
A : 12–14
P : 12–13

Notolychnus valdiviae**MYCTOPHIDAE**

PARALEPIDIDAE**General Characters**

Eleven genera and about 50 species of this myctophiform family occur worldwide. Nine genera and 15 species occur in the western North Atlantic. Tropical species are not included in this section.

Larval characters contrasted with other myctophiform families (Ege 1930; Rofen 1966).

Paralepididae	Other myctophiforms
Body compressed	Round and segmented in Chlorophthalmidae (p. 96) and Scopelosauridae (p. 100).
Head pointed; top of head not angular.	Top of head angular in Omosudidae (p. 160).
Snout and jaws not "duckbilled".	"Duckbilled" in Chlorophthalmidae (p. 96) and Scopelosauridae (p. 100).
Lower jaw slender (not deep).	Massive in Omosudidae (p. 160) and Alepisauridae (p. 162).
Toothless margin of upper jaw at symphysis.	
Both jaws relatively straight.	Strongly curved in some Scopelarchidae (p. 166).
No teeth on tongue.	Hooked teeth on tongue in some Scopelarchidae (p. 166).
Palatine teeth do not enter mouth profile when open.	Teeth do so in Evermannellidae (p. 164).
Distinct slender teeth in 1-2 rows.	
Eye large, lateral, round or slightly squared.	
Dorsal and pelvic fins posterior (about mid-trunk).	Anterior in Omosudidae (p. 160), Scopelarchidae (p. 166), and Evermannellidae (p. 164).
Dorsal fin small.	
Anal fin far posterior (usually most prominent fin).	
Anterior anal rays the longest.	
Gut lengthens gradually during larval development; gut pigment patches form sequentially on peritoneum.	In Scopelarchidae, gut lengthens suddenly at metamorphosis; 1 or 3 gut pigment patches form at one time (e.g. <i>Benthalbella</i> sp.).
Transformation occurs at large size.	

General Characters**PARALEPIDIDAE****Important specific characters**

- Relative shape and length of head and body.
- Position of pelvic fin relative to dorsal fin.
- Nature of pigment on caudal fin and peduncle.
- Number of gut pigment patches and size at which they develop.
- Eggs and rate of growth are undescribed.

Distribution

Vertical distribution data for *Sudis* and *Stemonosudis* are scanty. Larvae of the other genera occur at depths of 20–200 m, with those of *Paralepis* and *Notolepis* generally deeper than 100 m. It is not uncommon for larvae of several species to occur in two or three distinct depth strata (i.e. *Paralepis coregonoides*, with peaks at 100 m and again at 200 m). Larger larvae are commonly found deeper than smaller larvae. (Ege 1930; Rofen 1966.)

Meristic characters of western North Atlantic paralepidids (Rofen 1966)

Species	Vertebrae		Fin rays		Max. No. gut pigment patches
	Total	Precaudal	Dorsal	Anal	
<i>Paralepis atlantica</i>	60–73	28–38	9–11	20–26	4*
<i>Paralepis elongata</i>	65–67	32–36	10–12	20–25	12
<i>Paralepis coregonoides</i>	68–74	32–37	9–11	22–26	10
<i>Notolepis rissoi</i>	80–85	38–41	8–11	31–34*	12
<i>Lestidium atlanticum</i>	75–87	35–41	9–11	26–32	8
<i>Lestidiops affinis</i>	75–85	30–35	8–10	27–30	11
<i>Lestidiops jayakari</i>	76–85	30–35	10	27–31	12
<i>Lestrolepis intermedia</i>	91–98*	28–30	9	41–44*	8
<i>Macroparalepis affine</i>	96–103*	57–62*	10–14	25–28	12
<i>Macroparalepis breve</i>	81–86	49–53	11–13	19–24	8
<i>Stemonosudis intermedia</i>	111–121*	49–56	9–10	41–47*	18*
<i>Sudis hyalina</i>	59–60*	33	12–16*	21–24	8
<i>Sudis atrox</i>	53–54*	28–30	12	21	6

* Diagnostic counts.

PARALEPIDIDAE**Diagnosis of western North Atlantic paralepidid postlarvae 10–40 mm (Rofen 1966)**

Taxon	Characters
<i>Sudis hyalina</i> , <i>S. atrox</i>	Pectoral fins elongate ; body short, head large, snout long, preopercle spines present.
<i>Pontosudis adventa</i> *	Pelvic fins elongate ; occurs in Gulf of Mexico and east of Florida.
<i>Paralepis</i>	Pectoral fins short ; body short, head large, snout long (except <i>P. elongata</i>).
<i>Macroparalepis</i>	Body elongate, head very small; intestine curved under head (<10 mm); caudal fin spotted with melanophores; 10 or fewer gut pigment patches (12 in W. Atlantic <i>M. affine</i>).
<i>Stemonosudis</i>	Body and head elongate; intestine behind head ; caudal fin unpigmented ; 10 or more gut pigment patches; highest vertebral and anal fin-ray counts.
<i>Paralepis coregonoides (borealis)</i> <i>Lestidiops affinis</i>	One or more lines of melanophores on side of body.
<i>Notolepis rissoi (krøyeri)</i> <i>Lestidiops jayakari (jayakari)</i> <i>Lestidium atlanticum</i>	Numerous oblique lines above and below vertebral column on caudal peduncle in larger larvae.
<i>Paralepis atlantica</i>	One vertical pigment band on body above anal fin.
<i>Lestidiops mirabilis</i> *	Two vertical pigment bands on body above anal fin; occurs in Carribbean Sea.
<i>Lestrolepis intermedia</i>	Single curved line of melanophores on top of head; scattered spots on caudal region.
<i>Macroparalepis affine (americana)</i>	Numerous minute black spots on caudal fin.
<i>Macroparalepis breve</i>	Large black spots on caudal fin.

* Species not included in this guide.

PARALEPIDIDAE**Development of peritoneal pigment**

Numbers (or range) of gut pigment patches observed in paralepidid larvae by species and size-class.

Species	Size of larvae (mm)																
	4	6	7	8	9	10	11	12	13	14	15	16	17	18	20	21	
<i>Paralepis elongata</i>	3	8	6	...	...	6	...	
<i>Paralepis coregonoides</i>	...	1	...	1	2	...	...	...	...	...	3	4	...	...	...	...
<i>Parelepis atlantica</i>	1	2	...	2	...	2	...	2	...	...	3	...	...	...
<i>Lestidium atlanticum</i>	...	0	...	...	...	4	...	...	...	...	...	...	8	...	...	...
<i>Notolepis rissoi</i>	1	...	...	...	...	...	...	...	...	...	2	...	
<i>Lestidiops affinis</i>	0	...	...	2	...	...	...	...	3	...	9	...	8	10	...	...
<i>Sudis hyalina</i>	...	4	...	...	...	...	...	...	...	...	6	8	...	...	...	...
<i>Lestrolepis intermedia</i>	1	...	...	5	...	7	...	...	...	...	...	8	...	
<i>Macroparalepis affine</i>	0	...	...	...	...	...	2	4*	6	...	9	...	10*	
<i>Stemonosudis intermedia</i>	16	...	16	...	
<i>Lestidiops jayakari</i>	2	...	...	...	4-5	5	...	7-9	10	...	9	10-12	...	
<i>Macroparalepis breve</i>	0	...	...	0	...	4	...	7	8	...	7	...	...	8	

Species	Size of larvae (mm)														
	22	23	24	25	26	27	28	29	30	34	37	38	42	43	45
<i>Paralepis elongata</i>	9	...	...	11-12	...	...	...	...	...	...	...	...	...	...	...
<i>Paralepis coregonoides</i>	...	6	...	...	...	...	...	...	9	...	...	...	...	...	...
<i>Paralepis atlantica</i>	3	...	...	...	3	...	...	...	...	...	...	...	...
<i>Lestidium atlanticum</i>	8	...	...	...	...	...	...	...	(← faded, indistinct →)	...	...	...	...	...	...
<i>Notolepis rissoi</i>	...	3	...	...	...	...	4	...	5	...	...	8	...	...	12
<i>Lestidiops affinis</i>	11	10	...	...	...	...	12	...
<i>Sudis hyalina</i>	7	...	...	...	...	...	...	...	...	...	7	...
<i>Lestrolepis intermedia</i>	8	...	...	...	...	...	...	...	...	...	...
<i>Macroparalepis affine</i>	12*	...	11*	...	10	...	12*	...	...	...	...	...	...
<i>Stemonosudis intermedia</i>	18	...	...	...	...	...
<i>Lestidiops jayakari</i>	12	...	...	...	12	...	...	12	...	...	...	...
<i>Macroparalepis breve</i>	8	...	...	7	...	...	...	7	...	...

* Values refer to western Atlantic form of *M. affine*.

PARALEPIDIDAE***Paralepis elongata* (Brauer)**

- Spawning:** Most intense in May; postlarvae present year-round.
- Morphology** — Snout relatively short, deep and conical.
 — Pelvic fin forms under dorsal fin at about mid-body.
 — Caudal and anal rays formed by 14.4 mm, dorsal rays by 15.6 mm, and pelvic rays by 22 mm.
- Pigmentation** — Total lack of pigment on posterior body in early stages (compare to *Notolepis* and other *Paralepis* species).
 — Characteristic pattern of stellate melanophores on occiput, nape and interorbital, develops at 12–14 mm and spreads posteriorly with development.
 — Five or 6 large gut patches located anterior to dorsal fin origin (2 in *P. atlantica*, p. 150; gut pigment patches (anterior much larger) develop as follows:

Gut patches	3	6	8	6	9	11–12
Larval size (mm)	14.4	16.7	15.6	20.0	22.0	25.0

Meristic features
 Vert: 65–67(32–36)
 D : 10–12
 A : 20–25
 () = precaudal vert.

***Paralepis coregonoides* Risso**

- Morphology** — Snout relatively long (compare to *P. elongata*).
 — Head smaller, snout shorter and gut pigment patches more than in *P. atlantica*.
 — Pelvic fin forms under dorsal fin at about mid-body.
 — Most caudal and anal rays formed by 15.5 mm; all rays formed by 30.5 mm.
- Pigmentation** — U-shaped line of pigment on interorbital (rounded side anterior) forms at 14–16 mm.
 — Gut pigment patches (1 to 9) develop as follows:

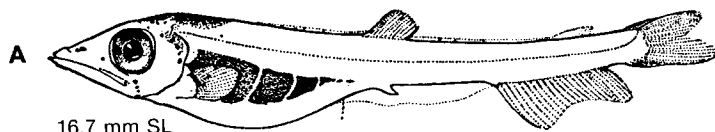
Gut patches	1	1	2	3	4	6+	9
Larval size (mm)	6.0	8.8	9.7	15.5	16.1	23.0	30.5

Meristic features
 Vert: 68–74(32–37)
 D : 9–11
 A : 22–26
 () = precaudal vert.

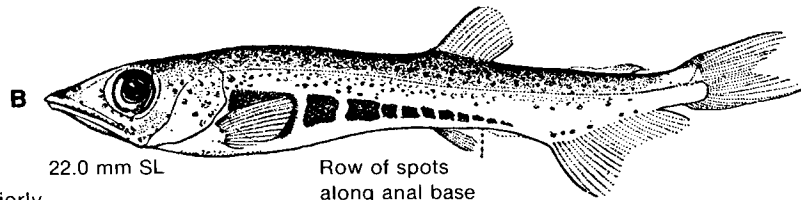
- Subspecies** — *P. coregonoides borealis*, with 73–77 myomeres (mode 74–75), occurs in eastern Atlantic and Greenland.
 — *P. coregonoides barracudina*, with 69–75 myomeres (mode 72–73), occurs in western Atlantic.

Paralepis elongata

PARALEPIDIDAE



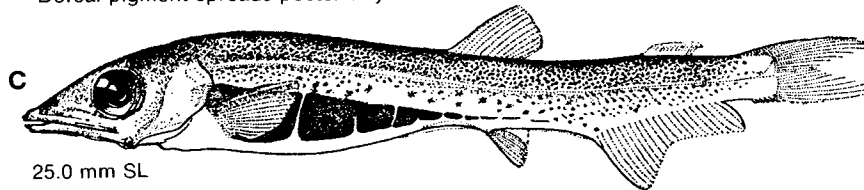
16.7 mm SL

Snout unpigmented;
few spots at jaw angleFew spots on pectoral fin;
other fins unpigmented

22.0 mm SL

Row of spots
along anal base

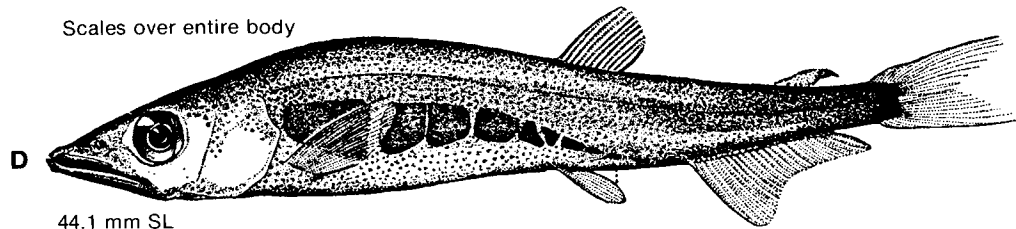
Dorsal pigment spreads posteriorly



25.0 mm SL

Anus located under
posterior dorsal rays

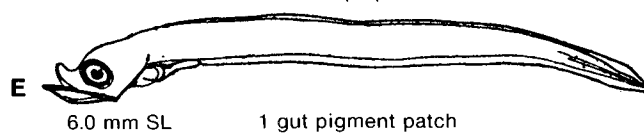
Scales over entire body



44.1 mm SL

Paralepis coregonoides

1 deep spot above notochord

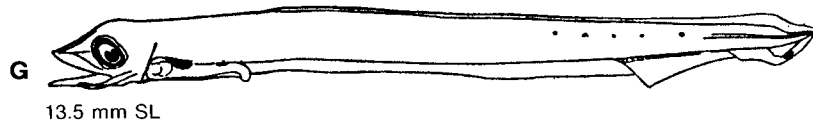


6.0 mm SL

1 gut pigment patch



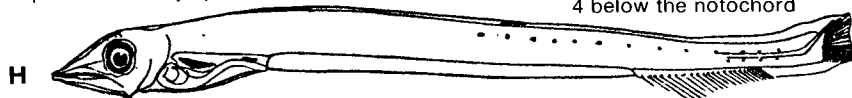
11.8 mm SL

3 deep spots
above notochord

13.5 mm SL

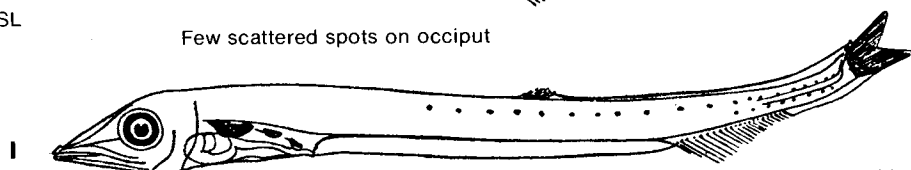
3 deep spots above, and
4 below the notochord

Top of head finely spotted >15 mm



18.0 mm SL

Few scattered spots on occiput



22.0 mm SL

Number of deep spots above and below
notochord increases with development

PARALEPIDIDAE***Paralepis atlantica* Krøyer**

- Spawning:** Mostly in Sargasso Sea and near Bermuda, mainly March–June; post-larvae present year-round. **Meristic features**
- Morphology** — Body shorter and head deeper than in *P. coregonoides*, with lower number of myomeres.
 — Head and snout longer than in *P. elongata*.
 — Anus moves posteriorly early in development, reaching final position (67–72% SL) by 13–15 mm (compare with other species).
 — Pelvic fin forms under dorsal fin; all fin rays (except pelvic) formed by 14.6 mm.
- Pigmentation** — Deep pigment between adipose and anal fins, begins as 2 spots above and below vertebral column at 10.5 mm.
 — Spots at origin of dorsal and anal fins form at 10.5 mm; spots present on lower principal caudal rays.
 — Gut pigment patches (maximum 3, but only 2 anterior to dorsal fin) develop as follows:

Gut patches	1	2	2	2	2	3	3	3
Larval size (mm)	5.8	8.2	10.5	12.2	14.6	17.2	24.7	28.0

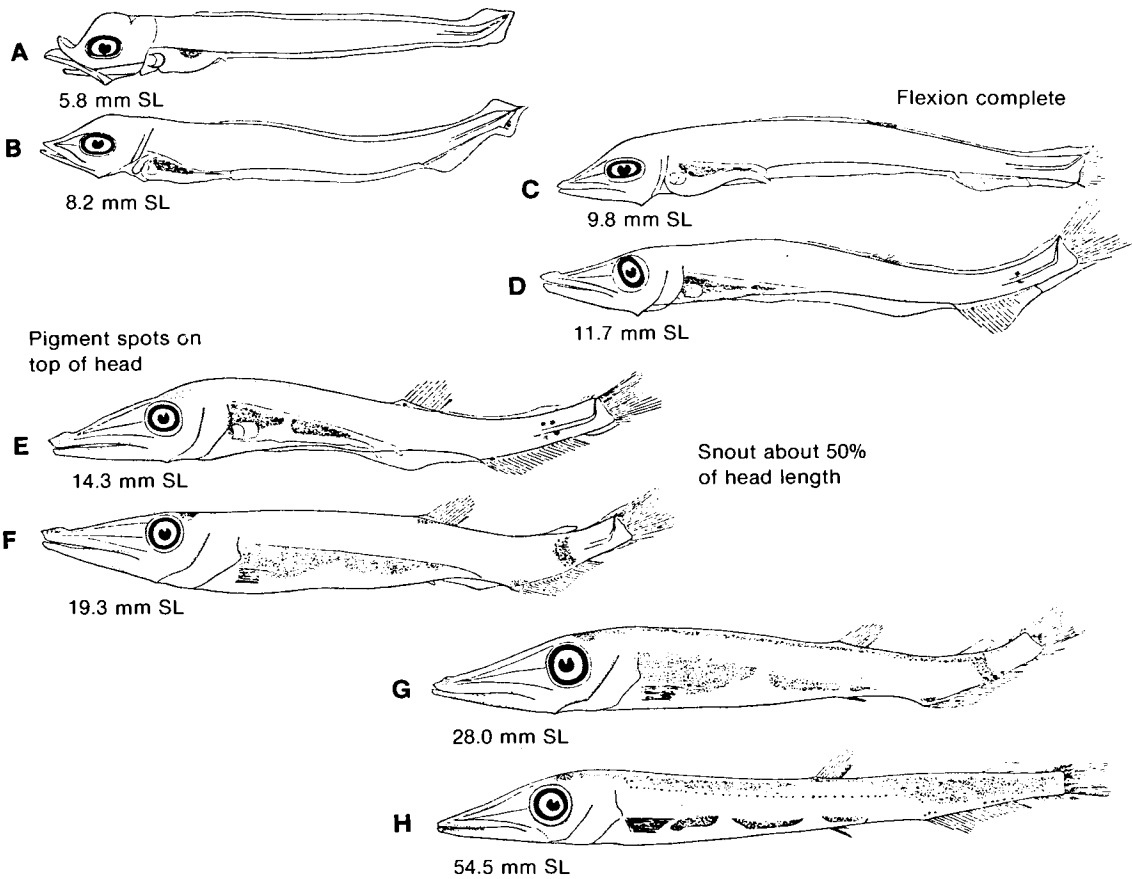
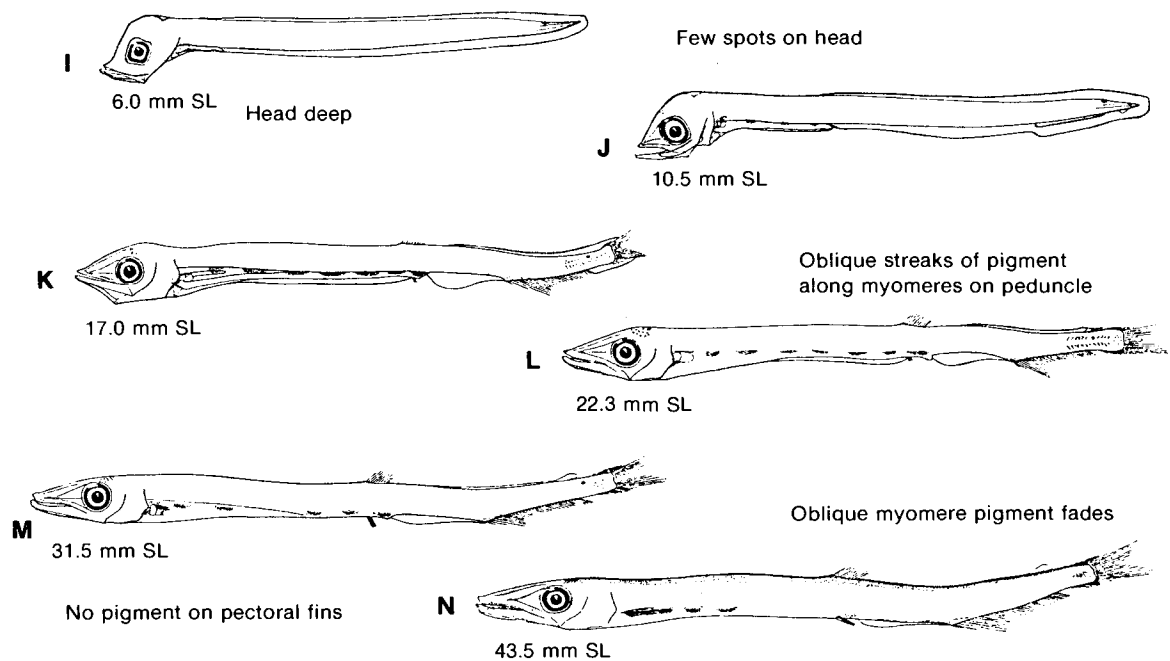
***Lestidium atlanticum* Borodin**

- Spawning:** Mostly in Caribbean Sea, mainly November–April. **Meristic features**
- Morphology** — Head deep in early larvae; eye almost square, but becomes round at about 10.5 mm.
 — Anus reaches final position (under posterior end of dorsal fin) at 17 mm.
 — Pelvic fin forms under or slightly anterior to first dorsal ray; dorsal, anal and pelvic rays formed by 22–23 mm.
- Pigmentation** — Body lightly pigmented; single prominent spot above notochord near caudal fin present from smallest larvae to size of 31.5 mm.
 — Light gut pigment patches (0 to 8) develop as follows:

Gut patches	0	4	8	8	(indistinct)	
Larval size (mm)	6.0	10.5	17.0	22.3	31.5	43.5

Fig. — A–N, Ege 1930.

Ref. — Rofen 1966.

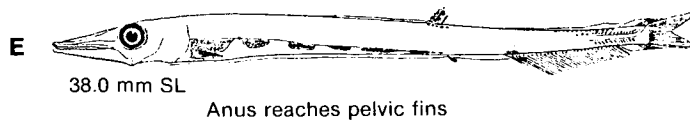
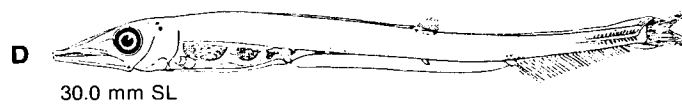
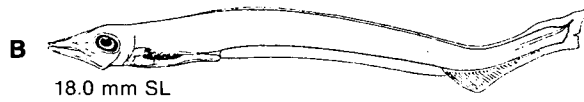
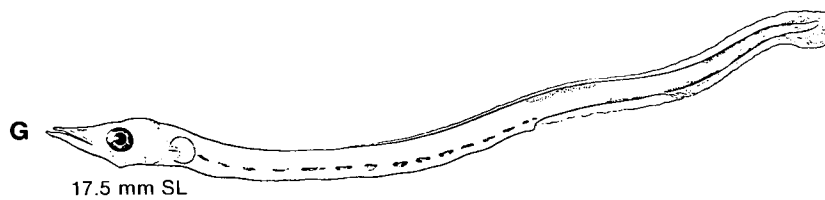
Paralepis atlantica**PARALEPIDIDAE*****Lestidium atlanticum***

PARALEPIDIDAE *Notolepis rissoi krøyeri* (Lütken)

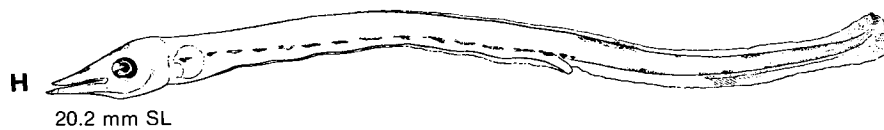
Spawning:	Mostly in May, but extends from January to September; postlarvae common to very abundant on Georges Bank, Scotian Shelf and over continental shelf.	Meristic features Vert: 80–85(38–41) D : 8–11 A : 31–34 () = precaudal vert.																
Morphology	<ul style="list-style-type: none">— Body elongate; snout becomes more elongate with development.— Pelvic fin forms under dorsal fin at about 28 mm, and moves to a position behind dorsal fin at about 38 mm.— Caudal rays formed by 20.5 mm, dorsal rays by 30 mm, and anal rays by 28 mm.																	
Pigmentation	<ul style="list-style-type: none">— Five spots over posterior anal fin at 20.5 mm, increase to 2 lines of spots, one dorsal and one ventral to posterior end of notochord.— Four spots at anal fin origin at 23 mm, become more intense.— Large spots develop along base of dorsal fin, become more prominent at 38.8 mm.— Gut pigment patches (1 to 12) develop as follows:																	
	<table><tr><td>Gut patches</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>8</td><td>12</td></tr><tr><td>Larval size (mm)</td><td>9.5</td><td>20.5</td><td>23.0</td><td>28.0</td><td>30.0</td><td>38.0</td><td>45.0</td></tr></table>	Gut patches	1	2	3	4	5	8	12	Larval size (mm)	9.5	20.5	23.0	28.0	30.0	38.0	45.0	
Gut patches	1	2	3	4	5	8	12											
Larval size (mm)	9.5	20.5	23.0	28.0	30.0	38.0	45.0											

***Stemonosudis intermedia* (Ege)**

Morphology	<ul style="list-style-type: none">— Body long and snout pointed.— Pelvic fin develops well anterior to dorsal fin; all fin rays formed by 34.3 mm.	Meristic features Vert: 111–121(49–56) D : 9–10 A : 41–47 () = precaudal vert.								
Pigmentation:	<ul style="list-style-type: none">— Spots on lower jaw tip; row of spots over brain.— Long patches (3–4) of spots both dorsally and ventrally, on tail posterior to dorsal fin.— Dense pigment develops on caudal fin at about 20 mm.— Gut pigment patches develop as follows:									
	<table><tr><td>Gut patches</td><td>16</td><td>16</td><td>18</td></tr><tr><td>Larval size (mm)</td><td>17.5</td><td>20.2</td><td>34.3</td></tr></table>	Gut patches	16	16	18	Larval size (mm)	17.5	20.2	34.3	
Gut patches	16	16	18							
Larval size (mm)	17.5	20.2	34.3							

Notolepis rissoi krøyeri**PARALEPIDIDAE*****Stemonosudis intermedia***

Lower jaw protrudes



PARALEPIDIDAE***Sudis hyalina* Rafinesque**

- Morphology** — Body short and stocky; head large and deep.
 — Spines over eye and along opercle at about 25 mm.
 — Long pectoral fins reach pelvic base at 9 mm, and extend beyond anus at sizes >9 mm.
 — Pelvic fin forms anterior to dorsal; all rays (except pelvic) formed by 25.4 mm.
- Meristic features**
 Vert: 59-60(33)
 D : 12-16
 A : 21-24
 () = precaudal vert.

- Pigmentation** — Distinctive spots at anterior and mid-dorsal fin base, over mid-anal base and at base of caudal; spots on pectoral rays.
 — Maximum 7-8 gut pigment patches develop as follows:

Gut patches	4	6	8	7	7	7
Larval size (mm)	6.5	15.6	16.1	25.4	43.1	100.2

Note: The tropical species, *Sudis atrox*, is similar and may be taken in the Gulf Stream: 53-54 vertebrae, maximum 6 gut pigment patches; pectoral fin reaches pelvic base at 16.5 mm, but does not extend further; dorsum pigment uniform, without saddles; spines along lower jaw and on dorsum of head; difference in preopercle-angle spine (see Fig. F and G).

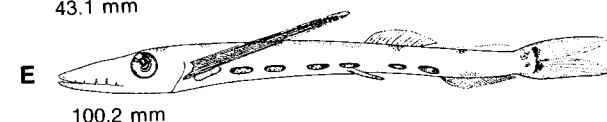
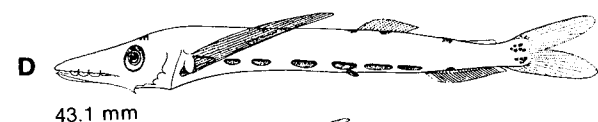
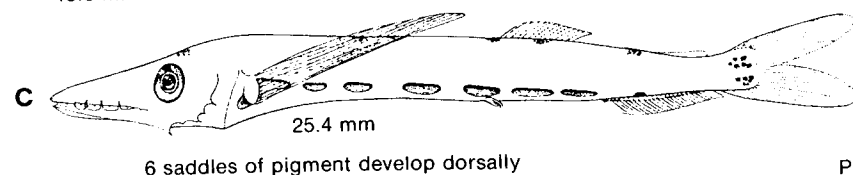
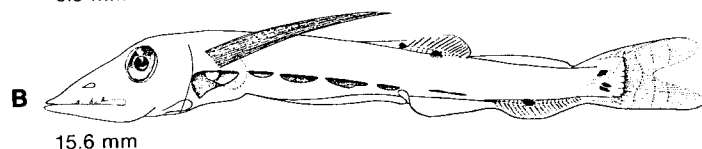
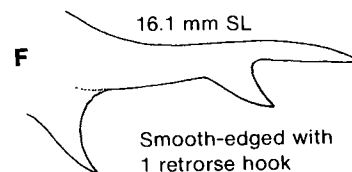
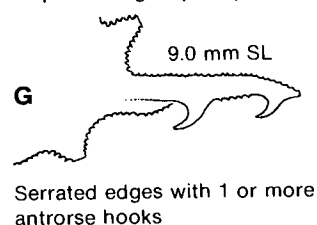
***Lestrolepis intermedia* (Poey)**

- Spawning:** Centered in Caribbean Sea, mainly during December-April.
- Morphology** — Body elongate; head fairly large and deep in early larvae.
 — Anus moves posteriorly with development, reaching final position at 20.5 mm.
 — Pelvic fin located well anterior to dorsal fin.
 — Anal and caudal rays formed at about 26 mm; all rays formed by 43.5 mm.
- Meristic features**
 Vert: 91-98(28-30)
 D : 9
 A : 41-44
 () = precaudal vert.
- Pigmentation** — Parallel lines of spots on side of peduncle; numerous spots form early on dorsal and ventral finfolds near caudal fin.
 — Maximum 8 gut pigment patches develop as follows:

Gut patches	1	5	7	8	8
Larval size (mm)	8.2	11.3	13.5	20.5	26.0

Fig. — A-E, Sanzo 1917; F-G, Shores 1969; H-M, Ege 1930.

Ref. — Berry and Perkins 1966; Rofen 1966.

Sudis hyalina**PARALEPIDIDAE**Preopercle-angle spine (*S. hyalina*)Preopercle-angle spine (*S. atrox*)***Lestrolepis intermedia***

In addition to finfold spots; 4 parallel rows of spots form near tip of notochord; upper and lower rows become indistinct, leaving a row above and a row below midline

Spots over anterior
anal fin base

PARALEPIDIDAE***Macroparalepis affine* Ege**

Note: Two subspecies in the North Atlantic; text refers to *M. affine americana* from western North Atlantic, and illustrations opposite are *M. affine affine* from eastern North Atlantic.

- Morphology**
- Body elongate, snout relatively short, and eye square in early larvae.
 - Intestine begins under head in early larvae.
 - Pelvic fin forms anterior to dorsal fin.

- Pigmentation**
- Uniform pigment on caudal fin in *M. affine americana* (right) (compare to *M. breve* below and *Lestidiops affinis*, p. 158).
 - Series of spots on ventral edge behind anus decrease in number with development.
 - Single spot under eye in W. Atlantic form at 14.8 mm, becomes 2 spots at about 26 mm.
 - Spots in arc on top of head begin in W. Atlantic form at 17.7 mm, increase in number.
 - Gut pigment patches (maximum 12 in western and 10 in eastern North Atlantic) develop as follows:

Gut patches	0	2	4*	6	9	10*	12*	11*	10	12*
Larval size (mm)	8.0	14.0	14.8	15.5	18.5	21.4	24.0	26.1	28.0	30.6

* Western North Atlantic.

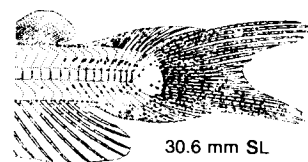
Meristic features

Vert: 96–103(57–62)

D : 10–14

A : 25–28

() = precaudal vert.



30.6 mm SL
M. a. americana
(Rofen 1966)

***Macroparalepis breve* Ege**

Spawning: Year-round in Sargasso Sea, but mainly during February–June.

- Morphology**
- Body and snout relatively shorter than in *M. affine*.
 - Eye almost square in early larvae.
 - Intestine begins under head in early larvae.
 - Dorsal and anal fin rays complete at 27.5 mm.

- Pigmentation**
- Series of spots along ventral edge from anus to anterior one-third of anal fin; number decreases with growth.
 - Spots develop over posterior end of anal fin at about 12 mm.
 - Conspicuous spotting on caudal fin (right) present from earliest larvae.
 - Gut pigment patches (maximum 7–8, in contrast to 11–12 in *M. affine*) develop as follows:

Gut patches	0	0	4	7	8	7	8	8	7	7
Larval size (mm)	7.5	10.0	12.0	14.5	15.5	17.0	21.5	27.5	30.5	30.7

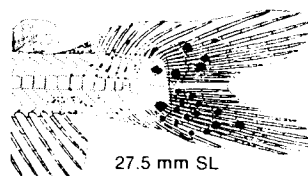
Meristic features

Vert: 81–86(49–53)

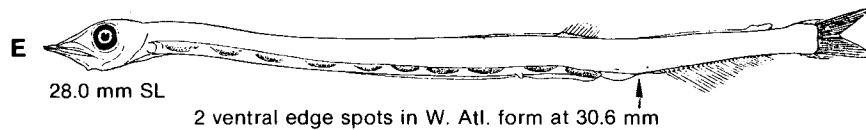
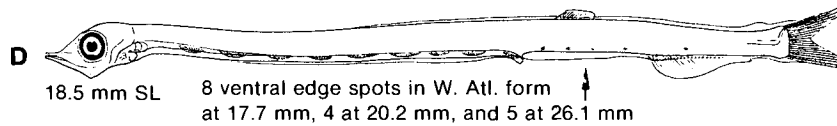
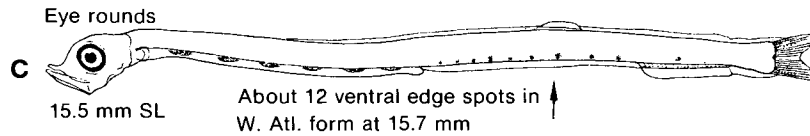
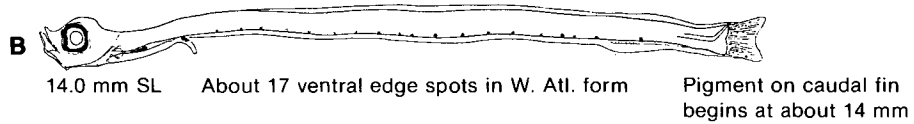
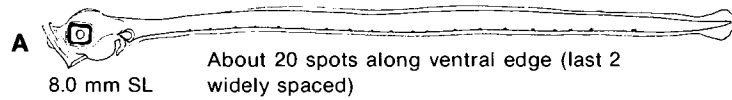
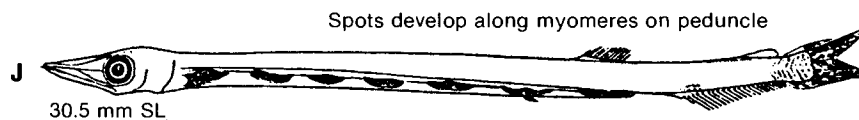
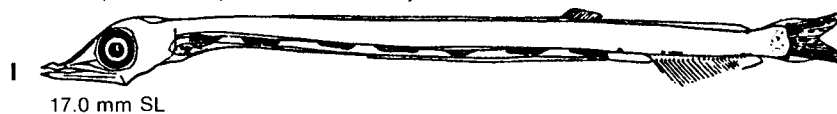
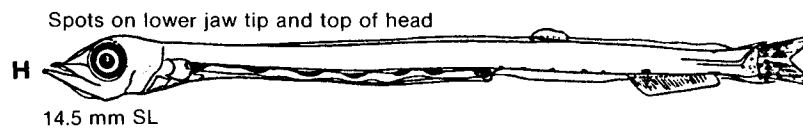
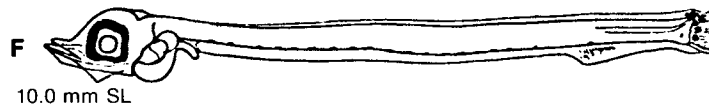
D : 11–13

A : 19–24

() = precaudal vert.



27.5 mm SL
(Rofen 1966)

Macroparalepis affine**PARALEPIDIDAE*****Macroparalepis breve***

PARALEPIDIDAE***Lestidiops jayakari* (Boulenger)**

Note: Two subspecies in western North Atlantic, *L. jayakari jayakari* and *L. jayakari pseudosphyraenoides*; postlarvae are similar, but differ in peduncle pigment.

Spawning: Mainly during May–August in the Sargasso Sea–Bermuda area.

Meristic features

Vert: 76–85(30–35)

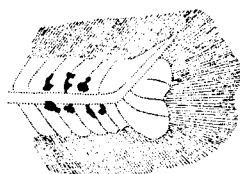
D : 10

A : 27–31

() = precaudal vert.

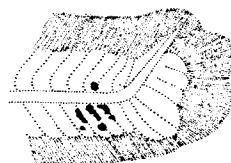
- Morphology**
- Head short and deep in early larvae.
 - Anus reaches final position under dorsal fin origin at about 20 mm.
 - Pelvic fin forms well anterior to dorsal fin and is complete at about 25 mm.
 - Anal fin rays complete at about 20 mm, and dorsal rays at about 25 mm.

- Pigmentation** — See peduncle pigment below and note illustrations on opposite page.



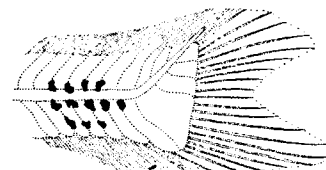
13.0 mm SL

L. j. jayakari
(Rofen 1966)



13.6 mm SL

L. j. pseudosphyraenoides (Ege)
(Rofen 1966)



15.6 mm SL

- Gut pigment patches (2 to 12) develop as follows:

Gut patches	2	4	5	5	7	9	10	9	10	12	12
Larval size (mm)	8.0	12.0	12.2	13.0	15.0	15.6	16.5	18.0	20.6	25	37

***Lestidiops affinis* Ege**

Spawning: Mainly April–June in Sargasso Sea, but some spawning during May–October in western North Atlantic.

Meristic features

Vert: 75–85 (30–35)

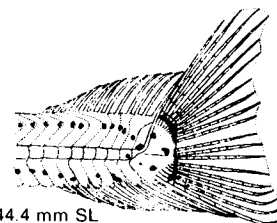
D : 8–10

A : 27–30

() = precaudal vert.

- Morphology**
- Head short and deep, with blunt snout; nostrils at mid-length of upper jaw.
 - Pelvic fin well anterior to dorsal fin.
 - Anus and pelvic fin farther anterior (relative to dorsal) than in *L. jayakari* and *Macroparalepis affine* (p. 156).
 - Most anal fin rays formed at about 30 mm, caudal rays at 30 mm, and all fin rays by 43 mm.

- Pigmentation**
- Two widely-separated mid-ventral spots at 8.5 mm become doubled at 10–15 mm.
 - Mid-ventral row and 2 lines of spots develop on side of peduncle at 15–80 mm.
 - Internal pigment develops between vertebrae over anal fin origin at 36.5 mm.
 - Gut pigment patches (0 to 12) develop as follows:



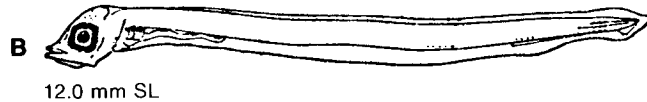
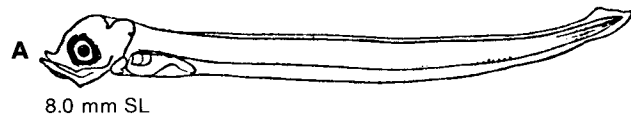
44.4 mm SL

(Rofen 1966)

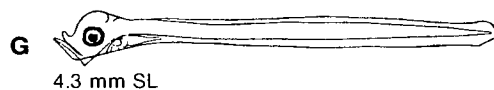
Gut patches	0	2	3	9	8	10	11	10	12
Larval size (mm)	4.3	8.5	13.5	15.3	17.5	18.1	29.0	29.8	43

Lestidiops jayakari**PARALEPIDIDAE**

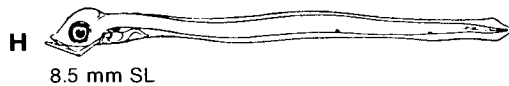
Note: 3 diagnostic groups of pigment spots: 1) ventral row between anus and anal fin origin, 2) ventral row over anterior anal fin, 3) midlateral on peduncle



Maximum gut pigment patches 12

***Lestidiops affinis***

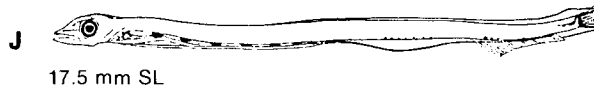
No pigment except in eye



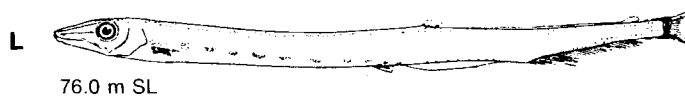
Spots at caudal base but not on peduncle in larvae <18 mm



Few spots on top of head



7 spots anus to anal fin and 3 over anterior anal fin, the latter 3 disappearing at 30 mm



Similar to postlarval *Macroparalepis affinis* (p. 156)

OMOSUDIDAE***Omosudis lowei* Günther**

Spawning: Probably year-round; postlarvae occur across north central Atlantic and are abundant around Bermuda.

Meristic features

Myomeres: 39-41
 Vert: 39-41(17-18)
 D: 9-11
 A: 13-14

Eggs — Undescribed.

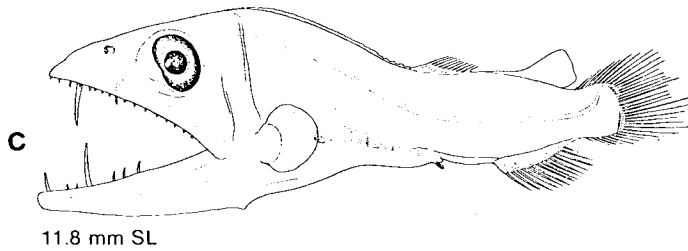
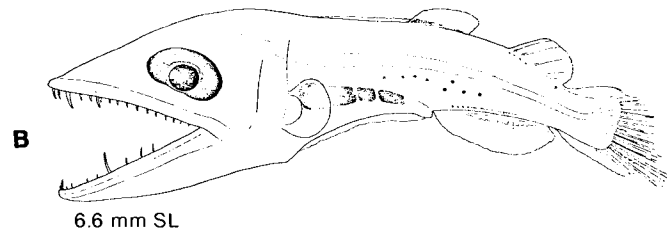
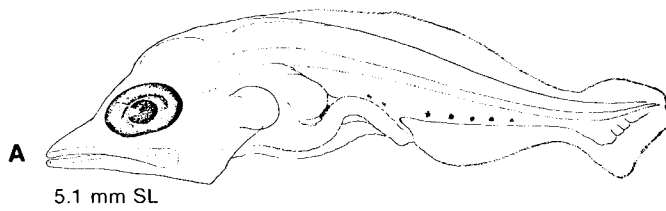
Larvae — Head and mouth larger and teeth (at about 6 mm) more prominent than in *Alepisaurus* (p. 162).
 — Snout to top of head almost straight (compare to *Alepisaurus*).
 — Single large canine tooth on lower jaw (compare to *Alepisaurus*), and large palatine canines.
 — Adipose fin present.
 — Anus well posterior to tips of pectoral fins which are much smaller than in *Alepisaurus*.
 — Small dorsal fin situated slightly behind mid-body; pelvic fin origin under middle of dorsal fin.
 — Dorsal, anal and caudal rays formed by 11.8 mm SL; caudal rays develop first and pectoral rays last.
 — Transformation gradual.
 — Pigmentation: no pigment on pectoral fins (compare to *Alepisaurus*); 3 or 4 gut pigment patches on peritoneum develop at about 6 mm and disappear at about 30 mm; 4 or 5 ventral spots posterior to anus in smaller larvae; very few spots in region of caudal peduncle.

() = precaudal vert.

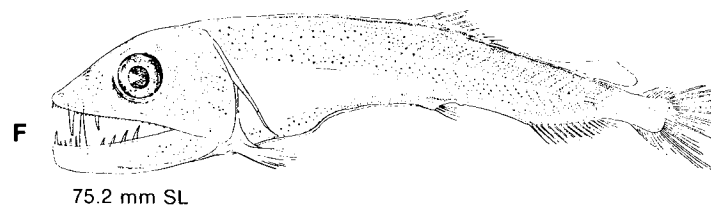
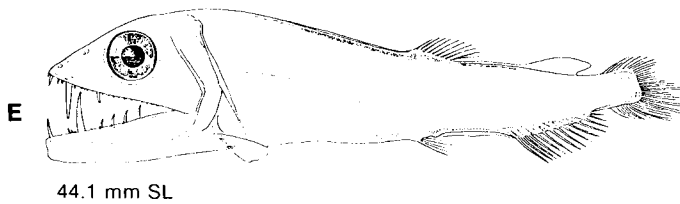
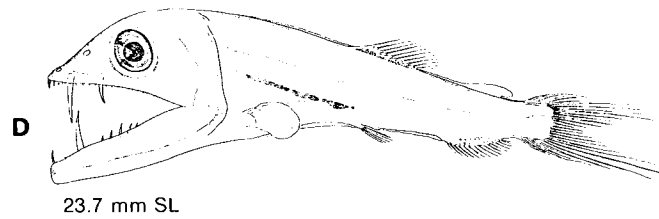
- Note:** (1) A 22.5 mm SL specimen, collected in the western Pacific differs as follows: pigment is dense, as in 75.2 mm SL specimen illustrated by Ege (1958) (Fig. F); distinct head spination present along edge of preopercle and along dorsum of head, culminating in a parietal spine (Okiyama 1981, pers. comm.).
- (2) Larvae superficially similar to scombrids (p. 306-323), but note presence of adipose fin and lack of fin spines.

Fig. — A-F, Ege 1958.

Ref. — Rofen 1966.

Omosudis lowei**OMOSUDIDAE**

Dorsal fin base short



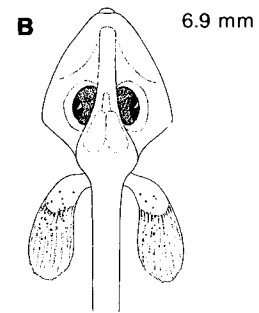
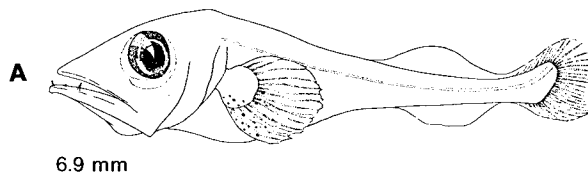
A-E (western and central North Atlantic); **F** (South China Sea.)

ALEPISAUROIDAE***Alepisaurus* sp.****Eggs** — Undescribed.**Meristic features**

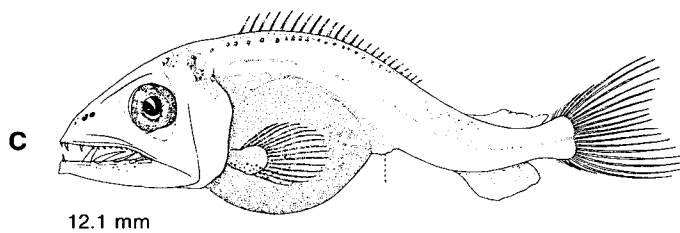
- Larvae** — Head and mouth large. Myomeres : ~50
 — Snout to top of head curved (compare to *Omosudis*, Vert : 50 (24)
 p. 160). D : 36-48
 — Teeth small in early larvae; large depressed canines A : 13-18
 form along lower jaw (compare to *Omosudis*). () = precaudal vert.
 — Adipose fin present.
 — Pectoral fin rays develop early; fin is large, on a long base (pedicel), and tip extends posterior to anus at sizes >20 mm.
 — Dorsal fin origin over edge of opercle and fin base long (compare to *Omosudis*).
 — Anal fin forms later than caudal and dorsal fins; pelvic fin forms late.
 — Transformation gradual.
 — Pigmentation: 2 very distinct gut pigment patches on peritoneum overlain by external pigment on abdomen; saddle of pigment under adipose fin; no pigment on peduncle or lower body posterior to anus; in early larvae, pigment restricted mainly to eye and pectoral rays (compare to *Omosudis*); in larger postlarvae, spots on upper jaw edge, top of head, nape, and along dorsum to adipose fin patch.

- Note:** (1) Size of larva illustrated in Fig. E may be an error; it should probably be 21.8 mm.
 (2) Larvae superficially similar to scombrids (p. 306-323), but note presence of adipose fin and lack of fin spines.

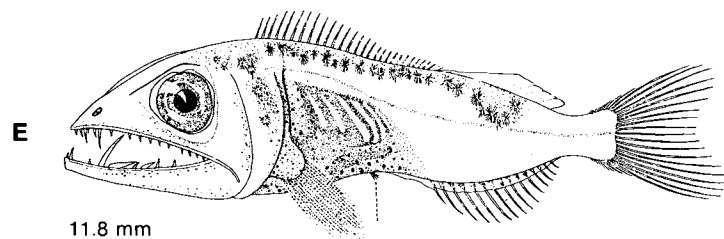
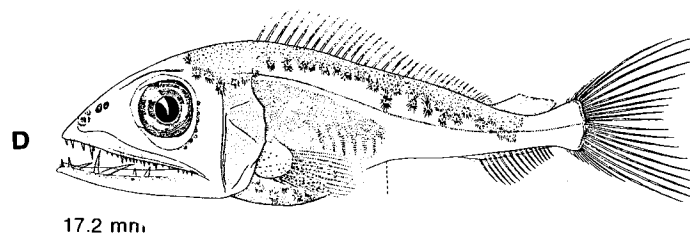
Fig. — A-E, Rofen 1966.**Ref.** — Haedrich 1964; Gibbs and Wilimovsky 1966.

Alepisaurus* sp.*ALEPISAUROIDAE**

Dorsum of head



Abdomen large and round



EVERMANNELLIDAE**Three Genera****Genera:** *Odontostomops*, *Evermannella*, *Coccorella*.**Meristic features*****Spawning:** Spring through autumn, possibly year-round; species occur in open ocean and are rarely caught.

Myomeres: 49-53

Vert: 49-53

Eggs — Undescribed.

D: 11-13

A: 25-36

Larvae — Specimens <10 mm SL are unidentifiable to species or identifiable only on the basis of capture location.

Plv: 8-10

P: 11-13

— Myomeres covered by mid-lateral trunk musculature and are difficult to count.

* Range for family

— Pelvic fin origin under dorsal fin; pectoral fin low and not divided as in Bathypteroidae (p. 98); adipose fin present.

— Stomach is a heavily-muscularized blind sac, expanding posteriorly with growth, reaching full extension (just behind pelvic fin base) in larvae 20-25 mm SL.

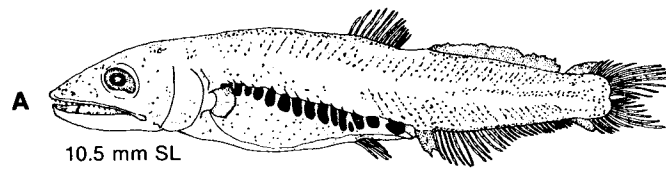
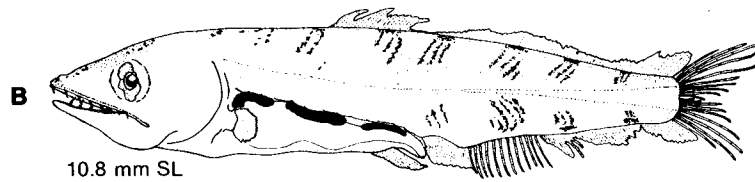
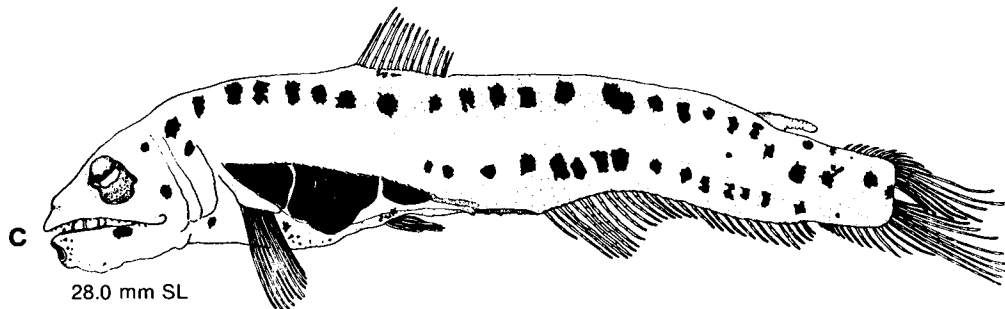
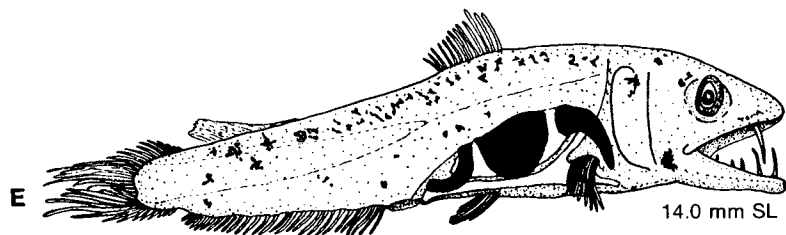
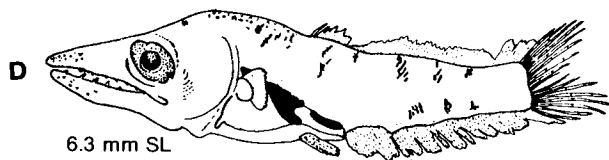
— Transformation gradual; adult characters acquired one-by-one until about 30 mm SL.

— Peritoneal pigment sections never paired as in Scopelarchidae (p. 166); begin as dorsolateral canopy over gut and spread ventrally until closed pigment tube forms at 35-45 mm SL.

Generic identification:

1. Number of peritoneal pigment sections: 12 or more (typically 13-15) in *Odontostomops*, 3 in *Evermannella*, and 3 in *Coccorella*.
2. Gut morphology: in *Coccorella*, a pyloric caecum extends anteriorly and enters head in larger larvae, juveniles and adults (visible initially as a short bud-like sac on anteroventral margin of intestine).
3. Pigmentation (two phases):
 - a) In larvae less than 12-15 mm SL, pigment bands occur along myosepta in groups, with myosepta between unpigmented (barred appearance). (Also see Schmidt 1918, fig. 21-23).
 - b) In larger larvae, the juvenile to adult pattern begins:
 - Odontostomops* — Fine spots cover head and body.
 - Evermannella* — Three rows of very large spots, each row associated with one of the main divisions of trunk musculature.
 - Coccorella* — Size of spots intermediate between those of other two genera, and spots not in rows.
4. Transformation begins with gradual onset of juvenile pigmentation, 30 mm SL being an arbitrary division between larvae and juveniles; peritoneal pigment bands fuse into one tube at about 35 mm SL in *Evermannella* and *Coccorella* and about 45 mm SL in *Odontostomops*.

Fig. — A-E, Johnson 1982.**Ref.** — Schmidt 1918; Rofen 1966.

Odontostomops normalops* EVERMANNELLIDAE**Evermannella balbo******Evermannella indica******Coccorella atlantica***

Note anteriorly directed pyloric caecum

SCOPELARCHIDAE *Scopelarchus* (3 species)

Generic characters

Eggs — Undescribed.

Meristic features*

Myomeres: 40-50

- Larvae** — Body moderately elongate, deep anteriorly and tapers to peduncle.
 — Snout elongate, with curved jaws and hooked teeth on tongue.
 — Dorsal and pelvic fin origins anterior, with pelvic origin under dorsal and dorsal base short; anal fin origin at about 50% SL, and base long; adipose fin present.
 — Fin formation sequence: caudal, dorsal and anal form first, followed by upper-pectoral, pelvic, and lower-pectoral.
 — Pigmentation: one anterior and a pair of posterior peritoneal pigment patches fuse at transformation; mid-lateral pigment stripes form posterior to dorsal fin.

* See table below

Comparative features for three species

Character	<i>S. guentheri</i> Alcock	<i>S. analis</i> (Brauer)	<i>S. michaelisarsii</i> Koefoed
Vertebrae	46-50	44-49	40-44
Dorsal rays	7-8	7-9	7-9
Anal rays	24-29	21-26	18-21
Pelvic rays	9	9	9
Pectoral rays	18-19(21)	18-22	18-21
Transformation complete	50-55 mm	45-55 mm	32-35 mm
HL at 14-30 mm	<20% SL	>20% SL	>25% SL
Pectoral pigment	None	Some >22 mm all >30 mm	>18 mm
Choroid pigment at <20 mm size	Produced above lens	Not produced above lens	Not produced above lens
Mid-lateral pigment	See figures	See figures	See figures
Peritoneal pigment	Posterior 2 form first	Anterior 1 forms first (at ~16 mm)	All 3 formed at 9.5 mm

Other possible species in western North Atlantic

- *Scopelarchoides danae* Johnson: distinct spots on dorsal peduncle, ventral midline of peduncle, gut near anus, and base of caudal fin.
 — *Benthalbella infans* Zugmayer: no pigment (except eyes) before transformation; pelvic fin origin well anterior to dorsal fin origin; transformation abrupt >50.0 mm.

Early larvae (Rofen 1966)

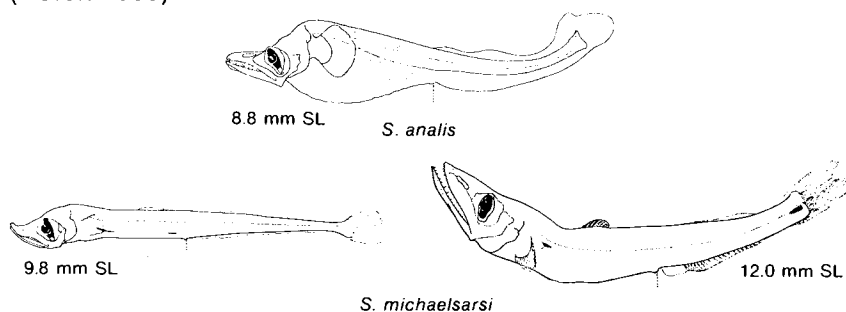
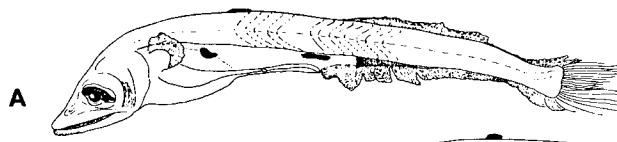
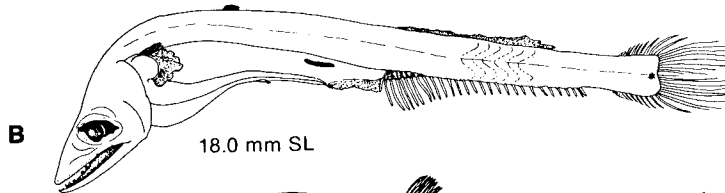


Fig. — A-G, I-J, Johnson 1974; H, Rofen 1966.

Scopelarchus guentheri**SCOPELARCHIDAE**

14.8 mm SL

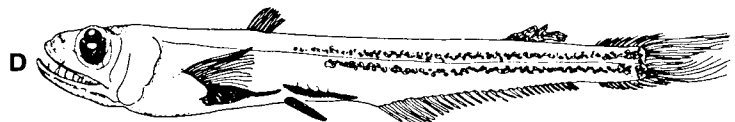
Spot on posterior peduncle forms at 15–17 mm, spreads, but pigment limited to peduncle until 28 mm



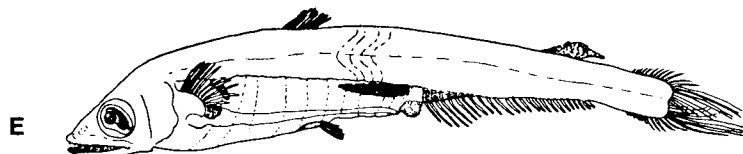
18.0 mm SL



28.2 mm SL

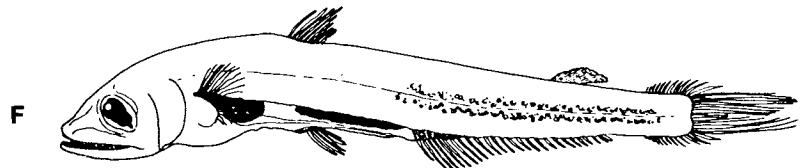


48.5 mm SL

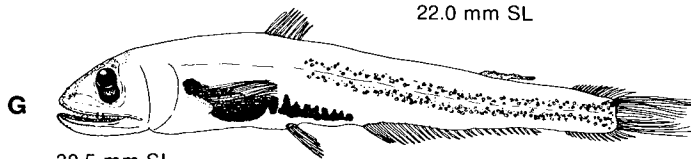
Scopelarchus analis

21.0 mm SL

At 19+ mm, pigment appears over anal fin, well ahead of peduncle, spreads anteriorly and posteriorly



22.0 mm SL



30.5 mm SL

Scopelarchus michaelisarsii

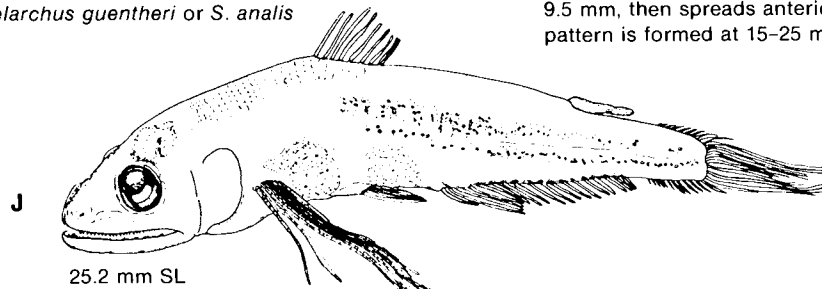
12.8 mm SL

Shorter, deeper body than *Scopelarchus guentheri* or *S. analis*



17.9 mm SL

Pigment forms on posterior peduncle at 9.5 mm, then spreads anteriorly until adult pattern is formed at 15–25 mm



25.2 mm SL

GADIFORMES Gadoidei

Gadidae, Merlucciidae, Moridae Bregmacerotidae, Macrouridae

General characters

- Eggs**
- Pelagic, buoyant, and usually small.
 - Membrane smooth, except hexagonal sculpting in Macrouridae.
 - Yolk homogeneous, usually with single oil globule, or multiple coalescing to one in few genera, or none in few genera (see table, p. 169).
- Larvae**
- Pigment patterns usually well-developed at hatching.
 - In early larvae, vent opens at side of finfold (not at margin); gut short and coiled; preanal length from 33% to 50% SL.
 - Pelvic fins thoracic (rarely jugular) in position, and usually elongate.
 - There may be 1, 2 or 3 dorsal fins, and 1 or 2 anal fins.
 - High numbers of dorsal and anal fin rays.
 - Barbels often form on symphysis of lower jaw (on snout in some species).
 - No head spines present during larval development (except in *Gaidropsarus*).
 - Gradual transformation, followed by pelagic-juvenile stage (except in Moridae and Macrouridae?).

Discriminating early larvae of three species



M. aeglefinus



G. morhua



P. virens

Melanogrammus aeglefinus. Single row of ventral spots along tail; no dorsal pigment on tail until later in development.

Gadus morhua. Three ventral accumulations of pigment on tail, including one on notochord tip; two dorsal accumulations of pigment on tail; ventral accumulations longer than dorsal and extend farther posteriorly.

Pollachius virens. Two ventral and two dorsal accumulations of pigment on tail (none at notochord tip); dorsal accumulations longer and unpigmented space between ventral groups wider than space between dorsal groups.

- The above illustrations are schematic on same body outline with pigment exaggerated. In larger larvae (>15 mm), when pigment patterns fuse, counts of pre-caudal vertebrae, anal fin rays and caudal rays on superior hypural are diagnostic (see below):

	<i>Melanogrammus aeglefinus</i>	<i>Gadus morhua</i>	<i>Pollachius virens</i>
Precaudal vertebrae	19–22	17–20	23–25
First anal rays (A_1)	21–25	20–24	24–28
Second anal rays (A_2)	20–24	17–22	20–21
Formation of anus	Under anterior end of 2nd dorsal	Under anterior end of 2nd dorsal	Under posterior end of 1st dorsal
No. of caudal rays on superior hypural	5	4	5

Ref. — Schmidt 1905a, 1905b, 1906a; Ehrenbaum 1909; deGaetani 1928; Sanzo 1933a; Svetovidov 1948; Marshall 1973; Marshall and Cohen 1973; Merrett 1978; Markle 1982.

**Gadidae, Merlucciidae, Moridae
Bergmacerotidae, Macrouridae**

**GADIFORMES
Gadoidei**

Developmental characters in genera of the family Gadidae and four other gadoid families.

Character	Gadidae			
	<i>Brosme</i>	<i>Enchelyopus</i> , <i>Gaidropsarus</i>	<i>Urophycis</i> , <i>Phycis</i>	<i>Gadus</i> , <i>Pollachius</i> , <i>Melanogrammus</i>
No. of dorsal fins ¹	1	1 (modified)+1	2	3
No. of anal fins ¹	1	1	1	2
First fin to form	Pelvic	Pelvic	Pelvic	Caudal (Pelvic late)
No. of pelvic rays — larvae	3	4	3-4	
No. of pelvic rays — adults	4-5	5-7,8-9	2-3	6-7
Pelvic fin elongate?	Yes	Yes	Yes	No
Formation of pectoral rays	Late	Late	Late	Late
Body shape	Elongate	Stocky	Stocky	Elongate
Range of vertebrae	64-66	51-55	45-50	49-57
Egg diameter (mm)	1.3-1.5	0.66-0.98	0.63-0.97	1.0-1.8
No. of oil globules	1	Multiple to 1	Multiple to 1	None
Other features	Barbel forms on lower jaw in juveniles	Barbels form on lower jaw and snout Pterotic spines present in <i>Gaidropsarus</i> and eastern Atlantic <i>Phycis</i>	Barbel forms on lower jaw	Barbel forms on lower jaw during/ after juv. stage

Character	Moridae ²	Bregmacerotidae	Merlucciidae	Macrouridae ²
No. of dorsal fins ¹	2	1 single ray on head plus 1 fin (divided by low midsection)	2 (2nd divided by low midsection)	2
No. of anal fins ¹	1-2	1 (divided)	1 (divided)	1
First fin to form	Pelvic	Pelvic (with 1st dorsal ray)	Caudal (pelvic in midsequence)	Pelvic (with anal and dorsal)
No. of pelvic rays	6-9	3	7	5-17
Pelvic fin elongate?	Yes (most)	Yes	Moderately	Moderate (stalked)
Formation of pectoral rays	?	Late	Late	Late (paddle- shaped)
Body shape	Tapers to nar- row peduncle	Elongate	Elongate	Attenuated
Range of vertebrae	?	47-59	53-56	80-116+
Egg diameter (mm)	?	?	0.8-1.2	1.0-4.0
No. of oil globules	?	?	1	1
Other features	Barbel forms on lower jaw in some			Barbel on lower jaw in some; no caudal fin

¹ Number of dorsal and anal fins reflects external appearance, not structure or spacing of pterygiophores.

² See illustrations in Miscellaneous Section (p. 396).

GADIDAE***Brosme brosme* (Müller)****Spawning:** April–July in the Gulf of Maine.**Meristic features**

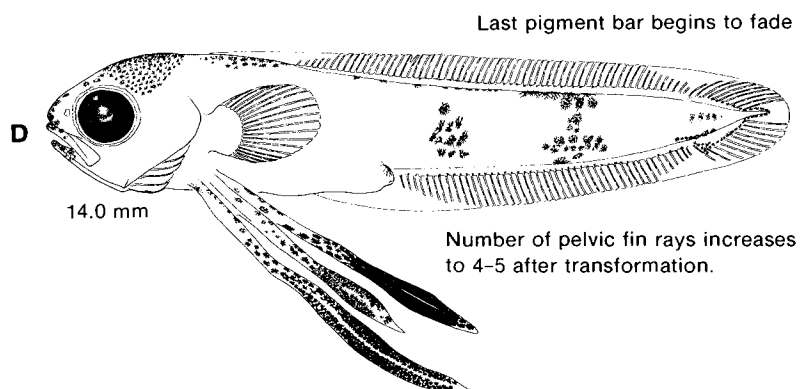
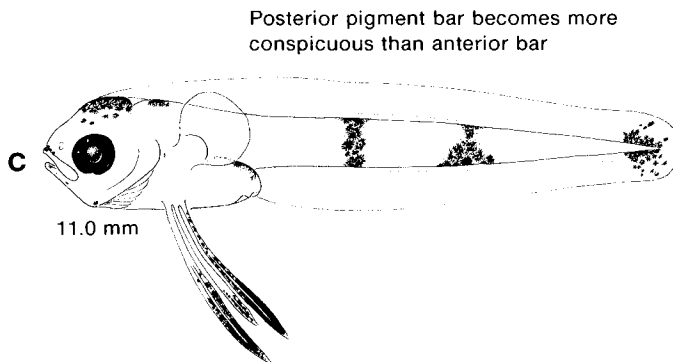
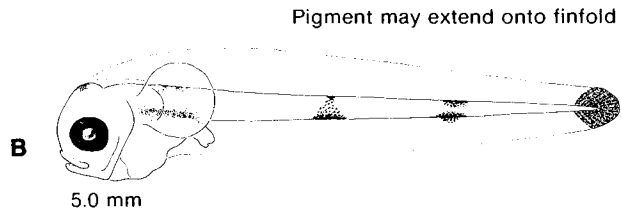
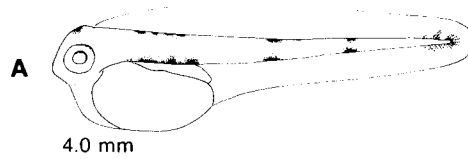
- Eggs**
- Pelagic, buoyant and spherical, usually with coppery tint.
 - Diameter: 1.3–1.5 mm.
 - Shell: smooth (finely pitted).
 - Yolk: homogeneous.
 - Oil globules: 1 (pinkish).
 - O.G. diameter: 0.25–0.30 mm.
 - Perivitelline space: narrow.
- Larvae**
- Hatching occurs at about 4 mm; oil globule posterior in yolk; little eye pigment; characteristic larval pigment pattern present.
 - Yolk absorbed at about 5 mm.
 - Body; elongate and tapered, with short rounded snout.
 - Barbel forms on lower jaw at about 37 mm.
 - Sequence of fin formation: Plv, C, D and A, P.
 - Three pelvic rays form at 6 mm, not connected by membrane, the middle ray being shortest (fourth or fifth tiny rays sometimes visible medially); dorsal and anal rays begin forming at about 12.5 mm and are complete at 28 mm; caudal rays also begin forming at 12.5 mm.
 - Transformation occurs at about 40 mm.
 - Pigmentation: spots on crown, peritoneum and body margin over gut; two bands on tail, each paired or constricted at midline; prominent pigment at end of notochord, on finfold or caudal rays; pelvic fins heavily pigmented on distal portion.

Myomeres : 64–66
Vert : 64–66
D : 85–105
A : 71–76
Plv : 4–5

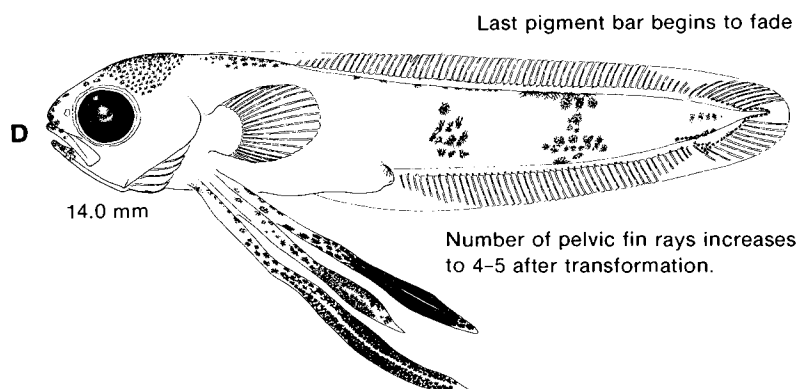
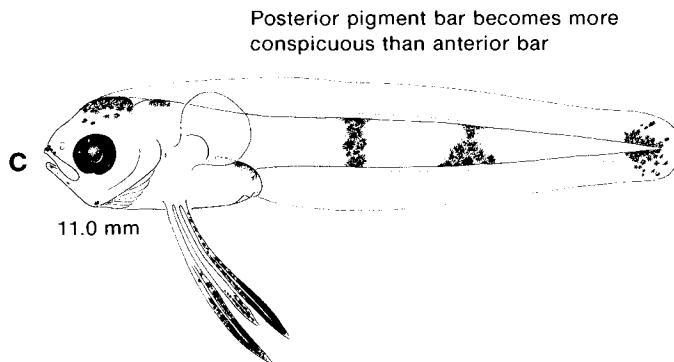
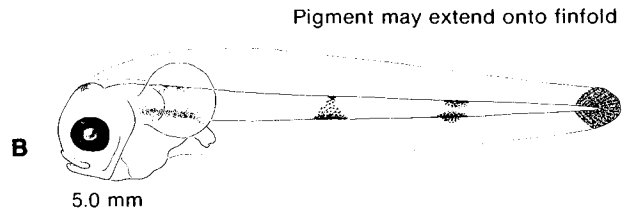
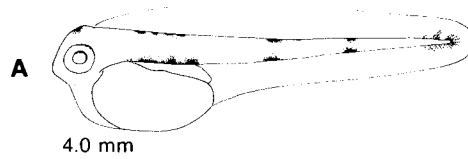
Note: Early eggs similar to those of *Scomber scombrus* (p. 318), separable by fine pitting in *Brosme brosme*; early larvae superficially similar to *Lophius americanus* (see note, p. 190).

Fig. — A–D, Schmidt 1905b (redrawn).

Ref. — Leim and Scott 1966; Colton and Marak MS 1969.

Brosme brosme**GADIDAE**

A-D (eastern Atlantic material)

Brosme brosme**GADIDAE**

A-D (eastern Atlantic material)

GADIDAE***Enchelyopus cimbrius* (Linnaeus)****Spawning:** May to October.**Meristic features**

Eggs	— Pelagic, buoyant, spherical and transparent.	Myomeres : 51-55
	— Diameter: 0.66-0.98 mm.	Vert : 51-55
	— Shell: smooth.	D : 1, ~50, 45-55
	— Yolk: homogeneous.	A : 39-49
	— Oil globules: multiple, coalesce to 1 (greenish-yellow); pigmented.	Plv : 5-7
	— O.G. diameter: 0.13-0.20 mm (when single).	P : 15-19
	— Perivitelline space: narrow.	

- Larvae**
- Hatching occurs at 1.6-2.4 mm (late embryo has characteristic larval pigment pattern and lightly pigmented eyes).
 - Body short and stocky with rounded head and snout.
 - Vent opens laterally on finfold (not at margin) in early larvae.
 - Yolk absorbed at about 3.6 mm.
 - Barbel develops on lower jaw at about 10 mm NL (3 barbels form on snout during juvenile stage).
 - Pigmented pelvic rays develop early at about 3 mm; second dorsal and anal fins begin to form at about 6 mm and are complete before 10 mm; first dorsal fin begins to form at about 10 mm and is complete at 15-20 mm (unique first dorsal fin, with one long ray followed by about 50 very short separate rays, Fig. G); pectoral rays develop last.
 - Transformation occurs at about 20 mm (after development of first dorsal fin).
 - Pigmentation: spots on snout and crown; nape and peritoneal pigment sometimes merged into oblique swath as in *Gaidropsarus*; band on midtail, most dense at dorsal and ventral margins; spot at notochord tip on finfold (disappears with caudal ray formation); entire pelvic fin black with pigment, which persists until transformation when it may be restricted to distal part of fin only.

- Note:**
- (1) Meristic characters above pertain to material north of Cape Hatteras (Cohen and Russo, 1979).
 - (2) Early larvae of *Urophycis* (and *Phycis*?) lack pigment at tip of notochord, and pigment on pelvic fin (if present) is restricted to the tips of the rays. Later larvae are distinguished by the structure of the first dorsal fin, barbels on the snout and number of pelvic fin rays (2-3 in *Urophycis*, 3-4 in *Phycis*, and 5-7 in *Enchelyopus*).
 - (3) See Markle (1982) for description of larval *Gaidropsarus ensis* and Demir (1982) for larval descriptions of two Mediterranean species of *Gaidropsarus*. Prominent posttemporal (or pterotic) spines are present in the larvae of all three species; otherwise larvae are very similar to *Enchelyopus*.

Fig. — A-F, M. P. Fahay (see p. 11); G, Cohen and Russo 1979.

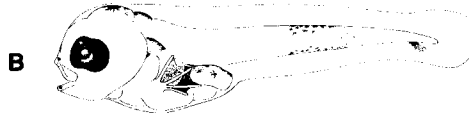
Ref. — Colton and Marak MS 1969; Markle 1982.

Enchelyopus cimbrius

GADIDAE



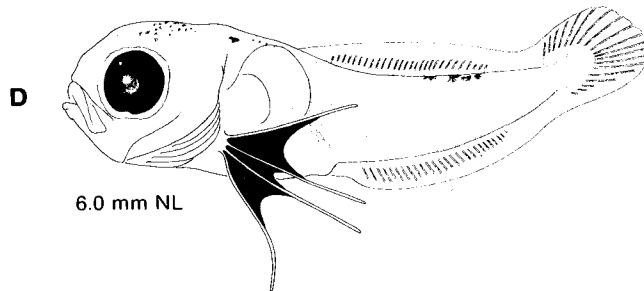
2.6 mm NL



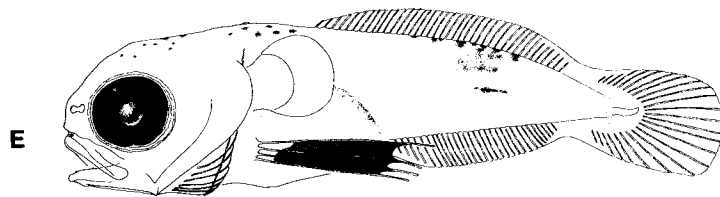
2.9 mm NL



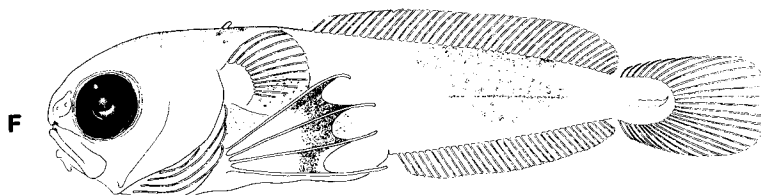
3.8 mm NL



6.0 mm NL

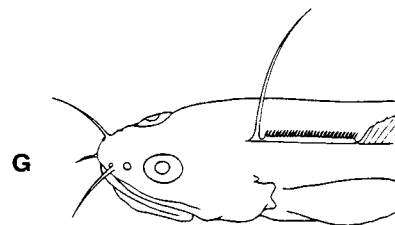


7.2 mm NL



10.3 mm NL

Number of pelvic fin rays
increases to 5-7 after transformation



Adult

GADIDAE***Urophycis chuss* (Walbaum)****Spawning:** Summer into autumn.**Meristic features**

- Eggs**
- Pelagic, buoyant, spherical and transparent.
 - Diameter: 0.63–0.97 mm (most 0.7–0.8 mm).
 - Shell: smooth.
 - Yolk: homogeneous.
 - Oil globules: multiple, coalesce into 1 (pigmented).
 - O.G. diameter: 0.17–0.20 mm.
 - Perivitelline space: narrow.
- Meristic features**
- Myomeres: 45–50
 - Vert: 14–16+32–36
 - D: 9–11, 53–64
 - A: 45–56
 - Plv: 2
 - P: 16
- (See note 1 below)

- Larvae**
- Hatching occurs at 1.8–2.0 mm; eyes unpigmented, and body pigment scattered.
 - Body long and tapering, with bulbous head.
 - Vent opens laterally on finfold (not at margin) in early larvae.
 - Gut becomes short and coiled; preanal length <50% SL.
 - Head length about 25% SL; body depth at pelvic fin origin 25% SL.
 - Barbel appears on lower jaw at about 15 mm.
 - Three pelvic rays develop early (at 2.75 mm NL) and extend to anus by about 6 mm NL; long anal and second dorsal fins formed by 6.6 mm NL; short first dorsal and pectoral rays form last.
 - Transformation occurs at about 25 mm (pelagic-juvenile stage); descent to bottom occurs at 35–40 mm.
 - Pigmentation: in early larvae, spots between eyes and on forehead, scattered spots on dorsal and ventral body margins, and oil globule pigmented; rapid change in later larvae, with spots on nape, crown and peritoneum, black pigment on tips of pelvic fin membrane; pair of spots on midtail (one dorsal and one ventral); midline stripe develops and ventral spot at midtail disappears.

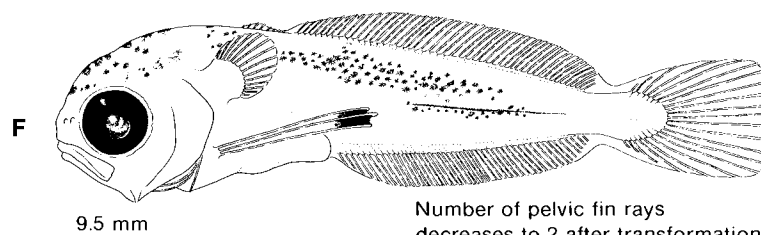
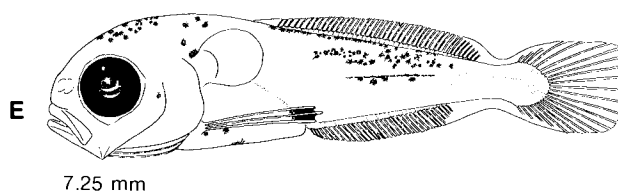
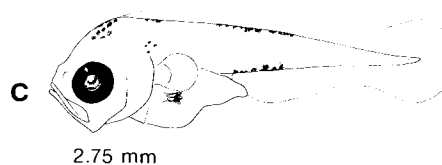
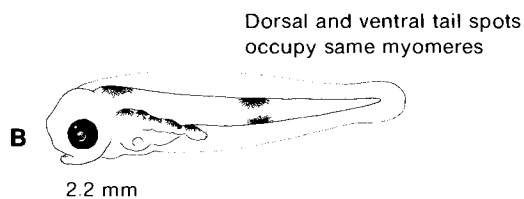
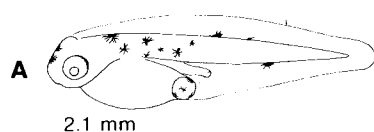
Note: (1) Vertebral count distribution in 414 *U. chuss* pelagic-juveniles from the Middle Atlantic Bight:

Pre-caudal	Caudal				
	32	33	34	35	36
16	—	—	—	1	—
15	1	40	254	53	1
14	—	2	27	31	1

- (2) The larval development of *Urophycis tenuis* and *Phycis chesteri* is undescribed. Postlarvae and juveniles of these species resemble *U. chuss* and the larvae are presumably very similar.

Fig. — A–B, Miller and Marak 1959; C–F, Hildebrand and Cable 1938 (all redrawn).

Ref. — Miller MS 1958; Musick 1973.

Urophycis chuss**GADIDAE**

GADIDAE***Urophycis regia* (Walbaum)****Spawning:** Late summer into winter.**Meristic features**

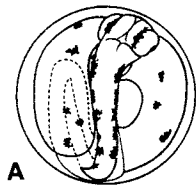
- Eggs**
- Pelagic, buoyant, spherical and transparent.
 - Diameter: 0.67–0.81 mm.
 - Shell: smooth.
 - Yolk: homogeneous.
 - Oil globules: multiple, coalesce into 1.
 - O.G. diameter: 0.14–0.22 mm.
 - Perivitelline space: narrow.

Myomeres: 42–49
 Vert : 13–15+31–35
 D : 8–9, 43–51
 A : 41–50
 Plv : 2
 (See note below)

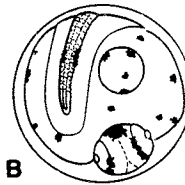
- Larvae**
- Hatching occurs at 1.4–1.6 mm NL: eyes unpigmented, mouth unformed, yolk pigmented, and oil globule pigmented posteriorly.
 - Body long and tapering, with bulbous head (deeper-bodied than *Urophycis chuss*, p. 174).
 - Vent opens laterally on finfold (not at margin) in early larvae.
 - Barbel appears on lower jaw at about 15 mm NL.
 - Pelvic rays develop early at about 4 mm NL; anal and second dorsal rays develop before 7 mm NL (rays in dorsal and anal fins longer than in *U. chuss*); first dorsal formed at about 10 mm NL; pectoral rays are the last to form.
 - Transformation occurs at about 20 mm NL (pelagic-juvenile stage); descent to bottom occurs at 40–50 mm NL.
 - Pigmentation: two spots above and between eyes and one (rarely 2) at snout tip in late embryo and early larva (compare to *U. chuss*); usually two dorsal spots on midtail (usually one in *U. chuss*); no spots at nape or on tips of pelvic fins; streak of spots laterally, and variable pigment over anal fin base; in postlarvae, body pigment consists of large spots overlying a field of smaller spots.

Note: Vertebral count distribution in 318 *U. regia* pelagic-juveniles from the Middle Atlantic Bight:

Pre-caudal	Caudal				
	31	32	33	34	35
15	—	1	2	8	—
14	2	98	141	10	4
13	—	6	35	11	—

Urophycis regia**GADIDAE**

A
Late stage egg



B
Late stage egg

7-10 spots along dorsolateral trunk and tail



C
1.98 mm
Ventral spot at myomeres 27-30

1 or 2 (usually 2) dorsal spots at myomeres 22-26



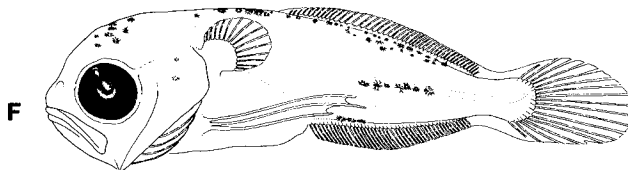
D
2.03 mm

Dorsolateral spots on trunk disappear; migrate to form peritoneal pigment

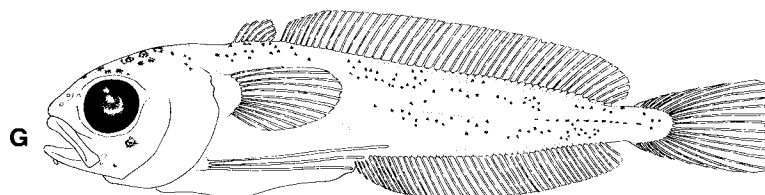


E
2.05 mm
Dorsal and ventral tail spots separated by a few myomeres

Intermediate sizes similar to *U. chuss* — no pigment on pelvic fin tips, slightly deeper-bodied



F
7.0 mm



G
15.0 mm

Number of pelvic fin rays decreases to 2 after transformation

GADIDAE***Gadus morhua* Linnaeus**

Spawning: December–April (peak in February), in Georges Bank, Gulf of Maine and Middle Atlantic Bight areas; April–June in Newfoundland and Grand Bank areas.

Eggs — Pelagic, buoyant, spherical and transparent.
 — Diameter: 1.2–1.6 mm.
 — Shell: smooth.
 — Yolk: homogeneous.
 — Oil globules: none.
 — Perivitelline space: narrow.

Larvae — Hatching occurs at 3.3–5.7 mm; mouth unformed but eyes pigmented; characteristic larval pigment present in late stage embryo.
 — Body and tail long and tapering.
 — Vent opens laterally on finfold (not at margin) in early larvae; it is located under anterior part of second dorsal fin in later larvae.
 — Preanal length <50% TL (39% at hatching).
 — Caudal rays begin formation at about 9 mm; second and third dorsal fin rays and first and second anal fin rays complete at 20 mm; first dorsal fin rays complete at 26–30 mm; pelvic fin buds form at about 13 mm and rays complete at about 23 mm; pectoral rays are the last to form.
 — Transformation occurs at sizes greater than 20 mm; descent to bottom occurs at 25–50 mm.
 — Pigmentation: spots on crown, lower jaw and peritoneum; two dorsal and two ventral groups of spots on tail (ventral groups wider and extend farther posterior than dorsal); ventral spots on tip of notochord; distinct preanal streak of ventral pigment present (compare to *Pollachius*, p. 180); lateral continuous streak of pigment forms on tail at about 6.5 mm TL; all tail pigment fuses at 8–10 mm; all unpaired fins unpigmented until transformation.

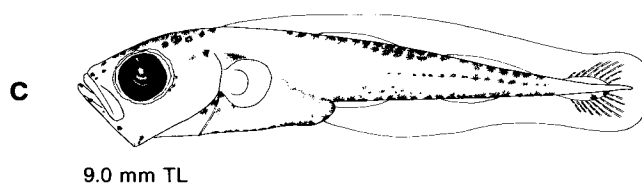
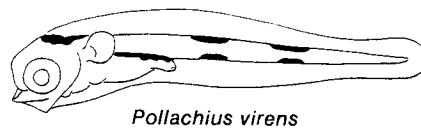
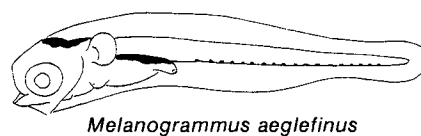
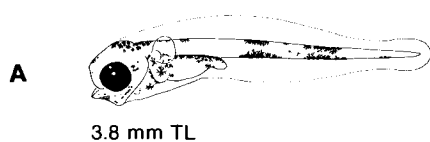
Meristic features

Myomeres: 49–53
 Vert : 17–20+32–35
 D : 13–16, 16–25, 18–21
 A : 20–24, 17–22
 Piv : 6–7

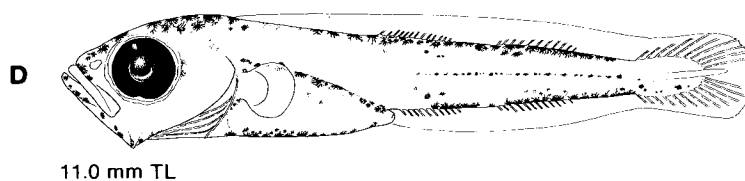
Note: (1) Early egg similar to *Melanogrammus* egg (p. 182).
 (2) See table of comparative features (p. 168).

Fig. — **A**, Dannevig 1919; **B–E**, Schmidt 1905a (all redrawn).

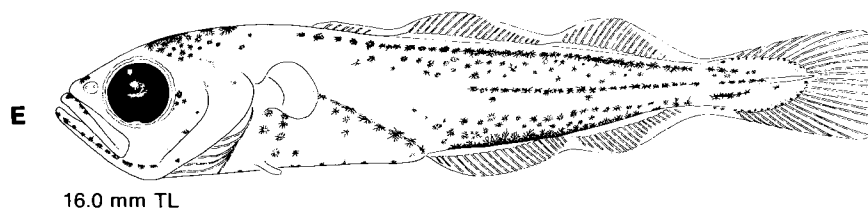
Ref. — Schmidt 1906a; Ehrenbaum 1909; Bonnett 1939; Leim and Scott 1966; Colton and Marak MS 1969; Markle 1982.

Gadus morhua**GADIDAE**

Ventral pigment farther posterior than dorsal



4 primary caudal rays on superior hypural



Lateral streak originates under middle of second dorsal fin

A-E (eastern Atlantic material)

GADIDAE***Pollachius virens* (Linnaeus)**

Spawning: September to March (peak November to February); rarely spawns west of Cape Cod.

Meristic features

Myomeres: 53-57

Vert: 23-25+29-32

D : 13-14, 21-22, 24-28

A : 24-28, 20-21

Plv : 6-7

P : 19-22

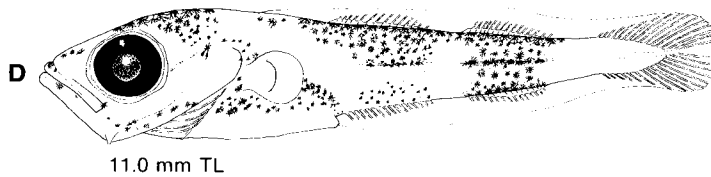
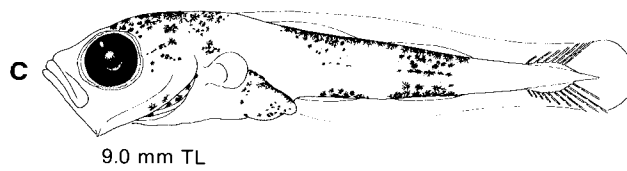
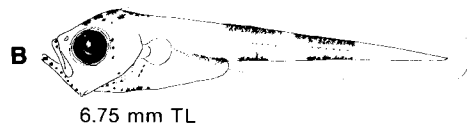
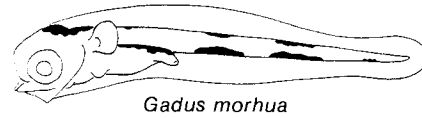
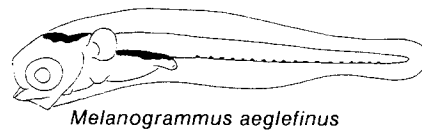
Eggs — Pelagic, buoyant, spherical and transparent.
 — Diameter: 1.0-1.2 mm.
 — Shell: smooth.
 — Yolk: homogeneous.
 — Oil globules: none.
 — Perivitelline space: narrow.

Larvae — Hatching occurs at 3.0-4.0 mm; eyes unpigmented; anterior pigment scattered and light.
 — Long tapering body and tail.
 — Vent forms under posterior part of 1st dorsal fin, and opens laterally on finfold (not at margin) in early larvae.
 — Transformation occurs at >25 mm (juveniles descend to bottom at <50 mm).
 — Sequence of fin formation: caudal, 2nd and 3rd dorsals and 1st and 2nd anals, 1st dorsal, pectoral, and pelvic.
 — Caudal fin rays begin forming at about 9 mm; 2nd and 3rd dorsal and 1st and 2nd anal rays begin to form at about 11 mm.
 — Pelvic fin buds present at 12.5 mm.
 — Pigmentation: spots on crown, lower jaw and peritoneum; 2 dorsal and 2 ventral groups of spots on tail, dorsal groups wider than ventral groups, more space between ventral groups, dorsal groups fuse at about 9 mm; no pigment at notochord tip; preanal ventral streak weak, shorter than streak in *Gadus*; lateral interrupted streak distinct at 6.7 mm, most intense posteriorly.

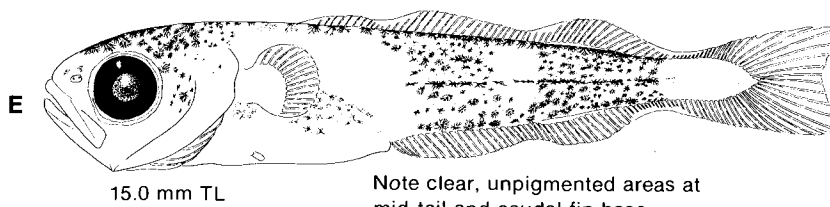
Note: See table of comparative features of various gadids (p. 168).

Fig. — A, Rass 1949; B-E, Schmidt 1905a (all redrawn).

Ref. — Schmidt 1906a; Leim and Scott 1966; Colton and Marak MS 1969; Markle 1982.

Pollachius virens**GADIDAE**

5 primary caudal rays
on superior hypural



Note clear, unpigmented areas at
mid-tail and caudal fin base

GADIDAE***Melanogrammus aeglefinus* (Linnaeus)****Spawning:** January to July (peak in spring).**Meristic features**

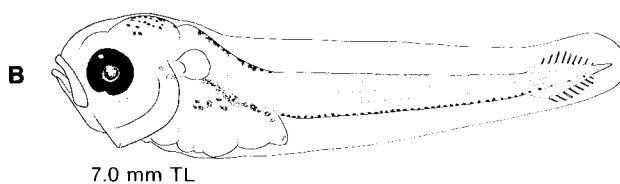
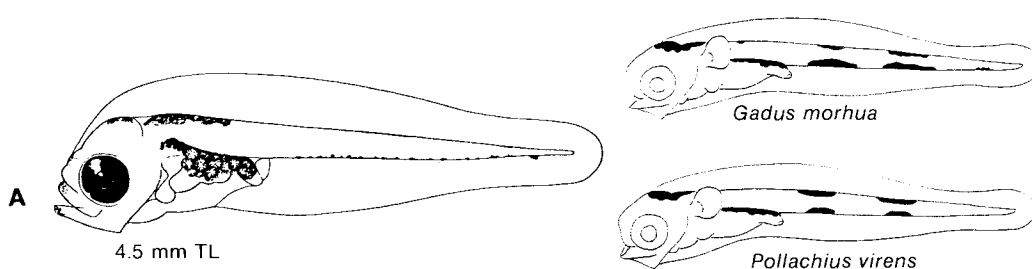
- Eggs** — Pelagic, buoyant, spherical, and transparent.
 — Diameter: 1.20–1.60 mm.
 — Shell: smooth.
 — Yolk: homogeneous.
 — Oil globules: none.
 — Perivitelline space: narrow.
- Larvae** — Hatching occurs at 2–4 mm NL; eyes unpigmented; mouth unformed.
 — Body slightly deeper than in *Gadus* and *Pollachius*; head blunt and large.
 — Vent forms under anterior half of 2nd dorsal fin, and opens laterally on finfold (not at margin) in early larvae.
 — Preanal length <50% TL, increasing slightly with growth.
 — Transformation occurs at about 20 mm NL.
 — Sequence of fin formation: caudal, 2nd and 3rd dorsals and 1st and 2nd anals, 1st dorsal, pectoral and pelvic.
 — Caudal fin rays begin to form at about 7 mm; dorsal and anal rays at 9–10 mm.
 — First dorsal last unpaired fin to develop rays; all rays complete at 16–20 mm.
 — Finfold between adjacent unpaired fins disappears by 25 mm.
 — Pigmentation: spots on crown, dorsum over gut, and peritoneum; row of ventral spots from vent to notochord tip (persists until about 10 mm); no preanal ventral pigment, or very few weak spots >9 mm; pigment on sides spreads posteriorly, but lateral streak does not form; pectoral and pelvic fins develop pigment at 10–15 mm; larger juveniles paler and first dorsal fin higher than in *Gadus* and *Pollachius*.

Myomeres: 50–57
 Vert : 19–22+32–35
 D : 14–17, 20–24, 19–22
 A : 21–25, 20–24
 Plv : 6–7
 P : 19–21

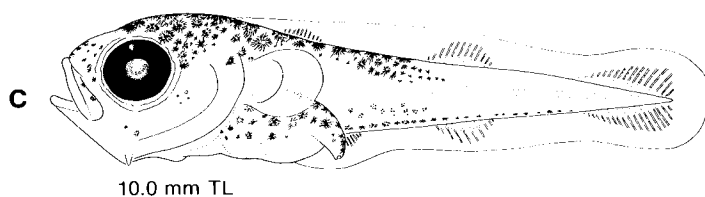
- Note:** (1) Pelagic juvenile *M. aeglefinus* (28–100 mm) often associate with medusae.
 (2) Early larvae of *M. aeglefinus* are similar to *Myoxocephalus aeneus* (p. 226) and *M. octodecemspinosus* (p. 228), but the latter species lack head pigment in early stages and have fewer myomeres.
 (3) See table of comparative features of various gadids (p. 168)
 (4) Second dorsal develops before 1st dorsal (Fig. C), but, as illustrated by Rass (1949), it appears that 1st dorsal rays form before 2nd dorsal rays.
 (5) Early eggs similar to *Gadus morhua* (p. 178) and *Glyptocephalus cynoglossus* (p. 372)

Fig. A. — Schmidt 1905a; **B**, Dannevig 1919; **C–D**, Rass 1949 (**B–D** redrawn).

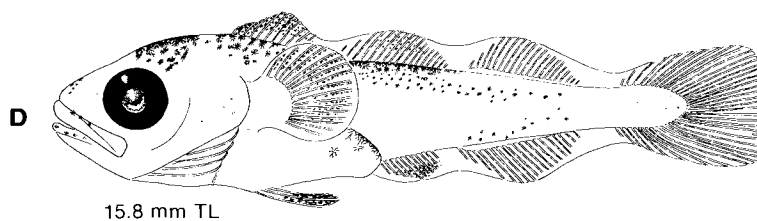
Ref. — Schmidt 1906a; Leim and Scott 1966.

Melanogrammus aeglefinus**GADIDAE**

No lateral streak of pigment



First and second dorsal fins pigmented



First anal fin pigmented; second anal fin remains unpigmented until juvenile stage (>30 mm)

A-D (eastern Atlantic material)

MERLUCCIIDAE***Merluccius albidus* (Mitchill)****Spawning:** April to July (?).**Meristic features**

- Eggs**
- Pelagic, buoyant, spherical and transparent.
 - Diameter: 1.05–1.15 mm.
 - Shell: smooth.
 - Yolk: homogeneous.
 - Oil globules: 1.
 - O.G. diameter: 0.29–0.36 mm.
 - Perivitelline space: narrow.

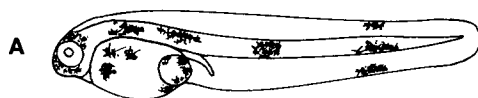
Myomeres: 53–55
 Vert : 25+28–30
 D : 10–13, 35–41
 A : 35–42
 Piv : 7
 P : 13–16

- Larvae**
- Hatching occurs at 3.0–3.8 mm; eyes unpigmented; mouth unformed; pigment on head, yolk and oil globule heavier than in *M. bilinearis* (p. 186).
 - Head and cleithral region deeper than in *M. bilinearis*.
 - Vent opens laterally on finfold (not at margin) in early larvae.
 - Transformation occurs at about 20 mm.
 - Pelvic buds formed at about 5 mm, and fins become moderately long.
 - Sequence of fin formation: caudal, 1st dorsal, pelvic, 2nd dorsal and anal, and pectoral.
 - Pigmentation: more pigment on snout and head in early larvae than in *M. bilinearis*, but snout unpigmented in later larvae; anterior of 2 tail bands less intense than posterior one; no spot at notochord tip until about 10 mm NL; lateral series of expanded melanophores forms on flank behind pectoral fin; pectoral and pelvic fins always pigmented, usually heavily.

Note: In juveniles and adults, 9–11 total gill rakers on first arch.

Fig. — **A**, Marak 1967; **B–E**, M. P. Fahay (see p. 11).

Ref. — Ginsburg 1954; Colton and Marak MS 1969.

*Merluccius albidus***MERLUCCIIDAE**

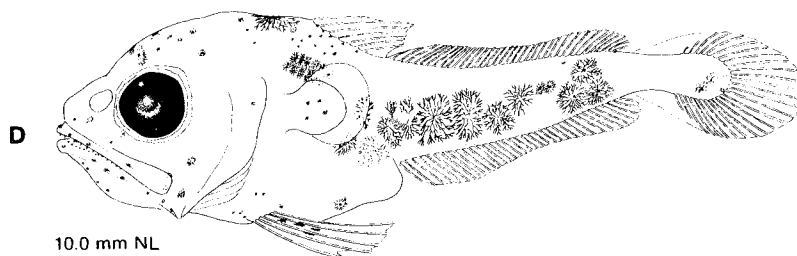
3.9 mm TL



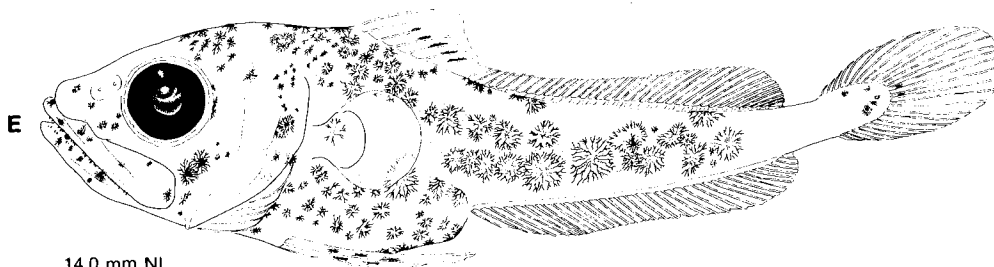
5.5 mm NL



8.5 mm NL



10.0 mm NL



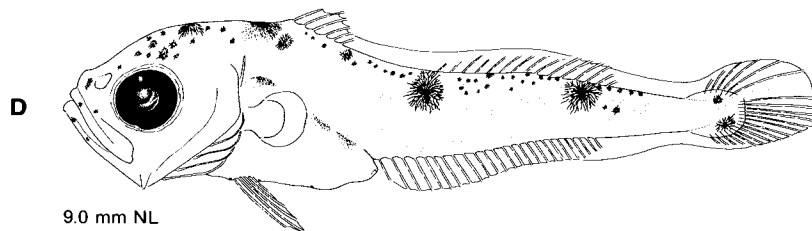
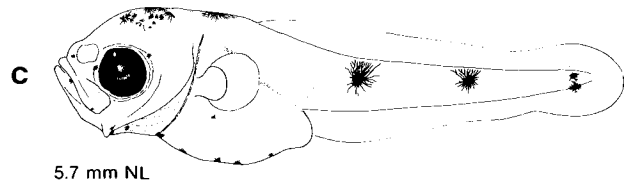
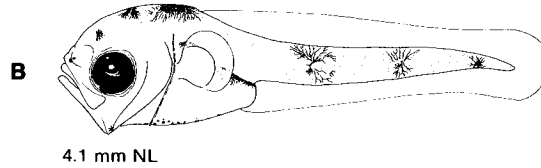
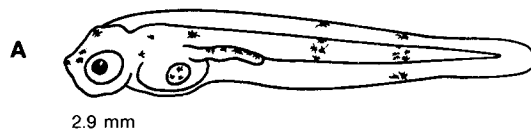
14.0 mm NL

MERLUCCIIDAE *Merluccius bilinearis* (Mitchill)**Spawning:** May to November (peak in June).**Meristic features**

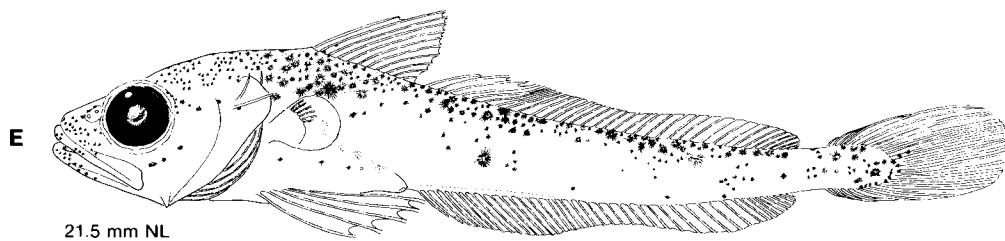
Eggs	— Pelagic, buoyant, spherical, and transparent.	Myomeres: 54-56
	— Diameter: 0.88-0.95 mm.	Vert : 27-28+26-27
	— Shell: smooth.	D : 11-14, 36-42
	— Yolk: homogeneous.	A : 37-42
	— Oil globules: 1.	Plv : 7
	— O.G. diameter: 0.24-0.29 mm.	P : 13-17
	— Perivitelline space: narrow.	

- Larvae**
- Hatching occurs at 2.6-3.5 mm; eyes unpigmented; mouth unformed; pigment on oil globule and on yolk near head and gut; scattered head and gut pigment, and 2 bands on tail.
 - Body slender and tapering, preanal length about 45% NL; head large, length about 25% NL.
 - Body depth at cleithrum about 25% NL, decreasing slightly at transformation.
 - Vent opens laterally on finfold (not at margin) in early larvae.
 - Transformation occurs at about 20 mm NL; descent to bottom occurs at 17-20 mm NL (or larger).
 - Sequence of fin formation: caudal, 1st dorsal, pelvic, 2nd dorsal and anal, and pectoral.
 - Pelvic fins moderately long: buds formed at about 7 mm NL and fins reach anus at about 10 mm NL.
 - Finfold between 1st and 2nd dorsal fins disappears by about 12 mm NL.
 - Pigmentation: 2 tail bands, about equal in intensity vary from distinct spots or bars to dendritic accumulations; spots on snout, crown, nape and peritoneum, and on notochord tip after yolk absorption; dorsal and anal fins unpigmented; pectoral and pelvic fins unpigmented (or rarely lightly pigmented).

Note: In juveniles and adults, 15-22 total gill rakers on first arch.**Fig.** — **A**, Colton and Marak MS 1969; **B-E**, M. P. Fahay (see p. 11).**Ref.** — Ginsburg 1954; Sauskan and Serebryakov 1968; Fahay 1974.

Merluccius bilinearis**MERLUCCIIDAE**

Uniform pigment spreads over body, obliterates original two spots



Becomes elongate, shallow-bodied

BREGMACEROTIDAE***Bregmaceros* sp.****Eggs** — Undescribed.**Larvae** — Body long and tapered, with large head.
— Body proportions decrease with increase in larval size from about 5 mm SL to 15 mm SL as follows:

Body depth	35 to 15% SL
Preal length	55 to 35% SL
Head length	30 to 15-20% SL

- Pectoral fin, with paddle-shaped fleshy base, situated high on body.
- Dorsal and anal fins long and notched in middle.
- Dorsal tentacle (or occipital ray) and pelvic fin rays form early.
- Pelvic fin rays long and trailing.
- Transformation occurs at about 18-20 mm SL.
- Pigmentation increases with growth; internal pigment spots often occur within muscle tissue.

Meristic features*

Vert:	44-59
D :	44-65
A :	44-68
Piv :	3

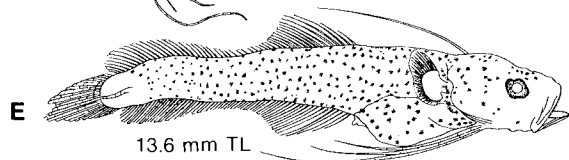
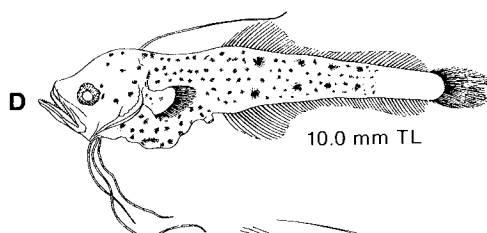
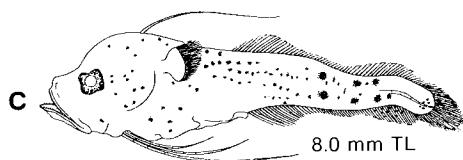
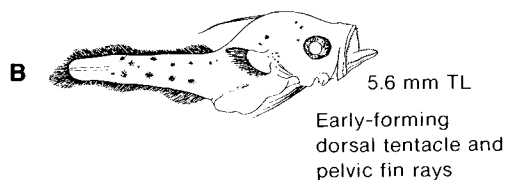
* Pertain to family, excluding Indo-Pacific species

- Note:**
- (1) Three or four species in the western North Atlantic; small tropical and sub-tropical fishes of the open ocean, occurring often in schools; larval development not well described, and illustrations (opposite) may include a mixture of more than two species.
 - (2) For a description of larvae of two other unnamed types of bregmacerotids, see Houde (1981).

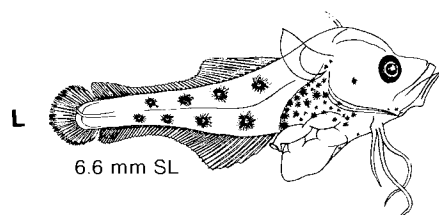
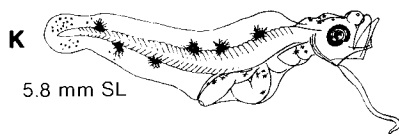
Fig. — **A-J**, d'Ancona and Cavinato 1965; **K-M**, Munro 1950.**Ref.** — Clancey 1956; Aboussouan 1968; A. W. Kendall 1980 (pers. comm.).

Bregmaceros sp.**BREGMACEROTIDAE**

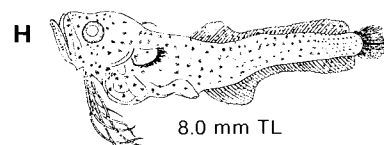
A-E. Described as
Bregmaceros maclellandii
(North Atlantic)



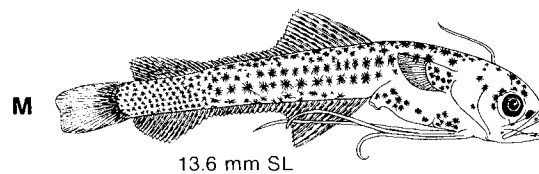
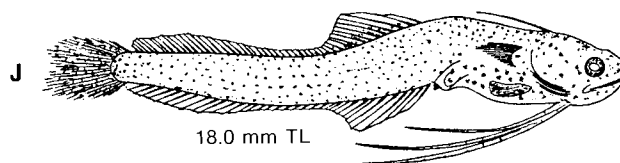
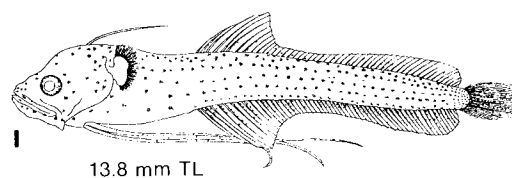
K-M. Described as
Bregmaceros maclellandii
(Australasia)



F-J. Described as
Bregmaceros atlanticus
(North Atlantic)



Pigment increases with growth



LOPHIIDAE***Lophius americanus* Valenciennes****Spawning:** Spring-summer.**Meristic features**

- Eggs**
- Pelagic, spherical, in veils.
 - Diameter: 1.61–1.84 mm.
 - Shell: smooth and transparent.
 - Yolk: homogeneous (amber).
 - Oil globules: 1.
 - O.G. diameter: 0.40–0.61 mm.
 - Perivitelline space: narrow.

Myomeres: 28–30
Vert: 28–30
D : 6, 11–12
A : 9–10
Piv : 5
P : 25–28

- Larvae**
- Hatching occurs at 2.5–4.5 mm (first dorsal ray base forming in finfold).
 - Gut very short.
 - Dorsal and pelvic rays form early and become elongated.
 - Pectoral rays form early and pectoral fin becomes large and fan-shaped.
 - Dorsal and anal fins last to form.
 - Fin-ray counts complete by 12 mm TL.
 - Transformation occurs at >50 mm TL (elongate fins lost).
 - Pigmentation prominent (see illustrations).

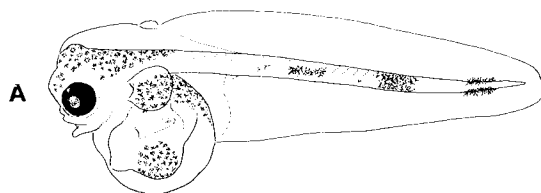
Note: Early larvae of *Brosme brosme* (p. 170) resemble *Lophius* larvae, but *Brosme* larvae have about twice the number of myomeres, an accumulation of pigment at the extreme tip of notochord, and lack the early-forming anterior dorsal rays.

Fig. — **A**, M. P. Fahay (see p. 11); **B**, Bigelow and Schroeder 1953; **C–E**, Tåning 1923 (**B–E** redrawn).

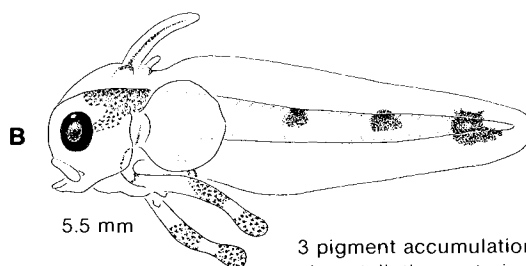
Ref. — J. H. Caruso 1981 (pers. comm.).

Lophius americanus

LOPHIIDAE

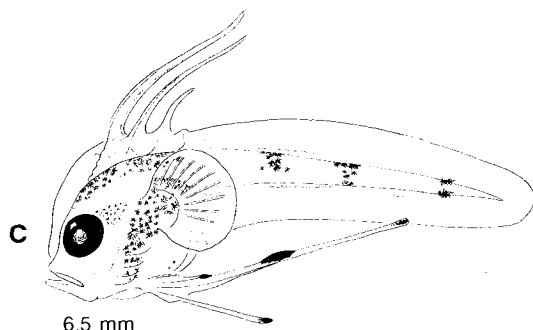


5.0 mm NL



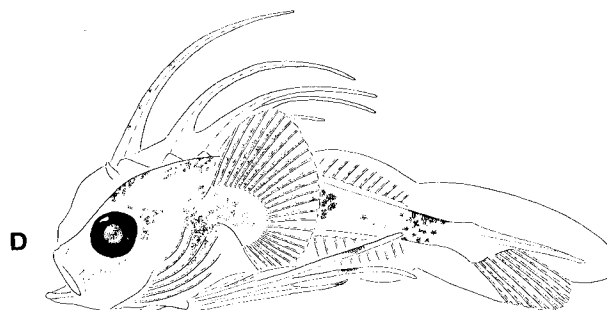
5.5 mm

3 pigment accumulations
along tail, the posteriormost
anterior to notochord tip

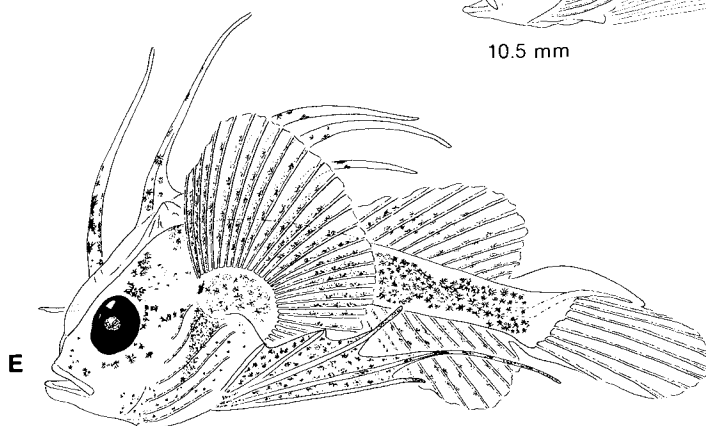


6.5 mm

Pelvic rays pigmented



10.5 mm



16.0 mm

ANTENNARIIDAE***Histrio histrio* Linnaeus**

Spawning: Year-round except February–March; eggs in veils in clumps of Sargassum weed.

Eggs — Initially oval, become spherical.
— Diameter: 0.62–0.65 mm (greatest).
— Shell: transparent.
— Yolk: segmented.
— Oil globules: none.

Larvae — Hatching occurs at 0.88–1.00 mm TL.
— Head large, occupying 33–50% of SL.
— Transforms to prejuvenile at about 5 mm SL.
— Fin formation sequence: caudal, anal, dorsal (rays), pelvic and pectoral.
— Dorsal spines last to form at about 10 mm SL (anteriormost becomes ilicium).
— Pigment conspicuous about head and midgut.

Prejuveniles — Changes during growth (5–10 mm SL) include elongation of pelvic base at about 9 mm SL, and fading of midgut pigment.

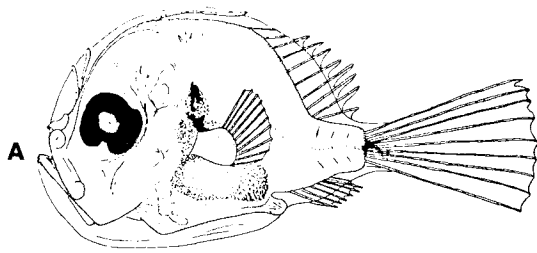
Meristic features

Myomeres: 18–19
Vert: 10+8
D : 3, 11–13
A : 7–8
Plv : 5
P : 9–11
C : 9*

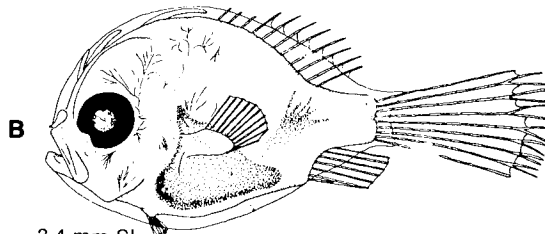
* 7 are branched.

Histrio histrio

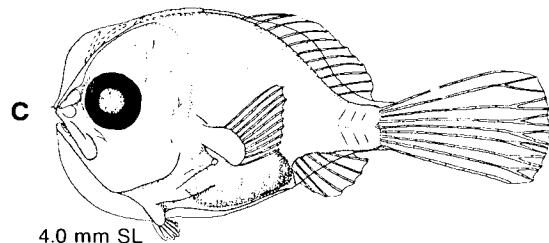
ANTENNARIIDAE



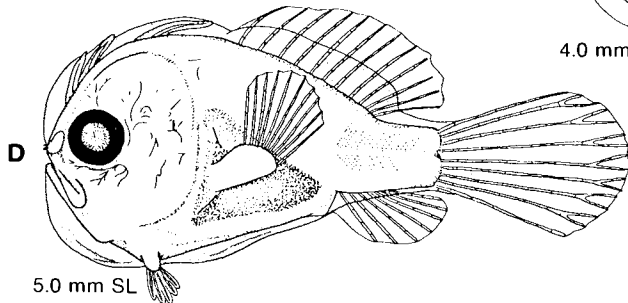
2.0 mm SL



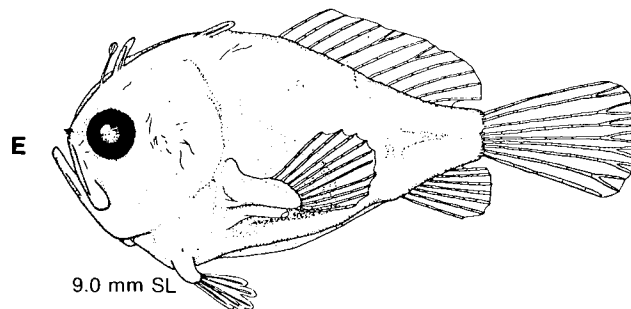
3.4 mm SL



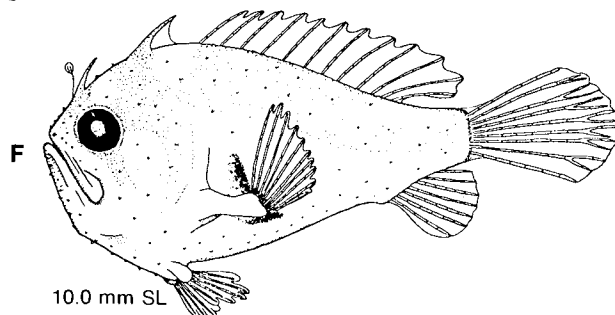
4.0 mm SL



5.0 mm SL



9.0 mm SL



10.0 mm SL

CERATIOIDEI**Ceratioid Larvae****General Features**

- Most ceratioids in the North Atlantic are summer spawners; larvae are epipelagic for several months (Mead *et al.* 1964).
- Males and females distinguishable in larval stages.
- Caudal rays usually 8 or 9, and branchiostegal rays usually 6.
- Very small larvae difficult to distinguish to family, except gigantactinids which have very large pectoral fins (even in smallest larvae observed) and no pelvic fins, and caulophrynids which have pelvic fins.

Key to Families Based on Larval Characters. (After Bertelsen 1951; Pietsch 1979; Pietsch and Seigal 1980; Pietsch and Van Duzer 1980.)

- I. Pectoral fins very large, pelvic fins present or absent.
 - A. Pelvic fins present in larvae and adult males; high dorsal ray count (14–22) except in *Robia legula* Pietsch (6 dorsal rays) Caulophrynidae
 - B. Pelvic fins absent; low dorsal ray count (3–10) Gigantactinidae
- II. Pectoral fins relatively short, no pelvic fins.
 - A. More than 10 dorsal rays.
 1. Dorsal rays 12–17, anal rays 3–5, body short and plump ... Melanocetidae
 2. Dorsal rays 11–13, anal rays 10–13, body slender Neoceratiidae
 - B. Ten or fewer dorsal rays.
 1. Body humpbacked, females with 2 or 3 caruncles on back anterior to dorsal fin; 8–9 caudal rays Ceratiidae
 - a. Well pigmented, 3 caruncles, 8 caudal rays *Cryptopsaras couesi*.
 - b. Unpigmented, 2 caruncles, 9 caudal rays *Ceratias* sp.
 2. Body straight, no caruncles, 9 caudal rays.
 - a. Females with illicium-like second cephalic ray; dorsal rays 5–6, anal rays 4, caudal rays 9 Diceratiidae
 - b. Larvae with small papilliform hyoid barbel below head; dorsal rays 5–7, anal rays 5–6, caudal rays 9 Centrophrynidae
 - c. Body elongate; branchiostegal rays 4–5, dorsal rays 3(2–4), anal rays (2)3, caudal rays 9 Linophrynidae
 - d. Skin on head and trunk highly inflated; dorsal rays 5–6, anal rays 4–5, caudal rays 9, branchiostegal rays 6 ... Himantolophidae
 - e. Body short and plump, variously pigmented, skin moderately inflated; dorsal rays 4–8, anal rays 4–7, caudal rays 9 Oneirodidae

- Note:**
- (1) The family Thaumatchthyidae is present in the Gulf of Mexico, Florida Straits, and Caribbean Sea. Larvae are unique among known ceratioids in that entire head and body are densely pigmented, except pectoral fin base and distal end of caudal peduncle. (See Bertelsen and Struhsaker, 1977.)
 - (2) Throughout the ceratioid section (p. 194–207), larval series have been assembled from all oceans. (See Bertelsen (1951) for specific locations.)

***Caulophryne jordani* Goode and Bean CAULOPHRYNIDAE**

- Larvae** — Body short, skin very inflated.
 — Only genus with pelvic fins (long in larvae).
 — Pectoral fins very large, reaching beyond dorsal and anal fins.

Note: *C. polynema* Regan also occurs in the western North Atlantic, but its larvae are undescribed; fin ray counts are dorsal 19–22, anal 17–19, pectoral 15–18, and caudal 8.

Meristic features

D : 16–19
 A : 14–18
 Plv : 3–4*
 P : 16–18
 C : 8

* In larvae and adult males.

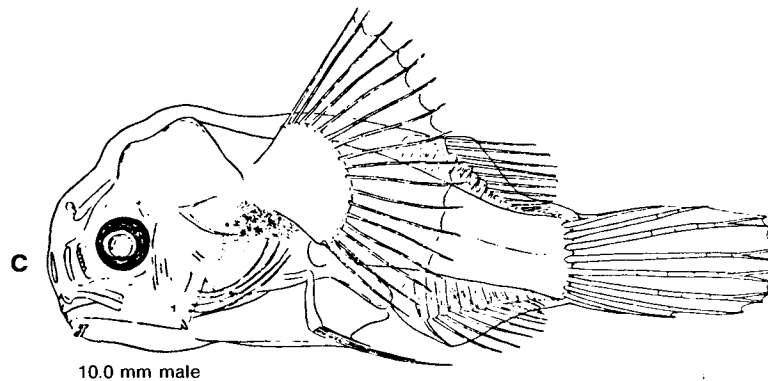
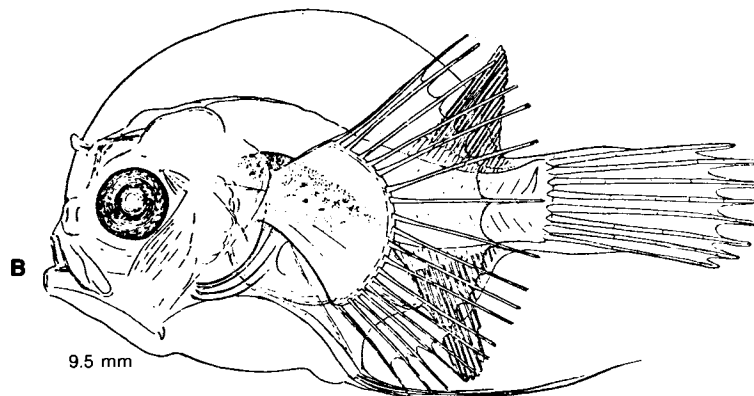
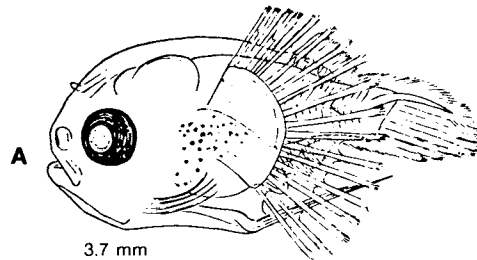


Fig. — A-C, Bertelsen 1951.

Ref. — Pietsch 1979.

MELANOCETIDAE**Generic Characters**

- Larvae** — Body ovoid, short and plump.
— Skin moderately inflated.
— No pelvic fins.
— Pectoral fins normal size, not extending posteriorly beyond dorsal and anal fins.

Meristic features

D : 12-17
A : 3-5
P : 15-23
C : 9

***Melanocetus johnsoni* Günther**

- Larvae** — Lateral pigment on peduncle, separate from dorsal pigment in small specimens, but merges with dorsal pigment in larger individuals.
— Anterior part of body unpigmented.

Meristic features

D : 13-17
A : (3)4(5)
P : 17-23
C : 9

***Melanocetus murrayi* Günther**

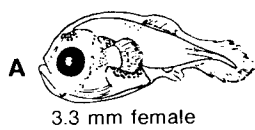
- Larvae** — Caudal peduncle unpigmented, but dorsal pigment may spread to peduncle in larger larvae.
— Gill cover faintly pigmented.

Meristic features

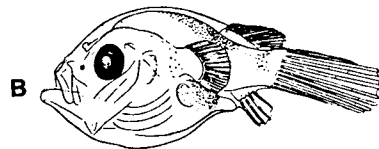
D : 12-14
A : 4
P : 15-20
C : 9

Fig. — A-M, Bertelsen 1951.

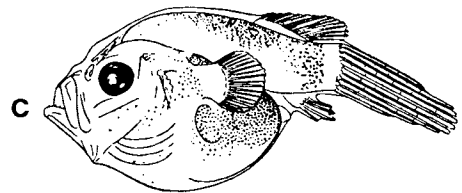
Ref. — Pietsch and Van Duzer 1980.

Melanocetus johnsoni**MELANOCETIDAE**

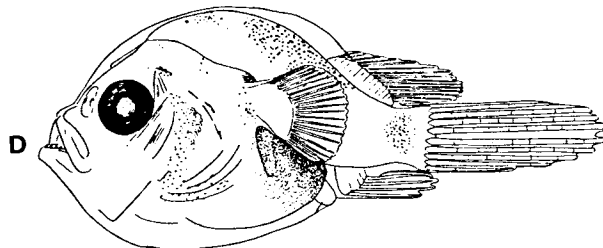
3.3 mm female



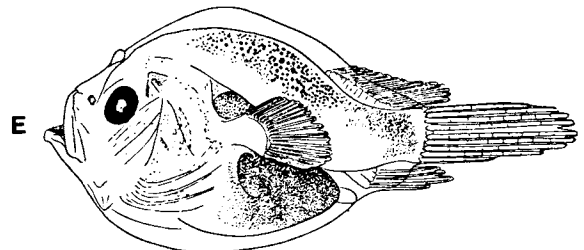
6.5 mm female



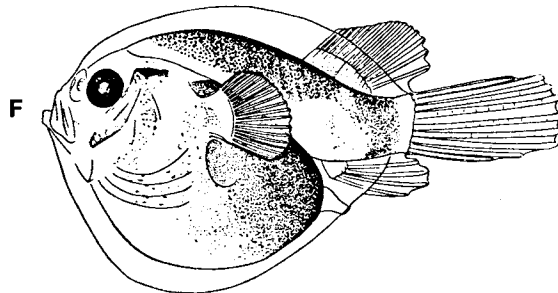
8.5 mm male



13.0 mm male



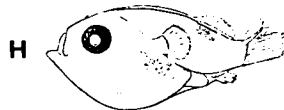
17.0 mm female



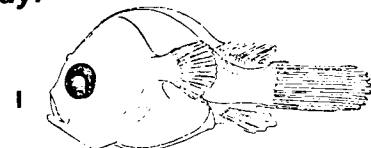
15.5 mm male

Melanocetus murrayi

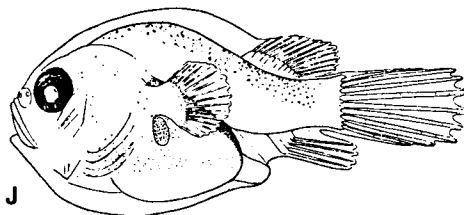
3.0 mm male



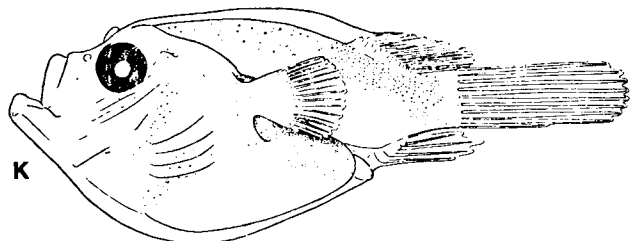
4.0 mm female



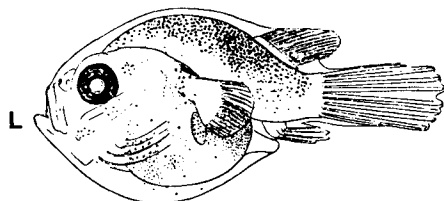
6.3 mm female



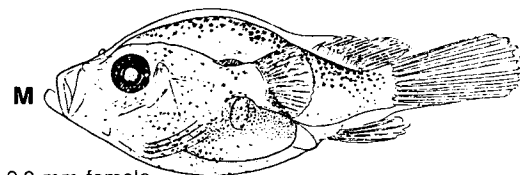
8.5 mm male



13.0 mm female



8.0 mm male



9.0 mm female

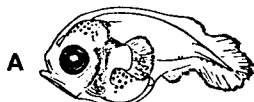
Note: L and M represent the dark type.

HIMANTOLOPHIDAE *Himantolophus groenlandicus* Reinhardt

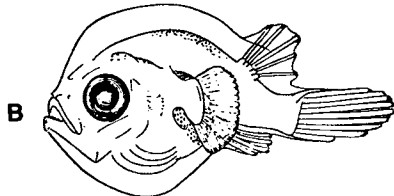
Larvae		Meristic features
—	Body nearly globoid.	D: 5–6
—	Skin on head and body anterior to dorsal and anal fins very inflated, except in small larvae (<4 mm) when skin features about the same as in other genera.	A: 4–5
—	No hyoid barbel.	P: 15–18
—	Pectoral fins normal size, not extending posteriorly beyond dorsal and anal fins.	C: 9
—	No pelvic fins.	
—	Pigmentation: melanophores in distinct groups; dorsal pigment present; peduncle pigment present in 5–6 mm larvae and merges with dorsal pigment under dorsal fin by 8–10 mm; lower jaw rarely pigmented.	

Himantolophus groenlandicus

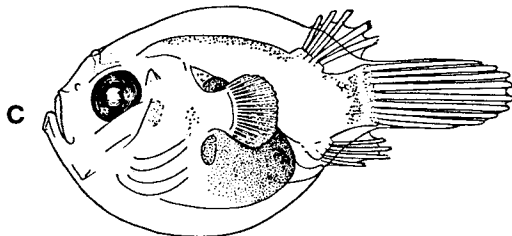
HIMANTOLOPHIDAE



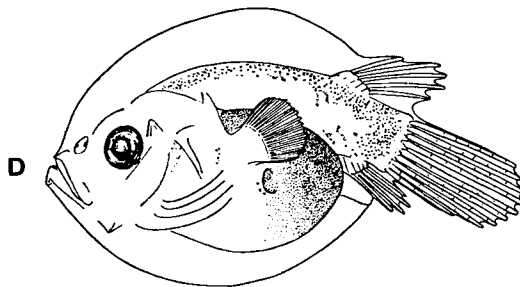
2.4 mm male



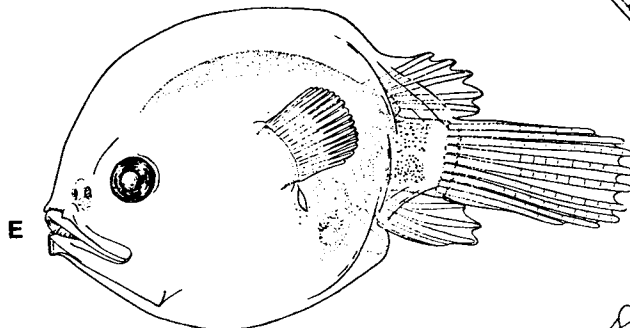
5.7 mm male



9.0 mm female

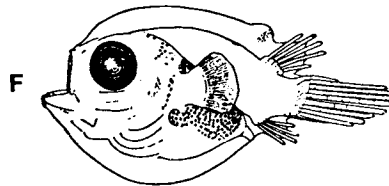


13.0 mm male

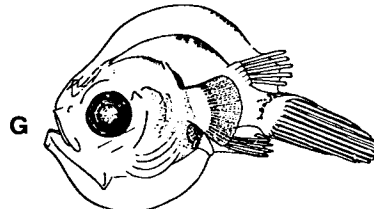


24.0 mm male

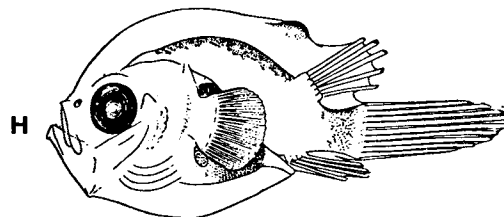
A-E (common type)



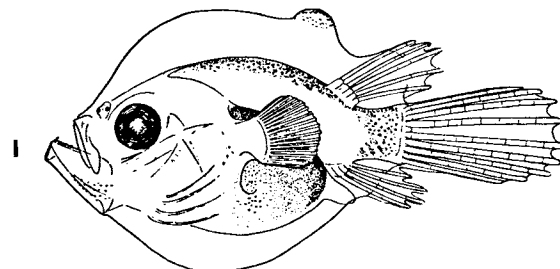
5.6 mm male



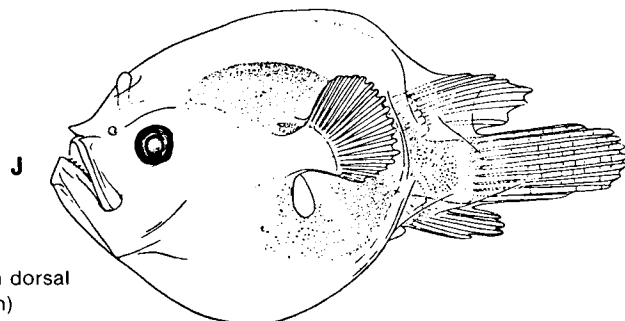
5.0 mm female



8.2 mm male



10.7 mm male



22.0 mm female

F-J (less common type with dorsal
spot of pigment on skin)

ONEIRODIDAE**Family Characters**

- General** — Largest ceratioid family, containing about 50% of all ceratioids.
 — Skin moderately inflated.
 — Melanophores in distinct groups.

Meristic features

D: 4-8
 A: 4-7
 P: 14-30
 C: 8-9

***Dolopichthys* sp.**

- Larvae** — Branchiostegal pigment very dark.
 — Peduncle pigment separated into dorsal, lateral and ventral groups.
 — No dark spot beneath suboperculum.

Meristic features

D: (4?)5-9
 A: (4)5-6
 P: 18-22
 C: 9

Chaenophryne draco* (group)

- Larvae** — Gill-cover pigment very faint.
 — Peduncle unpigmented.
 — Separate dorsal group of pigment spots on anterior part of body.

Meristic features

D: 6-8
 A: 5-6
 P: 16-19
 C: 9

* May include more than one species.

***Oneirodes* sp.**

- Larvae** — Gill cover evenly dark-pigmented.
 — Peduncle unpigmented.
 — Pigment on anterior part of body meeting peritoneal pigment.
 — Lower jaw usually pigmented in larger larvae.

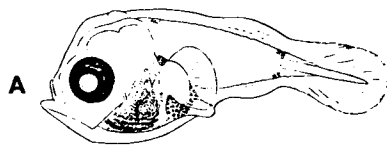
Meristic features

D: (4)5-7
 A: (3)4(5)
 P: (12)13-19
 C: 9

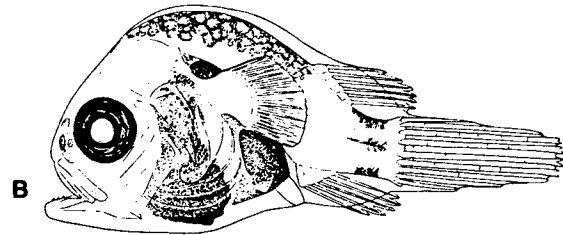
Note: *Leptacanthichthys gracilispinis* (Regan) occurs in the western North Atlantic, but its larvae are undescribed; fin rays counts are dorsal 4-6, anal 5-6, pectoral 18-21, and caudal 9.

Fig. — A-J, Bertelsen 1951.

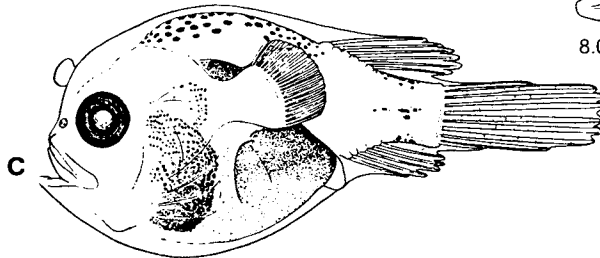
Ref. — Pietsch 1974, 1978.

Dolopichthys* sp.*ONEIRODIDAE**

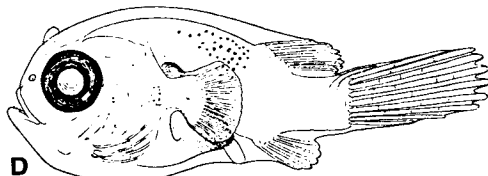
2.6 mm female



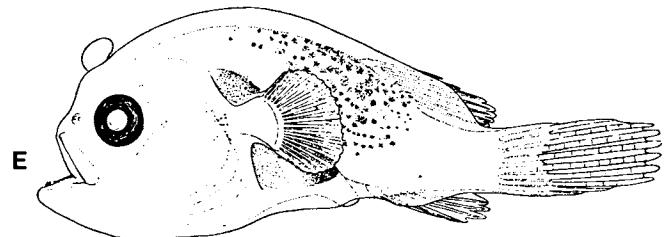
8.0 mm male



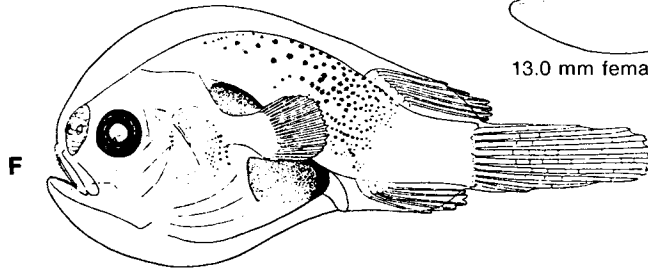
10.4 mm female

***Chaenophryne draco* (group)**

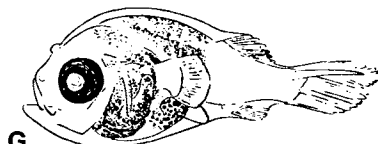
5.7 mm female



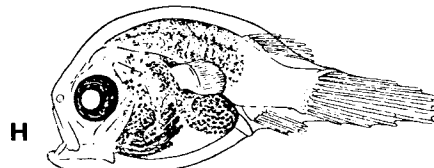
13.0 mm female



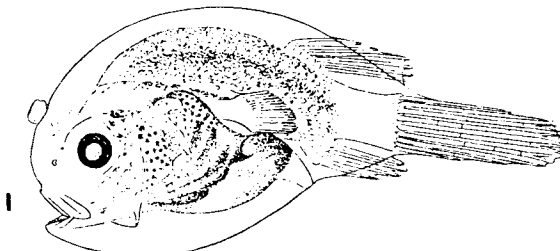
12.4 mm male

***Oneirodes* sp.**

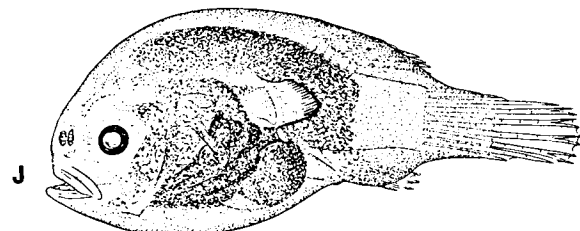
3.0 mm female



4.5 mm male



12.0 mm female



11.5 mm male (metamorphic)

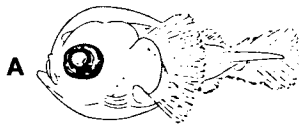
GIGANTACTINIDAE***Gigantactis* sp.**

Larvae		Meristic features
—	Body short; skin very inflated.	
—	No pelvic fins.	
—	Pectoral fins very large; may extend to or beyond the base of the caudal fin.	D: 4–10
—	Dorsal pigment may be absent, weak or well developed; if present, it is not contiguous with peritoneal pigment.	A: 4–8
—	No distinct pigment at base of pectoral lobe.	P: 14–22
		C: 9
—	Type A: Dorsal and peritoneal pigment well developed; no large spots on caudal peduncle; 5–7 dorsal and 3–7 anal rays.	
—	Type B: Dorsal and peritoneal pigment weak or absent; 5–7 dorsal and 5–7 anal rays.	
—	Type C: Dorsal and peritoneal pigment weak or absent; 8–10 dorsal and 5–8 anal rays (= <i>G. longicirra</i> Waterman).	
—	Type D: Dorsal and peritoneal pigment well developed; 3–4 large subcutaneous spots on dorsal and ventral surfaces of caudal peduncle; 5–7 dorsal and 5–7 anal rays (not illustrated).	

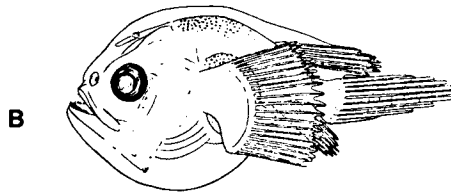
Note: Larvae of the genus *Rhynchactis* have been collected in the western Atlantic south of 30° N. Dorsal pigment is strongly developed, contiguous with peritoneal pigment, but not extending posteriorly to dorsal fin base. Dorsal rays 3–5 and anal rays 3–4. Other characters as for family Gigantactinidae (see Ceratioidei, p. 194).

Fig. — A–I, Bertelsen 1951.

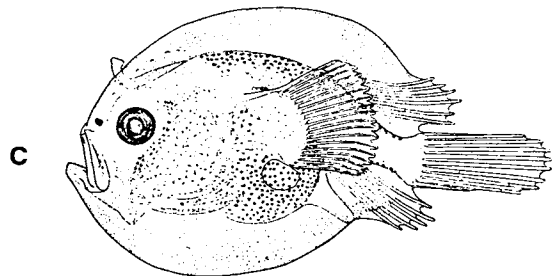
Ref. — Bertelsen *et al.* 1981.

Gigantactis* sp.*GIGANTACTINIDAE****Type A**

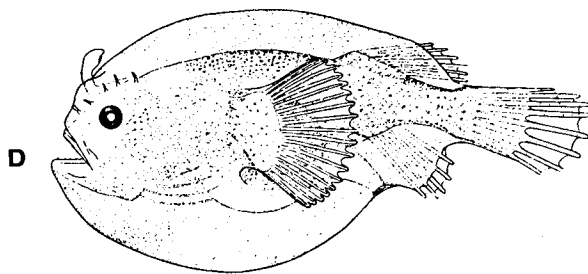
2.8 mm male



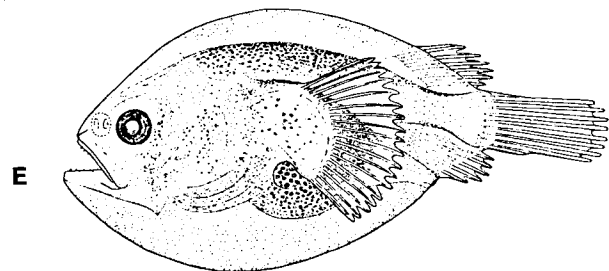
8.0 mm male



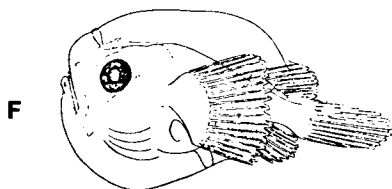
12.5 mm female



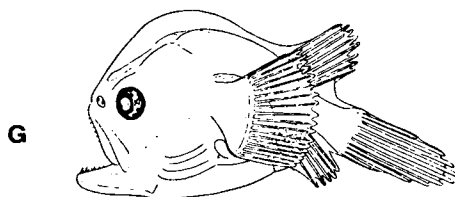
25.0 mm female (metamorphic)



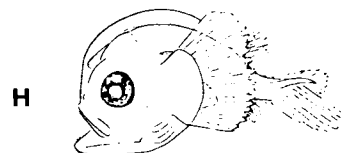
17.0 mm male (metamorphic)

Type C

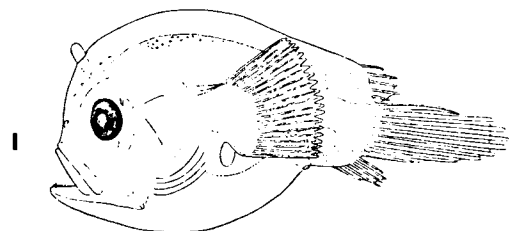
6.3 mm female



7.3 mm male

Type B

4.0 mm male



12.0 mm female

CERATIIDAE**Family Characters**

- Larvae**
- Body humpbacked.
 - Skin moderately inflated.
 - Mouth subvertical.
 - Less than 9 dorsal rays.
 - Pectoral fins do not extend posteriorly past dorsal and anal fins.
 - Females with caruncles on back.

Meristic features

D: 3-5

A: 3-5

C: 8-9

***Ceratias holboelli* Krøyer**

- Larvae**
- Females with 2 caruncles on back.
 - Body unpigmented.

***Cryptopsaras couesi* Gill**

- Larvae**
- Females with 3 caruncles on back.
 - Band of pigment posteriorly on head extends along each side from occipital region along margin of gill cover and meets anteriorly on isthmus.
 - In larger larvae, dorsal pigment meets laterally with pigment spreading from base of anal fin.
 - Isolated pigment on caudal peduncle.
 - Peritoneum pigmented dorsally.

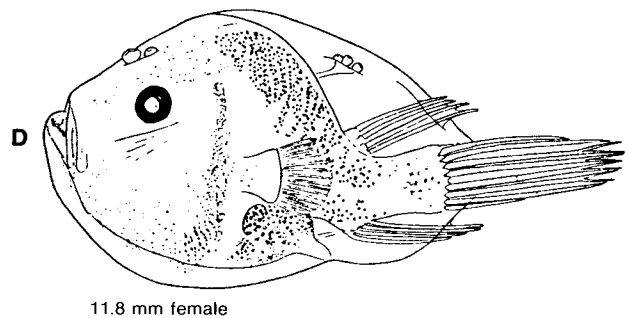
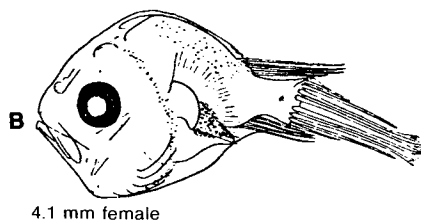
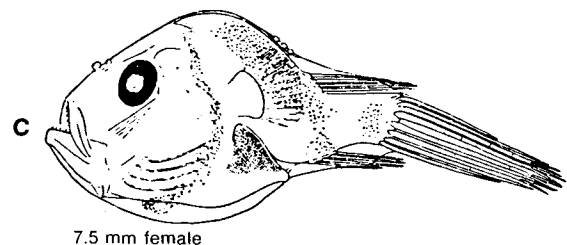
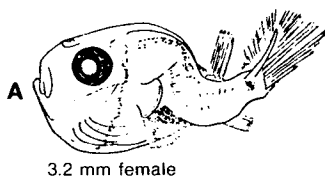
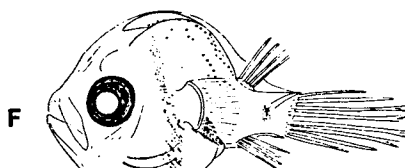


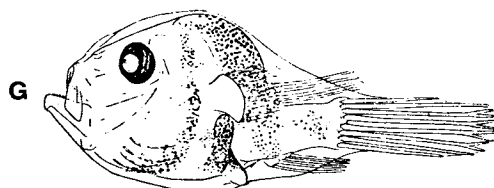
Fig. — A-N, Bertelsen 1951.

Cryptopsaras couesi* (cont'd)*CERATIIDAE**

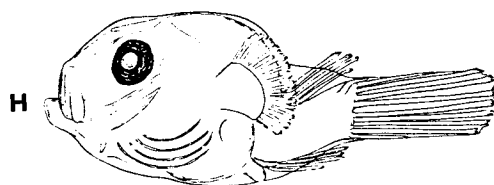
3.1 mm male



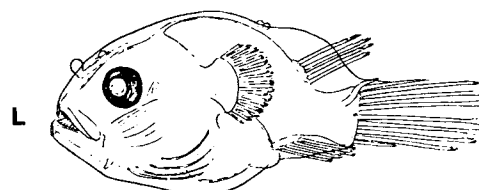
4.5 mm male



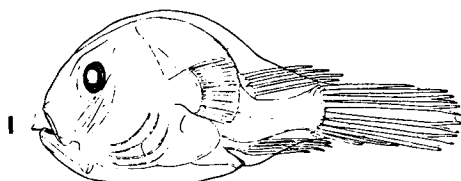
7.7 mm male

Ceratias holboelli

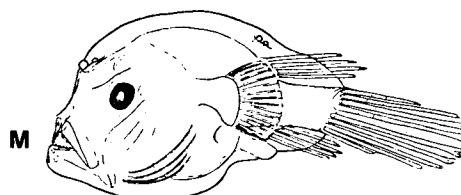
4.3 mm male



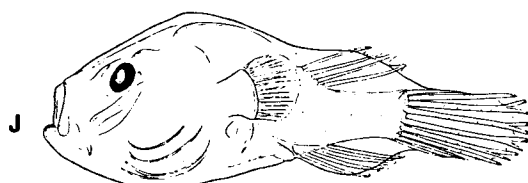
4.5 mm female



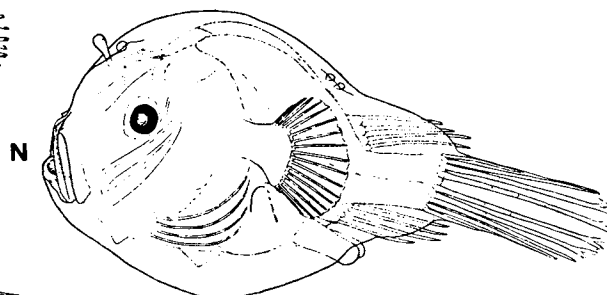
8.5 mm male



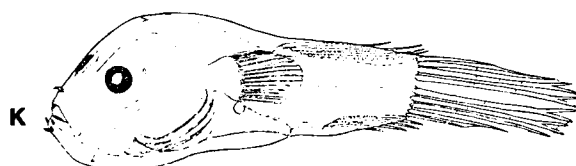
8.1 mm female



9.4 mm male



11.9 mm female



10.4 mm male (metamorphic)

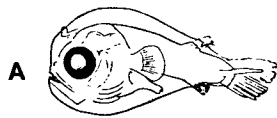
LINOPHRYNIDAE***Linophryne macrorhinus* (group)***

- Larvae** — Body fairly elongate, skin very inflated.
— Body depth <60% SL (including inflated skin).
— Long sphenotic spines.
— Branchiostegal rays 4–5.
— Pigment never present on dorsal part of body.
— Usually a group of melanophores on caudal peduncle (rarely unpigmented).

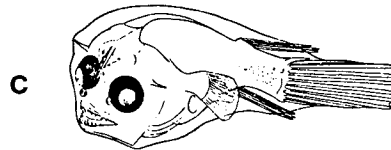
Meristic features

D: (2)3(4)
A: (2)3
P: 13–19
C: 9

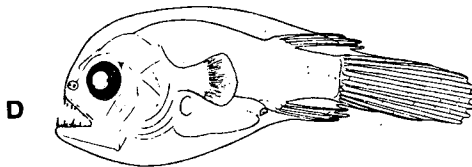
* May include more than one species.

Linophryne macrorhinus* (group)*LINOPHRYNIDAE**

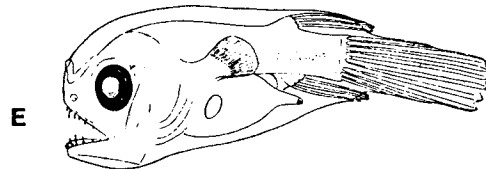
3.5 mm female



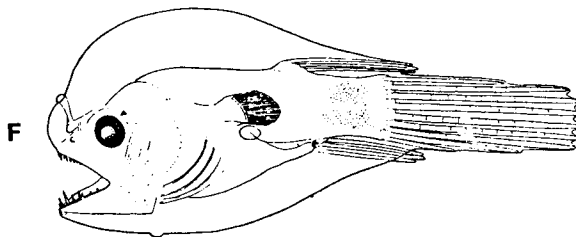
5.5 mm male



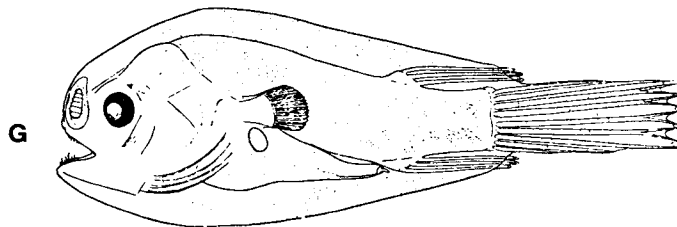
9.0 mm male



9.0 mm female



17.0 mm female



22.5 mm male (metamorphic)

EXOCOETIDAE**Flyingfishes**

- Eggs** — Pelagic and large.
 — Shell: note differences in species below.
 — Yolk: homogeneous.
 — Oil globules: none.
- Larvae** — Body deep anteriorly, tapers to narrow peduncle.
 — Persistent preanal finfold generally not present.
 — Caudal fin well developed at hatching; lower lobe longer and with more rays than upper lobe; fin unique with 7+8 principal rays.
 — Pectoral rays last to form.
 — Abundant in neuston samples.
- Meristic features**
 Myomeres: 39–50*
 * Range in 11 species.

***Exocoetus volitans* Linnaeus**

- Eggs** — Diameter: 2.8–3.0 mm.
 — Shell: smooth, with no spines or filaments.
- Larvae** — Pectoral fin long, pelvic short.
 — Pelvic fin origin under tip of pectoral fin (snout to pelvic fin base shorter than pelvic to caudal fin base).
- Meristic features**
 Myomeres: 42–45
 D : 13–15
 A : 13–14
 Plv : 6
 P : 14–15

***Cypselurus furcatus* (Mitchill)**

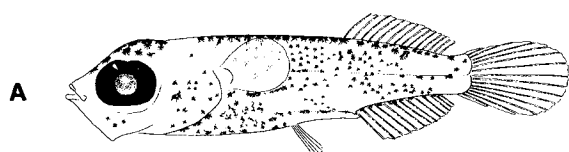
- Eggs** — Shell: with filaments.
- Larvae** — Fins formed at 5.0 mm.
 — Pectoral and pelvic fins long in juveniles.
 — Dorsal fin base longer than anal.
- Meristic features**
 Myomeres: 45–46
 D : 13–14
 A : 10
 Plv : 6

***Oxyporhamphus micropterus* (Valenciennes)**

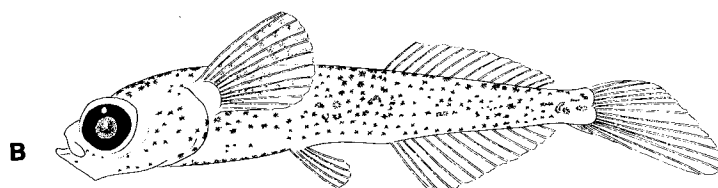
- Eggs** — Spherical (pinkish-brown).
 — Diameter: 1.95–2.10 mm.
 — Shell: with short spines.
- Larvae** — Pectoral and pelvic fins short.
 — Elongate lower jaw in juveniles only.
 — Note persistent preanal finfold in this species, as in scomberesocids, belonids and hemiramphids (p. 210); also late-forming pelvic fin rays.
- Meristic features**
 Myomeres: 49–51 (high)
 D : 13–15
 A : 13–16
 Plv : 6
 P : 11–13
- Note:** (1) *O. micropterus* included within Hemiramphidae by Parin *et al.* (1980).
 (2) Several other genera and species possible in the western North Atlantic, but larvae are undescribed.

Fig. — **A–B**, Kovalevskaya 1964; **C–D**, Hildebrand and Cable 1930; **E–F**, Kovalevskaya 1963 (all redrawn).

Ref. — Parin and Gorbunova 1966.

Exocoetus volitans**EXOCOETIDAE**

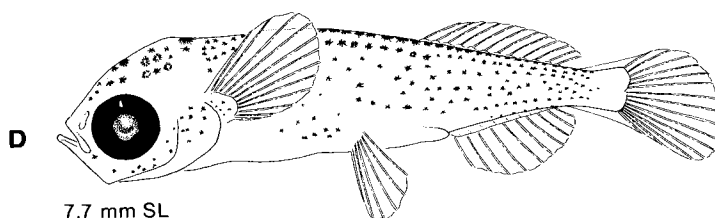
3.7 m SL



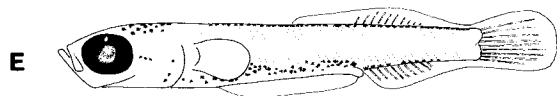
9.8 mm SL

Cypselurus furcatus

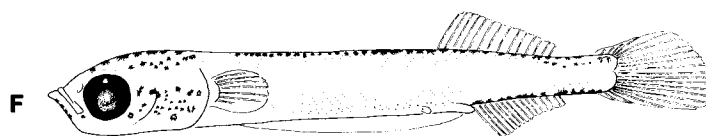
5.0 mm SL



7.7 mm SL

Oxyporhamphus micropterus

4.0 mm SL



6.9 mm SL

A-B (Pacific material).

EXOCOETIDAE**Generic Characters**

(Hemiramphidae)

- Eggs** — Demersal, with filaments on shell.
— Oil globules: none.
- Larvae** — Body long, slender, not tapered, with vent at about 66% TL.
— Dorsal and anal fins small and posterior.
— Persistent preanal finfold.
— Dorsal and ventral rows of pigment.

***Hemiramphus brasiliensis* (Linnaeus)**

- | | | |
|---------------|---|--|
| Larvae | — Preanal finfold ends anterior to pelvic fin.
— Pigment light up to size of 13.5 mm SL.
— Posterior dorsal rays elongated and pigmented.
— Posterior anal rays pigmented. | Meristic features
Myomeres: 52-55
D : 12-15
A : 11-15
P : 10-12 |
|---------------|---|--|

***Hyporhamphus unifasciatus* (Ranzani)**

- | | | |
|---------------|--|--|
| Larvae | — Preanal finfold ends posterior to pelvic fin.
— Pigment heavy at 7.0 mm SL.
— Posterior dorsal rays not elongated.
— Posterior anal rays not pigmented. | Meristic features
Myomeres: 49-53
D : 12-16
A : 14-18
P : (10)11-12 |
|---------------|--|--|

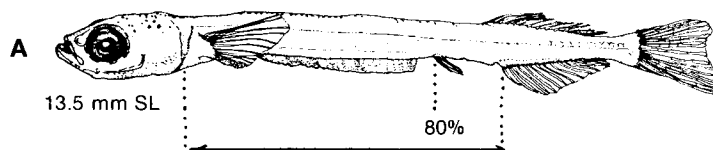
Note: *Hemiramphus balao* Lesueur (54-56 myomeres) and *Euleptorhamphus velox* Poey (71-73 myomeres) occur in western North Atlantic north to Cape Cod, but larvae are undescribed.

Fig. — A-C, Hardy and Johnson 1974.

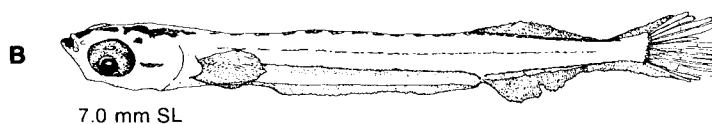
Ref. — Collette and Parin 1970; Collette 1974.

Hemiramphus brasiliensis**EXOCOETIDAE**
(Hemiramphidae)

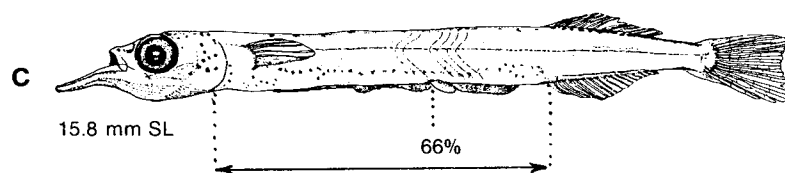
Halfbeaks



2 rows of small spots dorsally head to caudal fin base

Hyporhamphus unifasciatus

2 rows of large dorsal spots join posteriorly

Note difference
in pelvic fin origin

SCOMBERESOCIDAE *Scomberesox saurus* (Walbaum)

- Eggs** — Pelagic, oval.
 — Diameter: 2.15–2.76 mm (long axis).
 — Yolk: homogeneous.
 — Shell: bristles and filaments.
 — Oil globules: none.
- Larvae** — Hatching occurs at 6–8 mm.
 — Body long and slender, with vent at 60–70% of TL.
 — Persistent preanal finfold.
 — Dorsal, anal and pelvic fins posterior on body, finlets form posterior to dorsal and anal.
 — Pelvic fin buds appear at 14–17 mm, and rays at about 20 mm.
- Meristic features**
 Myomeres: 64–68
 Vert : 39–42+26–27
 D : 9–12
 A : 12–13
 Plv : 6
 C : 7+8*
- * Principal rays

BELONIDAE Four Western Atlantic Species

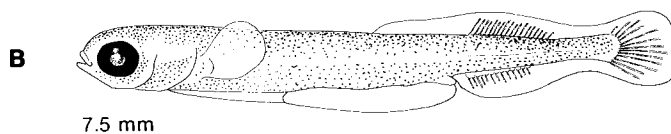
- Eggs** — Demersal, with filaments on shell.
 — Oil globules: none.
- Larvae** — Body long, slender and tapered, with anus at 66% of TL.
 — Persistent preanal finfold.
 — Pectoral and pelvic fins small; large dorsal and anal fins posterior on body.
 — Flexion occurs at hatching.

Meristic features for material from western Atlantic:

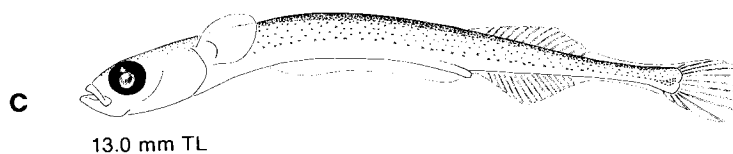
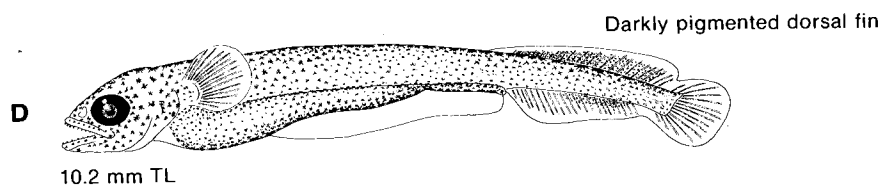
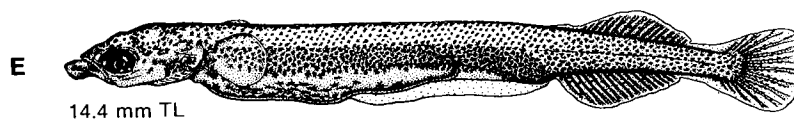
Species	Myomeres	D	A
<i>Tylosurus acus</i> (Lacépède)	90–95	22–26	20–24
<i>T. crocodilus</i> (Peron and Lesueur)	80–84	21–23	18–22
<i>Strongylura marina</i> (Walbaum)	69–77	14–17	16–20
<i>Ablennes hians</i> (Valenciennes)	93–97	23–26	24–28

Fig. — **A**, Nesterov and Shiganova 1976; **B**, Sanzo 1940; **C**, d'Ancona 1931; **D**, Mito 1958; **E**, Foster 1974 (**A–D** redrawn).

Ref. — Berry and Rivas 1962; Collette and Parin 1970; Collette 1974.

Scomberesox saurus**SCOMBERESOCIDAE**

All have well-developed
caudal fins at hatching

***Tylosurus acus*****BELONIDAE*****Strongylura marina***

Heavy pigment below lateral line

Both belonid species heavily pigmented

B-C (eastern Atlantic material); **D** (Pacific specimen)

MELAMPHAIDAE Western North Atlantic Genera

Common larval features

- Principal caudal rays 10+9.
- Pelvic fin develops early (preflexion stage), with 1 weak spine and 7–8 rays; origin anterior, under or posterior to pectoral fin.
- Pectoral fin forms early.
- Weak spines in dorsal and anal fins; dorsal fin origin anterior to anal fin origin, insertions about opposite.
- Body shape and pigment patterns are important in distinguishing the larvae.

Scopeloberyx Zugmayer

- Myomeres 23–27; dorsal rays 10–13.
- Note body shape relative to other genera.
- Pigment sparse; in 3–4 mm SL larvae, a swath of pigment extends from dorsal origin to anal insertion.
- See Fig. A below.

Scopelogadus Vaillant

- Myomeres 23–27; dorsal rays 10–12.
- Head about 50% SL.
- Heavily pigmented; in 3–4 mm larvae, a swath of pigment extends from dorsal origin to anal insertion.
- See *S. bispinosus* in Fig. B below.

Poromitra Goode and Bean

- Myomeres 25–29; dorsal rays 10–14.
- Well-developed preopercle spines.
- Rostral spine present in large larvae.
- See Fig. C and D on opposite page.

Melamphaes Günther

- Myomeres 25–31; dorsal rays 13–18.
- Note “hump” on head over the eye.
- Pigment characteristically in bands between dorsal and anal fins and on peduncle.
- See Fig. E–M on opposite page.

- Note:**
- (1) Anterior dorsal rays can be elongate in some species of the family.
 - (2) *Sio Moss* also occurs in the western North Atlantic (not illustrated).

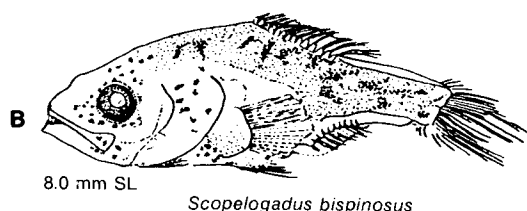
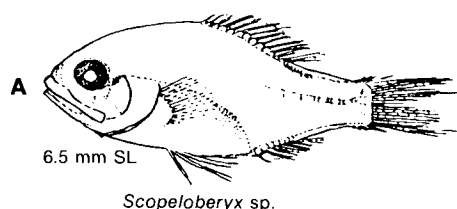
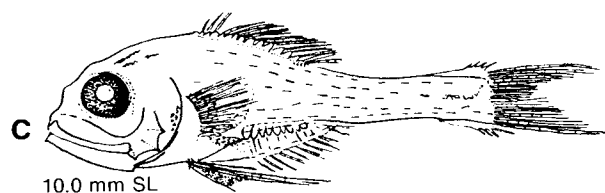
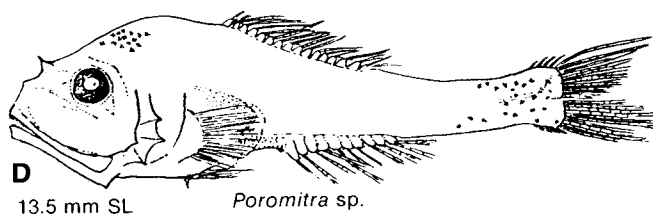
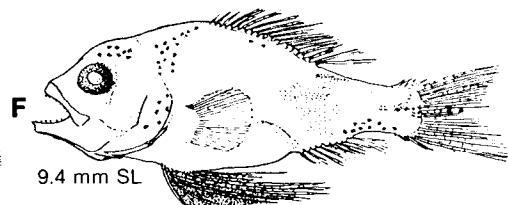
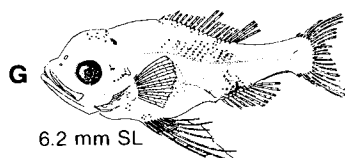
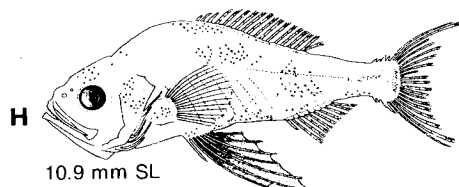
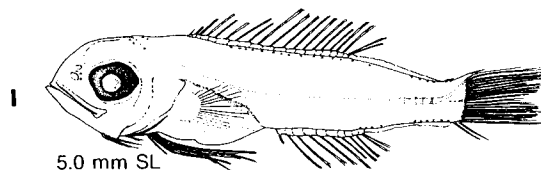


Fig. — A–M, Ebeling 1962.

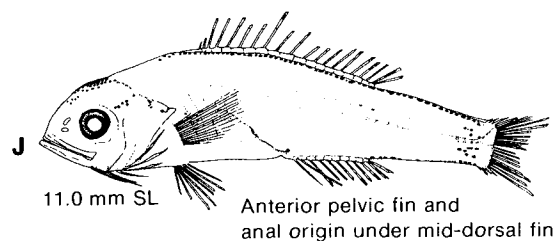
Ref. — Ebeling and Weed 1963, 1973.

Western North Atlantic Genera

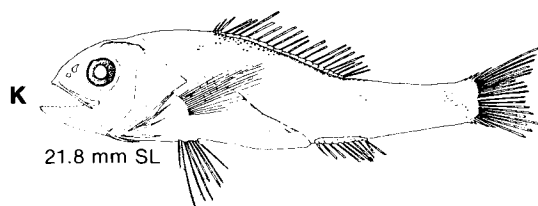
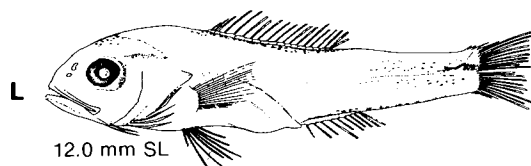
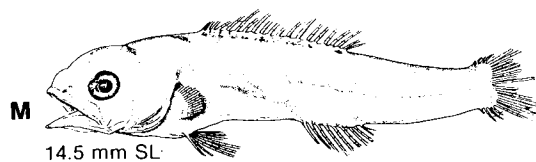
MELAMPHAIDAE

*Poromitra megalops**Melamphaes lugubris**Poromitra* sp.*Melamphaes typhlops*Five Western North Atlantic *Melamphaes* Species*M. typhlops* (also see Fig. F)*M. simus*

Deeply pigmented pelvic fins



Anterior pelvic fin and anal origin under mid-dorsal fin

M. microps*M. polylepis**M. suborbitalis*

E (North Pacific specimen)

SCORPAENIDAE***Sebastes marinus* (Linnaeus)****Spawning:** Spring-summer.**Meristic features**

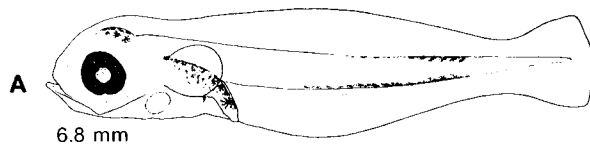
- | | | |
|---------------|---|---|
| Eggs | — Development is ovoviviparous, with internal fertilization, hatching of eggs within oviduct and "birth" of larvae. | Myomeres: 30-32
Vert : 30-32
D : XIV-XVI, 12-15
A : III, 7-9
P : 18-20
C : 11-12+8+7+11-12 |
| Larvae | — Hatch ("born") at 6.7-7.2 mm, with pigmented eyes and well-developed mouth.
— Flexion occurs at 8.5-11.8 mm, and transformation at about 24 mm.
— Body slender, with short gut which increases from 35% SL in preflexion to 58% SL in postflexion larvae.
— Dorsal and anal rays last to form; third anal spine and last dorsal spine begin as rays and change to spines in early juvenile stage.
— Pigmentation: spots on top of brain, dorsolateral surface of gut, embedded spot on nape and dorsal and ventral midlines of tail; caudal spot lacking in most specimens; ventral series of spots (range 11-24, \bar{x} = 18) extends from postanal myomeres 4-7 to postanal myomeres 19-22; dorsal series of spots (range 8-21, \bar{x} = 13) extends from postanal myomeres 10-15 to postanal myomeres 18-22. | |

***Sebastes viviparus* (Krøyer)**

- | | | |
|---------------|---|--|
| Larvae | — Hatch ("born") at 5.4 mm.
— Flexion occurs at 7.8-10.6 mm.
— Pigmentation: caudal spot present; top of snout pigmented at 6.0-10.6 mm (only occasionally present in <i>S. marinus</i>); lateral and ventral surfaces of gut pigmented (not present in <i>S. marinus</i> or <i>S. fasciatus</i>); medial surface of pectoral fin base pigmented at 6.0-10.6 mm, and pigment along bases of pectoral rays; possibly more spots in ventral series (range 18-29, \bar{x} = 25) than <i>S. marinus</i> . | Meristic features

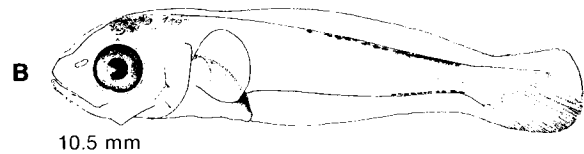
Myomeres: 29-31
(Meristic counts overlap or coincide with <i>S. marinus</i>) |
|---------------|---|--|
- Note:**
- (1) *S. viviparus* occurs only in Northeast Atlantic; it is included here to show similarity of larvae of all *Sebastes* species.
 - (2) Larvae of all *Sebastes* species develop prominent supraoccipital, posttemporal and preopercle spines.

Fig. — A-I, Tåning 1961.**Ref.** — Moser *et al.* 1977.

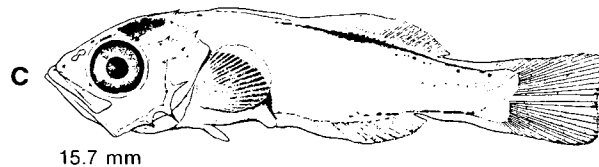
Sebastes marinus**SCORPAENIDAE**

No caudal spot in most specimens

Ventral spots become obscured as anal fin develops

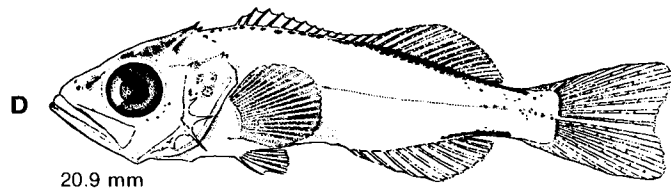


Entire dorsum pigmented at 15 mm

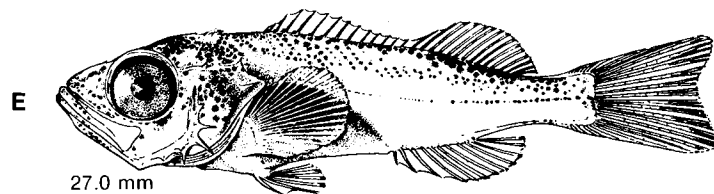


Spots appear at edge of hypurals

No pigment on pectoral or pelvic fins



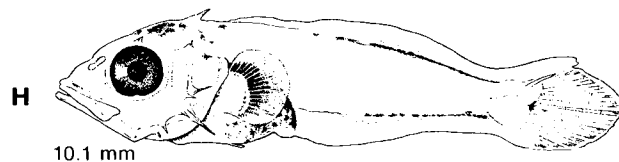
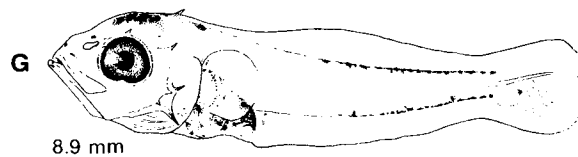
Dorsal spots spread anteriorly on both sides of developing dorsal fin

***Sebastes viviparus***

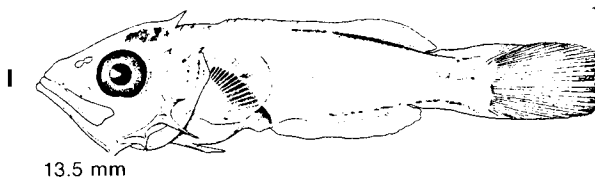
Snout pigmented in larvae 6.0–10.6 mm



Medial surface of pectoral fin base pigmented in larvae 6.0–10.6 mm



Preopercle spines more developed than in comparably-sized *S. marinus*



SCORPAENIDAE***Sebastes fasciatus* (Storer)**

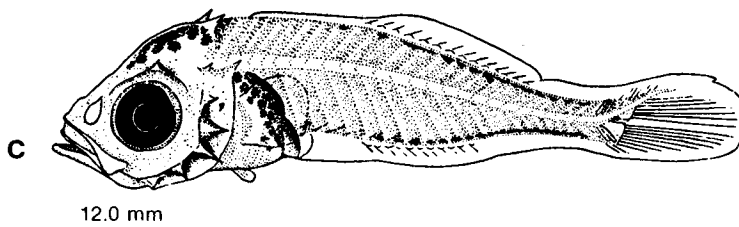
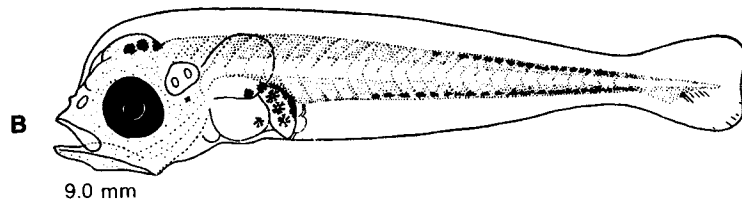
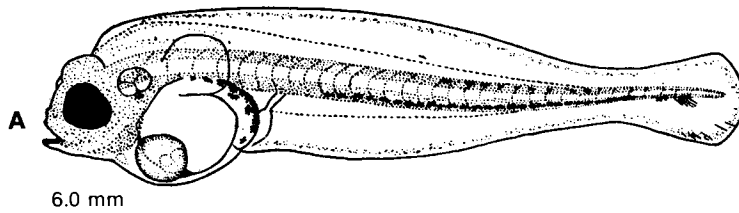
- Larvae**
- Hatch ("born") at 5.8 mm.
 - Body slender with short gut.
 - Flexion occurs at 8.5–10.0 mm.
 - Body slightly deeper than *S. marinus* in flexion and postflexion larvae.
 - Ossification features similar to *S. marinus*.
 - Pigmentation: spots on top of brain, dorso-lateral surface of gut, embedded spot on nape and dorsal and ventral midlines of tail, most specimens with 1 or 2 (sometimes 3 and 4) caudal spots; ventral series of spots (26–42) extends from postanal myomeres 1–4 to postanal myomeres 19–23, becoming obscure as anal fin develops, but some spots remain along anal fin base (compare to *S. marinus*); dorsal series of spots (3–9) extends from postanal myomeres 7–14 to postanal myomeres 14–22 (compare to *S. marinus*), splitting into two lines as in *S. marinus*; entire dorsum pigmented at about 10.8 mm.
- Meristic features**
- Myomeres: 29–30
 - Vert: 29–30
 - D: XIV–XVI, 12–15
 - A: III, 6–8
 - P: 17–20
 - C: 8+7(principal)

***Sebastes mentella* (Travin)**

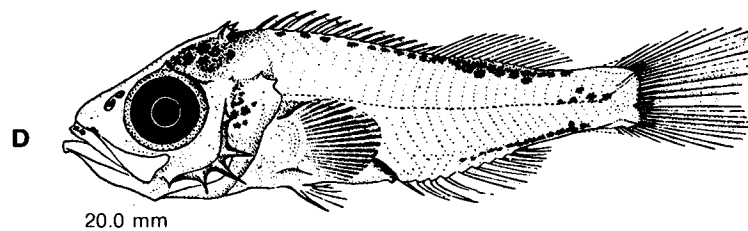
(not illustrated)

- Note:**
- (1) Recent papers (Templeman and Sandeman, 1959; Barsukov, 1968; Barsukov and Zakharov, 1972; Litvinenko, 1974; Templeman, 1980; Ni, 1981a, 1981b) have established that *S. marinus* occurs west of Flemish Cap only in small numbers. Resident species along the coasts of Canada and USA are *S. fasciatus* and *S. mentella*. Ni (MS 1981) has shown that *S. mentella* predominates in more northern areas and in deeper water than *S. fasciatus* which is more common in southern waters at shallow depths, although the depth ranges of the two species overlap.
 - (2) Comparisons have been made between juveniles of the four *Sebastes* species, but there are no adequate descriptions of larvae of the western North Atlantic forms. Presumably, *Sebastes* larvae collected in the Northwest Atlantic are either *S. fasciatus* or *S. mentella*. Anal fin ray counts may separate specimens greater than about 13 mm NL.
- Meristic features**
- Myomeres: 30–32
 - Vert: 30–32
 - D: XIV–XVI, 13–16
 - A: III, 8–11

Fig. — A–D, Bigelow and Welsh 1925.**Ref.** — Moser *et al.* 1977.

Sebastes fasciatus**SCORPAENIDAE**

See *Scomber* (p. 318) for comparative note



SCORPAENIDAE *Helicolenus dactylopterus* (Delaroche)**Spawning:** Mode of reproduction uncertain.**Meristic features**

- Larvae**
- Hatching occurs at <2.8 mm.
 - Flexion occurs at 6.0–7.9 mm.
 - Body moderately slender, with short gut.
 - Preanal length increases from 49% SL in preflexion to 58% SL in postflexion larvae.
 - Third anal and last dorsal spines begin as rays, and change to spines in early juvenile stage.
 - Mass of spongy tissue appears at 4.0 mm in region of spiny dorsal fin.
 - Sizes at beginning of ossification and completion of fin rays:

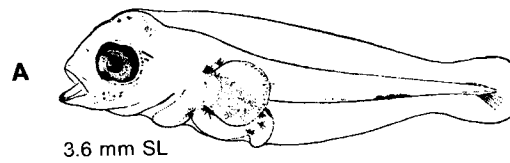
Caudal rays	4.0 mm	7.0 mm
Pectoral rays	4.0	8.0
Dorsal and anal rays	6.0	8.6
Pelvic rays (bud at 6 mm)	7.0	8.6

- Pigmentation: spots on top of head and lower jaw; dorsolateral pigment on gut spreads ventrally; few spots on trunk above pectoral base; medial surface of pectoral base solidly pigmented, with few spots inside distal edge of fin and on ray bases; few spots on ventral midline anterior to caudal fin.

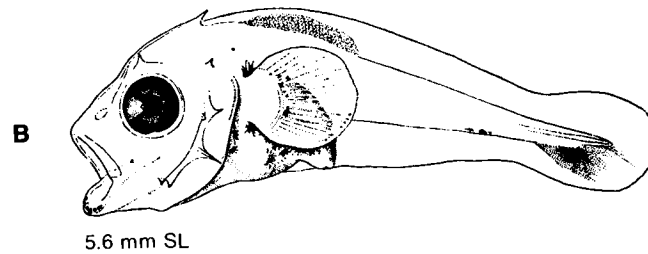
Note: *H. dactylopterus* is the most likely scorpaenid larva to be found south of Long Island and inshore of the Gulf Stream. Several other species may drift north in the Gulf Stream from (sub)tropical areas, but most of these are recognizable by large, early-forming, usually densely-pigmented pectoral fins.

Fig. — A-D, Tåning 1961.

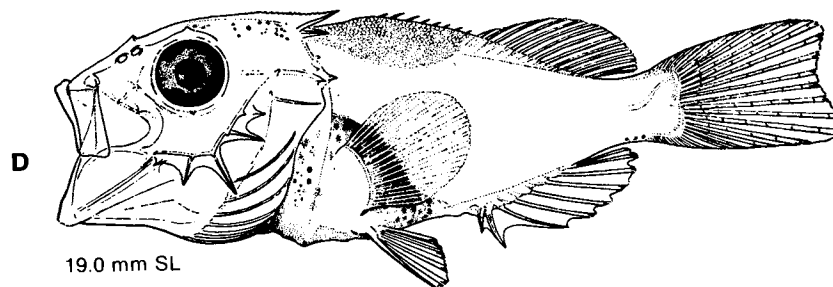
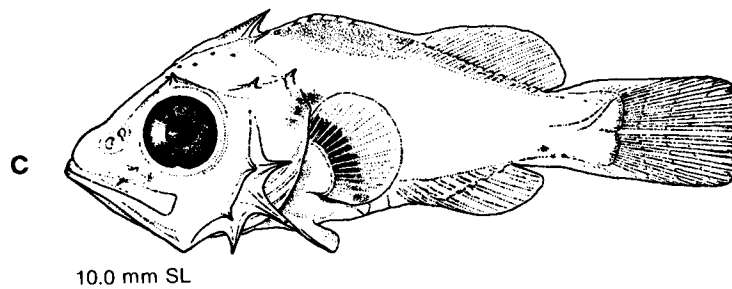
Ref. — Moser *et al.* 1977; Barsukov 1968.

Helicolenus dactylopterus**SCORPAENIDAE**

Dorsolateral gut pigment spreads ventrally with development



Few spots on ventral midline



A-D (eastern Atlantic material)

TRIGLIDAE***Prionotus* (2 Species)**

(Interim account based on Middle Atlantic Bight specimens)

Spawning: Late spring into summer.

- Larvae** — Strong head spines including bony ridge over eye; ridge contains strengthening rods or "struts".
- Large pectoral fins form early, with characteristic pigment patterns.
- Lowermost three pectoral rays separate from rest of fin.
- Body cross-section triangular (deep ventrally).
- Separate dorsal fins.
- Meristic features of two species:

	<i>Prionotus carolinus</i> (Linnaeus)	<i>Prionotus evolans</i> (Linnaeus)
Vert :	10+16	10+16
D :	X, 13-14	IX-XI, 12-13
A :	12(11-13)	12
Piv :	I, 5	I, 5
P :	14+3(separate)	13+3(separate)

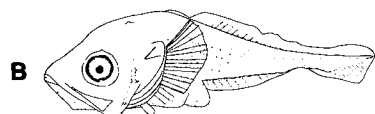
Note: The two species are found in coastal waters north of Cape Hatteras; other species may drift north with the Gulf Stream from southern areas.

Fig. — A-L, S. C. Goodwin (illustrator).

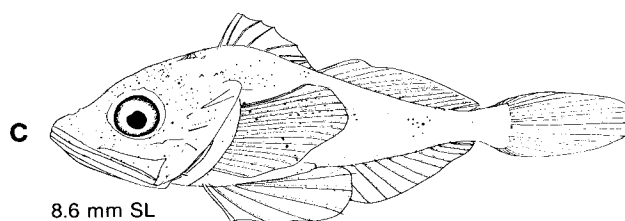
Ref. — Richards *et al.* 1979.

Prionotus carolinus**TRIGLIDAE**

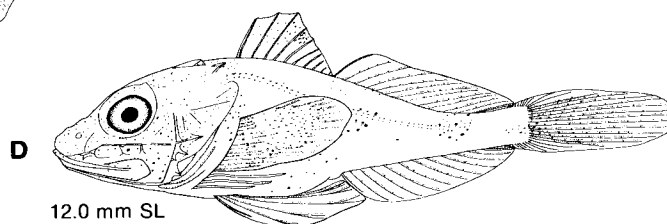
2.8 mm NL



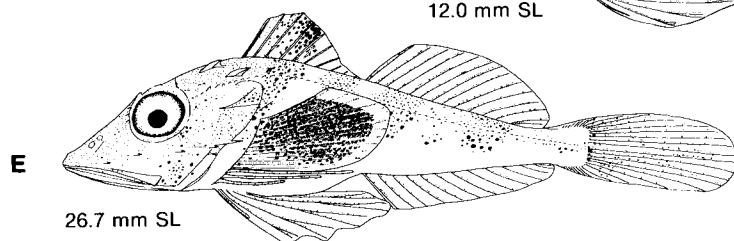
5.2 mm NL



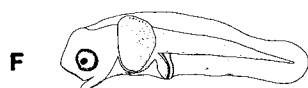
8.6 mm SL



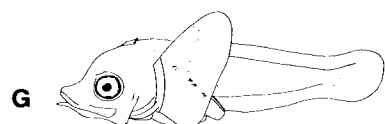
12.0 mm SL



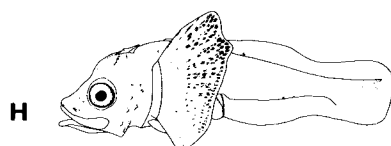
26.7 mm SL

Prionotus evolans

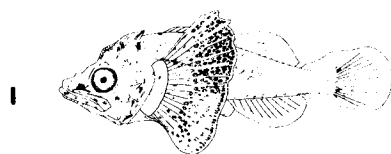
2.7 mm NL



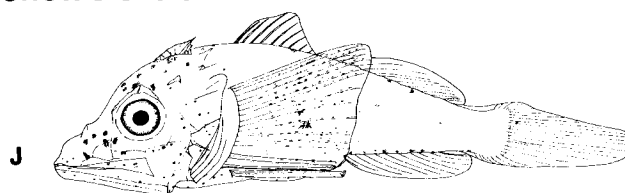
5.3 mm NL



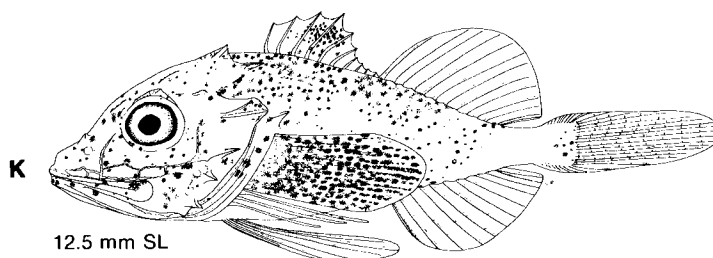
6.3 mm NL



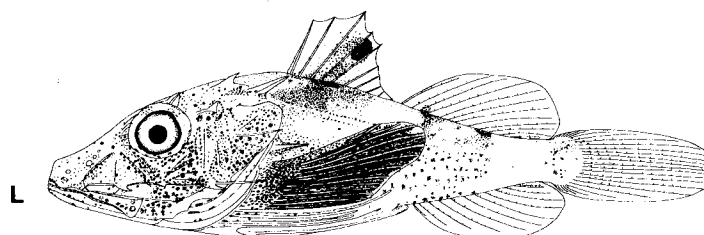
7.2 mm SL



8.7 mm SL



12.5 mm SL

Distinctive unpigmented area
anterior to caudal peduncle

24.8 mm

COTTIDAE***Hemitripteris americanus* (Gmelin)**

Spawning: Late autumn and early winter, in southern New England.

Meristic features

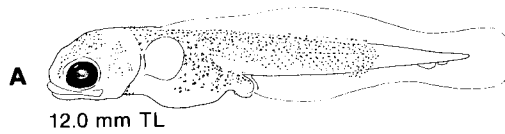
- Eggs** — Demersal, attached in clusters (usually on the sponge *Chalina*).
 — Diameter: 3.7–4.1 mm.
 — Shell: thick, tough and adhesive (pale yellow to light orange).
 — Oil globules: 1 (unpigmented).
 — O.G. diameter: about 0.8 mm.
 — Perivitelline space: narrow.

Myomeres: 38–39
 Vert : 38–39
 D : XVI–XVII, I, 12
 A : 13–14
 Piv : I, 3

- Larvae** — Hatching occurs at 10–14 mm; eyes pigmented and mouth well developed.
 — Body relatively deep, snout moderately pointed, and gut long (preanal length >50% SL, except shorter at hatching).
 — Bulging gut typical of cottids, but pronounced in this species.
 — Head length 20–25% TL at hatching, increases with growth.
 — Spines: 4 preopercle, 2 parietal, 2 supracleithral; 2 develop on opercle in juveniles.
 — Caudal fin develops shortly after hatching; all fin rays usually complete at 18–20 mm SL; dorsal fin origin anterior to gill opening (compare to *Myoxocephalus scorpius*, p. 231); sequence of fin development: C, D₂ and A, P, D₁, Piv.
 — Pigmentation: heavy dorsolaterally on head, body and peritoneum (denser than in *M. scorpius*, p. 231); spots develop on membranes of first and second dorsal fins and on anal fin; spots on ventral surface of lower jaw and occasionally on isthmus; few spots on ventrolateral gut but not ventral midline; ventral row of spots posterior to anal fin (deep-lying and difficult to see).

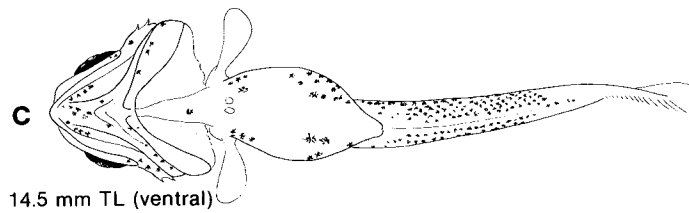
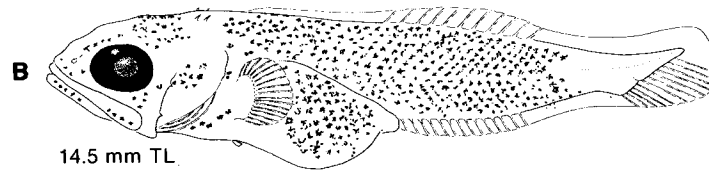
Fig. — **A**, Warfel and Merriman 1944; **B–D**, Khan MS 1972 (all redrawn).

Ref. — Fulman 1976; Okiyama and Sando 1976; Laroche MS 1980.

Hemitripterus americanus**COTTIDAE**

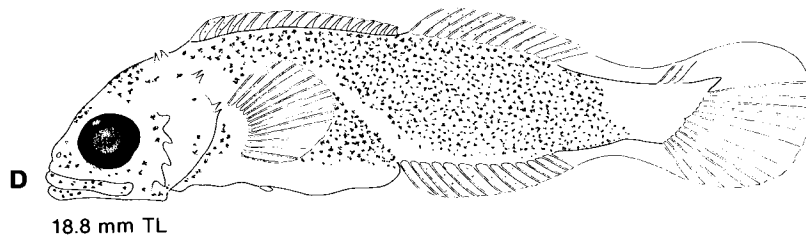
Hatches at larger size than
Myoxocephalus scorpius

Lateral body almost completely pig-
mented (except peduncle area) from
hatching through development



First 3 dorsal spines thicker
than other dorsal spines

Narrow unpigmented area posterior to dorsal gut
(compare to *Myoxocephalus scorpius*, p. 231)



Juvenile stage begins

COTTIDAE***Myoxocephalus aeneus* (Mitchill)**

Spawning: New Jersey to Gulf of St. Lawrence during winter-spring.

Meristic features

- Eggs**
- Demersal clusters on variety of substrates; incubation 40–57 days.
 - Diameter: 1.5–1.7 mm.
 - Shell: smooth and adhesive (clear, red, green, yellow).
 - Yolk: homogeneous.
 - Oil globules: 2 (coalesce to 1).
 - O.G. diameter: 0.2 mm.

Myomeres: 30–35
 Vert : 30–34
 D : VIII–XI, 12–17
 A : (8)10–11(14)
 Piv : I, 3–4
 P : 14–17

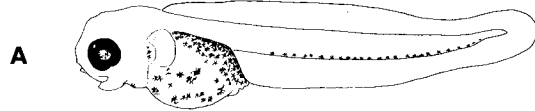
- Larvae**
- Hatching occurs at about 5 mm, and flexion at 6–8 mm.
 - Pigmentation: spots along ventral midline, isthmus to anus (occasionally fewer similar spots in *M. octodecemspinosus*) (see illustrations for more detail).
 - Fin and spine formation as follows:

Structure	Begin	Complete
Preopercle spines (4–6)	~5 mm	6–8 mm
Parietal spines (2)	~5	8–10
Supraorbital spine (1)	...	10–12
Supracleithral spine (1)	...	10–12
Pectoral rays	6–8	8–10
Caudal rays	6–8	8–10
Anal rays	6–8	8–10
Dorsal rays	6–8	8–10
Dorsal spines	8	8–10
Pelvic buds	~7.5	...
Pelvic rays	~8.5	9–10

Note: Hatching, flexion and relative development occur at smaller sizes than in *M. octodecemspinosus*.

Fig. — A–C, Lund and Marcy 1975; D, Khan MS 1972 (all redrawn).

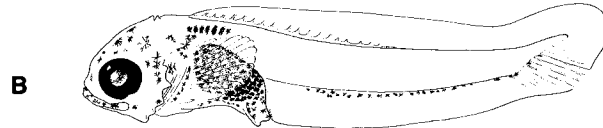
Ref. — Wheeler and Miller 1960; Ennis 1969; Cowan 1971; Laroche MS 1980.

Myoxocephalus aeneus**COTTIDAE**

5.4 mm TL

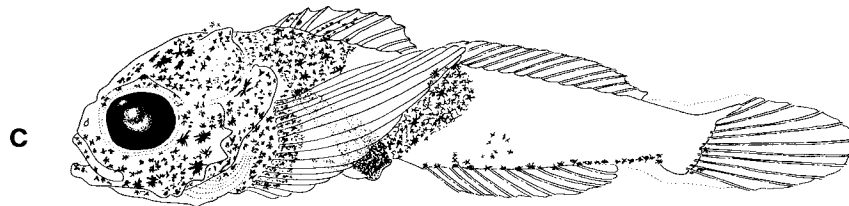
No spots on head in early larvae; heavy peritoneal pigment; spots at pectoral base; ventral row of spots begins at about myomere 8-13.

Internal pigment along dorsal fin base over pectoral fin



6.8 mm TL

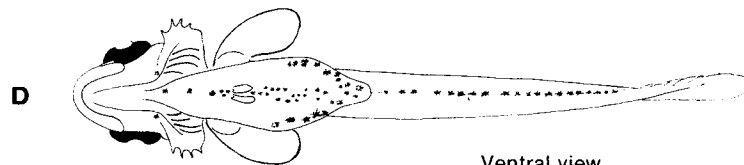
Head pigment can be very light



9.2 mm TL

Parietal spines merge to 1 per side at about 8.5 mm

Juvenile pigment developed at <12 mm; diagonal bands across body



9.7 mm TL

Ventral view

COTTIDAE *Myoxocephalus octodecemspinosus* (Mitchill)

Spawning: New Jersey to Gulf of St. Lawrence during late autumn to winter.

Meristic features

- Eggs** — Demersal clusters often deposited on sponge (*Haliclona*).
 — Diameter: 1.9–2.3 mm.
 — Shell: thick and adhesive (green, red, brown, orange).
 — Yolk: homogenous.
 — Oil globule: 1 or more.
 — O.G. diameter: varies.

Myomeres: 34–44
 Vert : 34–44
 D : VII–X, 15–17
 A : 12–15
 Piv : I, 3–4
 P : 16–19

- Larvae** — Hatching occurs at 6.3–7.3 mm, and flexion at 9–11 mm.
 — Resemble *Triglops murrayi* (see p. 230 for distinguishing characters).
 — Pigmentation: 3–5 large spots on isthmus in early larvae; small spots just anterior to anus disappear in larger larvae (see illustrations for more detail).
 — Fin and spine formation as follows:

Structure	Begin	Complete
Preopercle spines (4–6)	7.5 mm	8.5 mm
Parietal spines (2)	8.0	8.5
Supraorbital spine (1)	...	~14
Supracleithral spine (1)	...	~14
Pectoral rays	8–10	10–12
Caudal rays	8–10	14–16
Anal rays	8–10	12–14
Dorsal rays	10–12	12–14
Dorsal spines	11	12–14
Pelvic buds	~8.0	...
Pelvic rays	12–14	14–16

Note: Hatching, flexion and relative development occur at larger sizes than in *M. aeneus*.

Fig. — A, B, E, Colton and Marak MS 1969; C, D, Khan MS 1972 (all redrawn).

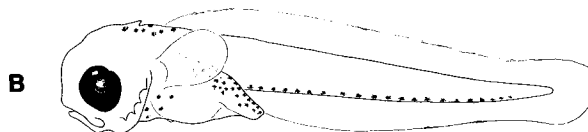
Ref. — Morrow 1951; Wheeler and Miller 1960; Ennis 1969; Cowan 1971; Laroche MS 1980.

Myoxocephalus octodecemspinosus**COTTIDAE**

6.8 mm TL

No spots on head in early larvae; ventral row of spots begins at about myomere 15, spaced apart anteriorly but close together posteriorly, begin to disappear at 12–14 mm.

Large spots on nape and peritoneum

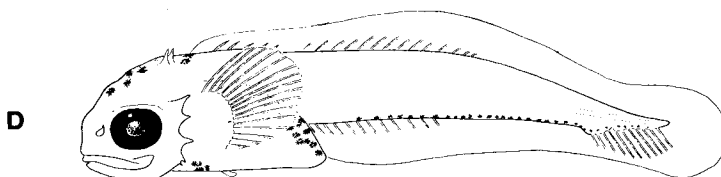


8.5 mm TL



9.5 mm TL

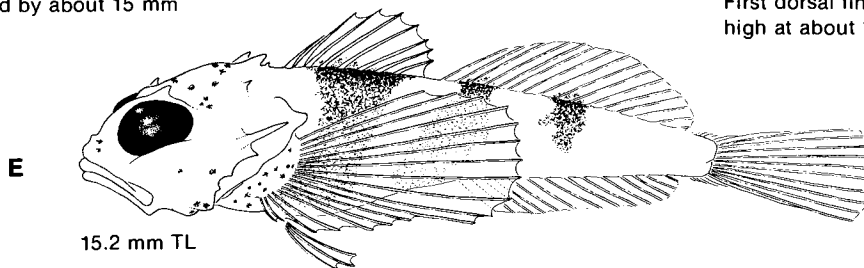
Ventral view



10.7 mm TL

Upper preopercle spine elongated by about 15 mm

First dorsal fin becomes high at about 15 mm



15.2 mm TL

Juvenile pigment developed at about 14 mm

COTTIDAE***Triglops murrayi* Günther**

Spawning: Gulf of Maine and more northern waters during autumn-winter.

Eggs — Undescribed.
— Oocyte diameter: 2.0–2.2 mm (pinkish).
— Oil globules: 3–15.

Larvae — Hatching occurs at about 7–8 mm, and flexion at about 12 mm.
— Distinguished from *Myoxocephalus octodecemspinosus* by meristic characters, deeper head, and development of 2 supraorbital spines at 12–14 mm (only 1 spine in *Myoxocephalus* species).
— Pigmentation: small group of tiny spots just anterior to anus at 8–10 mm (disappear later) (see illustrations for more detail).
— Fin and spine formation (see table below).

Meristic features

Myomeres: 43–46
Vert : 42–47
D : X–XII, 18–24
A : 19–23
PIV : 1,3
P : 16–19

***Myoxocephalus scorpius* (Linnaeus)**

Spawning: New York to Arctic waters in winter.

Eggs — Demersal in clusters; incubation about 3 months.
— Diameter: 2.0–2.5 mm.
— Shell: thick and adhesive (red-yellow to pinkish).
— Yolk: homogeneous.
— Oil globules: 1.
— O.G. diameter: 0.4–0.5 mm.

Larvae — Hatching occurs at 7.4–8.6 mm, and flexion at 9–15 mm.
— Preanus length shorter than in *Hemitripterus americanus*.
— Pigmentation: no abdominal or isthmus spots, but few just anterior to anus (see illustrations for more detail).
— Fin and spine formation (see table below).

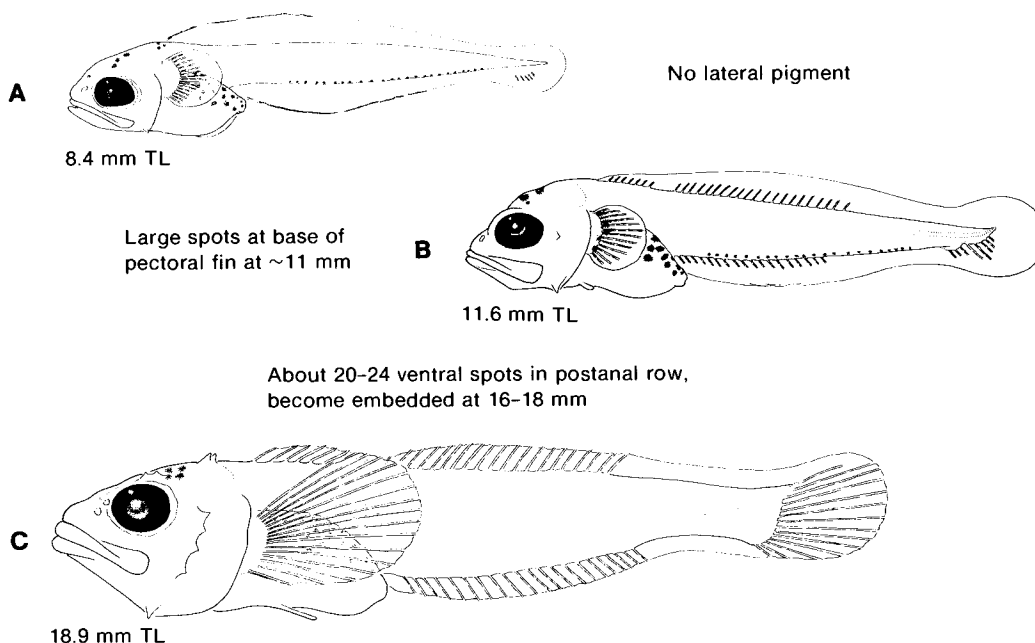
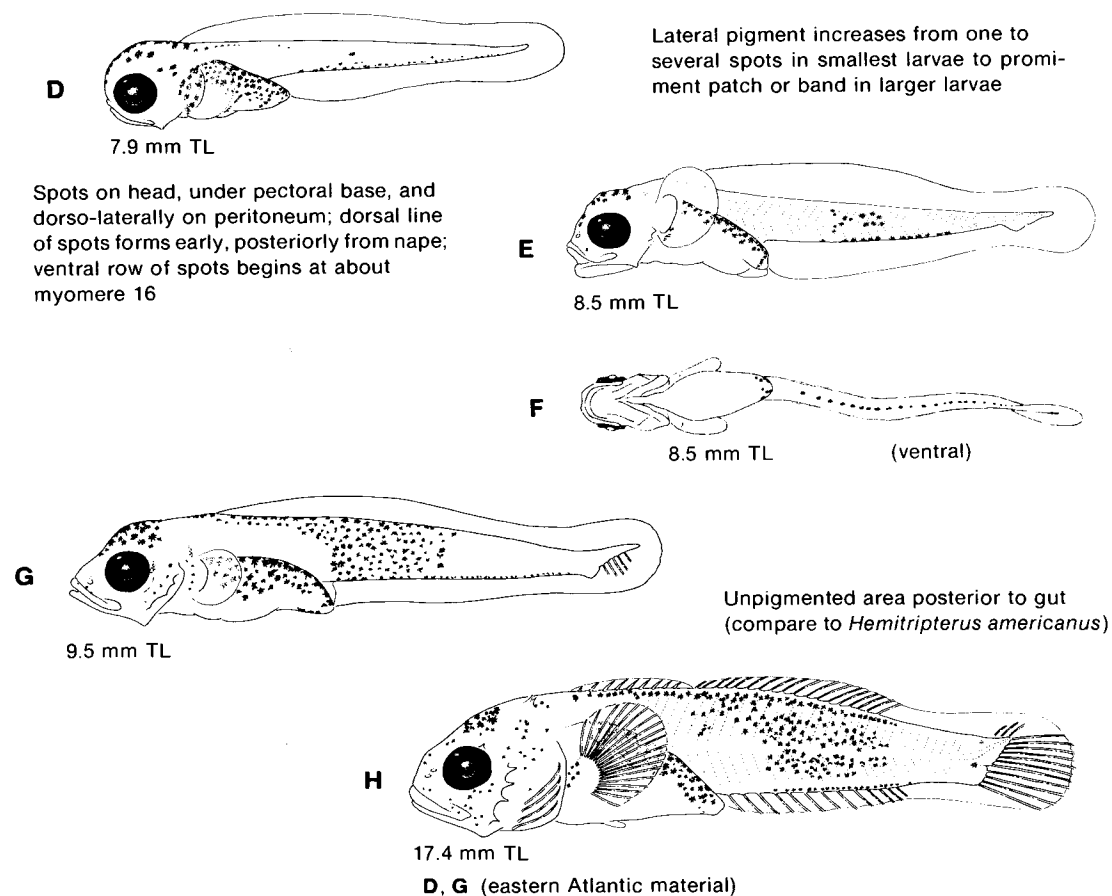
Meristic features

Myomeres: 32–41
Vert : 32–41
D : VII–XII, 12–20
A : 9–16
PIV : 1,3
P : 14–19

Structure	<i>T. murrayi</i>		<i>M. scorpius</i>	
	Begin	Complete	Begin	Complete
Preopercle spines (4)	12–14 mm	12–14 mm	10 mm	12–14 mm
Parietal spines (2)	12–14	12–14	10	16–18
Supraorbital spine(s)	12–14 (2)	12–14	... (1)	16–18
Supracleithral spine (1)	14–16	14–16	...	16–18
Pectoral rays	~8.5	12–14	10–12	14–16
Caudal rays	~8.5	14–16	8–10	14–16
Anal rays	~10.5	14–16	12–14	14–16
Dorsal rays	~10.5	14–16	12–14	16–18
Dorsal spines	~11.0	14–16	13–16	16–18
Pelvic buds	~9.0	...	9.0	...
Pelvic rays	14–16	16–18	14–16	16–18

Fig. — A–C, E–F, H, Khan MS 1972; D, G, Rass 1949 (all redrawn).

Ref. — Cox 1921; Vladikov 1933; Andriyashev 1954; Musick and Able 1969; Cowan 1971; Russell 1976; Laroche MS 1980; L. Van Guelpen 1981 (pers. comm.).

Triglops murrayi**COTTIDAE*****Myoxocephalus scorpius***

SERRANIDAE**Four Subfamilies****Serraninae**

- Larvae** — Body moderately stubby.
 — Short weak fin spines; or, if elongate, not serrated.
 — Reduced head armature.
 — Pigment variable, usually light.

Meristic features

Vert: 10+14
 D : X, 11-15
 A : III, 6-8

Anthiinae

- Larvae** — Deep-bodied.
 — Strong, barely elongate fin spines.
 — Paired spines on preopercle and interopercle.
 — Pigment usually light, some large blotches.

Meristic features

Vert: 10+16
 D : X, 13-20
 A : III, 7-8

Epinephelinae

- Larvae** — Body moderately long.
 — Dorsal and pelvic spines elongate with serrations.
 — Spines on preopercle.
 — Consolidated pigment patterns, especially on peduncle.

Meristic features

Vert: 10+14
 D : IX-XI, 13-20
 A : III, 7-12

Gonioplectrus hispanus (Cuvier)

(Subfamily Epinephelinae)

- Larvae** — Deep-bodied.
 — Elongate dorsal, anal and pelvic spines.
 — Spines on preopercle and upper opercle.
 — Consolidated pigment especially on peduncle.
 — Exhibit some characters of Anthiinae.

Meristic features

Vert: 10+14
 D : VIII, 13
 A : III, 7

Grammistinae*

- Larvae** — Body moderately long.
 — Dorsal spines (1 or 2) elongate, filamentous, with pigmented sheath.
 — Reduced head armature (spines weak, if present).
 — Reduced pigment.

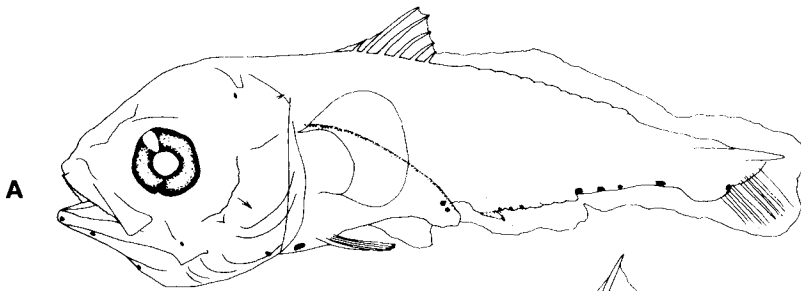
Meristic features

Vert: 10+14-15
 D : II-III or VII-VIII,
 24-26 or 12-15
 A : 0 or III,
 15-17 or 7-8

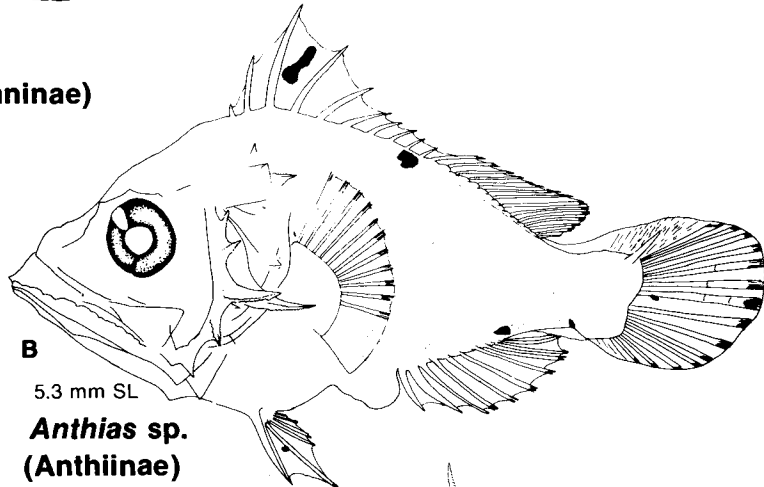
* Grammistidae in Robins *et al.* (1980).

Genera of Four Subfamilies

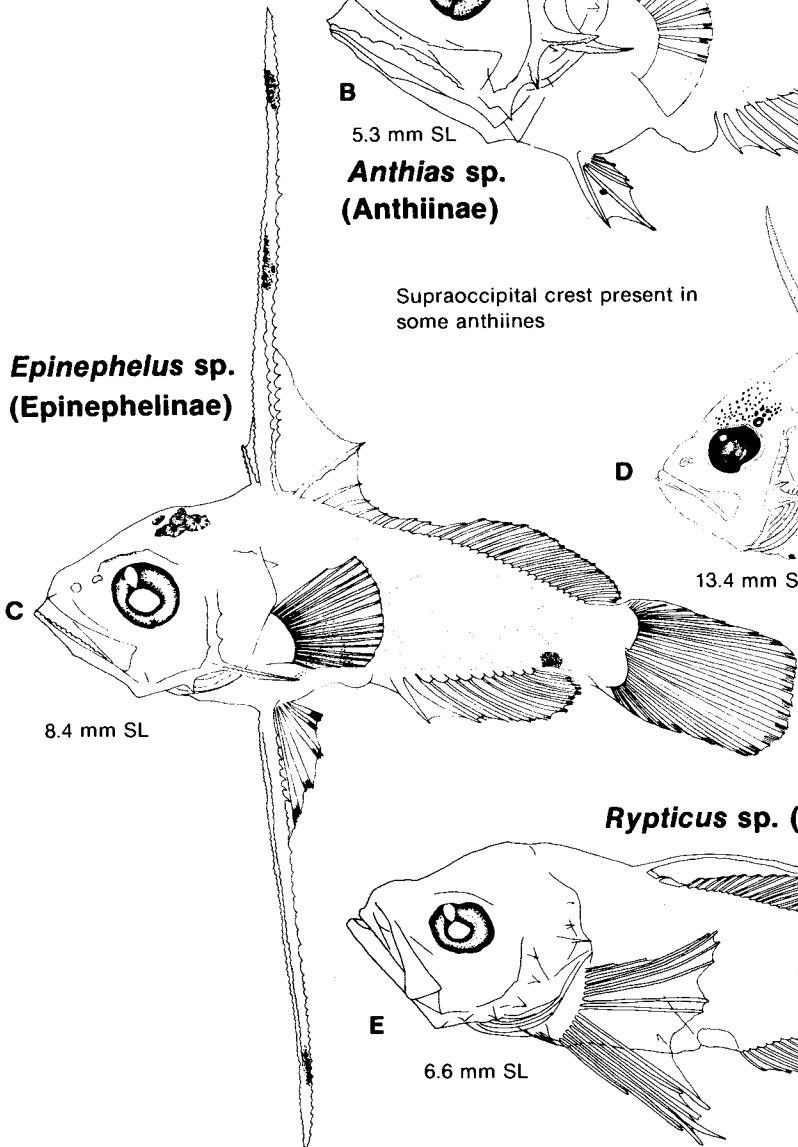
SERRANIDAE



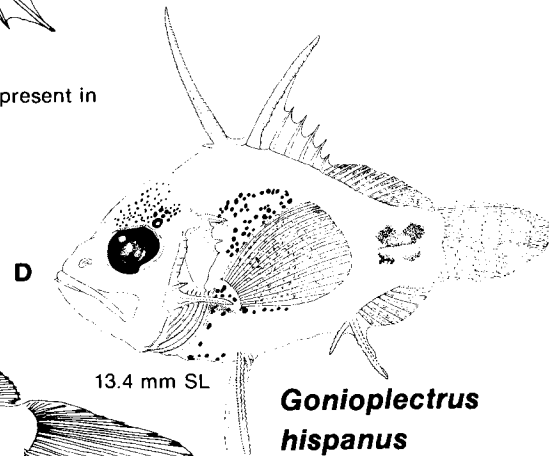
5.8 mm SL

***Diplectrum* sp. (Serraninae)**

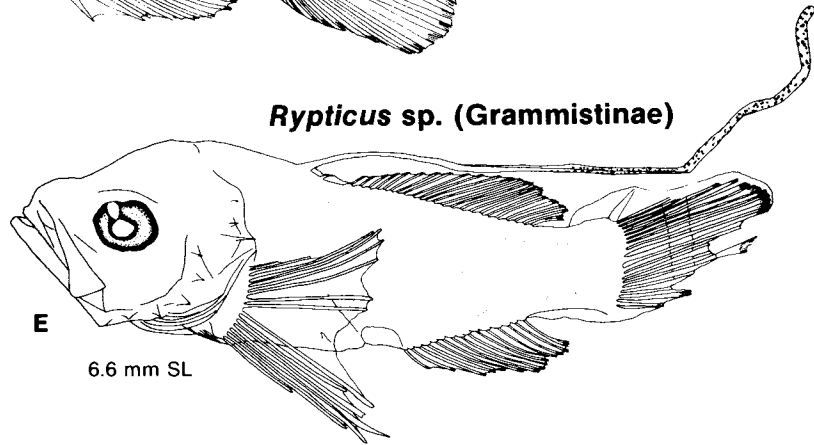
5.3 mm SL

***Anthias* sp.
(Anthiinae)**Supraoccipital crest present in
some anthiines***Epinephelus* sp.
(Epinephelinae)**

8.4 mm SL



13.4 mm SL

***Gonioplectrus*
hispanus
(Epinephelinae)*****Rypticus* sp. (Grammistinae)**

6.6 mm SL

SERRANIDAE
Serraninae

***Centropristis striata* (Linnaeus)**

Spawning: May–November in Mid-Atlantic Bight.

Meristic features

- Eggs**
- Pelagic, spherical.
 - Diameter: 0.8–1.0 mm.
 - Shell: smooth.
 - Yolk: homogeneous, amber.
 - Oil globules: 1.
 - O.G. diameter: 0.13–0.19 mm.
 - Perivitelline space: narrow.

Myomeres: 24
 Vert : 10+14
 D : X, 11
 A : III, 7
 P : 18
 Plv : I, 5
 C : 9–10+9+8+8

- Larvae**
- Hatching occurs at about 1.5–2.0 mm.
 - Body stocky, depth 25–27% SL; large head, 33% SL at 2–4 mm and 38% SL at 12 mm.
 - Preanal length increases from 50% SL at 5 mm to 58% SL at 10 mm to 65% SL in juvenile.
 - Lack extensive armature — preopercle and opercle have 4–7 short, widely-spaced spines in specimens >5 mm SL.
 - Most meristic characters develop between 6 and 10 mm SL.
 - Sizes at beginning of ossification and completion of fin rays and vertebrae:

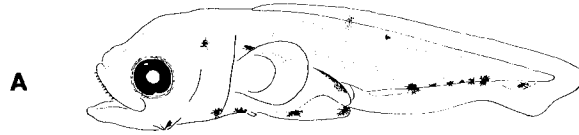
Principal caudal rays	5.0 mm	6.5 mm
Dorsal rays	4.6–5.5	8.7
Anal rays	5.5	6.5*
Pectoral rays (bud at 2.1 mm)	5.2	8.7
Pelvic rays (bud at 4.0 mm)	6.0	7.7
Vertebrae	4.6	6.7–7.0

* Third anal spine begins as a ray and changes at about 7 mm.

- **Pigmentation:** ventral pigment characteristic (note spots from posterior end of anal fin to caudal base); spot(s) under tip of lower jaw; pigment on gut; occasional dorsal pigment.

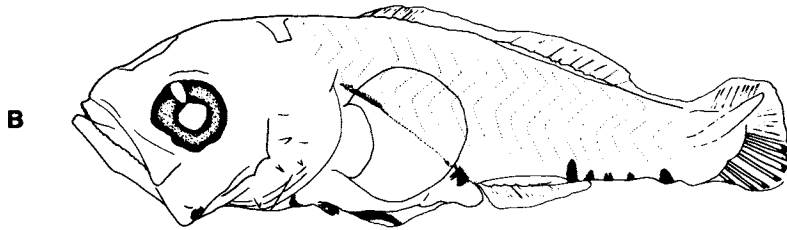
Fig. — **A, E**, Kendall 1972 (redrawn); **B–C**, Kendall 1979; **D, F**, Lippson and Moran 1974 (redrawn).

Ref. — Kendall 1977.

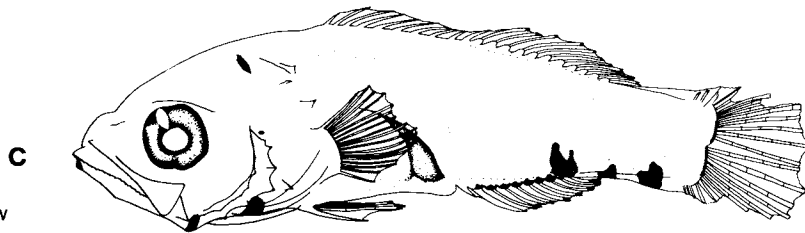
Centropristis striata**SERRANIDAE**

5.1 mm SL

Teeth apparent at 5.0 mm



4.7 mm SL



Spots under tip of lower jaw

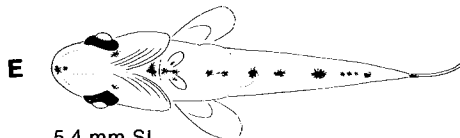
8.3 mm SL

Characteristic spots just anterior to cleithral symphysis and between pelvic bases

Ventral views



5.3 mm SL

Micropogonias undulatus (p. 278)

5.4 mm SL

Centropristis striata

Note difference in development of pectoral and pelvic fins and space between anus and anal fin origin in *Leiostomus* and *Micropogonias*.



5.6 mm SL

Leiostomus xanthurus (p. 276)

BRANCHIOSTEGIDAE* *Lopholatilus chamaeleonticeps* Goode and Bean

Spawning: Near edge of continental shelf north of Cape Hatteras in summer.

Meristic features

- Eggs**
- Pelagic, spherical and transparent.
 - Diameter: 1.16–1.25 mm.
 - Shell: thin with reticulations visible under low magnification.
 - Yolk: homogeneous (amber).
 - Oil globules: 1.
 - O.G. diameter: 0.18–0.20 mm.
 - Perivitelline space: moderate.
 - Above characteristics are for artificially-fertilized eggs; those caught in the wild are modally 1.3–1.4 mm in diameter, with oil globule modally 0.20–0.24 mm in diameter.

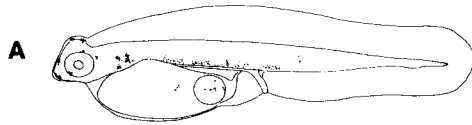
Myomeres : 24
 Vert : 10+14
 D : VII, 15
 A : I, 13–14
 Piv : I, 5
 P : 16–18

- Larvae**
- Hatching occurs at 2.6 mm 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 develops early, and cranial spines form sequentially in groups, all being well-developed by 5 mm NL.
 - Preanus length increases from about 55% to 70% NL, body depth increases from about 22% to 40% NL, and head length increases 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 SL.
 - Pelagic juveniles descend to bottom between 9.0 and 15.5 mm SL.
 - Sizes at beginning of ossification and completion of fin rays:

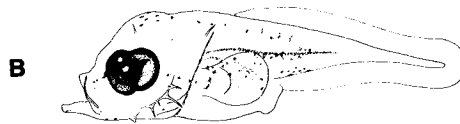
Caudal rays	~4.0 mm NL	5.4 mm SL
Dorsal rays	4.9	8.2
Anal rays	4.9	8.2
Dorsal spines	5.3	8.2
Pectoral rays	5.4	~8.5
Pelvic rays (bud at 4.5 mm NL)	6.5+	9.0

- 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.

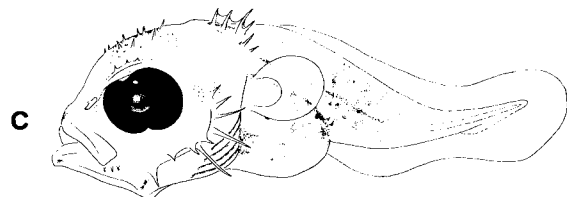
* Malacanthidae in Robins *et al.* (1980).

***Lopholatilus chamaeleonticeps* BRANCHIOSTEGIDAE**

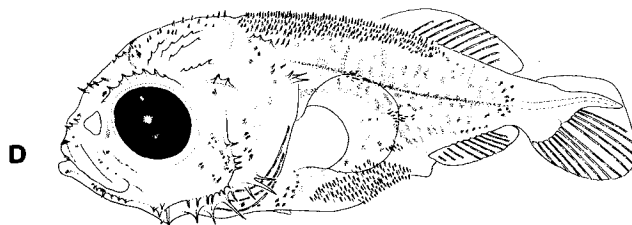
2.6 mm NL



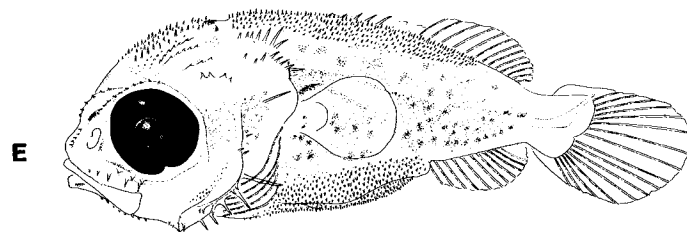
2.8 mm NL



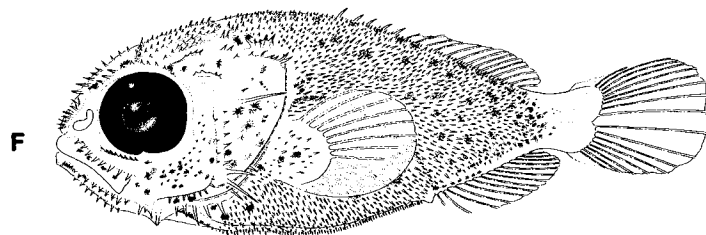
3.7 mm NL



4.8 mm NL



5.3 mm NL



6.0 mm NL

POMATOMIDAE *Pomatomus saltatrix* (Linnaeus)

Spawning: Summer in Mid-Atlantic Bight, earlier in South Atlantic Bight.

Meristic features

- Eggs**
- Pelagic, spherical.
 - Diameter: 0.95–1.00 mm.
 - Shell: smooth and transparent.
 - Yolk: homogeneous.
 - Oil globules: 1.
 - O.G. diameter: 0.26–0.29 mm.
 - Perivitelline space: narrow.

Myomeres: 26
 Vert : 11+15
 D : VII–IX, 23–28
 A : II–III, 24–29
 P : 18
 Plv : I, 5
 C : 9–10+9+8+9–10

- Larvae**
- Hatching occurs at 2.0–2.4 mm, eyes unpigmented, oil globule posterior; yolk absorbed at 3.3–3.6 mm; flexion occurs at 4.3–5.0 mm.
 - Body moderately elongate, with preanal length about 50% SL, decreasing to 33% SL with development and increasing to 50% SL in juvenile stage.
 - Preanal myomeres; 9 at hatching; 12 at 8.5 mm.
 - Teeth well developed at 4.3 mm; body deepens at about 6 mm.
 - Preopercle spines increase from 2 at 4.8 mm to 6 at 9.5 mm and to 7 at 12.8 mm (see note below).
 - Ossification onset sequence: C, D₂, A, D₁, P, Plv.
 - Size at completion of ossification of fin rays: dorsal at 7.0 mm, anal at 7.5 mm, pelvic at 8.5 mm (bud at 6 mm), caudal at 13.0 mm, and pectoral at 14.0 mm.
 - Ossification of vertebrae complete at 6.0–6.5 mm.
 - Pigmentation: (see illustrations opposite).

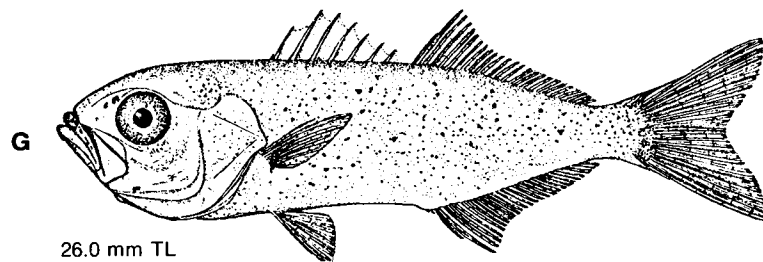
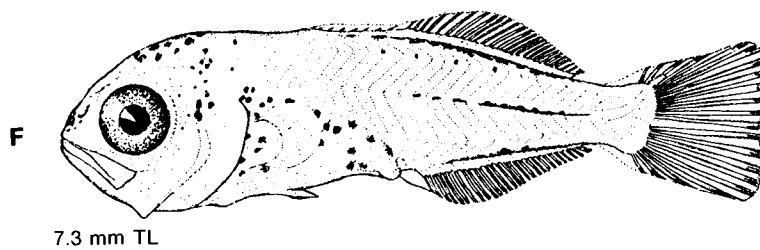
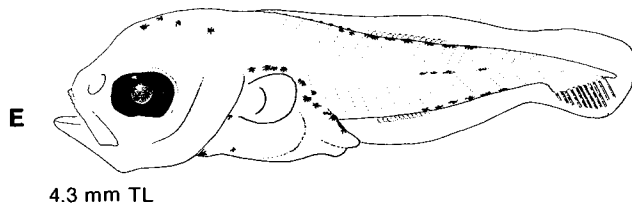
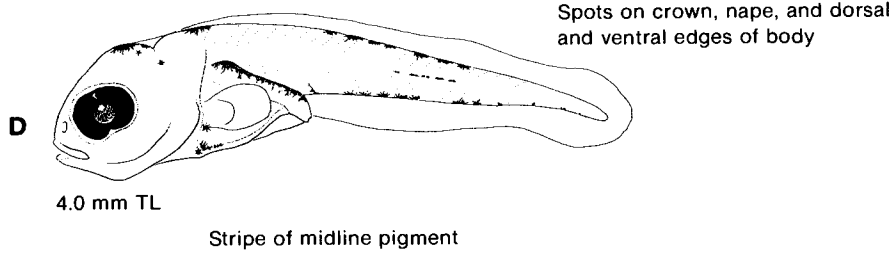
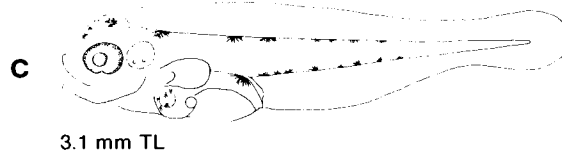
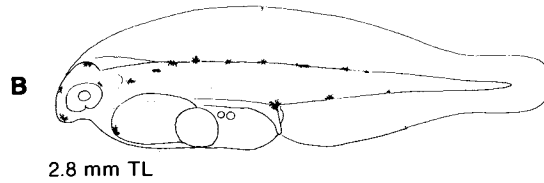
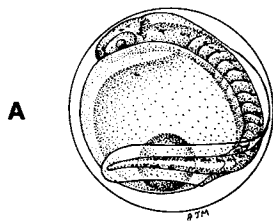
Note: Preopercle spines (not illustrated) are tiny and about equal in length. Spine at preopercle angle is pronounced in carangids (p. 240–259)

Fig. — A–C, Deuel *et al.* 1966; D, Norcross *et al.* 1974; E–G, Pearson 1941 (B–E redrawn).

Ref. — Kendall and Walford 1979.

Pomatomus saltatrix

POMATOMIDAE



CARANGIDAE 28 Species in Western North Atlantic

General characters

- Eggs** — Pelagic, shell smooth, yolk homogeneous or segmented, 1 oil globule anterior in late eggs and hatchling (eggs described in only a few species).
- Larvae** — Usually 24 myomeres (maximum 26).
 — Principal caudal fin rays (9+8); pelvic fin ray counts (I, 5).
 — First 2 anal spines widely separated from 3rd spine.
 — First dorsal fin has maximum of 8 spines (number less in some species).
 — Median occipital crest present in some species.
 — Orbital crest and posttemporal spines present in some species.
 — Preopercle spines present on margin and on ridge (secondary spination in *Oligoplites*, *Elagatis*, and *Seriola zonata*).
 — Fin ray and gillraker counts are useful in *Caranx* longer than 14 mm SL.

Useful generic characters

a) Number of dorsal and anal rays about equal

- Chloroscombrus** — Relatively deep-bodied, with median occipital crest.
Oligoplites — Relatively elongate body, with no occipital crest.

b) Few more dorsal than anal rays

- Alectis** — Relatively deep-bodied, with median occipital crest.
Caranx — Relatively deep-bodied, with median occipital crest.
Selene — Relatively deep-bodied, with median occipital crest.
*Vomer** — Relatively deep-bodied, with median occipital crest.
Decapterus — Relatively elongate body, with median occipital crest.
*Trachurus** — Relatively elongate body, with median occipital crest.
Selar — Relatively elongate body, with median occipital crest.
Trachinotus — Relatively elongate body, with no occipital crest.
Hemicaranx — Larvae undescribed.

c) Many more dorsal than anal rays

- Naucrates* — Relatively deep-bodied, with median occipital crest.
Elagatis — Relatively elongate body, with median occipital crest.
Seriola — Relatively elongate body, with no occipital crest.
Uraspis — Larvae undescribed.

* Based on larval descriptions of species outside the western North Atlantic.

CARANGIDAE 28 Species in Western North Atlantic**Meristic characters and sources of larval descriptions**

	Source of description ^a	Dorsal		Anal	No. of vertebrae
		First	Second		
<i>Alectis crinitus</i> ^b		VII	I,18-19	II,I,15-16	24
<i>Caranx bartholomaei</i>	3	VIII	I,25-28	II,I,21-24	24
<i>Caranx crysos</i>	3,4	VIII	I,22-25	II,I,19-21	25
<i>Caranx hippos</i>	3?,12,13	VIII	I,19-21	II,I,16-17	24
<i>Caranx latus</i>	3?	VIII	I,19-22	II,I,16-18	24
<i>Caranx lugubris</i>		VIII	I,22	II,I,19	24
<i>Caranx ruber</i>		VIII	I,26-30	II,I,23-26	24
<i>Caranx dentex</i> ^c	11	VIII	I,25-26	II,I,21-23	
<i>Chloroscombrus chrysurus</i>		VII-VIII	I,24-28	II,I,25-27	24
<i>Decapterus macarellus</i>		VIII	I,31-37	II,I,27-31	24
<i>Decapterus punctatus</i>	1,2	VIII	I,27-34	II,I,24-30	25
<i>Decapterus tabl</i>		VIII	I,29-34	II,I,24-27	24
<i>Elagatis bipinnulatus</i>	1,5	V-VI	I,25-30	II,18-22	24
<i>Hemicaranx amblyrhynchus</i>		VII-VIII	I,27-29	II,I,23-25	26
<i>Naucrates ductor</i>	8	III-IV	I-II,26-28	II,II,15-16	25
<i>Oligoplites saurus</i>	1	V-VI	I,19-21	II,I,18-21	26
<i>Selar crumenophthalmus</i>	9,14,15	VIII	I,24-26	II,I,21-23	24
<i>Selene vomer</i>	1	VII-VIII	I,21-23	II,I,18-20	24
<i>Seriola dumerili</i>	2,10	VII	I,29-35	II,I,19-22	24
<i>Seriola fasciata</i>		VII-VIII	I,28-32	II,I,18-21	
<i>Seriola rivoliana</i>		VII-VIII	I,27-33	II,I,19-22	24
<i>Seriola zonata</i>	1	VII-VIII	I,33-40	II,I,19-21	24
<i>Trachinotus carolinus</i>	6	V-VI	I,22-27	II,I,20-23	24
<i>Trachinotus falcatus</i>	6	VI	I,17-21	II,I,16-19	24
<i>Trachinotus goodei</i>	6,7	VI	I,19-20	II,I,16-18	
<i>Trachurus lathami</i>		VIII	I,28-33	II,I,26-30	24
<i>Uraspis heidi</i>		VIII	I,29	O-I,21	
<i>Vomer setapinnis</i> ^d		VIII	I,20-23	II,I,17-20	24

- ^a Sources: 1. Aprieto 1974. 9. Delsman 1926.
 2. Hildebrand and Cable 1930. 10. Sanzo 1933b.
 3. Berry 1959. 11. Schnakenback 1931.
 4. McKenney *et al.* 1958. 12. Chacko 1950.
 5. Okiyama 1970. 13. Subrahmanyam 1964.
 6. Fields 1962. 14. Miller *et al.* 1979.
 7. deGaetani 1940. 15. Zvyagina and Rass 1977.
 8. Sanzo 1931b.

^b = *A. ciliaris*

^c = *Pseudocaranx dentex* (Block and Schneider) (see Berry and Smith-Vaniz 1978).

^d = *Selene setapinnis* (Mitchill) (see Berry and Smith-Vaniz 1978).

CARANGIDAE***Caranx crysos* (Mitchill)**

Spawning: Mostly during January–August, with peak during the summer.

Eggs — Undescribed.

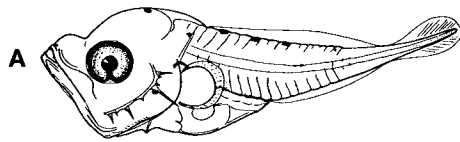
Larvae — Mouth large, nearly vertical.
— Flexion occurs at 4.2–5.3 mm SL, and metamorphosis at about 8 mm SL.
— Body depth and head length proportions:

Meristic features

Myomeres: 25
Vert : 10+15
D : VIII, I, 22–25
A : II, I, 19–21
C : 8–9+9+8+8–9
GR : 10–14+23–28

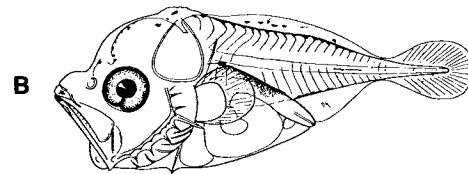
	Preflexion	Flexion	Postflexion
Size range (mm SL)	2.6–4.1	4.2–5.3	5.4–10.8
Body depth at pectoral base (% SL)	30–49	32–58	43–57
Head length (% SL)	35–42	32–42	33–41

- Dorsal and anal spines and principal caudal rays complete at about 5.4 mm SL.
- Pelvic buds form at 5.4 mm, and rays complete at about 6.2 mm SL.
- Dorsal and anal rays complete at 7.5–8.5 mm SL, and pectoral rays formed at about 8.5 mm SL.
- Preopercle spines, in 2 rows with largest spine at angle, form early and reach maximum relative size at 4–5 mm SL.
- Occipital crest with serrate edge forms at about 3.8 mm NL, becomes reduced, and disappears at about 8 mm SL.
- Tiny posttemporal spines present from about 4.2 mm NL until about 8.5 mm SL.
- Few spines along upper jaw in larvae about 4–5 mm SL.
- Pigmentation: row of spots along bases of second dorsal and anal fins and along lateral midline between these fins; spots appear over gut at about 4 mm NL and increase with growth; spots on head increase with development; peduncle unpigmented throughout larval stage.

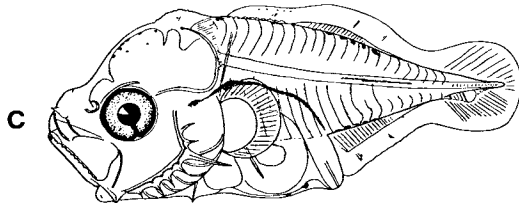
Caranx crysos**CARANGIDAE**

2.6 mm SL

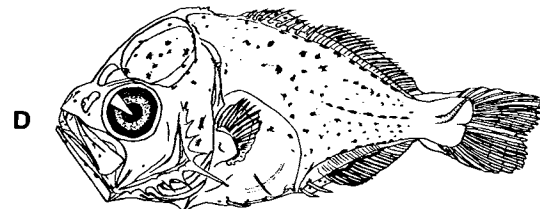
Body depth increases early



3.8 mm SL

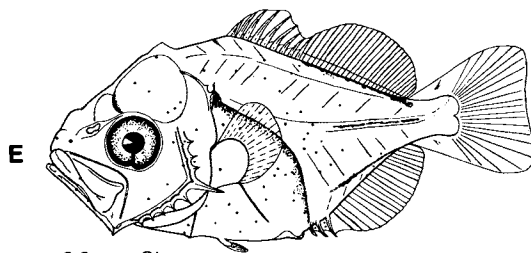


4.2 mm SL

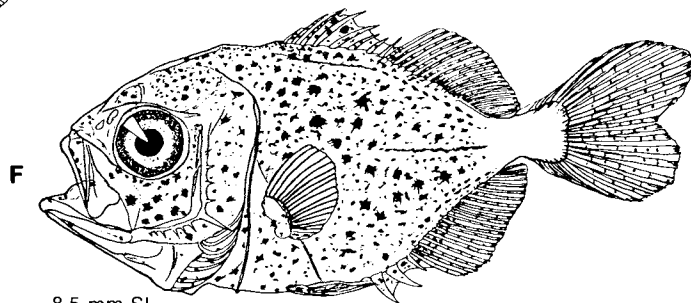
3 rows of spots and
scattered flank spots

5.4 mm SL

Dorsal and anal spine membranes pigmented

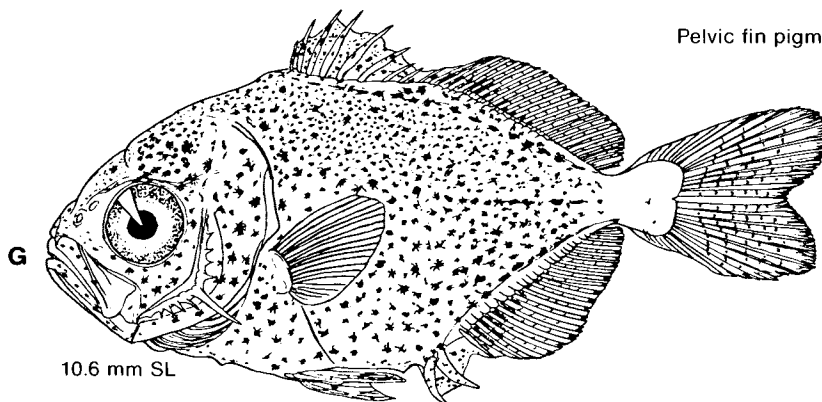


6.2 mm SL



8.5 mm SL

Pelvic fin pigmented



10.6 mm SL

Pigment bars form at 15-19 mm

CARANGIDAE***Caranx bartholomaei* Cuvier****Spawning:** Mainly south of United States in February–October.**Meristic features****Eggs** — Undescribed.

Myomeres: 24

Larvae — Specimen 6.0 mm SL tentatively identified.

Vert : 10+14

- Dorsal and anal spines and pelvic rays complete by about 6 mm SL; dorsal, anal and pectoral rays complete by about 8 mm SL.

D : VIII, I, 25–28

A : II, I, 21–24

C : 8–9+9+8+7–9

GR : 6–8+18–21

- Posttemporal spines and serrate occipital crest present at 6 mm SL, but no posttemporal spines at about 8 mm SL and occipital crest loses serrations.

- Preopercle spines decrease in relative size at about 10 mm.

- Pigmentation: rows of spots along second dorsal fin base and at midline; few spots on dorsal and anal spine membranes, on pelvic fin, and along anal fin base; peduncle unpigmented.

Caranx hippos* (Linnaeus) — *Caranx latus* Agassiz*Spawning:** Mainly south of United States in March–July (*C. latus*) or September (*C. hippos*).**Meristic features***C. hippos**C. latus***Eggs** — Undescribed.

Myomeres: 24

24

Vert : 24

24

Larvae — Similar for both species (not presently separable).

D : VIII, I, 19–21

VIII, I, 19–22

A : II, I, 16–17

II, I, 16–18

GR : 6–9+16–19

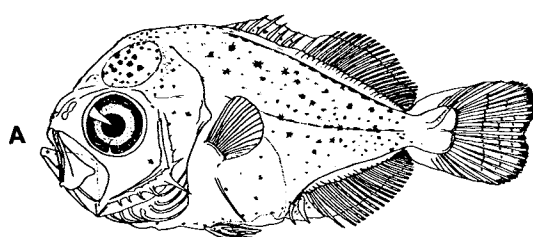
6–7+16–18

- Dorsal and anal spines complete at 5.4 mm; pelvic buds form at 5.4 mm and rays complete at 6.9 mm; principal caudal rays complete at 6.9 mm; dorsal, anal and pectoral rays complete at 8.3 mm.

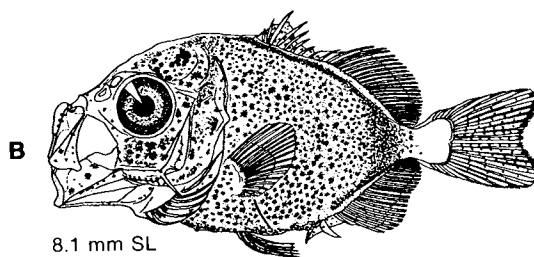
- Preopercle and posttemporal spines present.

- Serrate occipital crest present at 5.4 mm, and lost at 6.2 mm.

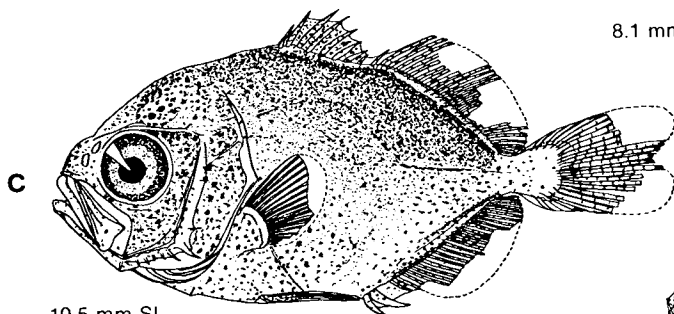
- Pigmentation: spots on membrane of anal spine and first 4 dorsal spines; midline row of spots present at 5.4–6.3 mm but absent by 6.9 mm; spots become scattered on body and head.

Caranx bartholomaei**CARANGIDAE**

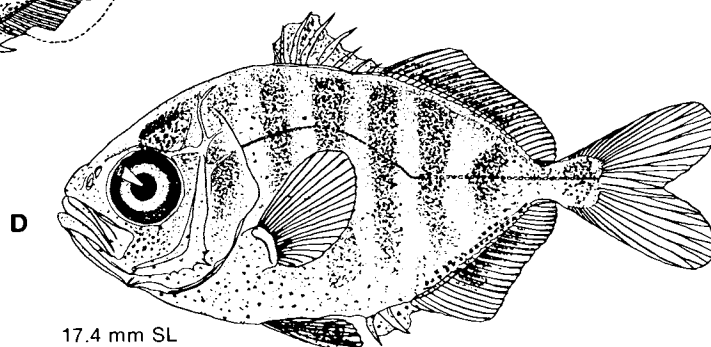
6.0 mm SL



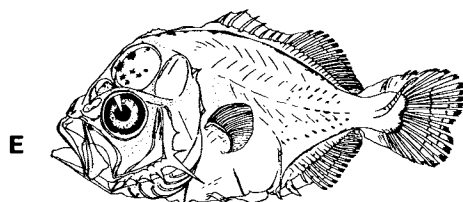
8.1 mm SL



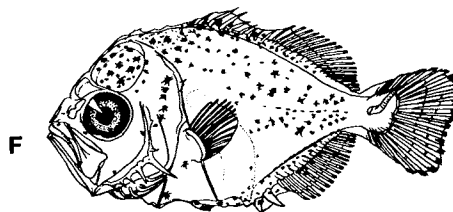
10.5 mm SL



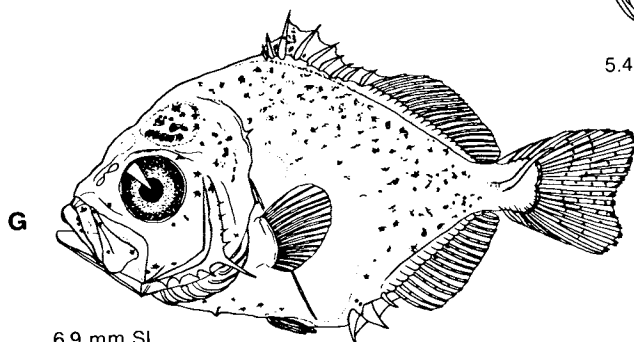
17.4 mm SL

Caranx latus* or *C. hippos

4.9 mm SL



5.4 mm SL



6.9 mm SL

CARANGIDAE***Decapterus punctatus* (Agassiz)****Spawning:** May–November (mainly July–September).**Eggs** — Undescribed.

- Larvae** — Body shallower and tail longer than *Caranx* (see below).
 — Flexion occurs at 4–8 mm, and metamorphosis at 12–14 mm.
 — Snout concave, becoming straight at flexion and convex in later larvae.
 — Body depth decreases from 35% to 31% SL during larval development and to 28% SL at metamorphosis.
 — Head long and deep; length increases from 27% to 35% SL in larvae and becomes 31% SL at metamorphosis.
 — Preanal length ranges from 52% to 60% SL in larvae and juveniles.
 — Sizes at beginning of ossification and completion of fin rays:

Meristic features

Myomeres:	25
Vert :	10+15
D :	VIII, I, 27–34
A :	II, I, 24–30
C :	8–9+9+8+8–9

Principal caudal rays	4 mm	6 mm
Dorsal rays	5	10
Anal rays	5	9–11
Pectoral rays	5	11
Pelvic rays (bud at 4–5 mm)	7	7

- Dorsal and anal finlets formed before metamorphosis.
 — Occipital crest present, but resorbed at metamorphosis; orbital crest with one weak spine in 3–7 mm larvae, but lost by 10 mm.
 — Preopercle spines on edge and ridge (lost at metamorphosis).
 — Pigmentation: sparse; paler than in *Elagatis* and *Seriola* (p. 249, 257).

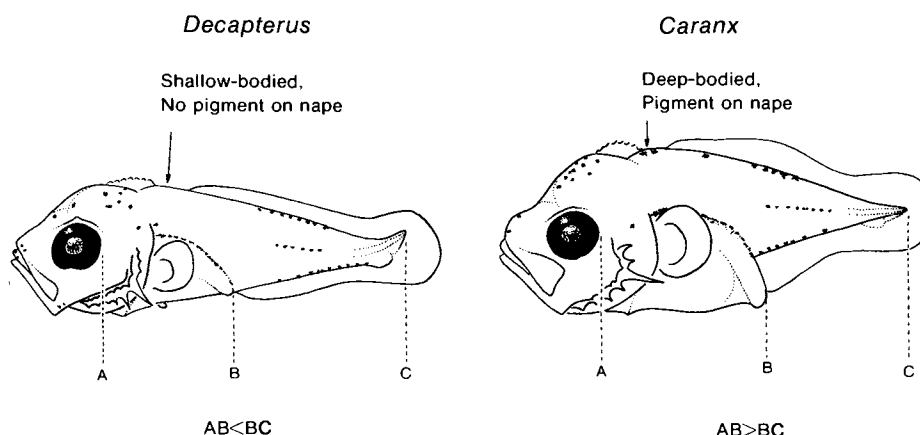
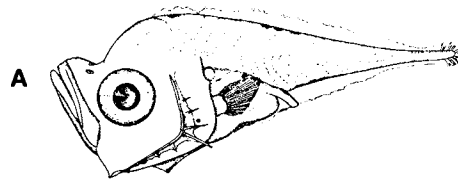
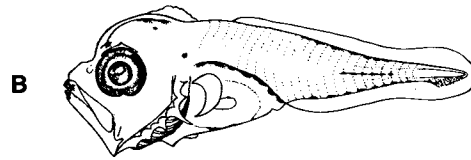


Fig. — **A**, Hildebrand and Cable 1930; **B–G**, Aprieto 1974.

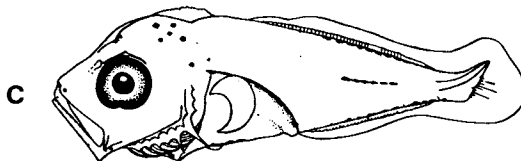
Decapterus punctatus**CARANGIDAE**

2.3 mm

Scattered spots on head

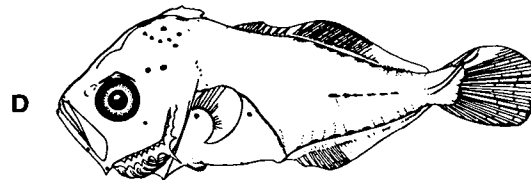
Specimen A distorted
(possibly dessicated)

3.1 mm SL

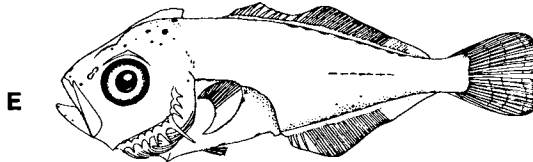


4.2 mm SL

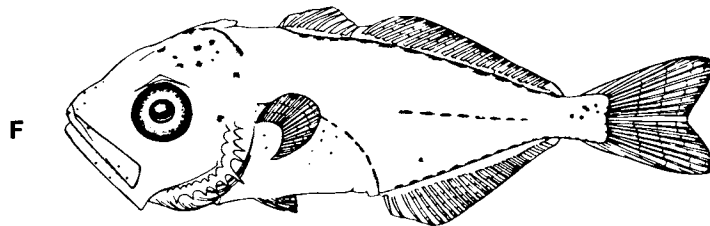
Peritoneal pigment

Rows of spots along dorsal and anal bases
and at posterior midline

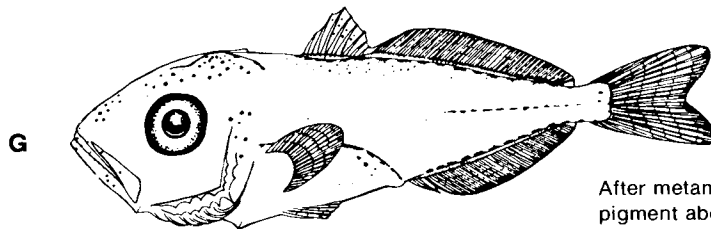
5.5 mm SL



6.5 mm SL



8.0 mm SL



12.0 mm SL

After metamorphosis, most
pigment above midline

CARANGIDAE *Elagatis bipinnulatus* (Quoy and Gaimard)**Spawning:** Year-round in offshore waters.**Eggs** — Undescribed.**Larvae** — Head deeper than long through larval development.

— Snout concave, becoming convex at metamorphosis.

— Flexion occurs at 4.6–8.0 mm SL, and metamorphosis at 10–14 mm.

— Body depth ranges from 32% SL at 3.8 mm to maximum 40% SL at flexion.

— Head length increases from about 32% SL at 3.8 mm to about 35% SL in late larvae and juveniles.

— Sizes at beginning of ossification and completion of fin rays:

Meristic features

Myomeres: 24

Vert: 10+14

D: V–VI, I, 25–30

A: II, 18–22

C: 7–11+9+8+10–11

Principal caudal rays	4.6 mm	7.0 mm
Dorsal spines	5.0	7.0
Anal rays	5.0	8.0–9.0
Dorsal rays	5.0	10.0
Pectoral rays	5.0	9.0
Pelvic rays	6.0	8.0

— Dorsal and anal finlets form after metamorphosis.

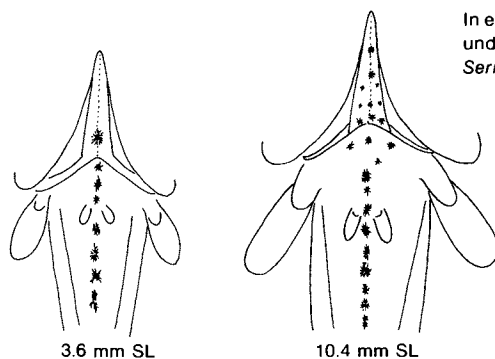
— Only 2 anal spines present; dorsal spines all equal in length.

— Occipital crest present in larvae, but lost at metamorphosis.

— Low orbital crest in early larvae.

— Preopercle angle spine has secondary serrations.

— Pigmentation: dense throughout development (see illustrations opposite).



In early larvae, a mid-ventral row of spots under gut and isthmus (not present in *Seriola*, p. 256).

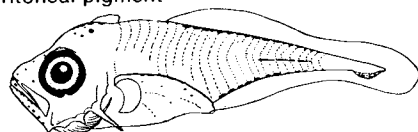
Pacific material (Okiyama 1970)

Fig. — A, D, G, Aprieto 1974; B–C, E–F, H, Okiyama 1970.**Ref.** — Fahay 1975.

Elagatis bipinnulatus

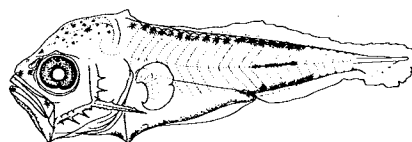
CARANGIDAE

Peritoneal pigment

A

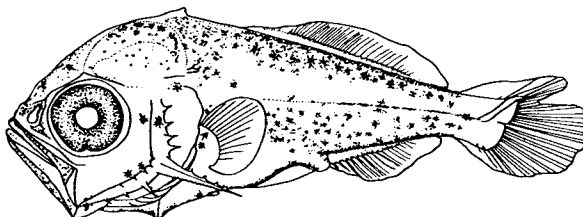
3.8 mm SL

Dorsal row becomes heavy

B

3.6 mm SL

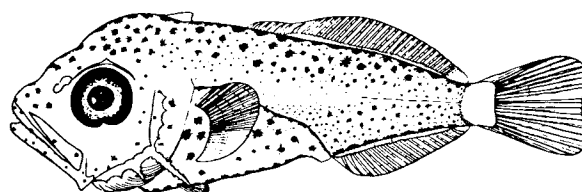
Rows of spots along dorsal and anal bases and at posterior midline

C

5.5 mm SL

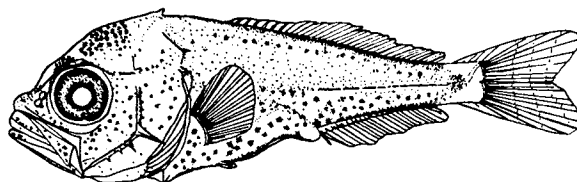
Midventral row of spots under gut

Peduncle unpigmented

D

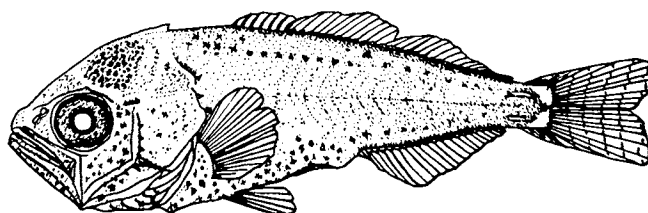
6.3 mm SL

Scattered head pigment

E

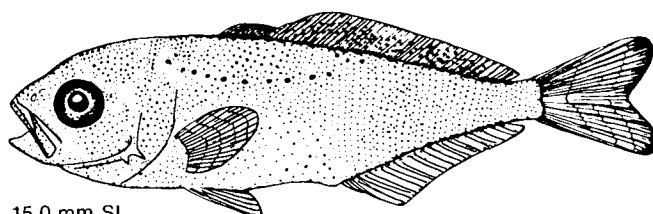
7.7 mm SL

Dorsal spines equal in length

F

10.4 mm SL

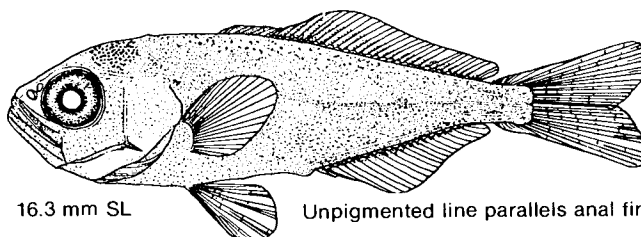
Two parallel, unpigmented lines on caudal peduncle

G

15.0 mm SL

On upper side of body, row of large spots overlies scattered small spots

Only 2 anal spines

H

16.3 mm SL

Unpigmented line parallels anal fin base

B, C, E, F, H (Pacific material)

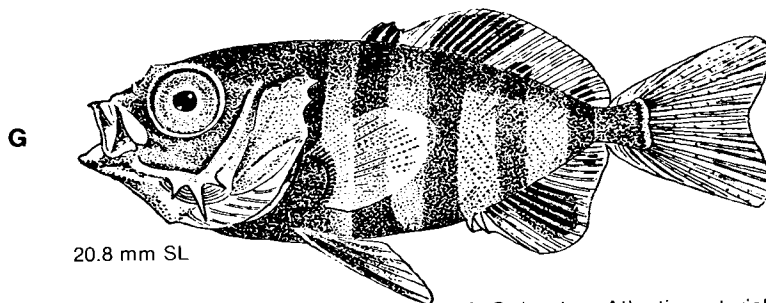
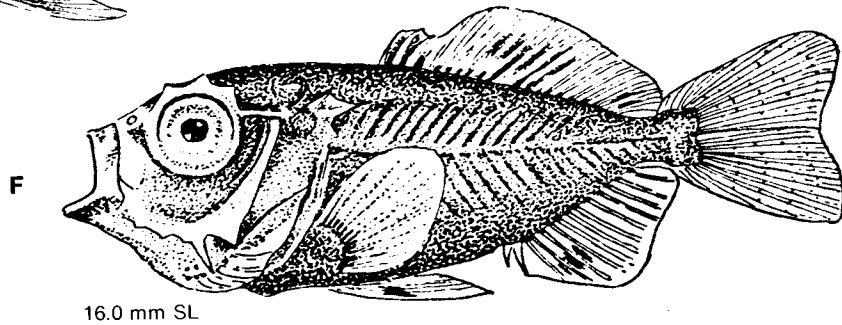
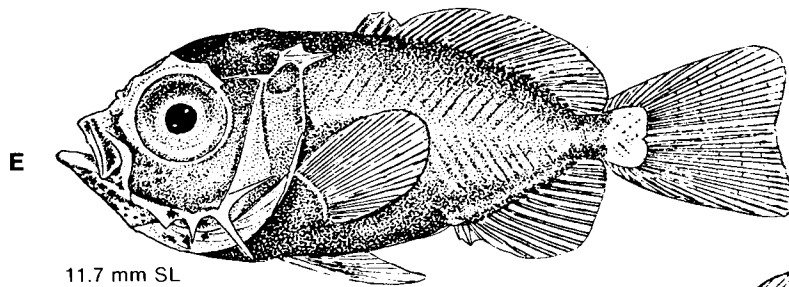
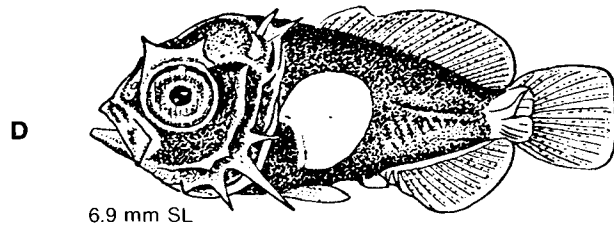
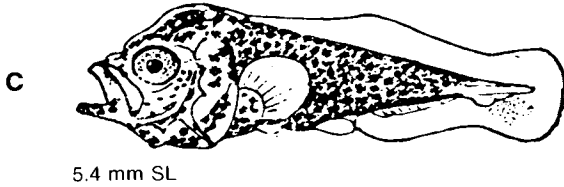
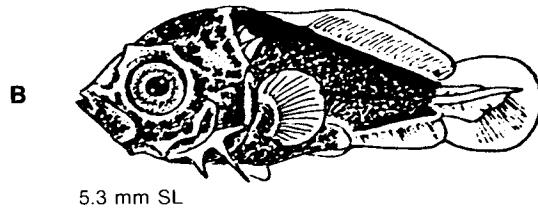
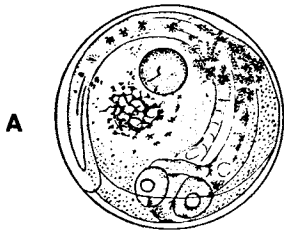
CARANGIDAE***Naucrates ductor* (Linnaeus)**

- | | | |
|---------------|---|--|
| Eggs | <ul style="list-style-type: none">— Pelagic, spherical and transparent.— Diameter: 1.32 mm.— Oil globules: 1.— O.G. diameter: 0.28 mm.— Perivitelline space: narrow. | Meristic features

Myomeres: 25
Vert : 10+15
D : III-IV, I-II, 26-28
A : II, II, 15-16 |
| Larvae | <ul style="list-style-type: none">— Deep-bodied with large deep head.— Morphometrics in illustrated specimens:<ul style="list-style-type: none">— Body depth at opercle increases from 29% to about 40% SL.— Preanal length ranges from 64% to 66% SL.— Head length increases from 34% to 40-42% SL.— Flexion complete at about 6.6 mm.— No occipital crest; large orbital crest with 3 spines.— Posttemporal spines (2) pronounced and heavy; preopercle spines pronounced, especially the marginal row.— Dorsal and anal fins complete at about 6.9 mm SL.— Pigmentation: body heavily pigmented except for peduncle; pelvic fins and dorsal spines pigmented at about 11.7 mm SL; pigmented areas on dorsal and anal fins at about 16 mm SL. | |

Fig. — A-G, Sanzo 1931b.

Ref. — Aboussouan 1975.

Naucrates ductor**CARANGIDAE**

A-G (eastern Atlantic material)

CARANGIDAE***Oligoplites saurus* (Schneider)**

Spawning: Mostly south of United States in shallow inshore waters in spring-summer.

Meristic features

Myomeres: 26
 Vert: 10+16
 D: V-VI, I, 19-21
 A: II, I, 18-21
 C: 9-10+9+8+8-10

- Eggs**
- Pelagic, spherical.
 - Diameter: 0.87-0.88 mm.
 - Shell: smooth.
 - Yolk: homogeneous and pigmented.
 - Perivitelline space: narrow.
 - Oil globules: 1 (pigmented).
 - O.G. diameter: 0.33-0.34 mm.

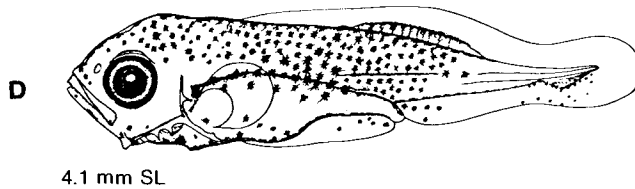
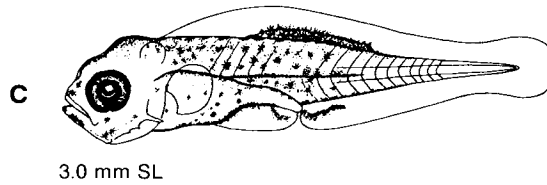
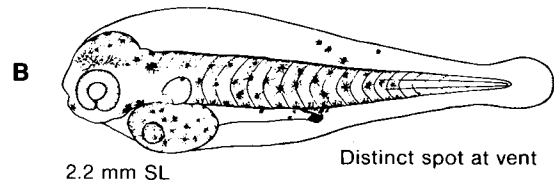
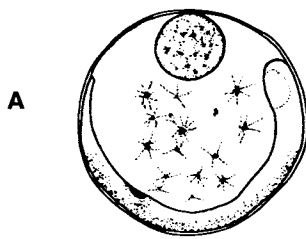
- Larvae**
- Hatching occurs at 1.9-2.0 mm NL; distinct pigment spot at vent.
 - Body relatively slender, depth increasing from 20% SL to maximum 32% SL at metamorphosis.
 - Snout convex; head deep; head length 23-36% SL.
 - Preanal length 51-61% SL in larvae, decreasing slightly at metamorphosis.
 - Flexion occurs at about 4-6 mm SL, and metamorphosis at 7-10 mm SL.
 - Sizes at beginning of ossification and completion of fin rays:

Dorsal and anal rays	5.9 mm	10 mm
Principal caudal rays	5.9	10
Pectoral rays	7.2	10
Pelvic rays (bud at 6 mm)	7.2	10

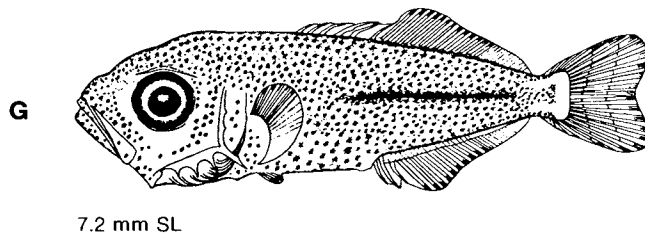
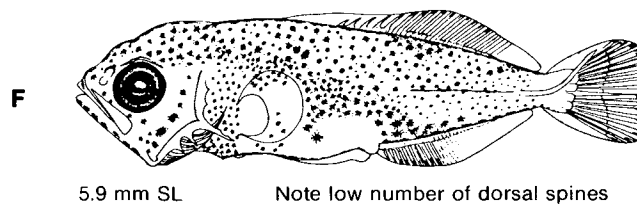
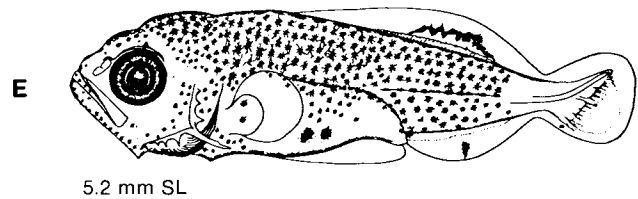
- No occipital crest; serrate orbital crest present from 4 mm to metamorphosis.
- Preopercle angle spine with 1-3 secondary serrations on dorsal surface.
- Pigmentation: uniform dense spots with prominent midline row; unpigmented U-shaped area on peduncle (7.2 to 20 mm); spots on membrane of dorsal and anal spines form after metamorphosis.

Oligoplites saurus

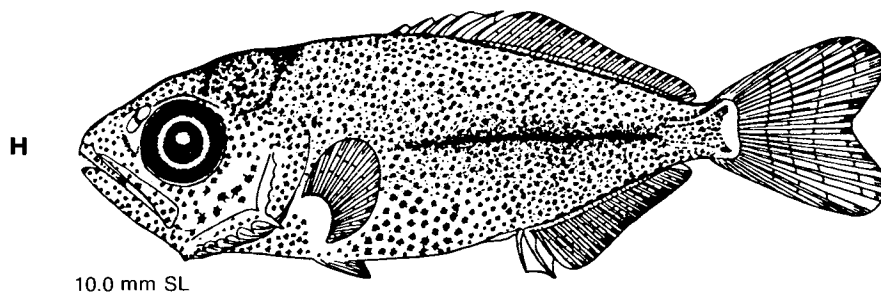
CARANGIDAE



Spine at preopercle angle has 1 to 3
secondary serrations dorsally



Posterior dorsal spine longest



CARANGIDAE***Selene vomer* (Linnaeus)**

Spawning: Probably year-round in the Atlantic.

Eggs — Undescribed.

Larvae — Body deep; head very deep with steep profile, slightly concave in early larvae.
 — Body depth increases from 32% SL at 2.5 mm to maximum 96% SL at 23.9 mm.
 — Preanal length decreases from 56% SL at 2.5 mm to 40% SL at metamorphosis.
 — Head length increases from 31% SL at 2.5 mm to maximum 42% SL at metamorphosis; head deepest relative to head length at about 4.6 mm.
 — Flexion occurs at 4.0–5.5 mm, and metamorphosis at <12 mm.
 — Sizes at beginning of ossification and completion of fin rays:

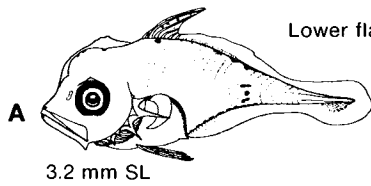
Meristic features

Myomeres: 24
 Vert: 10+14
 D: VII–VIII,
 I, 21–23
 A: II, I, 18–20
 C: 7–9+9+8+7–8

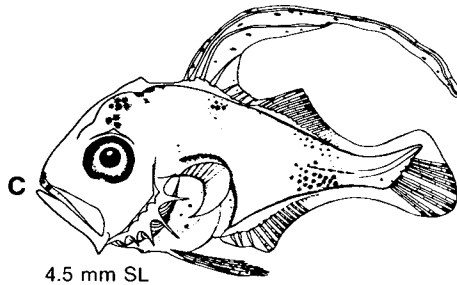
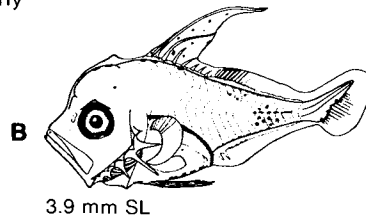
Pelvic rays	...	2.5 mm
Dorsal spines	2.5 mm	4.4
Dorsal rays	4.0	9.0
Principal caudal rays	4.0	7.6
Anal spines	4.0	6.0
Anal rays	4.4	6.0
Pectoral rays	5.0–6.0	9.0

- Occipital and orbital crests well developed in early larvae, and decline at about 5 mm.
- Preopercle spines in 2 rows, with marginal spines (4–7) longest; spines lost at metamorphosis.
- Pigmentation: spots develop early on lower side of tail; other spots scattered on jaw tips, head, pelvic fins, dorsal spines and caudal base; rows of spots along dorsal and anal fin bases and at posterior midline; pigment forms bars at metamorphosis.

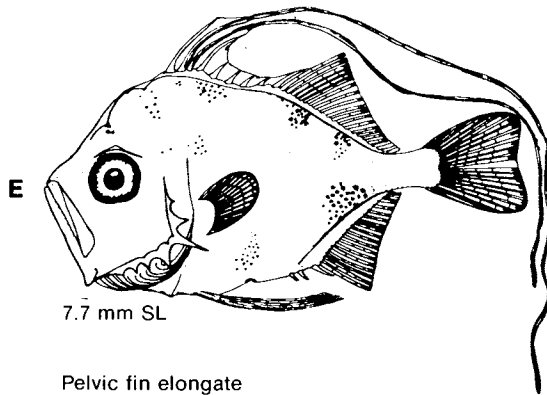
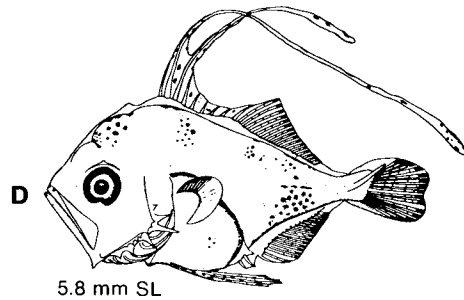
Note: Unusual for carangids to form pelvic rays and dorsal spines early.

Selene vomer**CARANGIDAE**

Lower flank spots form early

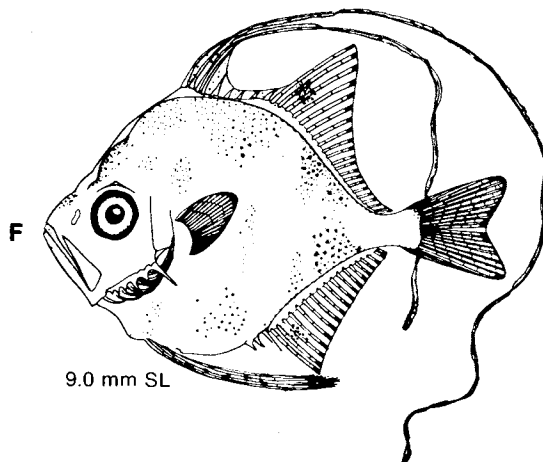


Peritoneal pigment

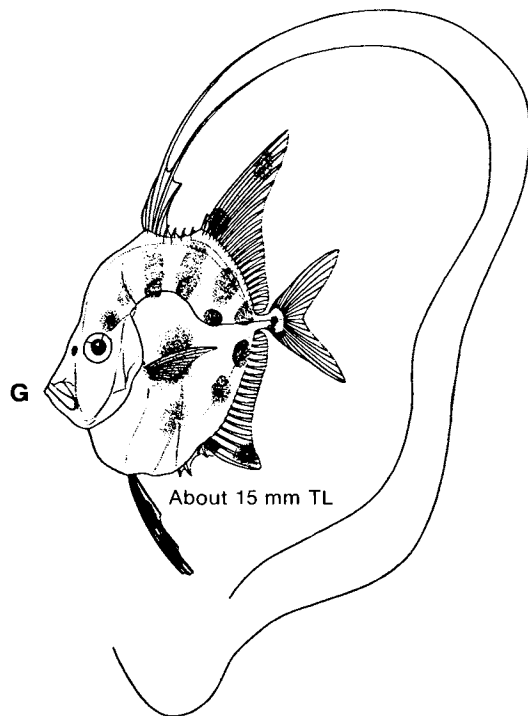
Midventral row of spots similar to *Elagatis* (p. 248).

Pelvic fin elongate

2nd and 3rd dorsal spines elongate



Vent located anteriorly, opens near pelvic fin base

Note: In superficially-similar larval *Alectis*, the first 2 dorsal rays are elongate

CARANGIDAE***Seriola zonata* (Mitchill)**

Spawning: Year-round, with possible interruption in summer, in offshore waters south of Cape Hatteras.

Meristic features

Eggs — Undescribed.

Myomeres: 24

Vert : 11+13

Larvae — Fairly deep-bodied with large head; concave snout becomes straight.

D : VII-VIII,

I, 33-40

— Similar to *Elagatis* (p. 248), but lack occipital crest.

A : II, I, 19-21

C : 8-12+9+8+9-11

— Body depth increases from 30% SL at 3.6 mm to 37% SL at flexion and through metamorphosis.

— Preanal length increases from 58% SL at 3.6 mm to 70% at metamorphosis.

— Head length increases from 33% SL at 3.6 mm to maximum 43% SL at 7 mm and then gradually decreases; head depth about equal to head length.

— Flexion occurs at 4.7-7.5 mm, and metamorphosis at about 13 mm.

— Sizes at beginning of ossification and completion of fin rays:

Principal caudal rays	4.4 mm	6.5 mm
Dorsal spines	5.5	8.4
Anal rays	5.5	~9.0
Dorsal rays	6.5	~9.0
Pectoral rays	6.5	11.2
Pelvic rays	7.0	9.5

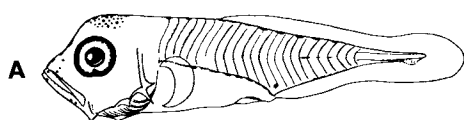
— Second dorsal count highest among western Atlantic *Seriola*.

— No occipital crest; low orbital crest with weak spine in early larvae.

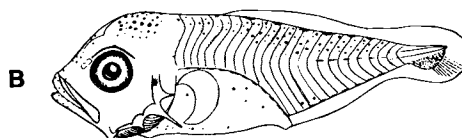
— Smooth spines on preopercle margin and ridge until metamorphosis, and then 2 secondary spines form on longest spine.

— Pigmentation: 5-6 spots form along dorsal base against background of smaller spots in early larvae; rows of spots along dorsal and anal bases and at posterior midline.

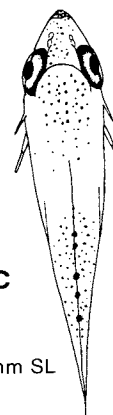
Note: Larvae of other western Atlantic *Seriola* species are probably similar, but *S. zonata* is apparently distinguished by large dorsal base spots in early larvae and by high dorsal-ray count in larvae >9 mm.

Seriola zonata**CARANGIDAE**

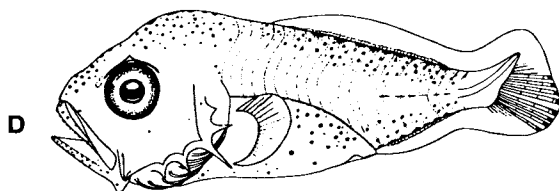
3.6 mm SL



4.8 mm SL

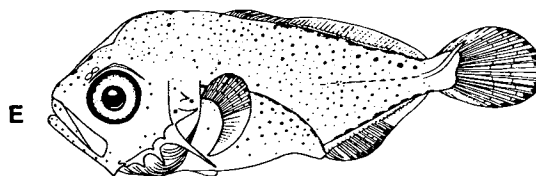
Dorsal
view

4.8 mm SL

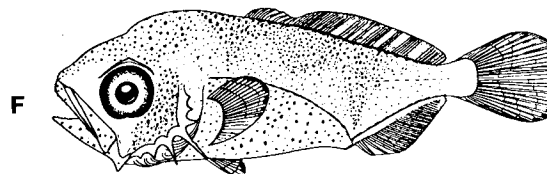
5-6 large spots along base of
second dorsal

5.5 mm SL

Peritoneal pigment



6.5 mm SL

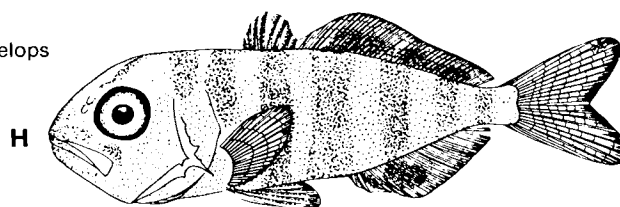
Dorsal spines unequal in length
(compare to *Elagatis*, p. 248).

8.7 mm SL

Banding due to expanded and
contracted melanophores

10.6 mm SL

Nuchal bar develops



18.0 mm SL

True banding begins at about 17 mm

CARANGIDAE***Trachinotus* (3 Species)****Common characteristics** (3 species)

- Larvae**
- Specimens <5 mm SL not identified to species.
 - Flexion completed by about 5 mm SL; teeth present at about 5 mm SL.
 - First dorsal fin high with a short base.
 - No occipital crest; orbital crest long, low and serrated.
 - Preopercle spines on margin and on ridge (3 longer spines at angle with the middle one longest); inner ridge spines conspicuous in small larvae, but lost at about 13 mm.
 - Posttemporal spines small and short (compare to *Naucrates*, p. 250).
 - Head length (in all 3 species) decreases from 39–44% SL in larvae <10 mm to about 25% SL in adults.
 - All fin rays apparently complete at 5–7 mm SL.

Distinguishing features

The 3 species are best distinguished by dorsal and anal fin-ray counts and relative body depth:

	Dorsal fin	Anal fin	Vert.
<i>T. carolinus</i> (Linnaeus)	V–VI, I, 22–27	II, I, 20–23	10+14
<i>T. falcatus</i> (Linnaeus)	VI, I, 17–21	II, I, 16–19	10+14
<i>T. goodei</i> Jordan and Evermann	VI, I, 19–20	II, I, 16–18	10+14

Size (mm SL)	*Body depth as percent of SL		
	<i>T. carolinus</i>	<i>T. falcatus</i>	<i>T. goodei</i>
5.0–6.9	...	30–33	...
7.0–9.9	32	35–44	36
10.0–13.9	28–39	40–48	35
14.0–16.9	31–34	41–53	34–36
17.0–20.0	34	43–55	36

* Body depth at origin of first anal spine.

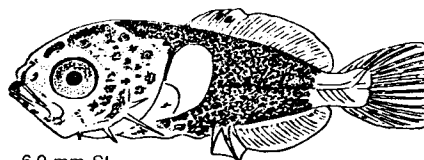
Note: Illustrations of *T. goodei* below (described as *Lichia glauca* by deGaetani 1940) indicate that the dorsal and anal spines form at same time as caudal rays (about 5.4–5.6 mm SL), pigment on dorsal spine membrane at 5.6 mm, and body heavily pigmented except peduncle.



5.4 mm SL



5.6 mm SL

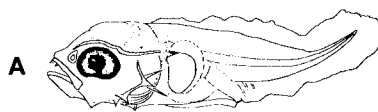


6.9 mm SL

(eastern Atlantic specimens)

Fig. — A–K, Fields 1962.

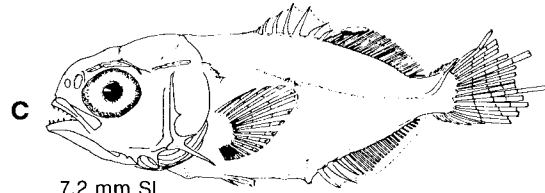
Ref. — Aboussouan 1975.

Trachinotus carolinus**CARANGIDAE**

3.1 mm SL

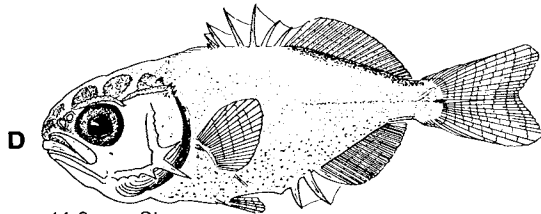


4.7 mm SL

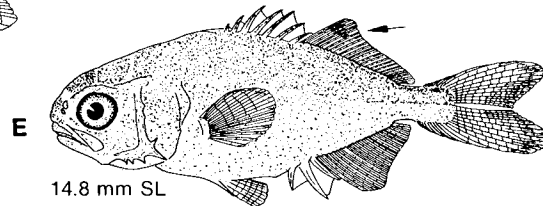
Species uncertain
for A and B

7.2 mm SL

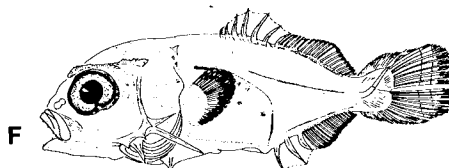
Distinct pigment between first 6-7 rays



11.0 mm SL

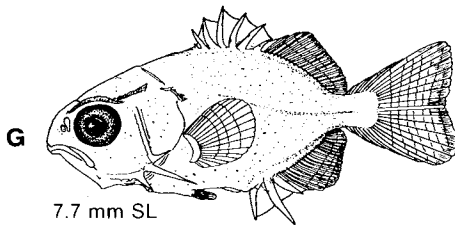


14.8 mm SL

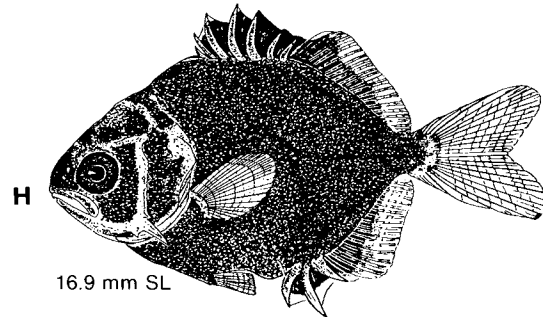
Trachinotus falcatus

5.0 mm SL

Midline pigment present

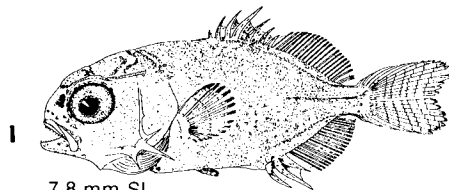


7.7 mm SL

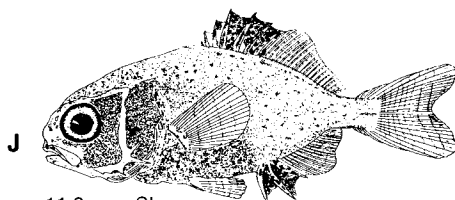


16.9 mm SL

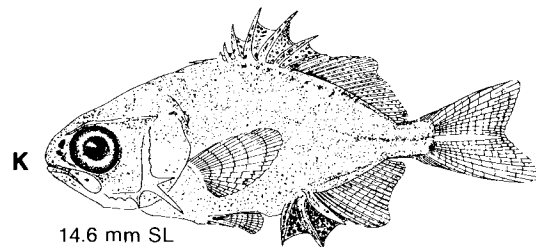
Very dark body

Trachinotus goodei

7.8 mm SL

Dorsal and anal spine membrane darkly
pigmented; body uniformly spotted

11.8 mm SL



14.6 mm SL

BRAMIDAE**Western North Atlantic Species****General characters**

- Six species possible in the area covered by this guide; widely distributed in open ocean.
- High number of myomeres; large fins.
- Preopercle spination varies among species.
- Spines weak or lacking in fins (total ray count is important).
- Pelvic fin rays: 1, 5.
- Principal caudal rays: 9+8.

Meristic characters of six species

Species	Vertebrae			Fin rays		
	Precaudal	Caudal	Total	D	A	P
<i>Pterycombus brama</i> Fries ¹	21-23	25-28	48-51	48-53	38-43	20-23
<i>Pteraclis carolinus</i> Valenciennes ²	24-25	25-28	49-52	48-54	42-47	18-19
<i>Brama brama</i> Bonnaterre ³	16-17	24-25	41-43	35-38	29-32	20-23
<i>Brama dussumieri</i> Cuvier ³	14-17	24-26	40-43	33-35	27-29	19-21
<i>Brama caribbea</i> Mead ³	15-16	21-22	36-38	32-35	27-30	15-16
<i>Taractichthys longipinnis</i> (Lowe) ¹	19-22	25-26	48-51	33-38	27-30	20-22

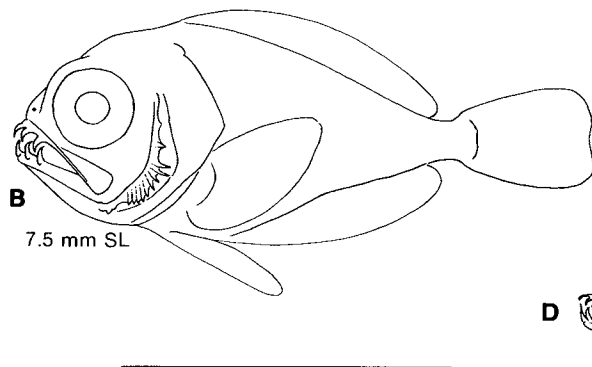
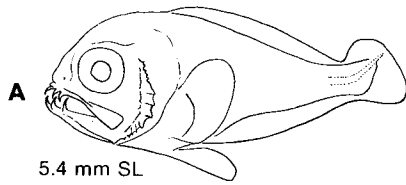
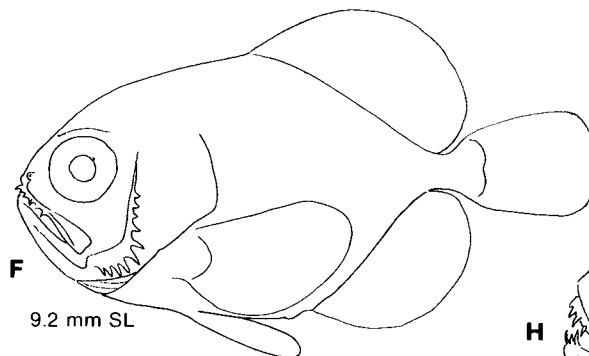
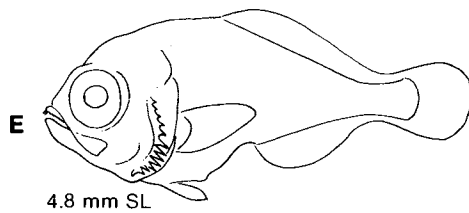
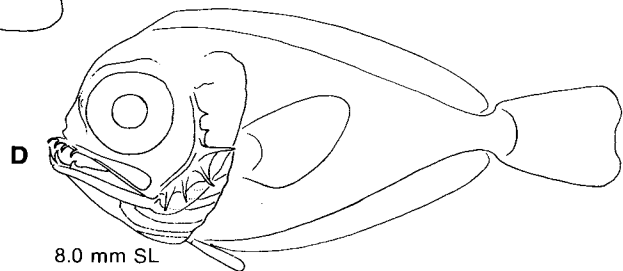
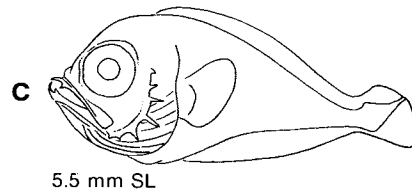
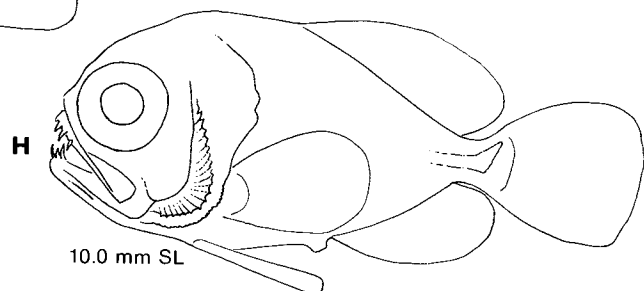
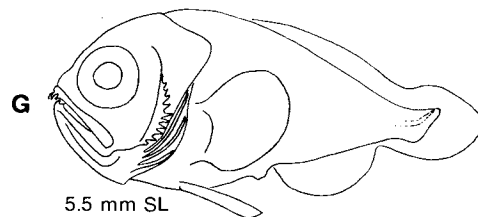
¹ Several oceanic records, Cape Hatteras to Scotian Shelf.

² Open ocean, east of Gulf Stream.

³ Most likely in oceanic collections off Cape Hatteras.

Western North Atlantic Species

BRAMIDAE

Pterycombus brama*Brama caribbea**Pteraclis carolinus**Taractichthys longipinnis*

HAEMULIDAE *Orthopristis chrysoptera* (Linnaeus)**Spawning:** Spring in Mid-Atlantic Bight.**Meristic features**

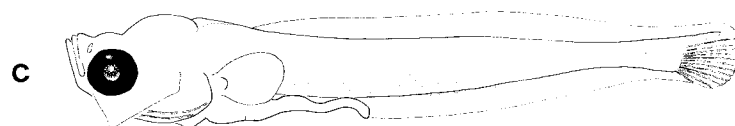
- | | | |
|---------------|---|--|
| Eggs | <ul style="list-style-type: none">— Pelagic, spherical.— Diameter: 0.7–0.8 mm.— Oil globules: 1 (usually).— O.G. diameter: 0.16 mm.— Perivitelline space: narrow. | Myomeres: 26
Vert : 10+16
D : XII–XIII, 15–17
A : III, 12–13
Piv : I, 5
C : 12–13+9+8+11–12 |
| Larvae | <ul style="list-style-type: none">— Hatching occurs at about 1.5 mm; eye unpigmented; paired spots over vent and on midline are green chromatophores.— Body elongate; preanal length <50% SL.— Mouth vertical.— Flexion occurs at 5–10 mm.— Fin formation: second dorsal and anal rays formed at 10 mm; caudal complete at about 10 mm; pelvic fin appears at 11 mm; first dorsal forms at 11 mm and is complete at about 20 mm.— Pigmentation: in the preserved specimens of Hildebrand and Cable (1930), there is no pigment until dorsal and ventral edges and midline acquire spots at about 13.5 mm. | |

Orthopristis chrysopterus**HAEMULIDAE**

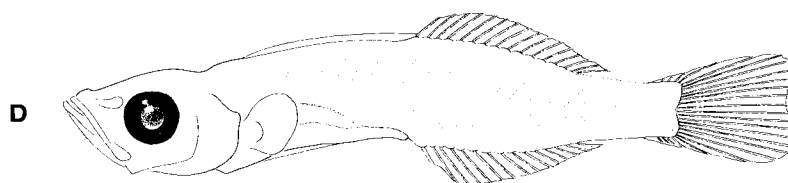
3.0 mm TL



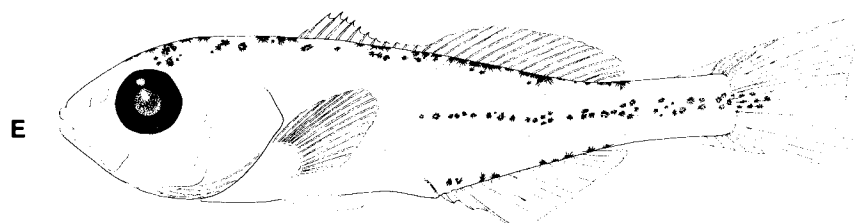
3.1 mm TL



4.9 mm TL



10.0 mm TL



13.5 mm TL

SPARIDAE***Stenotomus chrysops* (Linnaeus)**

Spawning: Late spring and summer in Mid-Atlantic Bight nearshore waters.

Meristic features

- Eggs**
- Pelagic, spherical.
 - Diameter: 0.81–1.00 (average 0.93 mm).
 - Shell: smooth.
 - Yolk: homogeneous.
 - Oil globules: 1 (pigmented).
 - O.G. diameter: 0.17–0.21 mm.

Myomeres: 24
 Vert : 10+14
 D : XII, 12
 A : III, 11–12
 Piv : I, 5
 C : 9–10+9+8+8–10

- Larvae**
- Hatching occurs at about 2 mm NL; eyes unpigmented, and mouth undeveloped.
 - Preanal length <50% TL until after flexion.
 - Flexion occurs at 4.8–5.6 mm SL.
 - Larval sizes and relative body proportions:

	Preflexion	Flexion	Postflexion
Larval size (mm SL)	2.0–4.6	4.8–5.6	6.1–16.9
Preanus length (% SL)	36–42	40–48	48–59
Body depth (% SL)	20–30	22–38	21–33
Head length (% SL)	10–21	20–23	21–30

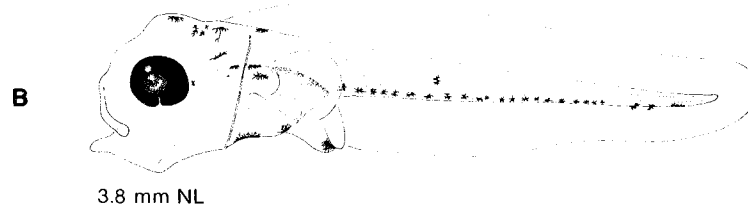
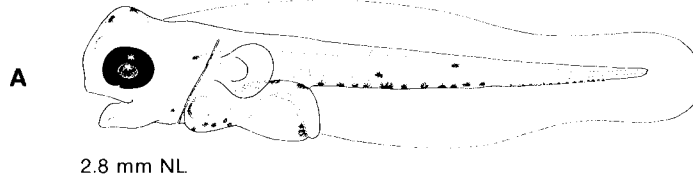
- Fin formation: caudal rays complete at about 5.3 mm SL; dorsal and anal spines and rays complete at about 10 mm SL; pelvic buds form at about 5.7 mm SL, and rays are complete at 12.8 mm SL.
- Weak preopercle spines present.
- Pigment in early larvae (2.0–2.5 mm NL): two dorsal rows of spots from head to myomere 20; no pigment on anterodorsal or ventral parts of head; prominent spot anterior to vent, becomes less intense at 5.0 mm SL.
- Pigment in later larvae: ventral row of spots develops postanally, the number increasing gradually with development; spot at cleithral symphysis and few spots on ventral gut surface; lateral pigment increases after fin rays are ossified.

Sparidae Family Characters

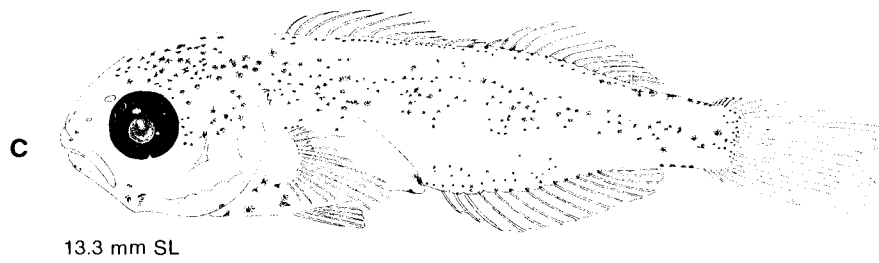
- Larvae**
- Usually 24 myomeres.
 - Oil globule posterior in yolk at hatching.
 - Pigment on yolk and oil globule.
 - Gut <50% TL.
 - Anal and second dorsal fins have about same number of rays.
 - Weak or no head spines.
 - Ventral row of postanal spots.

Fig. — A–C, P. L. Berrien (illustrator, reared specimens) (redrawn).

Ref. — C. A. Griswold and T. W. McKenney 1982 (pers. comm.).

Stenotomus chrysops**SPARIDAE**

(See note, p. 345)



SPARIDAE***Lagodon rhomboides* (Linnaeus)****Spawning:** Autumn to winter from North Carolina to Florida.**Meristic features**

- Eggs** — Diameter: 0.99–1.05 mm (unfertilized). — Oil globules: 1.
- Larvae** — Flexion occurs at about 5 mm. — Larvae less deep-bodied than *A. rhomboidalis* at 5–20 mm. — Teeth present at 10 mm. — Fin formation: dorsal, caudal and anal rays begin at 5–6 mm and are complete at 10 mm; pelvic bud forms at 7–10 mm and fins complete at >15 mm. — Pigmentation: few spots from isthmus to anus, and ventral row from anus to caudal base; spots appear on nape at 7.0 mm.
- Myomeres: 24
 Vert : 10+14
 D : XII, 11
 A : III, 11
 P : 16
 Plv : I, 5
 C : 10–11+9+8+7–10

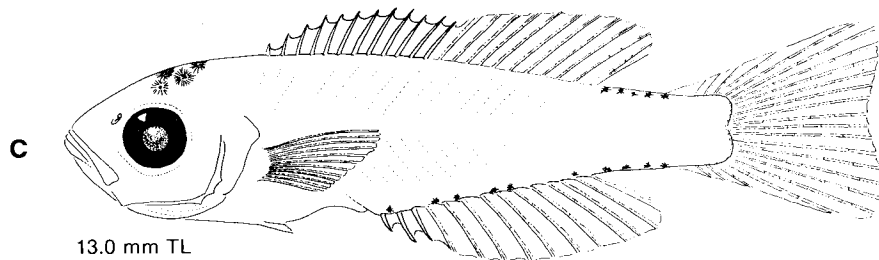
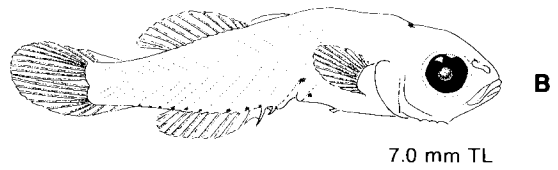
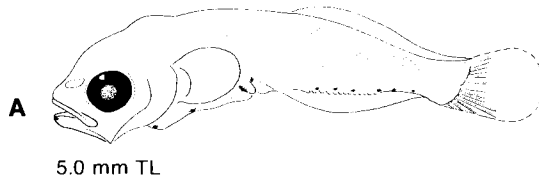
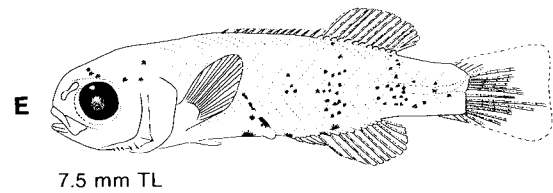
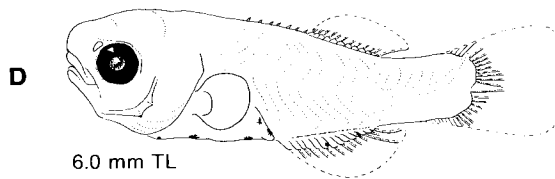
Archosargus probatocephalus* (Walbaum)*Spawning:** Spring off Florida.**Meristic features**

- Eggs** — Pelagic, transparent. — Diameter: about 0.8 mm.
- Larvae** — Hatching occurs at about 2.0 mm, and flexion at 6.0 mm. — Larvae deeper-bodied than *A. rhomboidalis* at 6–10 mm. — Feeble preopercle spines at 6 mm, lost by 15 mm. — Fin formation: dorsal has 7 spines and 12 rays at 6 mm and fin complete at 12 mm; anal spines and rays complete at 6 mm; pelvic bud at 6.5 mm and rays form at 8 mm. — Pigmentation: few spots from isthmus to anus and 2 spots on anal base.
- Myomeres: 24
 Vert : 10+14
 D : XII, 10–12
 A : III, 9–10
 P : 15–17
 Plv : I, 5
 C : 8–9+9+8+7

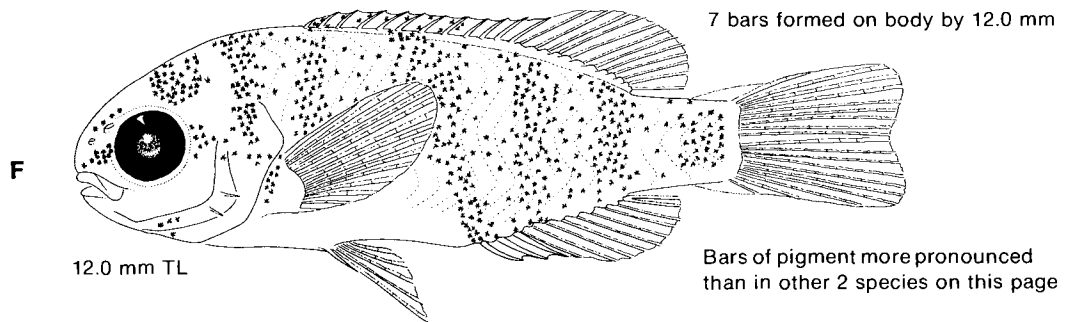
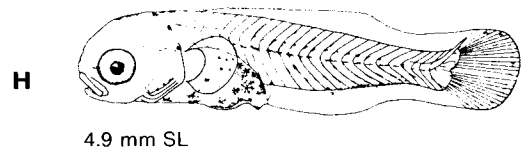
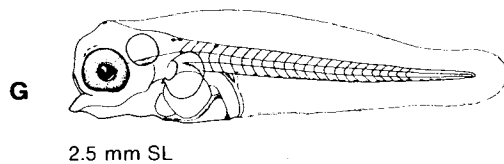
***Archosargus rhomboidalis* (Linnaeus)**

- Larvae** — Hatching occurs at 2.0–2.2 mm, and flexion at 4.2–4.4 mm. — Dorsal spines number 13.

Note: See p. 264 for Sparidae family characters.**Fig.** — A–F, Hildebrand and Cable 1938 (redrawn); G–H, Houde and Potthoff 1976.**Ref.** — Mook 1977.

Lagodon rhomboides**SPARIDAE*****Archosargus probatocephalus***

Earlier larvae have spot at angle of jaw

***Archosargus rhomboidalis***

SCIAENIDAE**Family Characters****Meristic characters of sciaenids**

Species	Dorsal fin	Anal fin	Vertebrae
<i>Bairdiella chrysoura</i>	X-XI, I, 19-23	II, 8-10	12+13=25
<i>Cynoscion nebulosus</i>	IX-X, 25-28	II, 10-12	13+12(or 12+13)=25
<i>Cynoscion regalis</i>	X, I, 24-29	II, 10-13	13+12(or 12+13)=25
<i>Larimus fasciatus</i>	X, I, 24-27	II, 6-8	10-11+14-15=25
<i>Leiostomus xanthurus</i>	IX-XI, I, 29-35	II, 12-13	10+15=25
<i>Menticirrhus</i> sp.	X, I, 19-27	I, 6-9	10+15=25
<i>Micropogonias undulatus</i>	X, I, 27-30	II, 8-9	10+15=25
<i>Pogonias cromis</i>	X, I, 19-23	II, 5-7	10+14=24
<i>Sciaenops ocellatus</i>	X, I, 23-25	II, 7-9	10+15=25
<i>Stellifer lanceolatus</i>	XI-XII, I, 20-24	II, 7-9	10-11+14-15=25

Larval morphology

- Body shape unspecialized: short gut, deep head, large oblique mouth.
- Range of myomeres: 23-27.
- Small preopercle and posttemporal spines present in all species but highly-developed head spines lacking.
- Early fin development: dorsal and anal fin bases formed at <5 mm and rays complete at <10 mm.
- Usual sequence of fin development: anal and dorsal rays, principal caudal rays, dorsal spines, pelvic spine and rays, pectoral rays, and procurent caudal rays. (*Larimus* differs in forming pectoral rays early, at time of notochord flexion.)
- Second dorsal fin base is at least twice as long as anal fin base, and dorsal rays about twice as numerous as anal rays.
- Marked gap between anus and anal fin origin in most species, except *Menticirrhus* sp. and *Cynoscion nebulosus*.
- Body depth at cleithral symphysis similar in early stages of all species (about 30% SL in larvae <3.5 mm), but later fall into 2 groups:

Shallow-bodied (BD < 32% SL)	Deep-bodied (BD > 32% SL)
<i>Cynoscion nebulosus</i>	<i>Larimus fasciatus</i>
<i>Leiostomus xanthurus</i>	<i>Stellifer lanceolatus</i>
<i>Micropogonias undulatus</i>	<i>Bairdiella chrysoura</i>
<i>Pogonias cromis</i>	
<i>Sciaenops ocellatus</i>	
<i>Cynoscion regalis</i> and <i>Menticirrhus</i> sp. are intermediate in body depth.	

Family Characters (cont'd)**SCIAENIDAE****Larval pigmentation**

- Ranges from sparse to moderately heavy.
- All have row of spots along ventral midline postanally; with development, this row has fewer spots and forms characteristic sequences relative to anal fin base; a feature useful in separating genera and species.
- Pigment on anterior surface of gut and internally at nape is better developed in sciaenids than in other larvae.
- Similarity to larvae of other families:
 - Pigment at angle of lower jaw and anterior to cleithral symphysis.
 - Pigment on dorsal, ventral and posterior surfaces of gut.
 - Pigment on ventral surface of brain.
 - Pigment at base of ventral lobe of caudal fin.

Similar larvae

- Apogonidae* (early stages): dorsal and anal fins form early (about 5 mm); 2 dorsal fins separated, the second short with low ray count (<10).
- Gerreidae*: distinct spots on dorsal midline behind 2nd dorsal; slimmer-bodied than sciaenids, fin ray counts and greater space between successive rays useful.
- Pomacentridae* (early stages): 2nd dorsal and anal fins form early (about 5 mm); lengths and counts about the same for both fins, 7+6 branched caudal rays.
- Sparidae: shorter gap between anus and anal fin base than in sciaenids; many lack spot at lower jaw angle; slimmer-bodied than sciaenids; fin rays counts and greater space between successive rays useful.
- Stromateidae (early stages): high myomere counts (>30).

* Larvae rarely taken north of Cape Hatteras.

SCIAENIDAE***Bairdiella chrysoura* (Lacépède)**

Spawning: Late spring to summer in estuarine and coastal waters.

Meristic features

- Eggs**
- Pelagic, spherical and transparent.
 - Diameter: 0.66–0.88 mm.
 - Shell: thin and horny.
 - Yolk: homogeneous.
 - Oil globules: 1–2 (sparsely pigmented).
 - O.G. diameter: 0.16–0.22 mm.

Myomeres: 25
 Vert : 12+13
 D : X–XI, I, 19–23
 A : II, 8–10
 Piv : I, 5
 P : 15–17

- Larvae**
- Hatching occurs at 1.5–1.9 mm, and flexion at 4.0–4.5 mm SL.
 - Preanus length increases from about 40% to 58% SL.
 - Body depth (at cleithrum) increases from about 32% to 37% SL.
 - Head length increases from <30% to about 38% SL.
 - Preopercle spines present through larval development, with 5 lateral and 4 marginal at 7.0–8.8 mm SL.
 - Posttemporal spines: 1 at 5.0–7.7 mm SL; 2 at 8.8 mm SL.
 - Fin formation: caudal, dorsal and anal rays and anal spines form during noto-chord flexion; sizes at beginning of ossification and completion of fin rays:

Caudal rays	4.1 mm SL	4.9 mm SL
Dorsal rays	4.1	~5.0
Anal spines and rays	4.1	5.7
Dorsal spines	5.7	5.7 (rapid)
Pectoral rays	5.7	8.8
Pelvic rays	5.7	7.0+

- Pigmentation: ventral row of spots postanally; spot at tip of snout >5.7 mm SL and tip of lower jaw >7.5 mm SL; spot on lower jaw ramus at 3.1–7.0 mm SL (increases to several); brain pigment begins at about 5.7 mm SL and spreads; 1 ventral spot at anus between 3.1 and 5.0 mm SL; 1 spot midway between anus and cleithral symphysis >3.3 mm SL; dark spot forms on gut over anus at >4.9 mm SL.

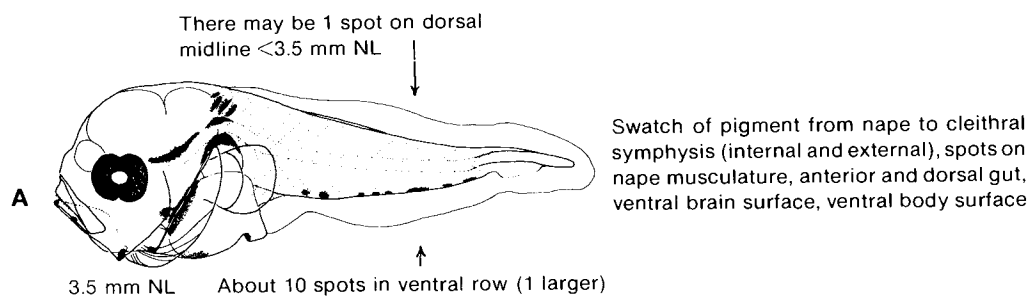
- Note:**
- (1) Larvae of *Menticirrhus* sp. (p. 280) have much darker body pigmentation. Larvae of *Stellifer lanceolatus* (p. 284) have similar meristic characters but different pigment features in early larvae and different caudal fin shape in late larvae.
 - (2) Best characters for *B. chrysoura*: pigment swath from nape to cleithral symphysis; spot anterior to anal fin base and at anal fin origin.

Fig. — A–D, Powles 1980.

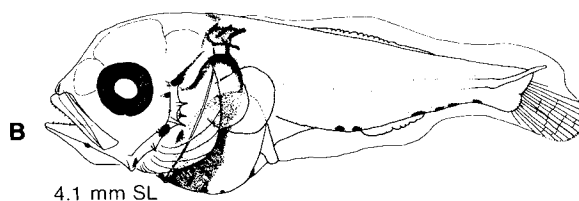
Ref. — Kuntz 1915; Welsh and Breder 1923; Joseph *et al.* 1964; Chao 1978.

Bairdiella chrysoura

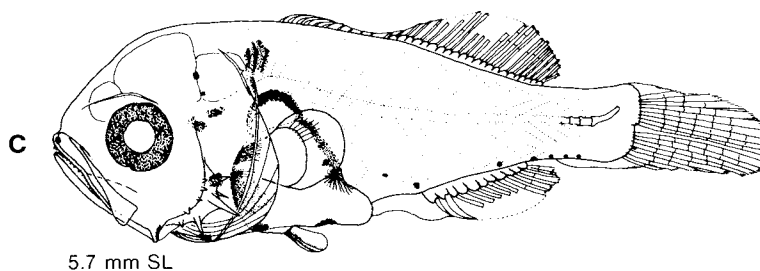
SCIAENIDAE



Spot at angle of lower jaw

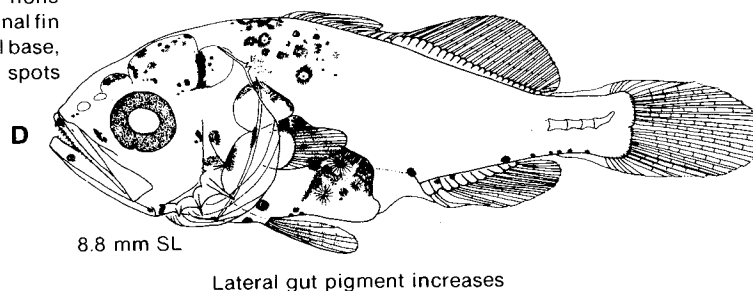


Ventral pigment: 1-2 spots anterior to
anal base, 1 at anal fin origin, 1 at posterior
end of anal base, 3-4 posterior to anal fin



Ventral pigment >7 mm SL: none
anterior to anal base, 1 spot at anal fin
origin, 1 at posterior end of anal base,
3-4 posterior to anal fin, small spots
begin at bases of rays

Dorsal pigment increases anterior to first dorsal fin



SCIAENIDAE *Cynoscion regalis* (Block and Schneider)**Spawning:** Spring through summer.**Meristic features**

- Eggs** — Pelagic, spherical.
 — Diameter: 0.75–0.87 mm.
 — Shell: smooth and transparent.
 — Yolk: homogeneous (amber).
 — Oil globules: 1–6 (usually 1).
 — O.G. diameter: average 0.20–0.25.

Myomeres: 24–25
 Vert : 13+12 or 12+13
 D : X, I, 24–29
 A : II, 10–13

- Larvae** — Hatching occurs at 1.50–1.75 mm, and flexion at 4.0–4.3 mm.
 — Body depth intermediate among sciaenids (29–43% SL).
 — Preanus length increases from <50% SL in small larvae to about 68% SL at 25 mm.
 — “Hump” on dorsal margin of gut over anus; gap between anus and anal fin origin.
 — Preopercle spines increase from 2 at 2.7 mm to 15 at 25 mm; 1 or 2 opercle spines present; 1–4 posttemporal spines present in most larvae 4.8–25.0 mm.
 — Fin formation: second dorsal and anal rays complete at 5.0 mm; pectoral fin bud present at 2.7 mm and complete at 10.1 mm; pelvic fin buds present at 4.3 mm and complete at 9.2 mm.
 — Ventral midline pigment: spot in anus-anal fin gap at <4.7 mm, spot at mid-anal base, and 0–3 spots posterior to anal base; spot on anterior end of anal base at >9.4 mm; 1–4 spots on ventral midline of lower jaw.
 — Midlateral pigment (>6 mm): 1–2 spots above mid-anal base and few below spiny dorsal fin; spots added below anterior part of second dorsal fin at about 8 mm; spot added to urostyle at 10.1 mm; this midlateral pigment not adequately shown in illustrations.
 — Other pigment: spots on dorsal midline at termination of second dorsal fin present at all sizes; spots develop on each side of spiny dorsal fin at about 6.7 mm.

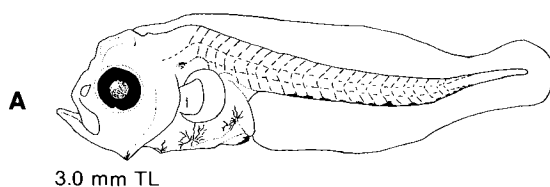
Cynoscion nebulosus* (Cuvier)*Spawning:** Spring and summer south of Chesapeake Bay.**Larvae** — See illustrations opposite.

Fig. — **A, C, D**, Pearson 1941; **B**, Perlmutter 1939; **E–F**, Fable *et al.* 1978; **G–H**, Hildebrand and Cable 1934 (**A–D** and **G–H** redrawn)

Ref. — Powles and Stender 1978.

Cynoscion regalis

SCIAENIDAE



Figures should include internal pigment on and in nape and behind dorsal fin

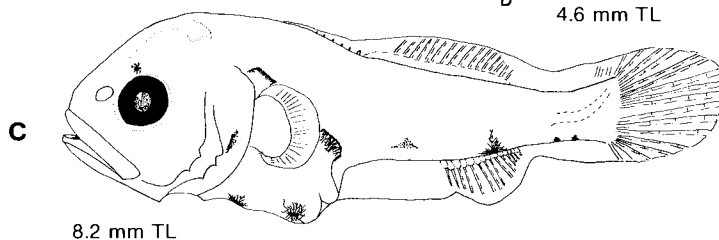
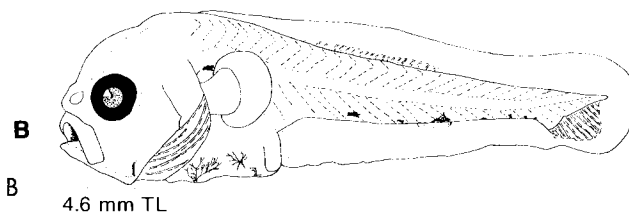
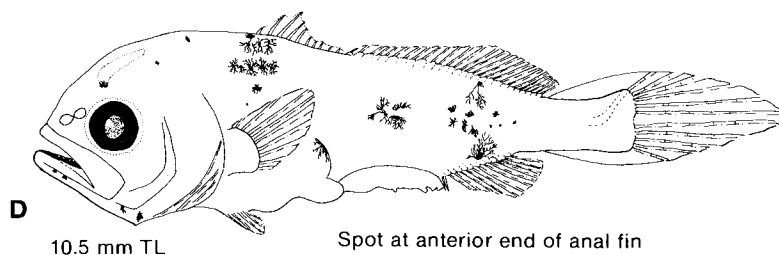
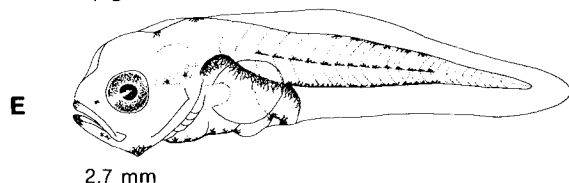


Figure should include spots at sides of spiny dorsal and some pigment along lateral line

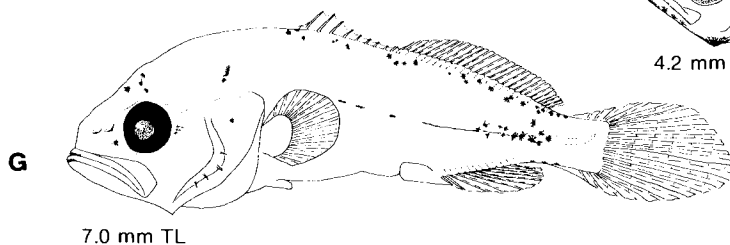
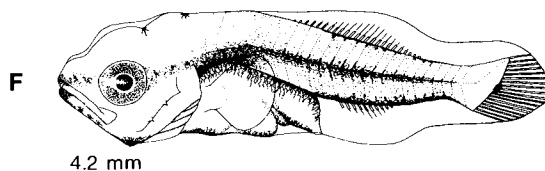
Figures C and D should show spot at tip of upper jaw and spot on each side of lower jaw tip

*Cynoscion nebulosus*

Band of pigment on snout

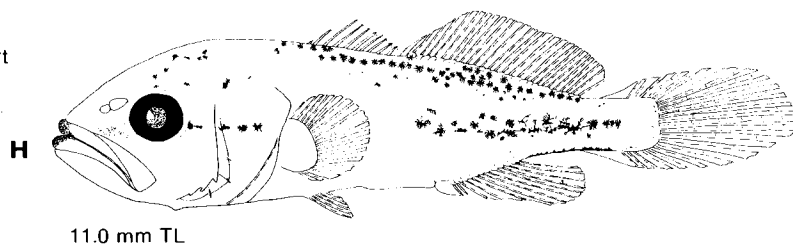


Heavily pigmented row of spots on midlateral line of tail



Dorsal midline pigment

Anus-anal fin gap short



SCIAENIDAE***Larimus fasciatus* Holbrook**

Spawning: Continental shelf south of Chesapeake Bay in April-June and August-October.

Meristic features

Eggs — Undescribed.

Myomeres: 25
 Vert : 10+15 or 11+14
 D : X, I, 24-27
 A : II, 6-8
 Piv : I, 5
 P : 16-17

Larvae — Body depth at cleithrum 40-45% SL in most.
 — Head length increases from about 34% to about 40% SL.
 — Preanus length increases from about 53% SL to >60% SL.
 — Flexion occurs at 3.6-4.0 mm SL.
 — Preopercle spines at all sizes, lateral spines smaller than marginal (not shown in Fig. C).
 — Posttemporal spines (1 or 2) and low supraorbital crest present >5.5 mm SL.
 — Sizes at beginning of ossification and completion of fin rays:

Dorsal rays	3.6 mm SL	4.8 mm SL
Anal spines and rays	3.6	4.9
Caudal rays	3.6	4.9
Pectoral rays	4.0	>6.0
Dorsal spines	4.4	5.8
Pelvic rays (bud at 3.6 mm)	4.9	5.8

- Pigmentation: ventral row of spots postanally; pigment on anterior forebrain, anterior and posterior midbrain, posterodorsal hindbrain, and ventral surface of brain posterior to eye (ring around midbrain seen in dorsal view); heavy pigment on pectoral fin base and fin membrane; spots on lateral gut, under pectoral fin, increase with growth; spots on gular membrane (between lower jaw rami), on preopercle posterior to eye, on lower jaw angle, and 1 spot ventrally anterior to cleithral symphysis; dorsal spot forms anterior to 1st dorsal fin base at >3.8 mm SL (not shown in Fig. C); line of 3 spots on ventral gut between cleithral symphysis and anus at <3.6 mm SL; spot at anus disappears at >3.6 mm SL, but spots posterior to cleithral symphysis increase in number at >4.5 mm SL.

Best Characters

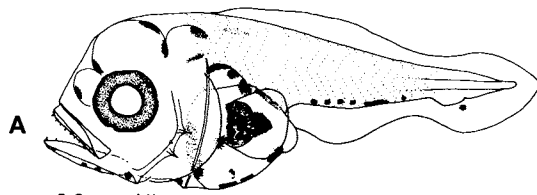
- Early-forming pectoral rays.
- Long preanus length (>50% SL).
- Brain and pectoral fin pigment.

Fig. — **A-B, D**, Powles 1980; **C, E-F**, Hildebrand and Cable 1934 (**C, E, F**, redrawn, with spot added over anal fin origin in **C**).

Ref. — Chao 1978.

Larimus fasciatus

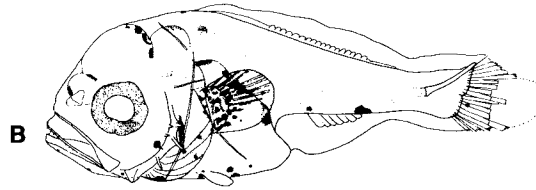
SCIAENIDAE



3.0 mm NL

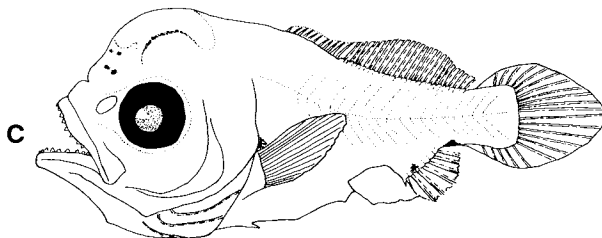
6 spots in ventral row (5th largest)

Dorsal spot anterior to first dorsal fin

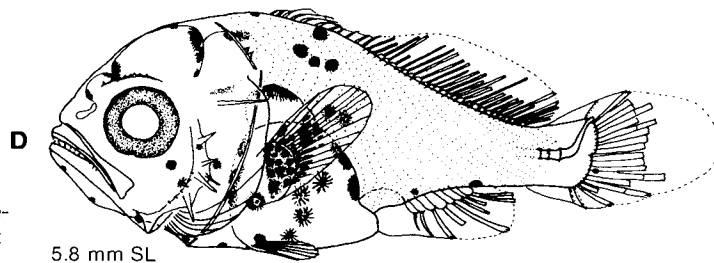


4.0 mm SL

2 spots in ventral row: large one at posterior end of anal fin, and small one just posterior to anterior end of anal fin

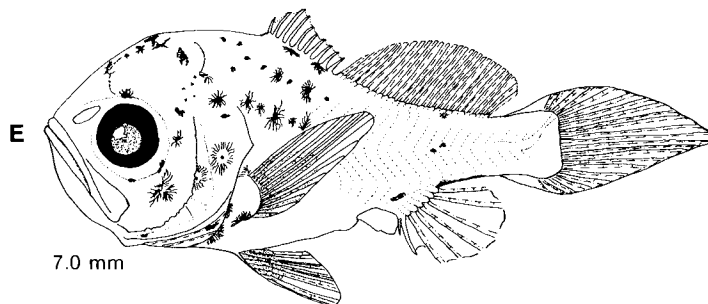


4.5 mm



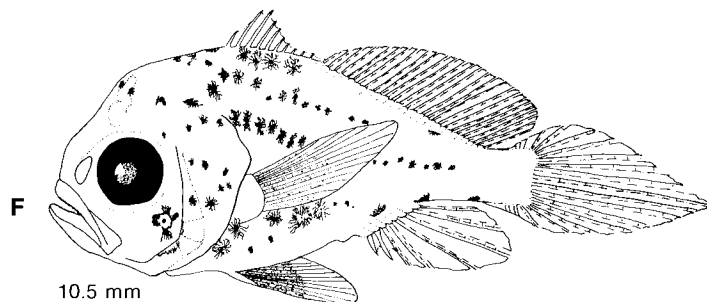
5.8 mm SL

Lateral pigment increases between first dorsal fin and gut



7.0 mm

Dorsal pigment increases



10.5 mm

SCIAENIDAE***Leiostomus xanthurus* Lacépède****Spawning:** Late autumn to early winter.**Meristic features**

- Eggs**
- Pelagic, spherical and transparent.
 - Diameter: 0.72–0.87 mm.
 - Shell: smooth.
 - Yolk: homogeneous (unpigmented).
 - Oil globules: multiple, coalesce to 1 usually, posterior in yolk (yellow with black pigment anteriorly).
 - O.G. diameter: 0.18–0.28 (when 1).
 - Perivitelline space: narrow.

Myomeres: 23–25
 Vert : 10+15
 D : IX–XI, I, 29–35
 A : II, 12–13
 Plv : I, 5
 P : 20–22

- Larvae**
- Hatching occurs at 1.6–1.7 mm SL; eye unpigmented, body lightly pigmented.
 - Body depth increases from about 20% SL at flexion to 30% SL in later larvae.
 - Preanus length increases from about 30% SL (yolk-sac) to about 40% (preflexion) and to 45–50% SL at sizes of 8–14 mm SL.
 - Head length increases from 15% SL (yolk-sac) to about 25% SL (preflexion) and to about 30% SL in later larvae.
 - Flexion occurs at 3.8–5.3 mm SL.
 - Preopercle spines develop at 4.4 mm SL (lost in juvenile), subopercle and interopercle spines at >12 mm SL, and posttemporal spine >14.6 mm SL.
 - Fin development sequence: C–A, D₂–D₁, P–Plv.
 - Sizes at beginning of ossification and completion of fin rays:

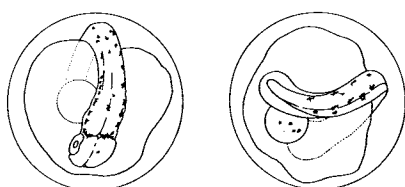
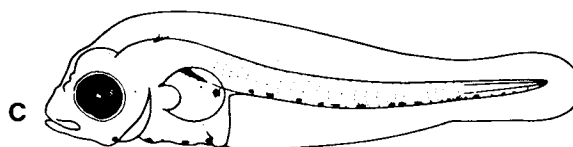
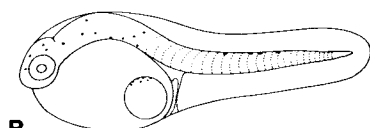
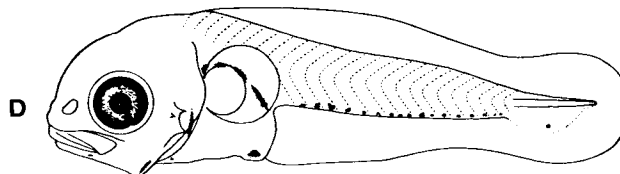
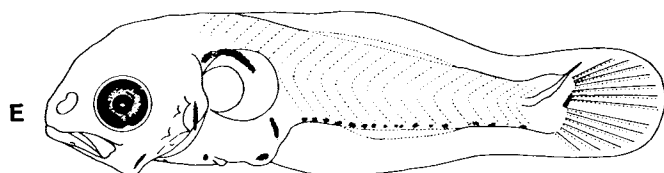
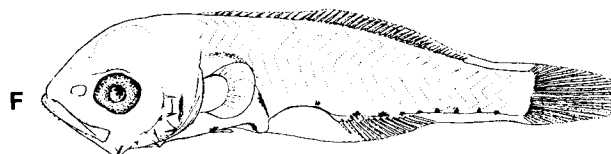
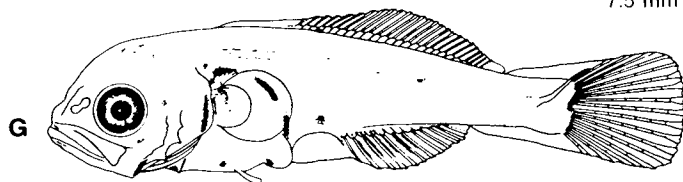
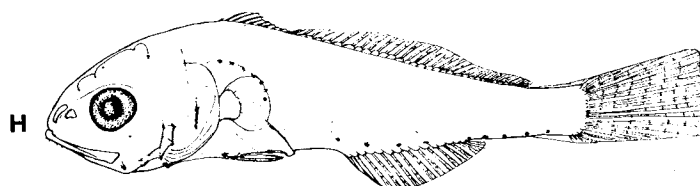
Caudal rays	4.6 mm SL	6.3 mm SL
Anal rays	6.3	8.2
Dorsal rays	6.7	8.8
Dorsal spines	8.0	10.8
Pectoral rays	8.0	~16.0
Pelvic rays (bud at 5.1 mm)	8.2	10.8

- Pigmentation: at hatching, scattered pigment on anterior body, few spots on anterodorsal oil globule, 2–5 dorsal spots on tail (disappear in later larvae); late yolk-sac larvae develop characteristic pigment pattern; row of spots along ventral midline, with at least 1 spot in anus-anal fin gap; internal pigment on air bladder and hindgut, and on anterior surface of gut between cleithra (>4 mm SL); triangle pattern formed by 3 spots anterior to anus (1 spot at anus and 1 at each pelvic fin base), occasional in preflexion larvae and present in all larger larvae (see Fig. K); spot at cleithral symphysis (>3.8 mm SL), and spot at lower jaw angle (>2.6 mm SL); spot at notochord tip, eventually outlines hypural edges; internal pigment on vertebral column (in some larvae 6–9 mm SL, and in most >9.0 mm SL).

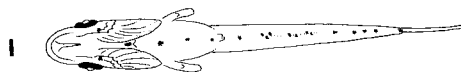
- Note:**
- (1) See p. 278 for characters to separate *Leiostomus* and *Micropogonias*.
 - (2) Anal fin pterygiophores (2 less than total number of anal fin elements) are complete at 6.3 mm SL, and their higher count (12–13) will separate *Leiostomus* from all sciaenids except *Cynoscion*.
 - (3) *Cynoscion nothus* larvae (with 27 vertebrae) may occur at same time as *Leiostomus xanthurus*; other members of the genus *Cynoscion* have 13–15 pre-caudal vertebrae.

Fig. — A–E, G, Powell and Gordy 1980; F, H–I, K, Lippson and Moran 1974; J, Kendall 1972 (redrawn).

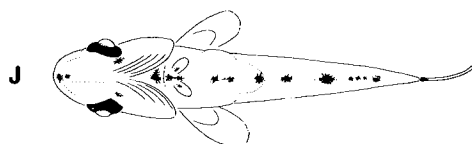
Ref. — Powles and Stender 1978; Fruge and Truesdale 1978; Chao 1978.

Leiostomus xanthurus**SCIAENIDAE****A** Late stage egg (2 views)**C** 2.6 mm SL**B** Newly-hatched larva**D** 4.1 mm SL**E** 5.2 mm SL**F** 7.5 mm SL**G** 8.0 mm SL**H** 12.8 mm SL

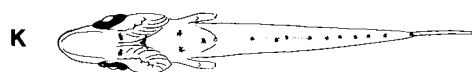
Ventral views

**I** 5.3 mm SL *Micropogonias undulatus*

Note difference in development of pectoral and pelvic fins

**J** 5.4 mm SL *Centropristis striata* (p. 234)

Note space between anus and anal fin origin in Fig. I and K

**K** 5.6 mm SL *Leiostomus xanthurus*

Note triangular pigment pattern anterior to anus in Fig. K (compare to usual condition in Fig. I).

SCIAENIDAE *Micropogonias undulatus* (Linnaeus)

Spawning: Continental shelf waters north of Cape Hatteras during September–November (to January or February?)

Meristic features

Eggs — Undescribed.

Myomeres: 23–26

Larvae — Body depth <30% SL; head length varies from 26 to 36% SL.

Vert : 10+15

D : X, I, 27–30

A : II, 8–9

Plv : I, 5

P : 17–18

— Preanus length increases from about 50% SL (small larvae) to 55–60% SL (larger larvae); greater than in *Leiostomus* (p. 276).

— Eye diameter in larvae <4.5 mm SL much smaller than in *Leiostomus*.

— Flexion occurs at 4–5 mm SL.

— Preopercle spines develop at 3–4 mm SL, and posttemporal spines at 8.3 mm SL.

— Fin development sequence: C–A, D₂–D₁, P–Plv.

— Sizes at beginning of ossification and completion of fin rays:

Caudal rays	4.8 mm SL	6.8 mm SL
Anal rays	4.4*	7.1
Dorsal rays	4.4*	10.0+
Dorsal spines	7.4	8.4
Pectoral rays	7.8	11.9
Pelvic rays (bud at 8.4 mm)	9.4	11.8

* Postflexion

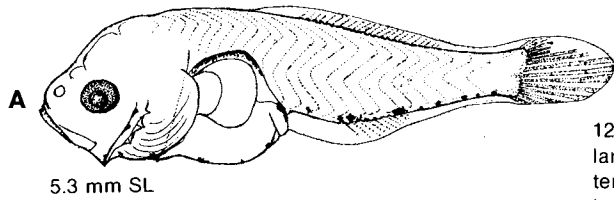
— Pigmentation: row of spots along ventral midline from anus to notochord tip (number decreases with growth); spot at cleithral symphysis; usually 3 ventral spots in line from anus to cleithral symphysis (<9.8 mm SL), although triangle pattern typical of *Leiostomus* sometimes present; no internal pigment on anterior surface of gut between cleithra.

Characters for Distinguishing *Micropogonias* and *Leiostomus* Larvae

Characters	<i>Leiostomus</i>	<i>Micropogonias</i>
Internal pigment		
— Anterior gut	Present	Absent
— Ventral brain	Present	Usually not present
— Vertebral column	In most >9 mm SL.	Absent
Ventral pigment		
— Postanal	Complete row from anus to caudal base including at least 1 spot in anus-anal fin gap.	Gap forms in row over developing anal fin; number of spots decreases with growth.
— Preanal	Triangle pattern; 1 spot at anus and 1 at each pelvic base.	Usually no triangle pattern; 3 spots in line from anus to cleithral symphysis.
— Caudal base	Spot at notochord tip which eventually outlines hypural edges (in all).	May have pigment at notochord tip or caudal base (contrary to published descriptions).
Anal pterygiophores (>6.3 mm SL)	12–13 (two less than total anal fin elements).	Fewer

Fig. — A–D, F, Lippson and Moran 1974; E, Kendall 1972 (redrawn).

Ref. — Joseph *et al.* 1964; Powles and Stender 1978; Fruge and Truesdale 1978; Chao 1978.

Micropogonias undulatus**SCIAENIDAE**

5.3 mm SL

Spot at angle of lower jaw

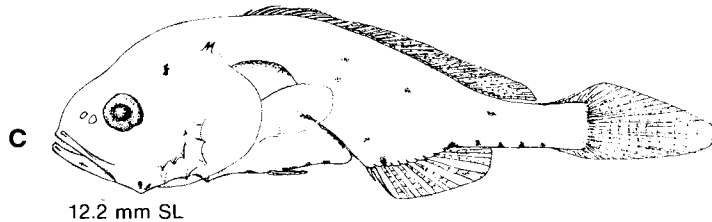
12 or more spots along ventral midline, 1 (or 2) large spot at anal fin origin, 1 large spot at posterior end of anal fin with none between (gap in series not present in *Leiostomus*), 3-6 spots posterior to anal fin.



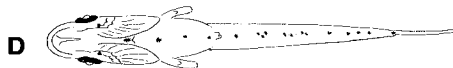
7.7 mm SL

No dorsal or lateral pigment present <11.8 mm SL

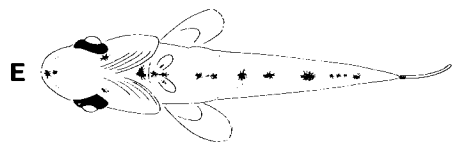
Lateral spots along midline increase from 3 at >11.8 mm SL to 10 by 21.5 mm SL



12.2 mm SL

Ventral views5.3 mm SL *Micropogonias undulatus*

Note difference in development of pectoral and pelvic fins

5.4 mm SL *Centropristis striata* (p. 234)

Note space between anus and anal fin origin in Fig. D and F

5.6 mm SL *Leiostomus xanthurus*

Note triangular pigment pattern anterior to anus in Fig. F (compare to usual condition in Fig. D)

SCIAENIDAE***Menticirrhus* sp.**

Spawning: *M. americanus* (Linnaeus) spawns in coastal waters of Mid-Atlantic Bight during May–June.

M. saxatilis (Block and Schneider) spawns in coastal waters of Mid-Atlantic Bight during May–September.

M. littoralis (Holbrook) spawns in coastal waters of North Carolina during May–August.

Meristic features

Myomeres: 25
 Vert: 10+15
 D : X, I, 19–27
 A : I, 6–9
 Piv : I, 5

(Counts for 3 species)

Generic characters

- Larvae** — Body depth at cleithrum usually >30% SL at sizes <4 mm, decreases to 27–30% SL.
 — Head length varies from 30 to 37% SL; preanus length 53–64% SL.
 — Gap between anus and anal fin short, <5% SL (unusual among sciaenids).
 — Flexion occurs at 3.6–4.1 mm SL.
 — One anal spine (unique among sciaenids).
 — Preopercle spines (lateral and marginal) form at 3.6 mm SL, and increase in number.
 — One to several posttemporal spines form at 6.6 mm SL.
 — Fin formation sequence: C–D₂, A–D₁–P, Piv.
 — Sizes at beginning of ossification and completion of fin rays:

Caudal rays	3.6 mm SL	...
Dorsal rays	4.1	4.4 mm SL
Anal rays	4.1	4.6
Anal spine	...	6.0
Dorsal spines	6.6	...
Pectoral rays	6.8	...
Pelvic fin (bud at 4.1 mm)	...	6.8

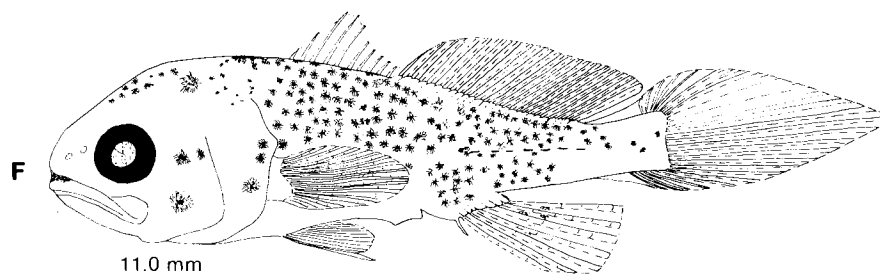
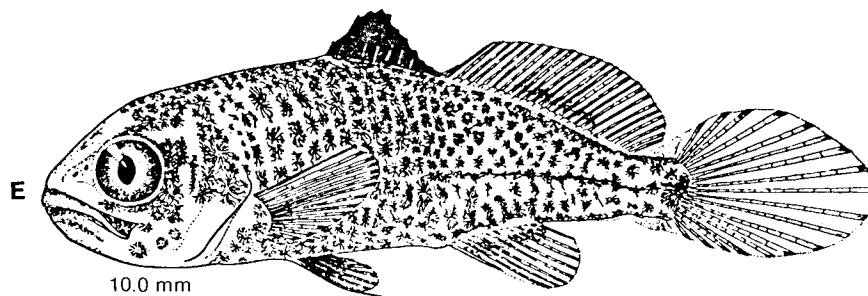
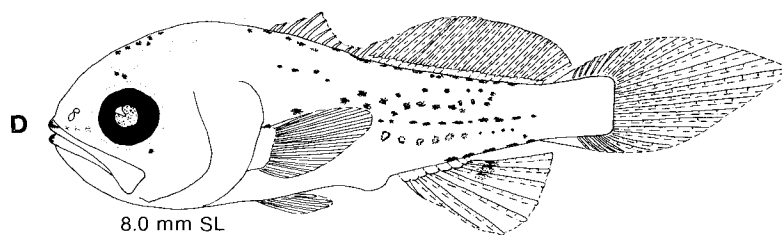
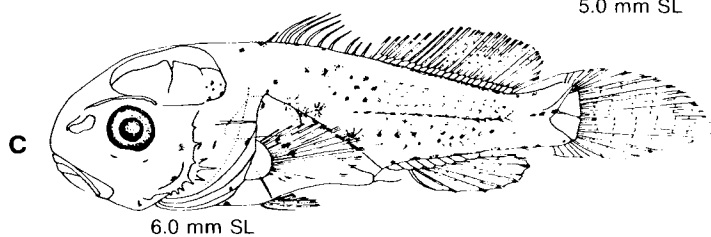
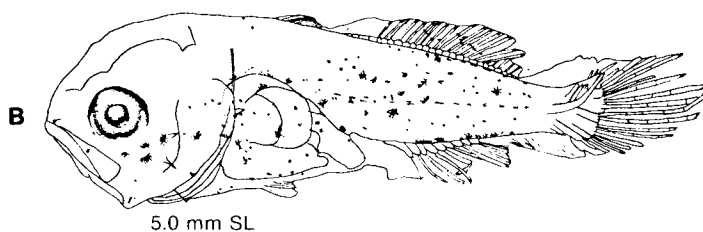
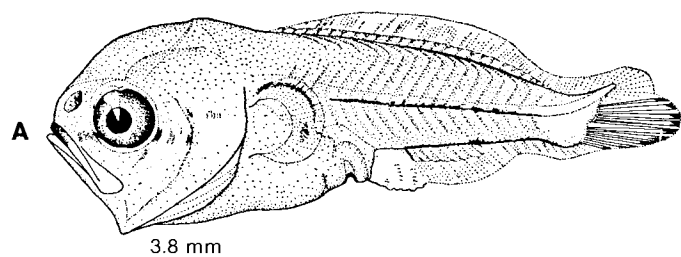
- Pigmentation: heavy on midline of tail, on ventral midline (>2.8 mm SL), on dorsal midline (>6.1 mm SL), overall dusky appearance (>8.0 mm SL); 1–4 spots on nape <3.6 mm SL and 1 spot >3.6 mm SL; no ventral spot anterior to cleithral symphysis; ventral pigment present in anus-anal fin gap at <3.4 mm SL but absent in larger larvae; most specimens (>75%) have well-defined pigment at upper end of pectoral base.

Distribution: *M. americanus* is most abundant from Chesapeake Bay southward, *M. saxatilis* from Chesapeake Bay northward, *M. littoralis* from Cape Hatteras southward.

Note: Published descriptions of *Menticirrhus* larvae do not adequately permit separation to species and some descriptions include a mixture of species. Illustrations on opposite page are nominally *M. americanus* and *M. saxatilis*.

Fig. — A, D–F, Hildebrand and Cable 1934 (D and F redrawn); B, C, Jannke 1971. (A, C, D and F described as *M. americanus*; B and E described as *M. saxatilis*).

Ref. — Powles and Stender 1978; Chao 1978.

Menticirrhus* sp.*SCIAENIDAE**

SCIAENIDAE***Pogonias cromis* (Linnaeus)**

Spawning: Coastal and estuarine waters of Delaware Bay and southward in spring, with possible second spawning in autumn.

Eggs — Pelagic, spherical.
— Diameter: 0.82–1.02 mm.
— Oil globules: 1 to multiple (pigmented).

Larvae — Hatching occurs at 1.9–2.4 mm; eyes unpigmented.
— Slender body (depth 23.0–24.8% SL).
— Dorsal and anal rays complete at 4.6 mm; pelvic buds appear at about 8 mm.
— Pigmentation: very stellate and branching in tail region; 2–5 spots on ventral midline in <6 mm larvae; 1–2 spots along second dorsal fin base.

Meristic features

Myomeres: 24
Vert: 10+14
D : X, I, 19–23
A : II, 5–7

***Sciaenops ocellatus* (Linnaeus)**

Spawning: Coastal waters south of Chesapeake Bay in fall–winter.

Eggs — Pelagic, spherical.
— Diameter: 0.86–1.07 mm.
— Shell: smooth.
— Yolk: homogeneous.
— Oil globules: 1 (usually) to 6.
— O.G. diameter: 0.22–0.36 mm.
— Perivitelline space: narrow.

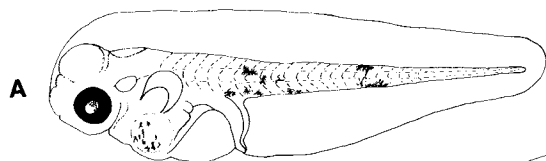
Larvae — Hatching occurs at 1.7–1.8 mm; eyes unpigmented.
— Slender body (depth 26.5–31.1% SL).
— Flexion occurs between 3.2 mm NL and 5.1 mm SL.
— Dorsal rays complete at 6.1 mm, anal rays at 5.2 mm, and pelvic buds appear at 5.2 mm.
— Lateral and marginal preopercle spines present (not illustrated).
— Pigmentation: internal pigment prominent on dorsal surface of notochord; 1–2 spots at posterior end of anal fin base (usually branch up to midlateral line); 1 spot at second dorsal fin origin and one along its base, 1 stellate melanophore often present on midlateral line over anus.

Meristic features

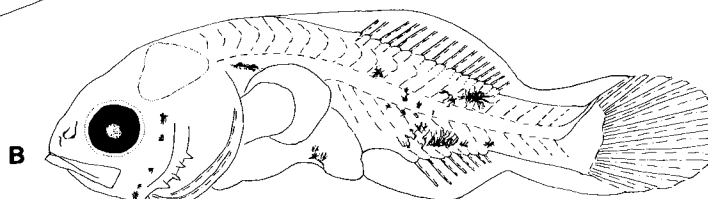
Myomeres: 25
Vert: 10+15
D : X, I, 23–25
A : II, 7–9

Fig. — A–C, Joseph *et al.* 1964; D–F, Pearson 1929 (all redrawn).

Ref. — Powles and Stender 1978; Holt *et al.* 1981.

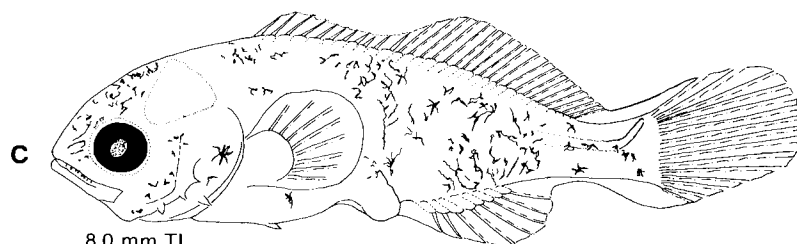
*Pogonias cromis***SCIAENIDAE**

2.9 mm TL

No internal pigment on
notochord in tail region

5.5 mm TL

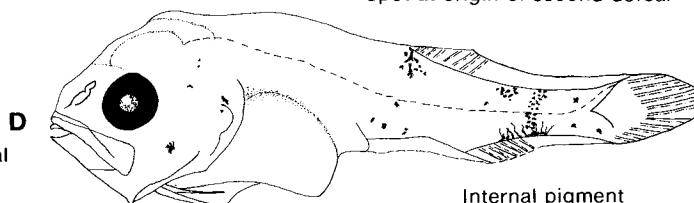
No spot at origin of second dorsal



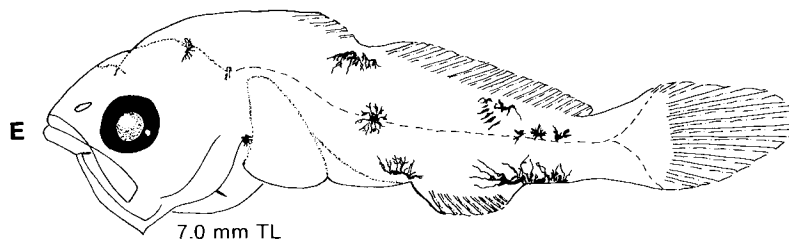
8.0 mm TL

Sciaenops ocellatus(Head pigment added
to original figures)

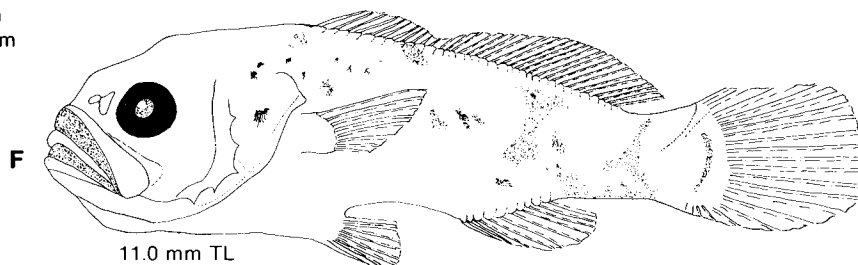
Spot at origin of second dorsal



4.5 mm TL

Internal pigment
on notochord

7.0 mm TL

Posterior surface
of visceral mass
heavily pigmentedPelvic bud which
appears at 5.2 mm
not shown in E.

11.0 mm TL

SCIAENIDAE***Stellifer lanceolatus* (Holbrook)**

Spawning: Estuarine and coastal waters south of Chesapeake Bay in early summer.

Meristic features

Eggs — Undescribed.

Myomeres: 25
 Vert : 10+15 or 11+14
 D : XI-XII, 20-24
 A : II, 7-9
 Piv : I, 5
 P : 19-20

Larvae — Deep body (34-41% SL); head length increases from about 30% SL to 39% SL; preanus length increases from 40-50% SL to 55% SL.
 — Flexion occurs at 3.3-4.3 mm SL.
 — Preopercle spines present through larval development (lateral spines smaller than marginal).
 — Posttemporal spine present at 5.1-7.8 mm SL.
 — Premaxillary and dentary teeth present through larval development.
 — Sizes at beginning of ossification and completion of fin rays:

Caudal rays	3.3 mm SL	5.5 mm SL
Dorsal rays	3.3	6.9
Anal spines and rays	3.3	6.9
Dorsal spines	4.5	6.9
Pectoral rays	6.9	14.0
Pelvic rays (bud at 4.9 mm)	6.9	7.8

— Pigmentation: ventral row of spots postanally; spot on dorsal edge of body over posterior end of anal fin (in most at 2.9-6.2 mm SL); internal spot on anterior gut surface between cleithra; spot over posterior gut appears and grows large at >4.1 mm SL; ventral gut spot between cleithral symphysis and anus at 2.9-6.2 mm SL, and spot at anus at 2.9-5.8 mm SL; ventral spot anterior to cleithral symphysis through larval development; spot on lower jaw angle <6.2 mm SL, and dark pigment forms at upper end of opercle >7.4 mm SL.

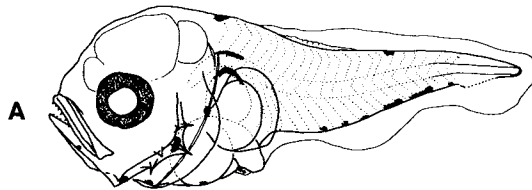
Note: Spot posterior to anal fin in 9 mm larva (Fig. E) of Hildebrand and Cable (1934) may be an error, according to Powles and Stender (1978).

Fig. — A-D, Powles 1980; E, Hildebrand and Cable 1934 (redrawn).

Ref. — Chao 1978.

Stellifer lanceolatus

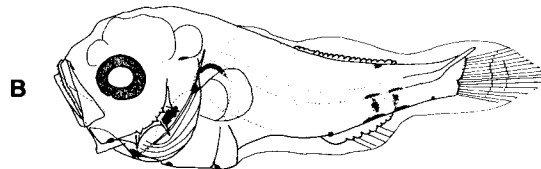
SCIAENIDAE



2.9 mm NL

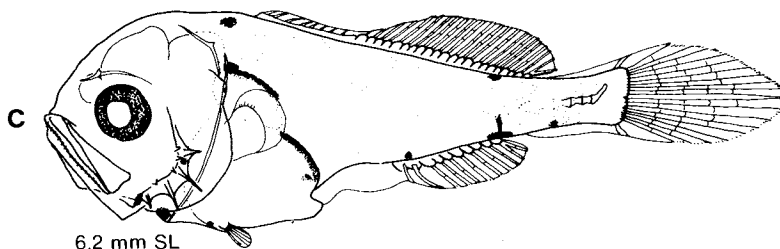
Anterior dorsal spot and internal pigment on notochord in larvae <3.8 mm SL

5-6 ventral spots from anus to notochord tip; 4th (and 5th?) larger



4.3 mm SL

1-3 spots posterior to anal fin



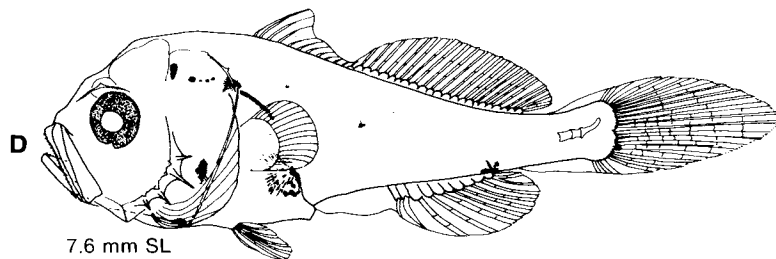
6.2 mm SL

1-2 expanded spots form at posterior end of anal fin (often branched dorsally)

Spot retained at base of second anal spine; none anterior to anal base

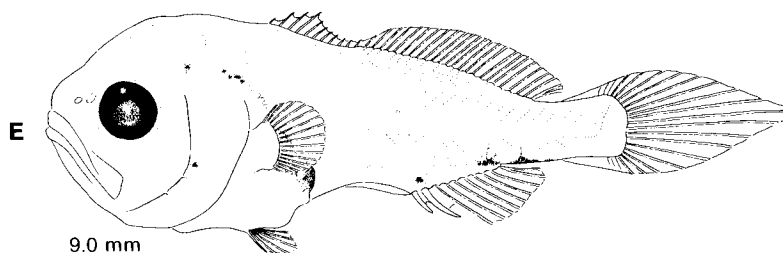
BEST CHARACTERS:

- dorsal spot over posterior anal fin
- no spot anterior to anal fin base



7.6 mm SL

No spots posterior to anal fin >6.9 mm SL; spots reappear after 10 mm SL



9.0 mm

In larvae >10 mm SL, pigment spreads but does not become very heavy

EPHIPPIDAE
(=Ephippidae)

***Chaetodipterus faber* (Broussonet)**

Spawning: Maryland and southward in spring-summer.

Meristic features

Eggs — Undescribed; Smith (1907) noted oocytes <1.0 mm diameter in ripe fish off North Carolina.

Myomeres: 24

Vert: 10+14

D: IX, 21-23

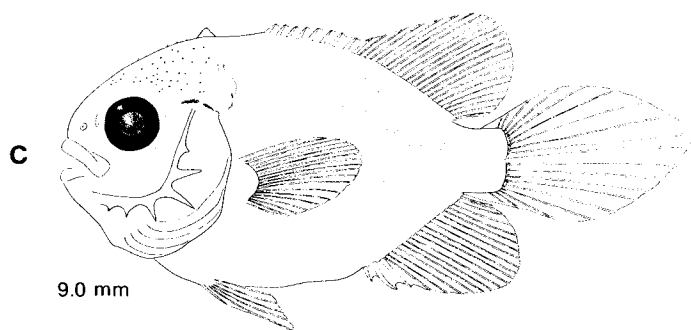
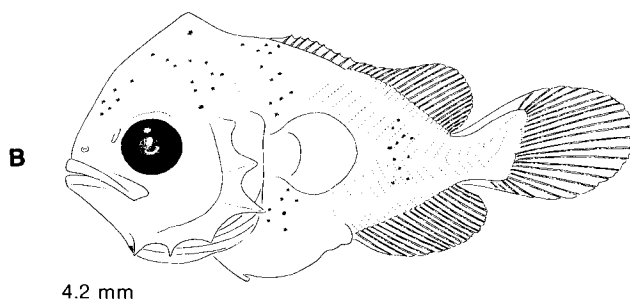
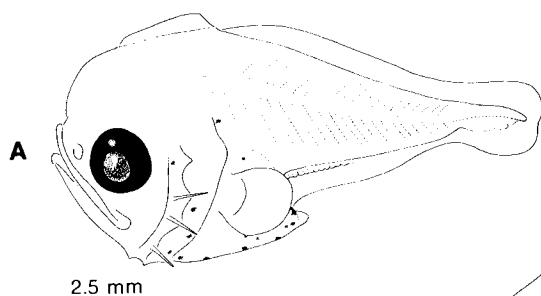
A: III, 17-20

Piv: I, 5

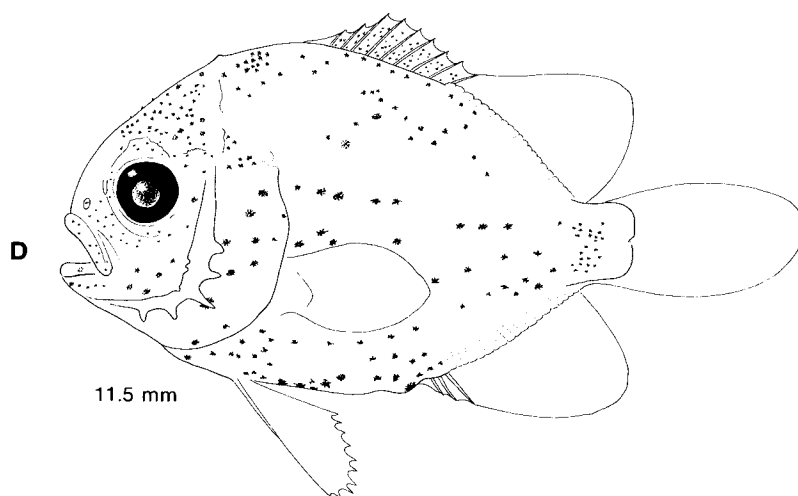
P: 17-18

C: 5-6+9+8+5-6

Larvae — Hatching occurs at about 2.5 mm.
— Body stout, deep anteriorly; preanus length about 50% TL; steep profile; large oblique mouth; crest on head.
— Prominent preopercle spines (disappear at about 20 mm).
— Flexion occurs at about 4 mm.
— Dorsal, anal and caudal rays develop early and are complete at about 4 mm; pelvic fin last to form.
— Teeth present at 9 mm.
— Pigmentation: spots scattered around abdomen in 2.5 mm larvae; bars between second dorsal and anal fins and through pectoral base at 4.2 mm; in 9.0-11.5 mm juveniles, body very dark all over, pelvic fins very dark and other fins light.

Chaetodipterus faber**EPHIPPIDAE**

Pigment on body and pelvic fins very dense; lightened on 9.0 mm and 11.5 mm larval illustrations



MUGILIDAE***Mugil cephalus* Linnaeus**

Spawning: Outer continental shelf off United States coast in late autumn to winter.

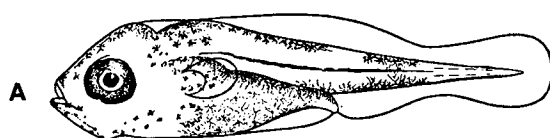
Meristic features

- Eggs**
- Pelagic, spherical.
 - Diameter: 0.91–0.99 mm.
 - Shell: smooth and transparent.
 - Yolk: homogeneous.
 - Oil globules: 1.
 - O.G. diameter: 0.30–0.36 mm.
 - Perivitelline space: narrow.

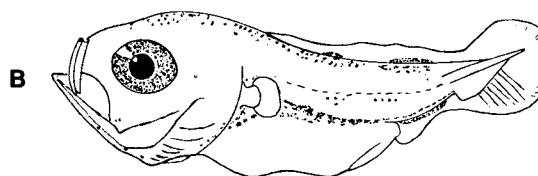
Myomeres: 24
 Vert : 11–12+12–13
 D : IV, I, 7–8
 A : III, 8
 Plv : I, 5
 P : 14–18
 C : 7–8+7+7+7–8

- Larvae**
- Hatching occurs at 2.2–3.6 mm; eyes unpigmented.
 - Body moderately stocky; preanus length >50% SL.
 - Flexion occurs at 4–5 mm TL.
 - Caudal rays first to form; pelvic buds appear at 5.4 mm TL, fins abdominal; anal rays complete at 6.2 mm TL.
 - Dorsal fins well separated and posterior on body; 2nd dorsal rays complete at 5.4 mm TL.
 - Dorsal spine count low (4), formed at 6.7 mm TL.
 - Pectoral fins high on trunk (noticeable early in development).
 - Pigmentation: heavy dorsal pigment from head through 2nd dorsal fin; dorsal surface of gut heavily pigmented; ventral pigment from vent to caudal fin base.

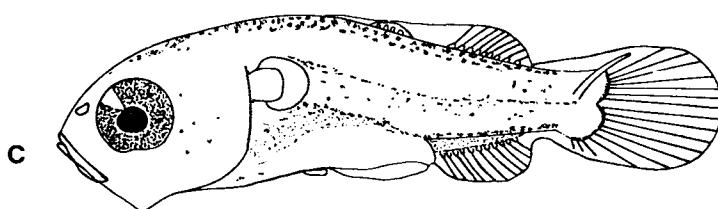
Note: The very similar *Mugil curema* Valenciennes is distinguishable after completion of anal fin development by its higher total count of 12 (rarely 13) elements; usually II, 10 in young.

Mugil cephalus**MUGILIDAE**

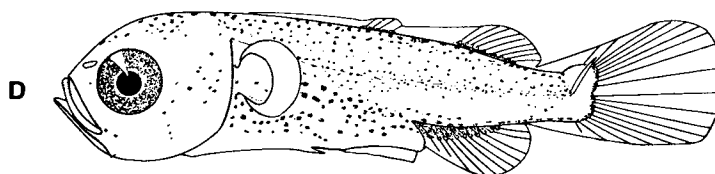
2.8 mm TL



4.0 mm TL

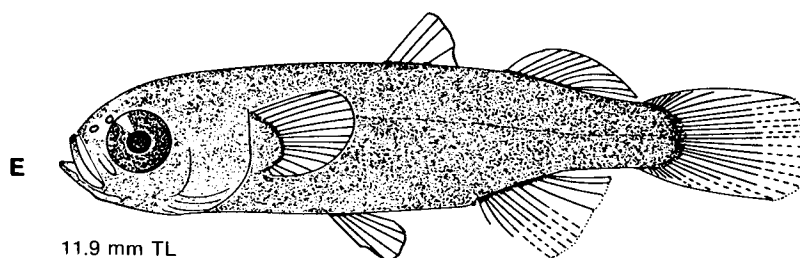


5.4 mm TL



6.7 mm TL

Note low principal caudal ray count (7+7)



11.9 mm TL

A (Black Sea specimen)

SPHYRAENIDAE***Sphyraena borealis* DeKay****Spawning:** Off Florida in winter.**Eggs**

- Pelagic, spherical.
- Diameter: 1.22–1.24 mm.
- Yolk: lightly segmented.
- Oil globules: 1.
- O.G. diameter: 0.27–0.29 mm.
- Perivitelline space: narrow.

Larvae

- Hatching occurs at about 2.6 mm SL; eyes unpigmented, mouth undeveloped, oil globule anterior in yolk and pigmented; 14 preanal and 10 postanal myomeres.
- Body slender, with long gut.
- Mouth forms at about 4 mm SL, with elongate jaws, fleshy tip on lower jaw and teeth develop at about 5 mm SL.
- Flexion occurs at 7.4–9.0 mm SL, and transformation at about 13.5 mm SL (rays complete, and finfold gone).
- Head length increases from 13% SL at hatching to 33% SL in 9 mm larvae.
- Vertebrae and 2nd dorsal fin complete at 10 mm, anal fin at 10–11 mm, caudal fin at 10–12 mm, 1st dorsal at 11–12 mm, pectoral fin at 13–14 mm, and pelvic fin (bud at 9 mm) complete at 14 mm.
- Pigmentation: (see illustrations opposite).

Meristic features

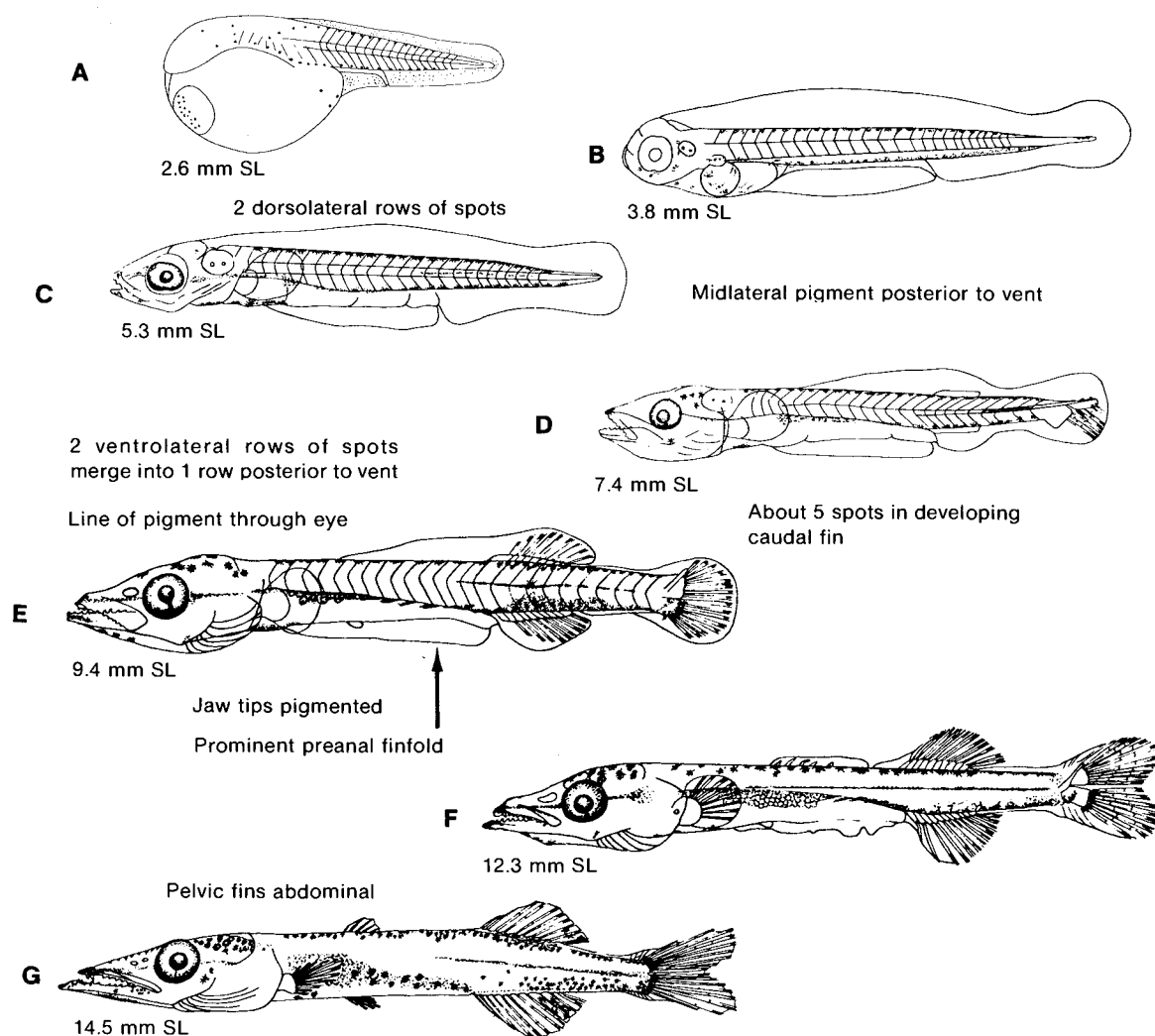
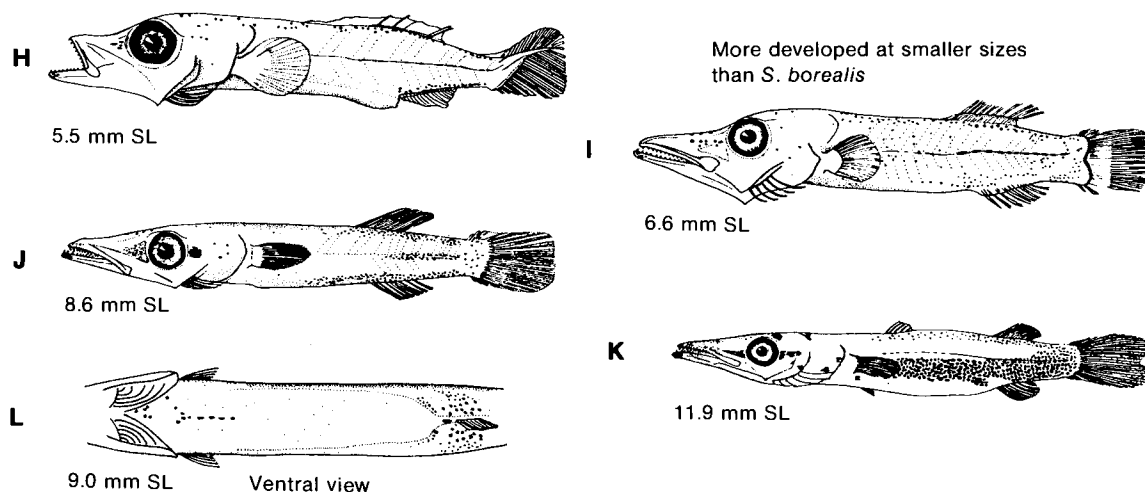
Myomeres: 24
 Vert : 12+12
 D : V–VI, I, 8–9
 A : I–II, 8–9
 Piv : I, 5
 C : 9+9+8+9

Sphyraena barracuda* (Walbaum)*Larvae**

- Body deeper and snout longer than in *S. borealis*.
- Head proportionately longer (36% SL at 5.5 mm) than in *S. borealis*.
- Pigmentation: spots in front of eye, on tip of lower jaw, along anal fin base, and scattered dorsally on body; midlateral line of postanal spots becomes dense.
- May be found as stray north of Cape Hatteras.

Meristic features

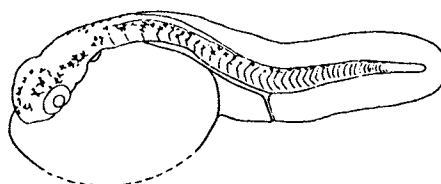
Myomeres: 24
 (Meristic counts overlap or coincide with those of *S. borealis*)

Sphyraena borealis**SPHYRAENIDAE*****Sphyraena barracuda***

LABRIDAE***Tautoga onitis* (Linnaeus)****Spawning:** Mid-Atlantic Bight during May–August.**Meristic features**

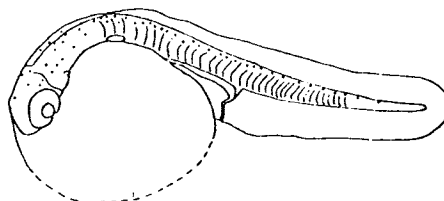
- Eggs** — Pelagic, spherical.
 — Diameter: 0.97–1.00 mm.
 — Shell: smooth.
 — Yolk: homogeneous.
 — Oil globules: none (unusual for family).
 — Perivitelline space: narrow.
- Larvae** — Hatching occurs at about 2 mm (small ratio of hatching size to egg diameter), eyes unpigmented, mouth undeveloped.
 — Preanal length about 50% TL.
 — Flexion occurs between 5 and 10 mm.
 — Dorsal, anal and caudal fins well differentiated by 10 mm; pelvic fins late forming.
 — Posterior caudal region unpigmented.
- Myomeres: 34–35
 Vert : (16)17+18
 D : XVI–XVII, 10–11
 A : III, 7–8
 Plv : I, 5
 P : 16
 C : 8+7 principal

Embryo excised from egg; heavy pigment between eyes; wide gap between yolk and anus.

***Tautogolabrus adspersus* (Walbaum)****Spawning:** Mid-Atlantic Bight during May–October (peak in June–August).**Meristic features**

- Eggs** — Pelagic, spherical.
 — Diameter: 0.84–0.92 mm.
 — Shell: smooth.
 — Yolk: homogeneous.
 — Oil globules: none.
 — Perivitelline space: narrow.
- Larvae** — Hatching occurs at about 2.2 mm (small ratio of hatching size to egg diameter); eyes unpigmented; mouth undeveloped.
 — Preanal length about 50% TL.
 — Flexion occurs at about 5 mm.
 — Dorsal fin begins to differentiate at 7–8 mm.
 — Band of pigment over gut, pair of spots between anus and caudal fin, and few spots on ventral notochord tip.
- Myomeres: 36
 Vert : 17+19
 D : XVIII, 9–10
 A : III, 8–9
 Plv : I, 5
 P : 16
 C : 8+7 principal

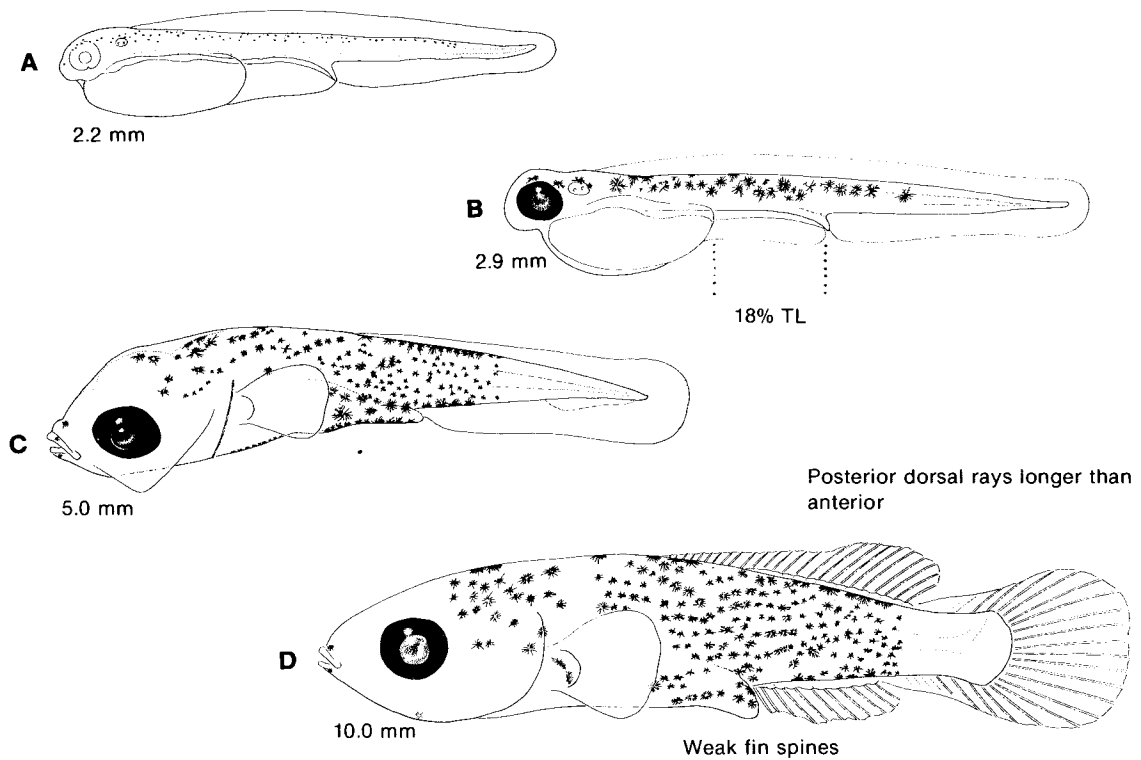
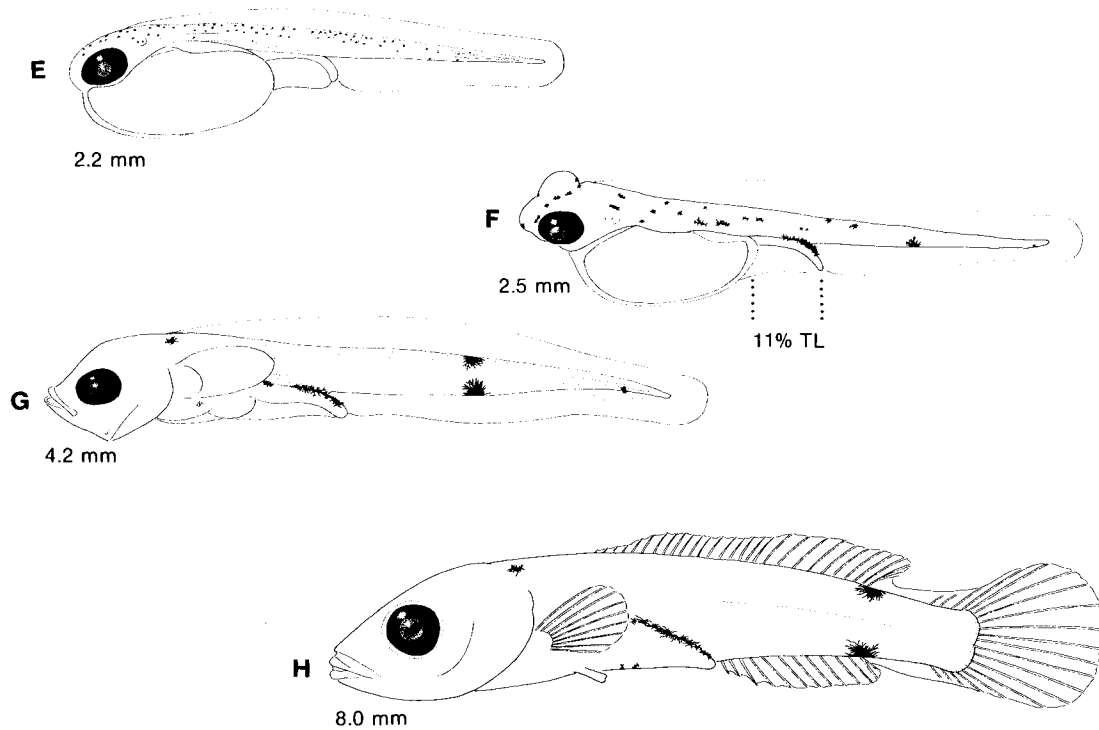
Embryo excised from egg; light pigment between eyes; narrow gap between yolk and anus.



- Note:** (1) Early eggs of *T. adspersus* similar to those of *Limanda ferruginea* (p. 380).
 (2) Other labrid (and very similar scarid) species may drift north with the Gulf Stream.

Fig. — **A**, Agassiz and Whitman 1885; **B–H**, Kuntz and Radcliffe 1917 (all redrawn).

Ref. — Williams 1967; Colton and Marak MS 1969.

Tautoga onitis**LABRIDAE*****Tautogolabrus adspersus***

PHOLIDIDAE STICHAEIDAE

Blennioid Larvae (2 Families)

Eggs — Demersal, adhesive.

Larvae — Body elongate with straight gut; snout short but slightly pointed; mouth large.
 — Preanal length $\leq 50\%$ SL (except *Pholis gunnellus* slightly $> 50\%$ SL).
 — Dorsal and anal fins long; pectoral fins wide and fan-shaped, situated just below midline.
 — All 5 species have rows of ventral spots from vent to caudal fin.
 — Meristic characters, pigmentation and range in western North Atlantic:

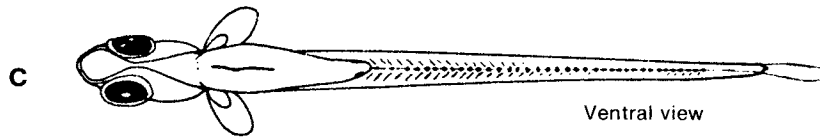
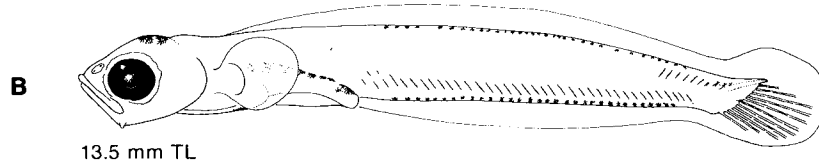
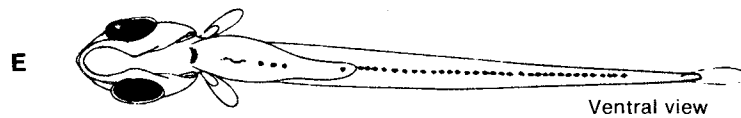
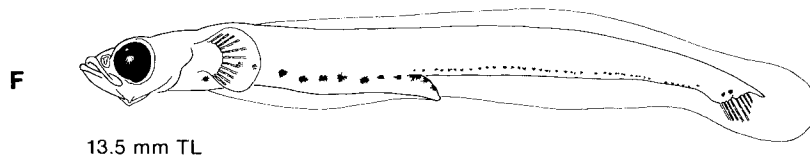
	Pholididae	Stichaeidae			
	<i>Pholis gunnellus</i>	<i>Stichaeus punctatus</i>	<i>Ulvaria subbifurcata</i>	<i>Lumpenus maculatus</i>	<i>Lumpenus Lumpretaeformis</i>
Meristics					
Myomeres	86-89	51-55	45-49	66-72	80-85
Postanal myomeres	49-51	33-37	28-33	38-44	58-63
Dorsal rays	80-83	46-49	43-44	57-64	68-76
Anal spines, rays	II, 42-44	I-II, 32-35	II, 30-31	I, 34-40	I, 46-53
Pelvic rays	I, 1	I, 4	I, 3	I, 3	I, 3
Pectoral rays	10-12	15-16	15	15	15-16
Pigmentation					
Intestine	Lateral (external)*	Dorsal (internal)	Dorsal (internal)	Lateral (external)	Lateral (external)
Preanal ventral	"Stitching" cleithrum to vent	Middle of gut	Middle of gut and spot near vent	None	None
Head	None	Present	Present	None	None
Dorsal edge	None	Posterior 1/2 in big larvae	Posterior 1/3 in big larvae	None	None
Notochord (internal)	None	At small sizes	At small sizes	None	None
Miscellaneous		Streaks on postanal myomeres	No streaks	About 38-44 postanal ventral spots	About 58-63 postanal ventral spots
Range					
	Delaware Bay and north	Massachusetts Bay and north	Woods Hole, Mass., and north	Cape Cod and north	Cape Cod and north

* Pigment may be faint or absent.

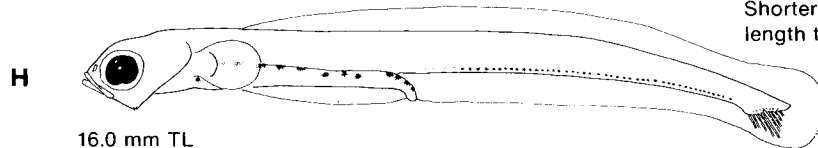
Note: See also Anarhichadidae (Barsukov 1959; McIntosh and Prince 1890).

Fig. — A, Rass 1949; B-I, Faber 1976 (A, B, D, F, H redrawn).

Ref. — Dannevig 1919; Makushok 1958.

Pholis gunnellus* (Linnaeus)*PHOLIDIDAE
STICHAEIDAE*****Stichaeus punctatus* (Fabricius)*****Ulvaria subbifurcata* (Storer)*****Lumpenus maculatus* (Fries)*****Lumpenus lumpretaeformis* (Walbaum)**

Shorter relative preanus
length than *L. maculatus*



A (eastern Atlantic specimen)

BLENNIIDAE**Family Characters****Eggs** — Demersal.

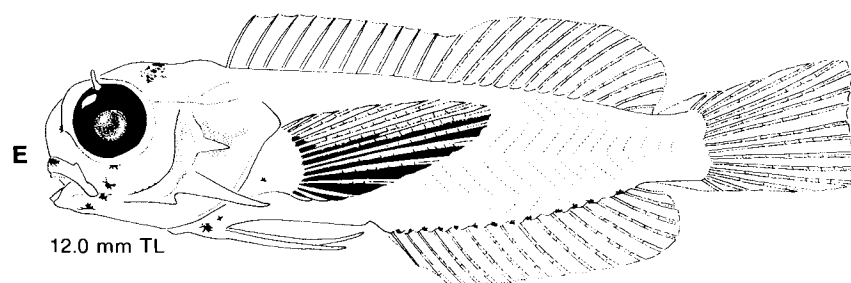
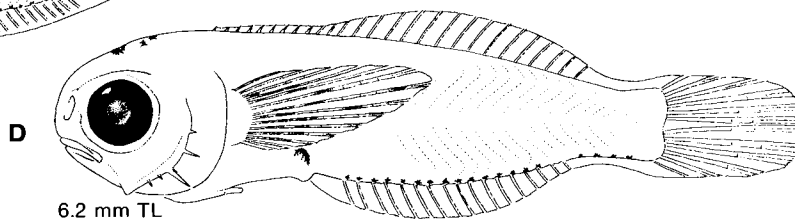
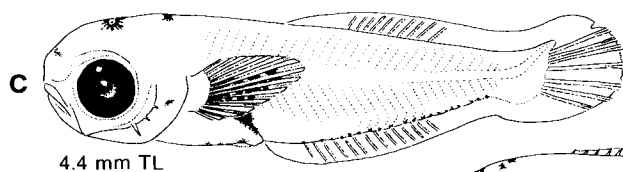
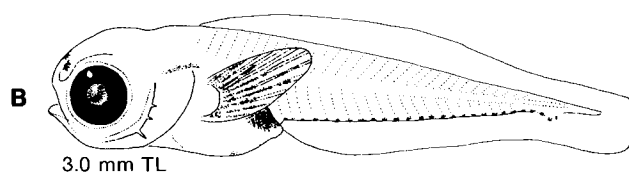
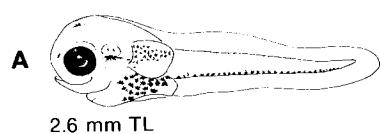
Larvae — Hatching occurs at about 2.5–3.5 mm.
 — Bulbous head, large eyes, short snout, and subterminal mouth.
 — Body fairly elongate, with short gut.
 — Spines present on preopercle; number of dorsal fin spines approximately equal to number of dorsal fin rays.
 — Flexion occurs at about 4–5 mm.
 — Pelvic fin forms late, and reduced to "I, 3".
 — Pigmentation: usually heavy on pectoral fins; ventral row of spots characteristic of family; location of pigment on head and nape may be specifically diagnostic.

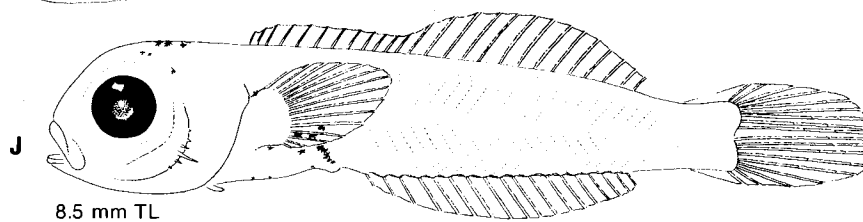
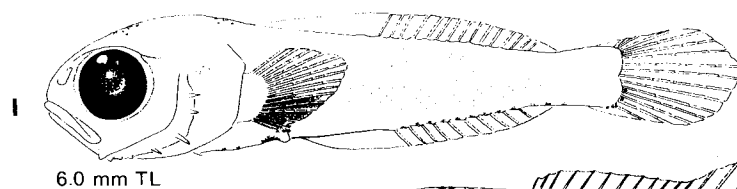
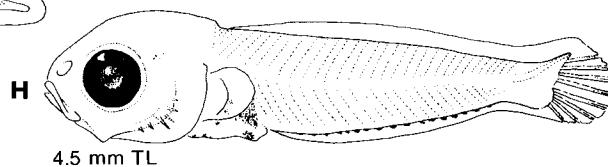
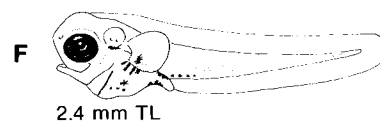
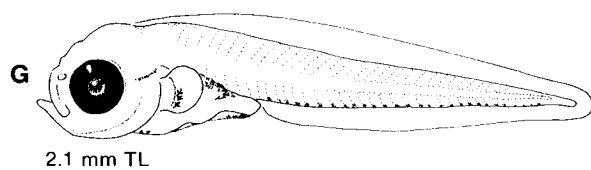
Meristic features*

Vert : 10+22–24
 D : XII, 13–15
 A : II, 16–17
 Piv : I, 3
 P : 13–15
 C : 5–6+7+6+5

* Counts pertain to
Hypsoblennius hentzi
 (Lesueur)

- Note:** (1) Preopercle spine development indicates that Fig. A–E may represent a mixture of 2 species (W. A. Laroche, 1981, pers. comm.).
- (2) Myomere range 32–35 in several blennioid species, the larvae of which may drift north in the Gulf Stream; meristic characters for other species overlap or coincide with those for *H. hentzi*.

Hypsoblennius hentzi**BLENNIIDAE**

Hypleurochilus geminatus

AMMODYTIDAE***Ammodytes* sp.**

Spawning: Mid-Atlantic Bight during winter-spring; later in northern waters.

Meristic features

- Eggs**
- Demersal, irregular shape.
 - Diameter: 0.67–0.91 mm.
 - Shell: sculptured, rough-surfaced (brownish).
 - Yolk: homogeneous (amber).
 - Oil globule: 1 (posterior in yolk sac).
 - O.G. diameter: 0.27 mm.
 - Perivitelline space: fairly wide.

	(1)	(2)	(3)
Myomeres :	59–78	(3 species)	
Vert :	61–68	64–75	61–73
D :	—	55–67	51–62
A :	—	26–35	23–33
P :	~13	~13	~13
Plv :	none (3 species)		
C :	(PrC, 3 species, 8+7)		

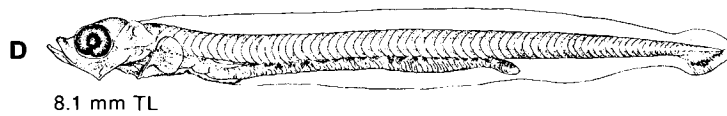
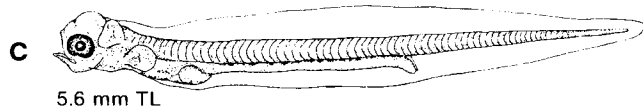
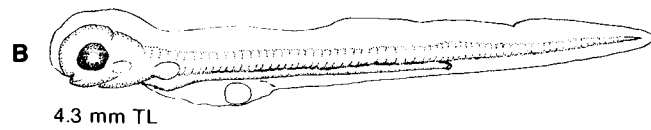
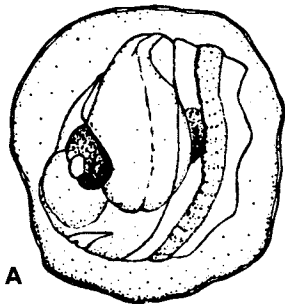
- Larvae**
- Hatching occurs at about 4 mm; no embryonic pigment.
 - Body elongate; vent opens at side of fin-fold (not margin).
 - Long gut (unusual for phylogenetically advanced fish, with internal folds).
 - Lower jaw protrudes anteriorly.
 - Flexion occurs at about 10–12 mm.
 - Caudal rays begin to form at 8 mm, complete at 15 mm, and fin forked at 22 mm.
 - Dorsal and anal rays begin to form at 13 mm, and development proceeds anteriorly; pectoral rays form late.
 - No pelvic fin.
 - Pigmentation: spots along dorsal edge of intestine, ventral row of spots on tail, and spots at base of caudal fin.

(1) = *A. americanus* DeKay
 (2) = *A. dubius* Reinhardt
 (3) = *A. hexapterus* Pallas

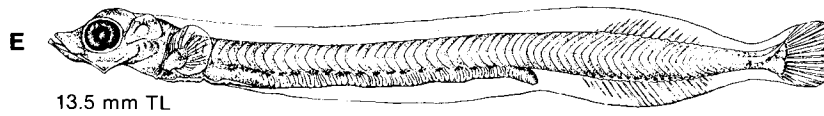
Note: Taxonomy of North American *Ammodytes* is unresolved; the validity of the 3 nominal species is questionable, and larvae should be tentatively identified as *Ammodytes* sp.

Fig. — **A–B**, Williams *et al.* 1964; **C–G**, Norcross *et al.* 1961.

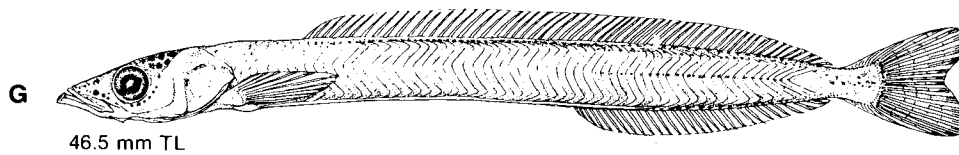
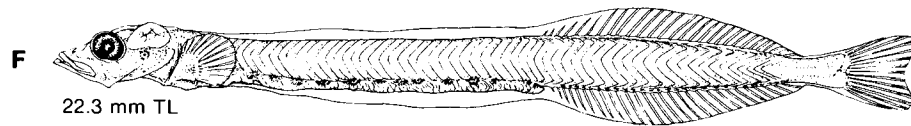
Ref. — Richards *et al.* 1963; Reay 1970.

Ammodytes* sp.*AMMODYTIDAE**

Internal notochord pigment forms at about 9 mm, increases with development



Dorsal row of spots forms at about 15 mm, extends anteriorly with development.



GOBIIDAE***Gobiosoma bosci* (Lacépède)**

Spawning: In estuaries during May–November in Mid-Atlantic Bight.

Eggs — Demersal (attached); shape irregular to elliptical.

Larvae — Hatching occurs at 2.0–2.6 mm; blunt snout; 13 preanal and 13 postanal myomeres; few pigment spots near vent and notochord tip.

— Flexion occurs at 4–5 mm.

— Anal, caudal and 2nd dorsal fins formed at 5.0–6.8 mm; pelvic buds formed at 6.8–7.5 mm; 1st dorsal begins at 6.8 mm and is complete at 10 mm; all fins complete at 10–15 mm.

— Pigmentation: (see illustrations opposite).

Meristic features

Myomeres : 27
 Vert : 11+16
 D : VI–VIII, 12–14
 A : 10–12
 P : 16–19

***Gobionellus boleosoma* (Jordan and Gilbert)**

Spawning: In coastal waters during March–August in Mid-Atlantic Bight.

Eggs — Demersal (attached); shape irregular to elliptical.

Larvae — Hatching occurs at 1.2 mm; preanal length 50% SL.

— Body elongate, head broad, mouth vertical, eyes large.

— Flexion occurs at about 5 mm SL.

— Caudal fin formed and dorsal and anal rays begin at 5.0 mm; 2nd dorsal and anal complete at 7.5 mm; all fins except 1st dorsal complete at 10 mm.

— Pigmentation: forms early over air bladder; 2–3 lines on chest at 5.0 mm; small spot at vent and one halfway to tail tip.

Meristic features

Myomeres : 26
 Vert : 10+16
 D : VI, 11
 A : 11–13
 P : 16

Common Characters for Both Species

Larvae — Body slender and lightly pigmented; preanal length about 50% SL.

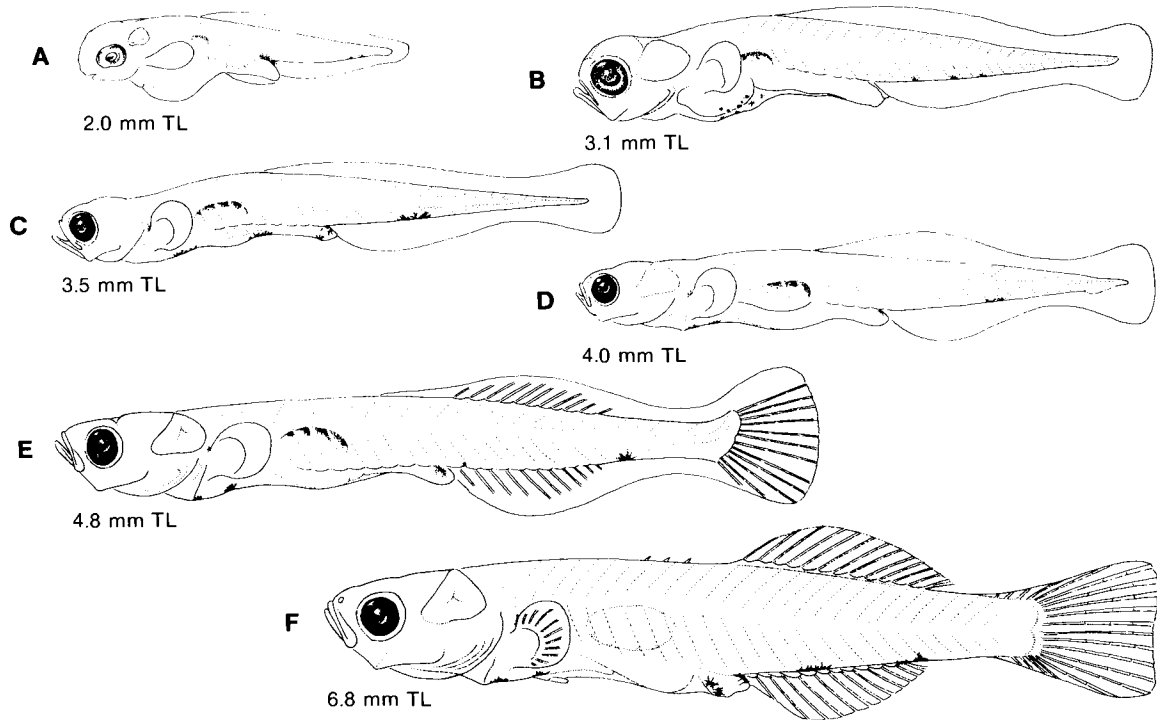
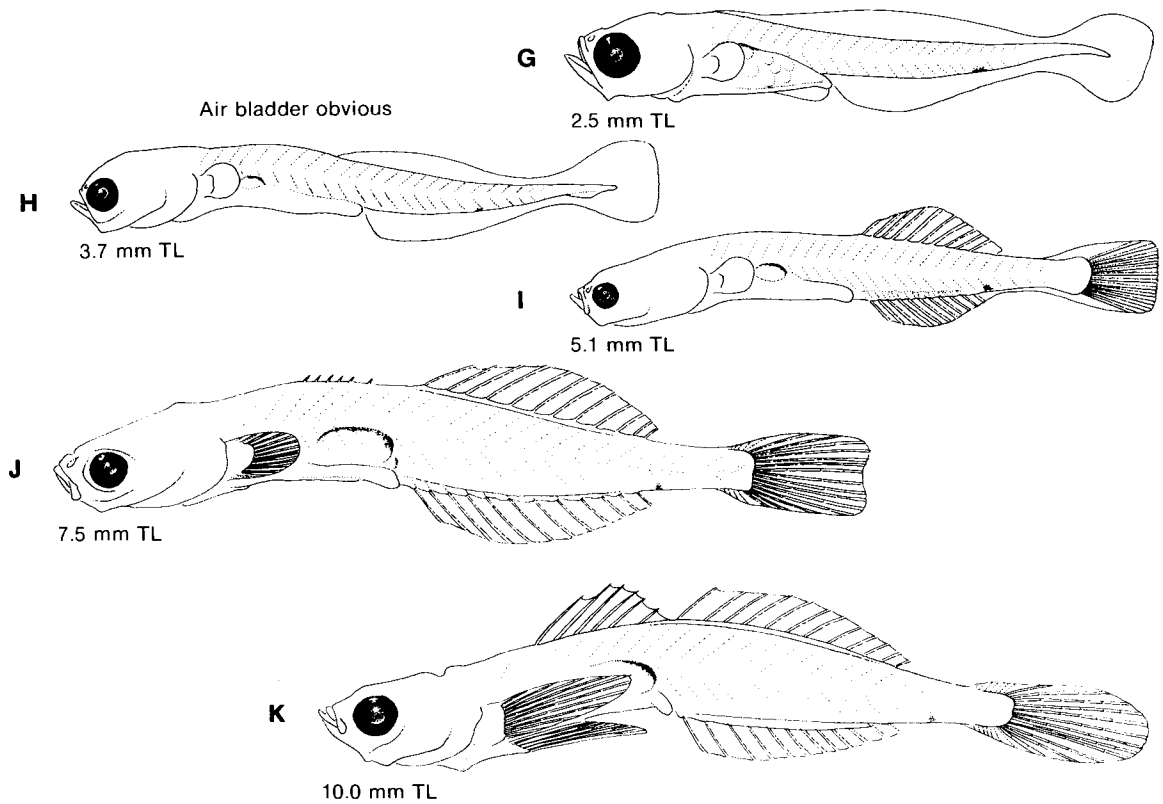
— Air bladder develops early, usually with pigment on dorsal surface.

— Principal caudal rays 8+7.

— Pelvic fin modified as sucking disc.

— Dorsal fins (2) well separated; spiny dorsal last fin to form.

— Occur in bays and coastal waters, and other species often abundant offshore (i.e. Gulf Stream).

Gobiosoma bosci**Gobiidae*****Gobionellus boleosoma***

GEMPYLIDAE***Gempylus serpens* Cuvier**

Spawning: Winter-spring in Florida Current and the Caribbean Sea.

Eggs — Undescribed.

Larvae — Pelvic fin rays form sequentially.
 — Pelvic spine shorter than in *Diplospinus multistriatus*.
 — Spiny dorsal fin lower than in *D. multistriatus*.
 — Flexion occurs at 7–8 mm SL.
 — Preopercle spines smooth (all long and slender); spine length order 1–2–3–4.

Meristic features

Myomeres: 49–53

D : XXX–XXXII, I–II, 10–12

A : II, I, 9–13

Piv : I, 0–4

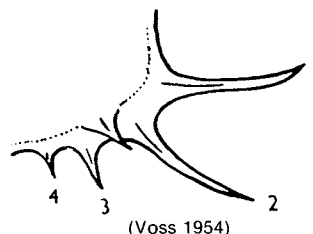
P : 12–15

C : 4+9+8+8

D finlets: 5–7

A finlets: 5–7

Preopercle
spines

**TRICHIURIDAE*****Diplospinus multistriatus* Maul**

Spawning: ?

Eggs — Undescribed.

Larvae — Deeper-bodied than *Gempylus serpens* and *Nesiarchus nasutus*.
 — No rays behind pelvic spine, which is long and strongly-serrate.
 — Very high spiny dorsal fin.
 — Flexion occurs at 8–10 mm SL.
 — Preopercle spine serrated; spine length order 2–1–4 (3rd missing).
 — Dorsal spine count almost complete in larvae >8 mm SL.

Meristic features

Myomeres: 58–61

D : XXX–XXXIV, 36–42

A : II, 29–32

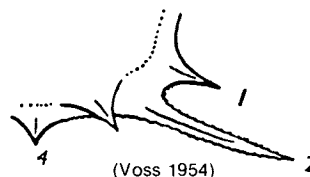
Piv : I, 0

P : 12–13

D finlets: none

A finlets: none

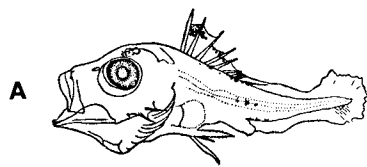
Preopercle
spines



- Note:**
- (1) Larvae of both species above have obvious dorsal and pelvic spines, which develop early, become large and have secondary serrations (not present in scombrids).
 - (2) Many authors consider *D. multistriatus* a member of the family Gempylidae (Backus *et al.* 1969; Parin and Becker, 1972; Evseenko and Serebryakov, 1974). Larvae more typical of the family Trichiuridae include *Trichiurus lepturus* Linnaeus (described by Mito, 1961b), *Lepidopus caudatus* Euphrasen (described by Schmidt and Strubberg, 1918), and *Benthodesmus elongatus* (Steindachner) (described by Evseenko, 1982).

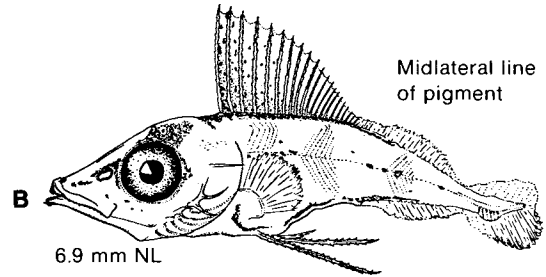
Fig. — A, C, Jones 1960b; B, D–I, Voss 1954; J, Strasburg 1964; K, Evseenko and Serebryakov 1974.

Ref. — Matsubara and Iwai 1952.

Gempylus serpens**GEMPYLIDAE
TRICHIURIDAE**

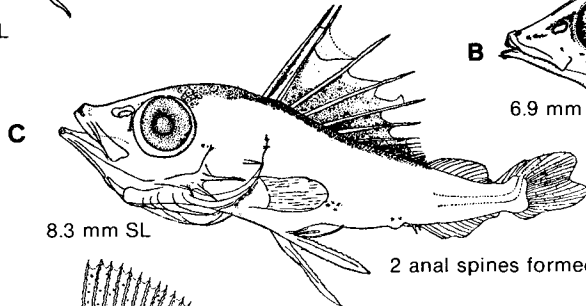
4.9 mm NL

Pelvic rays visible
as early as
5.6 mm SL



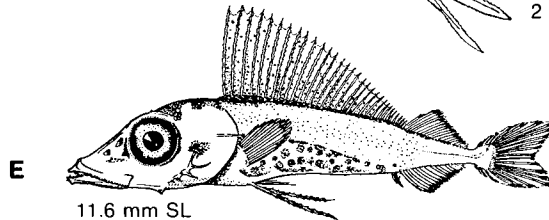
6.9 mm NL

Midlateral line
of pigment



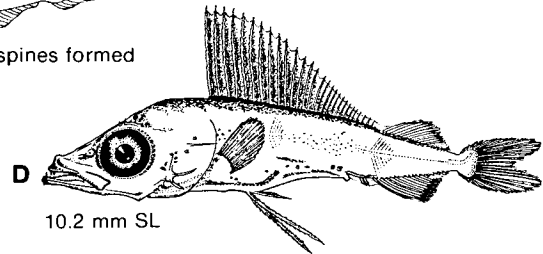
8.3 mm SL

2 anal spines formed

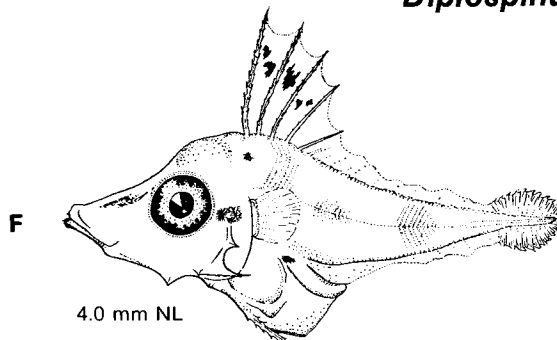


11.6 mm SL

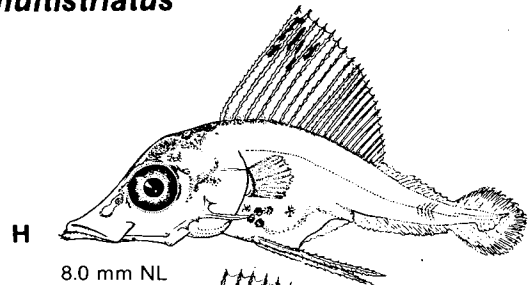
Second anal spine longer and stouter than first



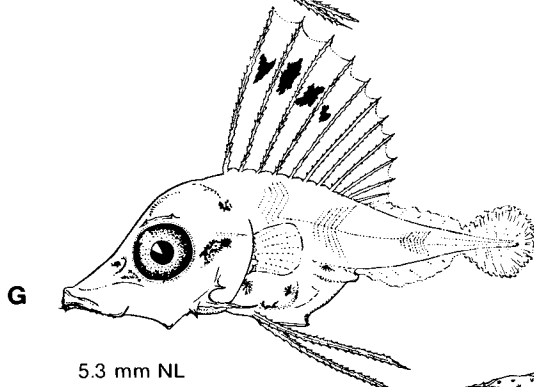
10.2 mm SL

Diplospinus multistriatus

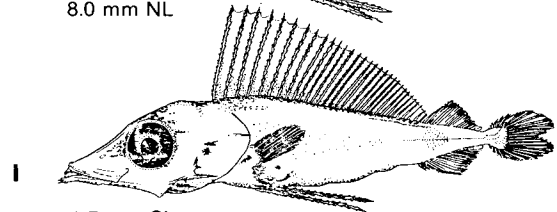
4.0 mm NL



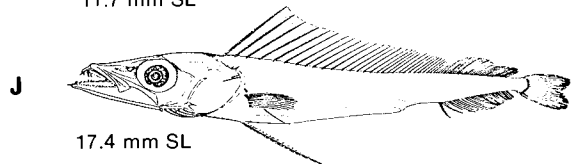
8.0 mm NL



5.3 mm NL

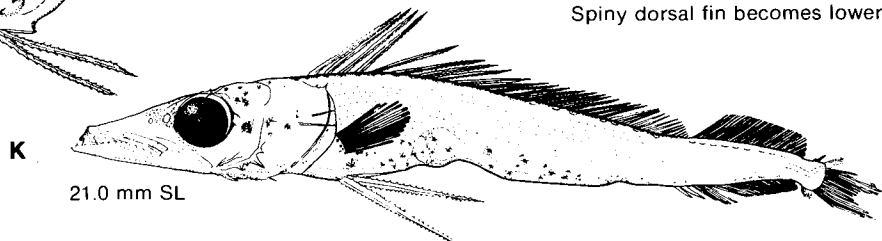


11.7 mm SL



17.4 mm SL

Spiny dorsal fin becomes lower



21.0 mm SL

A, C (Indian Ocean material); J (Pacific specimen)

GEMPYLIDAE***Nesiarchus nasutus* Johnson**

Spawning Probably year-round in the Caribbean Sea and Florida Current.

Eggs — Undescribed.

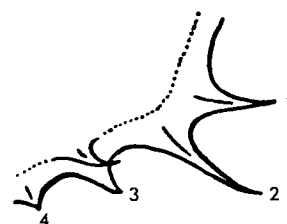
Larvae — Development much more rapid than *G. serpens* and *D. multistriatus* (p. 302); protruding lower jaw teeth lost earlier; fins and fangs develop sooner.

- Relatively low spiny dorsal fin, develops early.
- Relatively short pelvic spine, followed by rays, develops early.
- Preopercle spine length order 2-1-3-4 (1st, 2nd and 3rd usually upturned).
- Flexion begins at about 6 mm SL.
- 20 dorsal spines formed by 7.5 mm SL, and 2 anal spines form at about 8 mm SL (2nd being larger).
- Greatest body depth at pelvic base; head length about 50% SL at 7.5–11.3 mm SL.

Meristic features

Myomeres: 36
 D : XXII–XXIII, 22–23
 A : III, 18–19
 Piv : I, 5
 C : 7–8+9+8+9
 D finlets: 2
 A finlets: 2

Preopercle spines



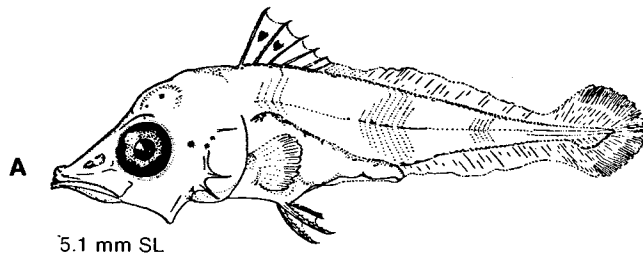
(Voss 1954)

Best characters for 3 gempylid-trichiurid species

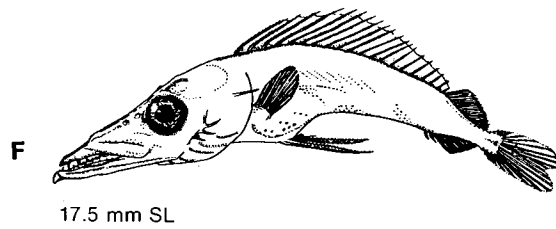
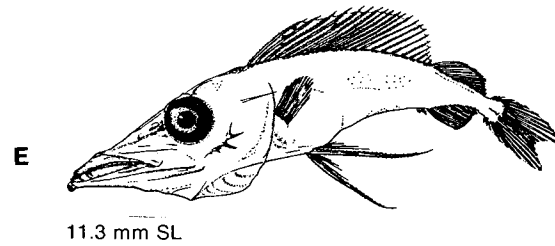
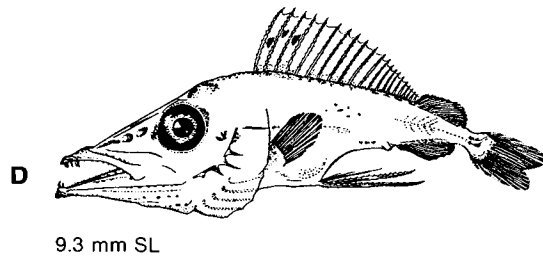
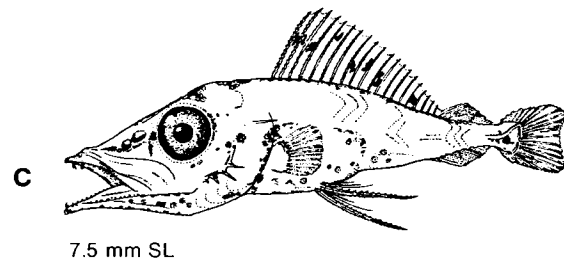
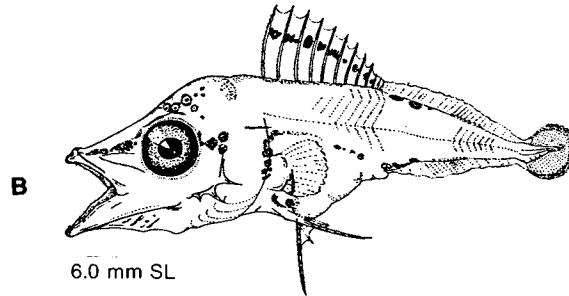
- Myomere number.
- Relative spiny dorsal fin height.
- Relative pelvic spine length.
- Preopercle spine pattern.

Fig. — A–F, Voss 1954.

Ref. — Strasburg 1964.

Nesiarchus nasutus**GEMPYLIDAE**

Few spots on midlateral line



SCOMBRIDAE**General Characters****Morphology**

- Head large, body deep; snout pronounced, may be elongate (i.e. *Acanthocybium*); jaws well-developed.
- Most with well-developed preopercle spines (also opercle, supraocular, and posttemporal or pterotic spines).
- Myomere number relatively high (31–66).
- Vertebral number usually stable within a species (range usually narrow).

Fin formation

- Caudal fin first to form; 9+8 principal rays.
- First dorsal fin forms before second (except in *Scomber*).
- Pelvic fin always I,5: forms at same time as first dorsal fin (except delayed in *Acanthocybium*).
- Gap between anus and anal fin origin (except in *Acanthocybium*).
- Number of pectoral fin rays important (development starts at top and proceeds ventrally).
- Finlets present posterior to dorsal and anal fins.
- Full complement of fin rays usually complete by ~15 mm SL.

Pigmentation

- Variable but important in some locations.
- Head pigment always present (except in some preflexion larvae); top of head to in front of the eyes in *Euthynnus*; top of head but not in front of eyes in *Auxis*.
- Ventral pigment on tail in early larvae coalesces in later larvae, then spots increase again and dorsal pigment added.

Meristic Characters

Meristic characters for species in 8 genera occurring in the western North Atlantic (Matsumoto 1967; Potthoff and Richards 1970; Miller and Jorgenson 1973; Potthoff 1974; Collette and Chao 1975; Berrien 1978).

Genus	First dorsal spines	Second dorsal rays	Dorsal finlets	Anal spines and rays	Anal finlets	Pectoral rays	Vertebrae
<i>Scomber</i>	10–17	9–15	4–6	11–14	4–6	17–22	31
<i>Auxis</i>	10–12	10–12	8–9	12–14	7–8	24–25	39
<i>Euthynnus</i>	15–16	11–12	7	12	7	26–27	39
<i>Thunnus</i>	13–16*	12–17	7–10	12–16	7–10	30–36	39
<i>Katsuwonus</i>	15–16	12–16	7–8	14–18	6–8	26–27	41
<i>Sarda</i>	20–23	13–18	6–9	14–17	6–8	23–26	50–55
<i>Scomberomorus</i>	14–19	14–19	8–11	16–21	6–10	20–23	41–53
<i>Acanthocybium</i>	21–27	12	9	12–13	9	23	62–66

* Usually 14.

Developmental Characters**SCOMBRIDAE**

Selected developmental characters in 8 genera (various sources, synthesized by Okiyama and Ueyanagi 1978)

Characters	<i>Scomber</i>	<i>Auxis</i> <i>Euthynnus</i> <i>Katsuwonus</i> <i>Thunnus</i>	<i>Sarda</i>	<i>Scomberomorus</i>	<i>Acanthocybium</i>
Morphological features					
Dorsal fin development	D ₂ first	D ₁ first	D ₁ first	D ₁ first	D ₁ first
Myomeres	31	39–41	50–55	41–53	62–66
Head/SL ratio	<1/3	>1/3	>1/3	>1/3	>1/3
Snout	Rounded	Pointed	Elongate	Elongate	Elongate
Jaws	Equal-sized	Equal-sized	Equal/unequal	Equal/unequal	Upper longer
Premaxillary teeth	Minute	Large	Large	Large	Large
Gut	Space between anus and anal fin origin	Space between anus and anal fin origin	Space between anus and anal fin origin	Space between anus and anal fin origin	Anus adjacent to anal fin origin
Spines					
Supraoccipital	Absent	Absent	Absent	Present	Absent
Preopercular	Absent	Present	Present	Present	Present
Supraorbital	Absent	Absent	Crest present	Crest present	Absent
Pterotic	Absent	Present	Present	Present	Present
Pigment					
Dorsal body	Heavy	Light	Light	Heavy	Light
Postanus	Extensive	Present in all but few spots (or absent) in <i>Thunnus</i> and <i>Katsuwonus</i>	Extensive	Extensive	Extensive
Cleithral symphysis	Yes (in <i>S. scombrus</i>) No (in <i>S. japonicus</i>)	Yes (in <i>Auxis</i> and <i>Euthynnus</i>); No (in <i>Katsuwonus</i> and <i>Thunnus</i>)	Yes	Yes	No

SCOMBRIDAE**Genus *Thunnus***

Pigmentation notes on identification of larvae (Matsumoto *et al.* 1972; Richards and Potthoff 1974)

A. Black pigment on trunk and tail: *T. thynnus*; *T. obesus*; *T. atlanticus*.

Body area	Number of black pigment cells in larvae 3–10 mm SL	
	<i>T. thynnus</i>	<i>T. obesus</i> , <i>T. atlanticus</i> ^a
Upper jaw tip	Few (>6 mm SL)	Few (>5 mm SL)
Lower jaw tip	2 inner edge	0–2 inner edge (>4 mm SL) ^b
Dorsal edge trunk	1–2 ^c	0
Lateral line	0–2 (mid-trunk) ^c	0
Ventral edge trunk	1–4 ^c	1 or more (to 6)
Internal	0; 1–2 in some ^c	0
Caudal fin area	Rarely present (3–6 mm SL)	1–2 (in 66% of specimens)

^a See discussion of *T. atlanticus* larvae next page.

^b May not form until 7.5 mm SL.

^c Richards and Potthoff (1974) analyzed 83 *T. thynnus* specimens, of which all had ventral edge pigment, 78 had dorsal edge pigment, 45 had lateral pigment, and 41 had internal pigment.

B. No black pigment on trunk and tail: *T. albacares*; *T. alalunga*.

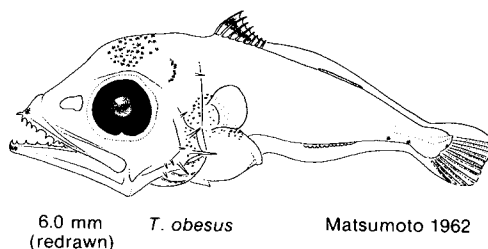
Body area	Size at which pigment appears in larvae 4–10 mm SL	
	<i>T. albacares</i>	<i>T. alalunga</i>
Upper jaw	Usually >6.0 mm SL	About 5.0 mm SL
Lower jaw	Sometimes <3.0 mm SL; usually 4.5–6.0 mm SL (at tip on inner edge, migrates to outer edge with growth)	9–10 mm SL (at tip on outer edge)
Caudal fin (both species)	3.0–8.5 mm SL; 1 (rarely 2) spots usually present	

Genus *Thunnus*

SCOMBRIDAE

Osteological characters

- Both *T. atlanticus* and *T. obesus* require further study and more complete series; based on pigment characters alone, either species may resemble *T. obesus*.
- Pigmentation characters may be unreliable, because *T. atlanticus* may lack ventral pigment and some *T. albacares* and *T. alalunga* may have ventral pigment (Richards and Potthoff 1974).
- Osteological characters in tunas >6.0 mm SL must be examined for accurate identification (Potthoff 1974, 1975; Richards and Potthoff 1974).



Matsumoto 1962

	<i>T. thynnus</i>	<i>T. alalunga</i>	<i>T. atlanticus</i>	<i>T. albacares</i> <i>T. obesus</i>
Precaudal plus caudal vertebrae	18+21=39 (95%)	18+21=39 (97%)	19+20=39 (98%)	18+21=39 (85%)
First closed haemal arch on vertebra #	10 (88%)	10 (99%)	11 (94%)	11 (93%)
Ceratobranchial (lower limb) gill rakers	17-20	14-16	11-13	14-16

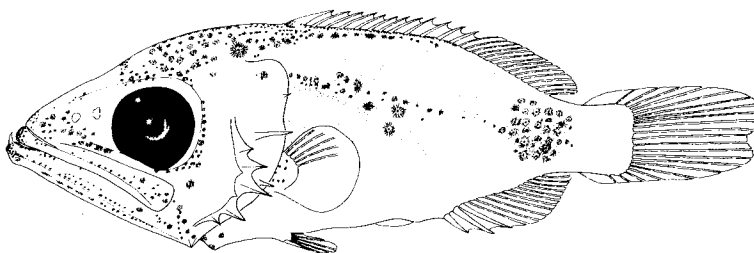
- For description of relationship between fin pterygiophores and interneural spaces see Potthoff (1974).
- Lacking positive osteological evidence, *Thunnus* larvae should be identified as *Thunnus* sp.

Similar larvae (*Scombrolabrax heterolepis*)

- This species (family Scombridae) is tropical and subtropical and spawns year-round; larvae are similar to scombrids.
- Low myomere count, body shape and pigment pattern separates this larva from all scombrids.
- Larvae less than 5.0 mm SL similar to *Thunnus* larvae in pigmentation, but pigment soon forms on cleithral symphysis, over forebrain, on lateral jaw rami, gular membrane, and laterally anterior to caudal peduncle; first dorsal fin unpigmented.
- Sequence of fin formation: caudal, dorsal and anal rays, dorsal and anal spines, pelvic, pectoral.
- All fin rays complete at about 7.5 mm SL, except pectoral complete at about 14 mm SL.

Meristic features

Myomeres: 30
 Vert : 13+17=30
 D : XII, 15-16
 A : III, 16-17
 Piv : I, 5
 P : 18-19
 C : 8-9+9+8+9-10
 (No finlets)

7.2 mm SL
(redrawn)

Potthoff et al. 1980

SCOMBRIDAE *Acanthocybium solanderi* (Cuvier)

Spawning: Near Cuba, Yucatan and Florida during May–October (peak in June).

Eggs — Undescribed.

Larvae — Snout elongate, with upper jaw longer than lower.
 — Long gut; anus forms just anterior to anal fin origin.
 — Head length increases from 30% SL to about 50% SL at 9–10 mm and then decreases.
 — Body depth increases from 6% SL to 8–10% SL at 9–10 mm.
 — Preanus length increases from 60% SL to about 73% SL at 9–10 mm.
 — High number of dorsal spines and myomeres; 26–30 preanal myomeres.
 — Two preopercle spines form at 4.1 mm SL, increasing to 6 at 9.4 mm.
 — Pterotic spines present; supraorbital and supraoccipital spines absent.
 — Flexion occurs at about 6 mm SL.
 — Vertebrae ossify from 6.8 to 17.8 mm SL.
 — Sizes at beginning of ossification and completion of fin rays:

Meristic features

Myomeres: 62–66
 Vert : 31–33+30–34
 D : XXI–XXVII, 12+9
 A : 12–13+9
 Plv : I, 5
 P : 23

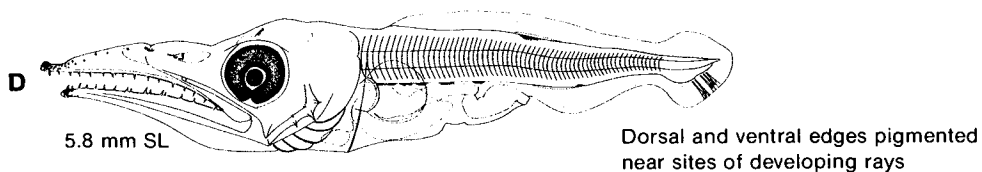
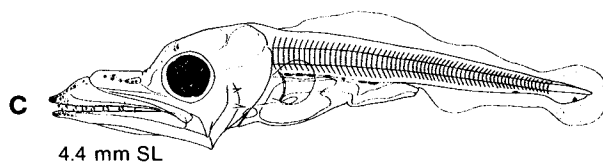
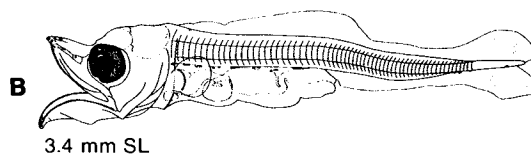
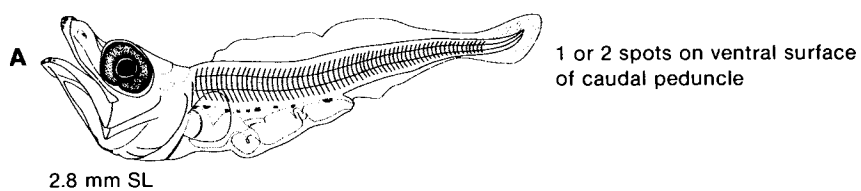
Caudal rays (principal)	5.8 mm SL	8.4 mm SL
Second dorsal rays	6.6	10.2
Anal rays	6.6	13.2
Pectoral rays	6.6	23.7
First dorsal spines	6.8	13.2
Pelvic rays (bud at 6.8 mm SL)	10.2	13.2

— Pigmentation: no spot at cleithral symphysis; see illustrations and notes on opposite page.

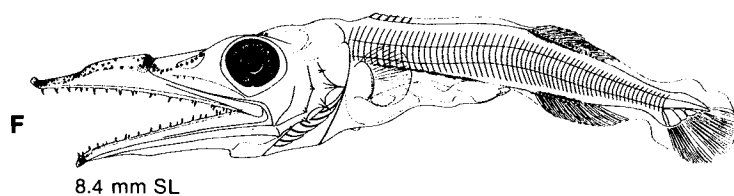
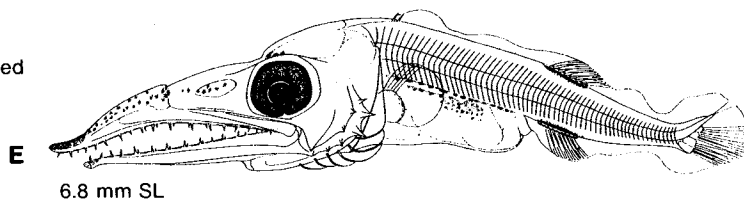
Note: See introduction to Scombridae section (p. 306).

Fig. — A–H, Matsumoto 1967.

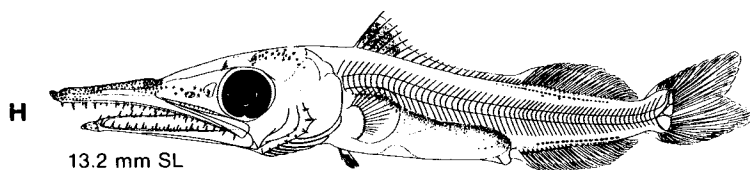
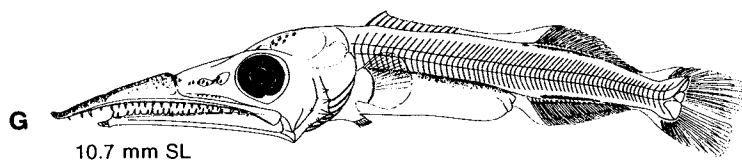
Ref. — Wollam 1969.

*Acanthocybium solanderi***SCOMBRIDAE**

Midbrain pigmented



Dorsal spines pigmented before 10 mm in Atlantic



A-H (Pacific material)

SCOMBRIDAE***Auxis* sp. (Types I and II)****Spawning:** Florida Current, probably during summer.**Meristic features**

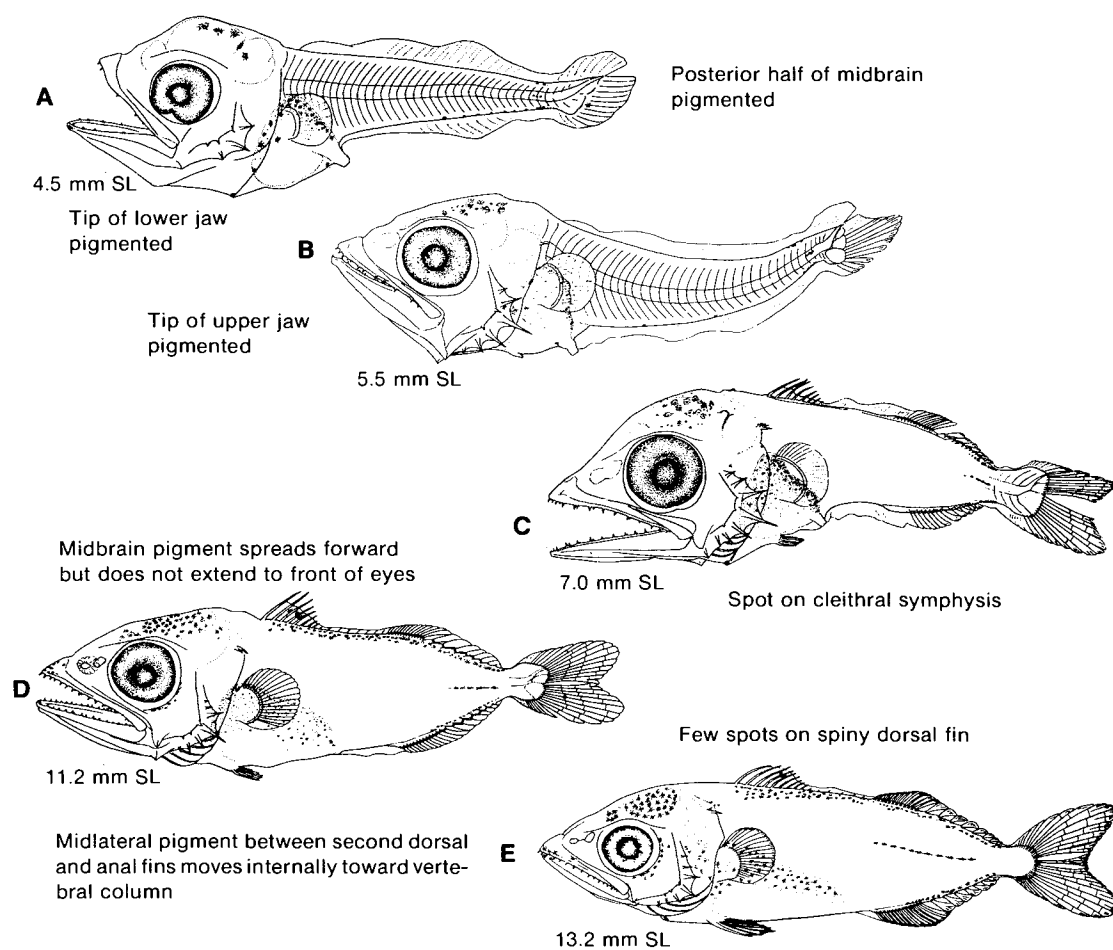
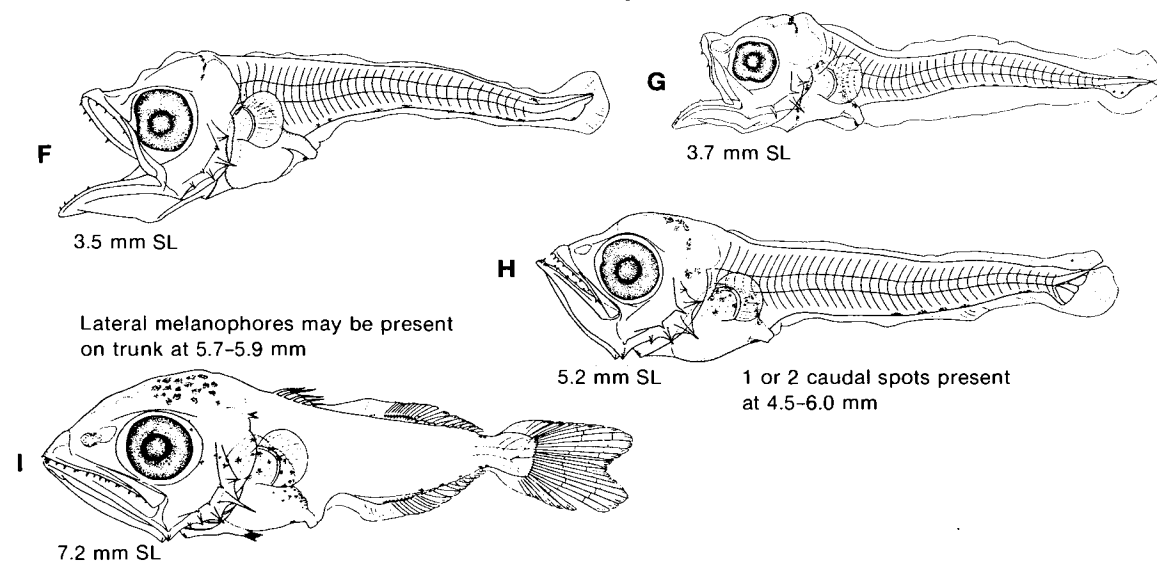
- Eggs**
- Pelagic, spherical.
 - Diameter: 0.82–1.10 mm.
 - Yolk: homogeneous.
 - Oil globules: 1 (or up to 5 smaller).
 - O.G. diameter: 0.24–0.29 mm.
 - Perivitelline space: very narrow.
- Larvae**
- Hatching occurs at 2.0–2.5 mm; preanal length 37–50% SL.
 - Similar to *Scomber* (p. 318), but head bigger, snout pointed, and head spines present.
 - Upper and lower jaws about equal in size.
 - Flexion occurs at 4.5–6.0 mm.
 - Dorsal, anal and pelvic fin rays begin to form at 6.0 mm, and pelvic well formed at 8.7 mm.
 - Low number of dorsal spines (10–12) discernible at 7–8 mm.
 - Preopercle and pterotic spines present, but supraoccipital and supraorbital spines absent.
 - Space between 1st and 2nd dorsal fins (after juvenile stage).
 - Pigmentation: spots on cleithral symphysis; pigment on top of head does not extend in front of eyes; few spots on spiny dorsal fin develop at about 8–10 mm; row of ventral trunk spots decrease in number between 4 and 8 mm, and then increase during subsequent growth; spots on dorsal trunk appear at about 6 mm, and increase with growth; pelvic fins unpigmented (compare to *Sarda sarda*, p. 314).

Myomeres: 39
 Vert : 20+19 or 19+20
 D : X–XII, 10–12+8–9
 A : 12–14+7–8
 Plv : I, 5
 P : 24–25

- Note:**
- (1) Larvae of Type II usually lack spots at side of caudal peduncle. The two types may refer to variants of the same species.
 - (2) See introduction to Scombridae section (p. 306).

Fig. — A–D, G, I, Matsumoto 1958; E, F, H, Matsumoto 1959.

Ref. — Potthoff and Richards 1970.

Auxis sp. (Type I)**SCOMBRIDAE****Auxis sp. (Type II)**

A-I (Atlantic, Pacific and Gulf of Mexico material)

SCOMBRIDAE *Euthynnus alletteratus* (Rafinesque)**Spawning:** Florida Strait during spring-summer.**Meristic features**

- Eggs** — Pelagic, spherical.
 — Diameter: 0.84–1.08 mm.
 — Yolk: homogeneous.
 — Shell: smooth and transparent.
 — Oil globules: 1.
 — O.G. diameter: 0.28.
- Larvae** — Hatching occurs at about 3 mm, with 34 myomeres.
 — Body stubbier, head bigger, and lower jaw more pigmented than in *Auxis* (p. 312).
 — Flexion occurs at 5.5–7.5 mm.
 — Pigmentation: spots form early on lower jaw and tip of upper jaw; spots on top of head extend to front of eyes; spot on cleithral symphysis (not present in *Thunnus* or *Katsuwonus*); caudal spot present throughout development; ventral row of spots decrease in number from 7.5 to 9.3 mm SL.

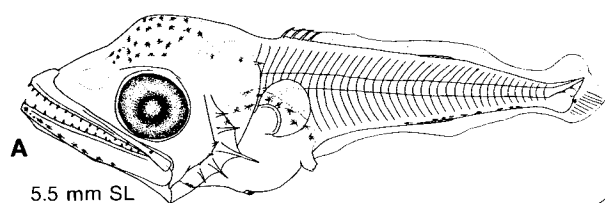
Myomeres: 39
 Vert : 19+20 or 20+19
 D : XV–XVI, 11–12+7
 A : 12+7
 Plv : I, 5
 P : 26–27

Sarda sarda* (Bloch)*Spawning:** Usually in summer (June–July), but in winter south of Cape Hatteras.**Meristic features**

- Eggs** — Pelagic, spherical and transparent.
 — Diameter: 1.15–1.30 mm.
 — Yolk: homogeneous.
 — Shell: smooth (or finely striated?).
 — Oil globules: Multiple, coalesce to 1.
 — O.G. diameter: 0.22–0.26 mm (as 1).
 — Perivitelline space: narrow.
- Larvae** — Hatching occurs at about 4.3 mm; eye unpigmented; pigment on yolk and oil globule.
 — Snout elongate; upper jaw may be longer than lower; head length >33% SL.
 — Preopercle and pterotic spines present; supraoccipital spine absent; supra-orbital crest present.
 — Pigmentation: spot on cleithral symphysis, at tip of snout, and on lower jaw tip and ramus; pigment on pelvic and first dorsal fins, and spots on caudal fin base over developing hypurals; dorsal pigment light (forms later in juvenile stage); postanus ventral pigment present, some spots become embedded in muscle tissue.

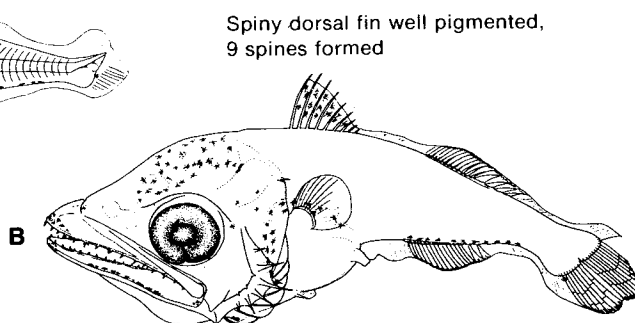
Myomeres: 50–55
 Vert : 50–55
 D : XX–XXIII, 13–18+6–9
 A : 14–17+6–8
 Plv : I, 5
 P : 23–26

Note: See introduction to Scombridae section (p. 306).**Fig.** — **A–E**, Matsumoto 1959; **F–H**, M. P. Fahay (see p. 11).**Ref.** — Sanzo 1932a; Sette 1943; Vodianitskii and Kazanova 1954; Klawe and Shimada 1959; Klawe 1961; Demir 1963; Potthoff and Richards 1970.

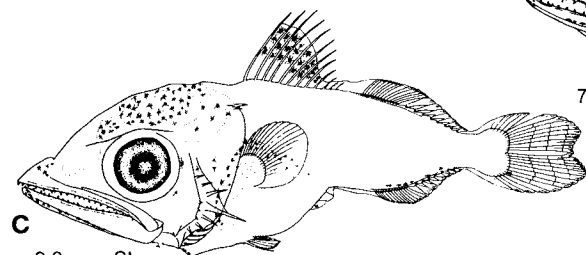
Euthynnus alletteratus**SCOMBRIDAE**

5.5 mm SL

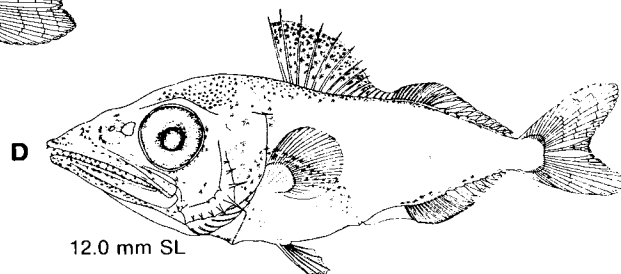
Lower jaw pigmented early



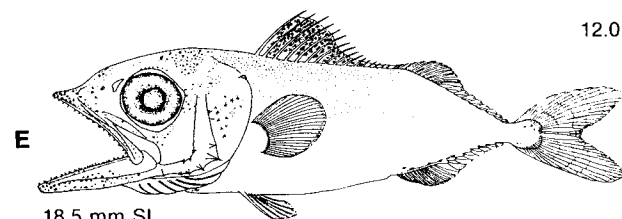
7.5 mm SL



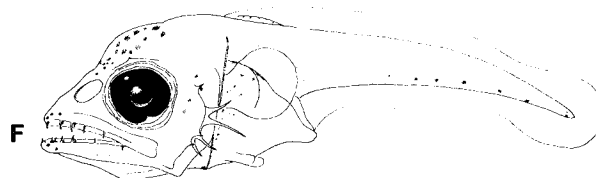
9.3 mm SL

Pigment over midbrain
spreads to front of eyes

12.0 mm SL



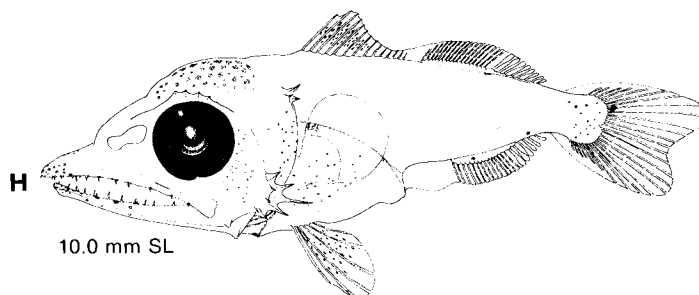
18.5 mm SL

Sarda sarda

5.3 mm SL



9.8 mm SL



10.0 mm SL

SCOMBRIDAE***Katsuwonus pelamis* (Linnaeus)**

Spawning: Florida Current to North Carolina (well off-shore) in summer.

Meristic features

- Eggs**
- Pelagic, spherical.
 - Diameter: 0.93–1.09 mm.
 - Oil globules: 1.
 - O.G. diameter: 0.22–0.27 mm.

Myomeres: 41
 Vert : 20+21
 D : XV–XVI, 12–16+7–8
 A : 14–18+6–8
 Plv : I, 5
 P : 26–27

- Larvae**
- Hatching occurs at 2.44–3.04 mm.
 - Head very large, and mouth with large gape.
 - Diagnostic myomere count (41) present at 5.4 mm TL.
 - Preopercle spines increase from 3 at 3.7 mm to 8 or 9 in later larvae.
 - Pterotic spines present; supraoccipital and supraorbital spines absent.
 - Flexion occurs at about 5.5 mm TL.
 - Dorsal spines begin to form at 6.5 mm TL.
 - Anus moves close to anal fin origin at 10–14 mm TL.
 - Pigmentation: no spot on cleithral symphysis, and none on isthmus or directly anterior to anus; single spot on ramus of lower jaw (compare to *Euthynnus*, p. 314); pigment only on outer edge of spiny dorsal fin; few spots appear along anal fin base at about 9 mm TL; ventral spot (usually large) on caudal peduncle throughout development; no dorsal pigment until about 9 mm TL, when spots form under 1st dorsal fin and spread posteriorly; no midlateral pigment until 10.9 mm TL.

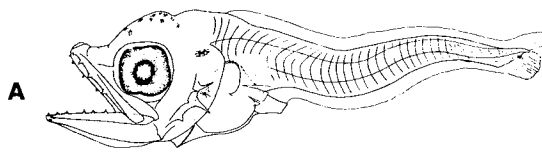
Note: *Scomberomorus cavalla* (p. 320) has similar myomere count (41–42). See introduction to Scombridae section (p. 306) for comparison of other characters.

Fig. — A–G, Matsumoto 1958.

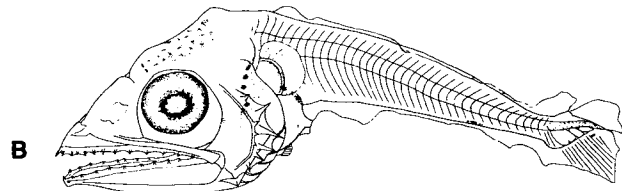
Ref. — Jones 1960a; Potthoff and Richards 1970.

Katsuwonus pelamis

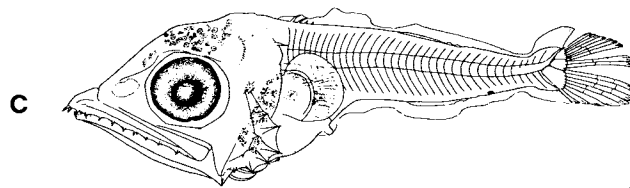
SCOMBRIDAE



3.7 mm TL

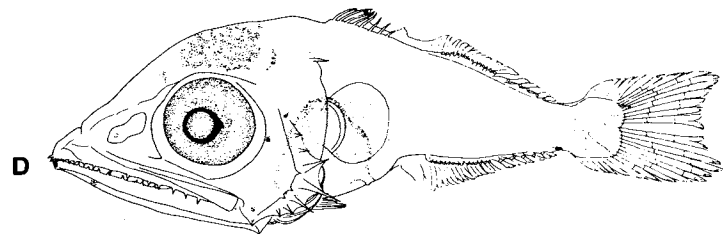


5.35 mm TL

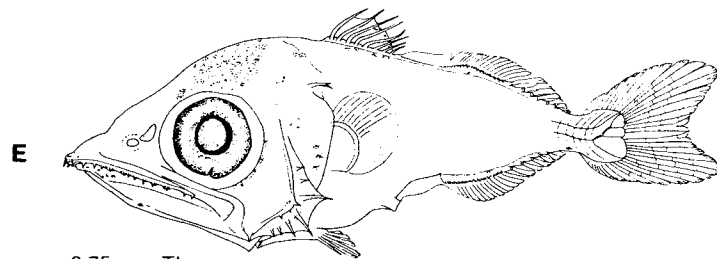


6.7 mm TL

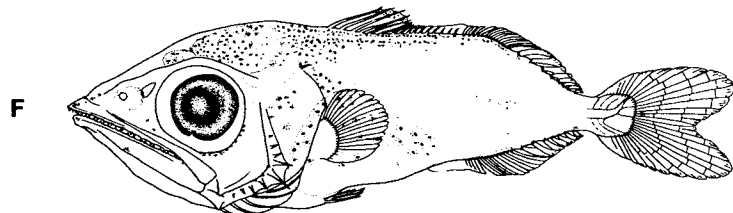
Single spot on ramus of lower jaw



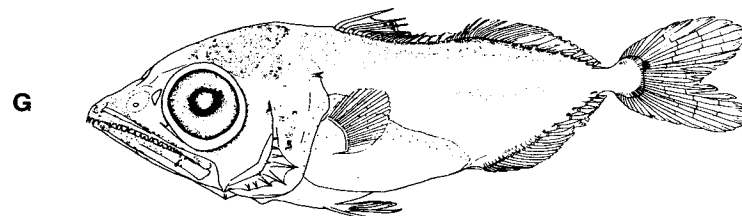
7.1 mm TL



8.75 mm TL



10.9 mm TL



14.5 mm TL

A-G (Pacific material)

SCOMBRIDAE***Scomber japonicus* Hottuyn**

Spawning: Winter-spring; larvae more common south of Cape Hatteras.

Eggs — Similar to *S. scombrus*, but yolk pigmented with several melanophores.

Larvae — Hatching occurs at about 3 mm.
 — Prominent teeth from about 4 mm to juvenile stage; no head spines.
 — Deeper-bodied than *S. scombrus* between 4 and 11 mm.
 — Preanus length longer than *S. scombrus* between 3 and 15 mm.
 — Vertebrae complete at 7.6 mm; D₁ spines complete at 13 mm; caudal rays begin forming at 5 mm.
 — Pigmentation: (see table below).

Meristic features

Myomeres: 31
 Vert : 14+17
 D : X-XI,12+4-5
 A : II, 11+5

***Scomber scombrus* Linnaeus**

Spawning: Spring-summer; larvae more common north of Cape Hatteras.

Eggs — Pelagic, spherical.
 — Diameter: 1.09-1.36 mm.
 — Yolk: homogeneous.
 — Shell: smooth and transparent.
 — Oil globules: 1.
 — O.G. diameter: 0.26-0.37 mm.
 — Embryo: no yolk pigment until just before hatching, when one spot per side appears just posterior to head.

Larvae — Hatching occurs at about 3 mm.
 — Prominent teeth from about 4 mm to juvenile stage; no head spines.
 — Shallower-bodied than *S. japonicus* between 4 and 11 mm.
 — Preanus length less than *S. japonicus* between 3 and 15 mm.
 — Vertebrae complete at 8.6 mm; D₁ spines complete at 17 mm; caudal rays begin forming at 7 mm.
 — Pigmentation: dorsal trunk and cleithral symphysis more heavily pigmented than *S. japonicus* (cleithral symphysis pigment may be lacking in *S. scombrus* specimens from the Scotian Shelf) (see table below).

Meristic features

Myomeres: 31
 Vert : 13+18
 D : XII-XVII,11+5
 A : II, 11+5

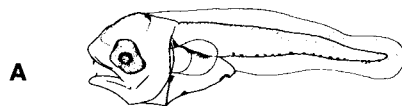
Pigment Acquisition in *Scomber*

Location	<i>S. japonicus</i>		<i>S. scombrus</i>	
	Present in some	Present in all	Present in some	Present in all
Forebrain	5.2 mm	8.7 mm	3.7 mm	5.7 mm
Hindbrain	3.5	5.5	(Present in all)	
Snout	5.2	10.5	4.3	6.3
Cleithral symphysis	(Lacking in all)		3.7	8.0
Lower jaw tip	8.3	11.7	4.6	6.2
Dorsal trunk	5.0	7.0	?	2.6

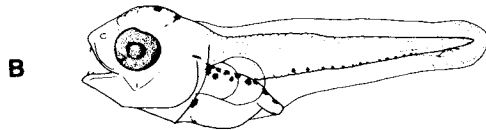
- Note:**
- (1) *Sebastes* larvae (p. 218) are similar but lack teeth at sizes <9 mm, are more slender, have shorter preanus length, and have posttemporal, supraoccipital and preopercle spines.
 - (2) See note on *Brosme brosme* (p. 170).
 - (3) See Scombridae introductory pages (p. 306-307).

Fig. — A-L, Berrien 1978.

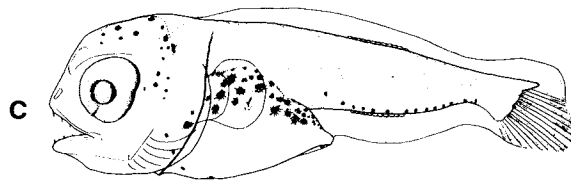
Ref. — Kramer 1960.

Scomber japonicus**SCOMBRIDAE**

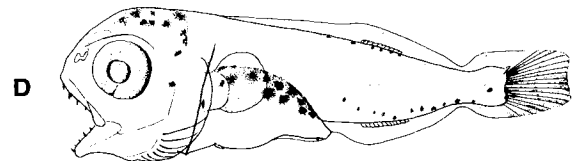
2.9 mm SL



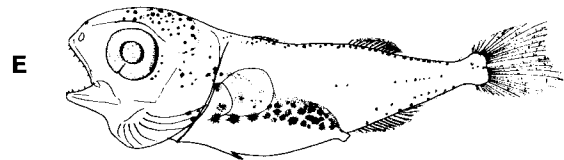
3.8 mm SL



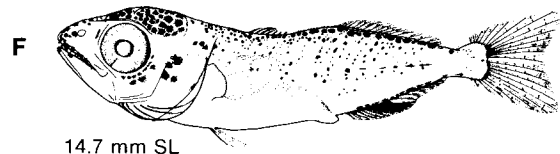
5.3 mm SL



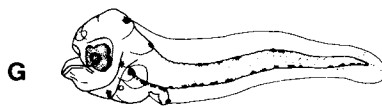
7.3 mm SL



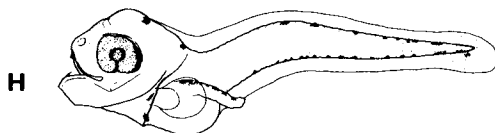
11.3 mm SL



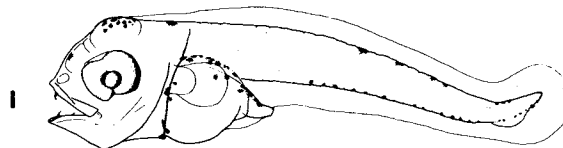
14.7 mm SL

Scomber scombrus

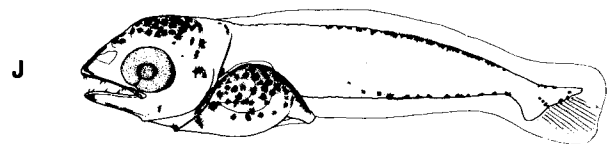
2.9 mm SL



3.8 mm SL



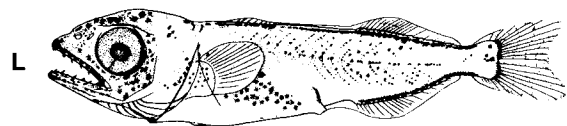
4.8 mm SL



7.2 mm SL



11.7 mm SL



15.1 mm SL

SCOMBRIDAE *Scomberomorus maculatus* (Mitchill)**Spawning:** Spring-summer.**Meristic features**

- | | | |
|---------------|--|--|
| Eggs | — Pelagic, spherical.
— Diameter: 1.02–1.27 mm.
— Shell: smooth and transparent.
— Yolk: homogeneous.
— Oil globules: 1.
— O.G. diameter: 0.25 mm.
— Perivitelline space: narrow. | Myomeres: 50–53
D : XVI–XVIII, 15–18+8–9
A : II, 14–17+8–10
Piv : I, 5
P : 20–23 |
| Larvae | — Myomere count 51 at 3.1 mm.
— Prominent preopercle spines: 3 at 3.1 mm, increasing to 7 at 29 mm.
— High fin-ray counts; development begins at 7–9 mm SL.
— Pigmentation: spot on lower jaw between rami and on cleithral symphysis; ventral row of postanal spots; few spots on dorsal fin base; midlateral row of spots evident at 13.5 mm. | |

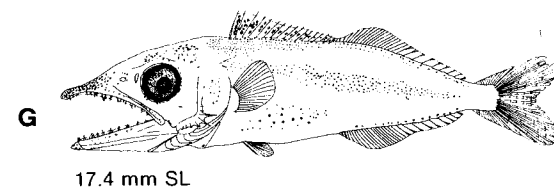
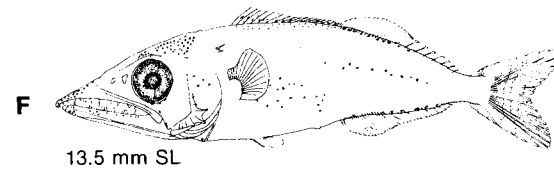
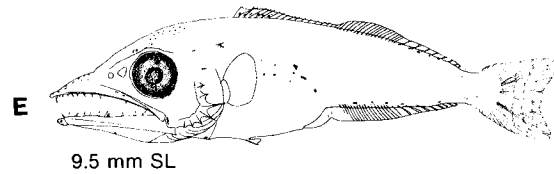
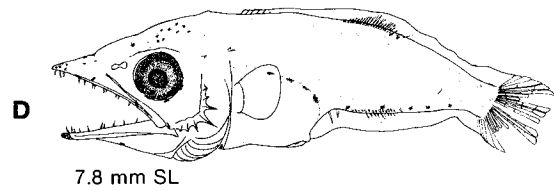
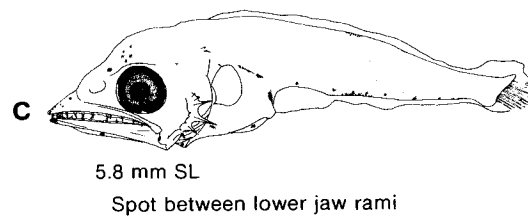
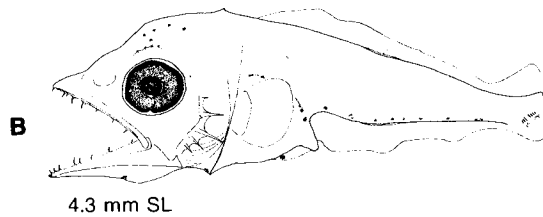
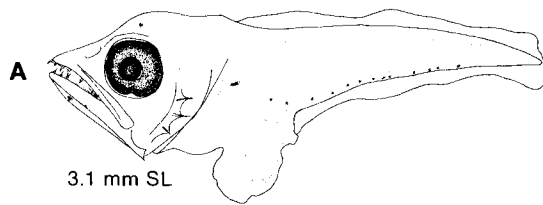
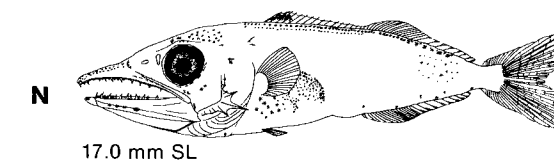
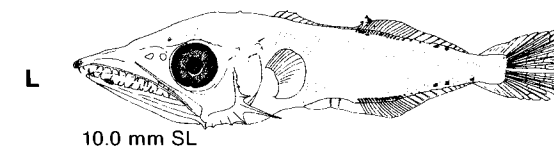
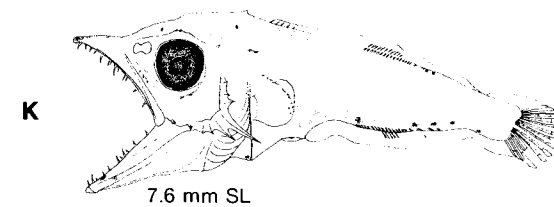
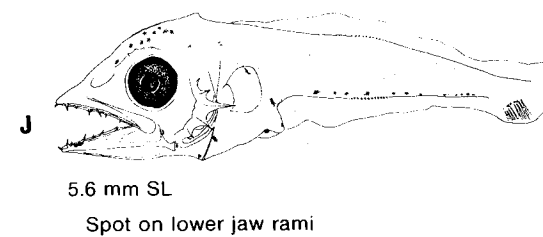
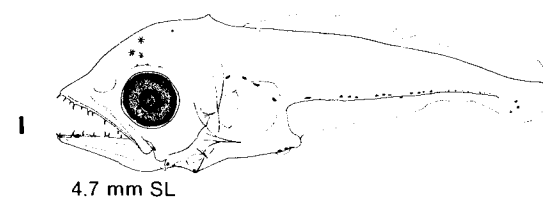
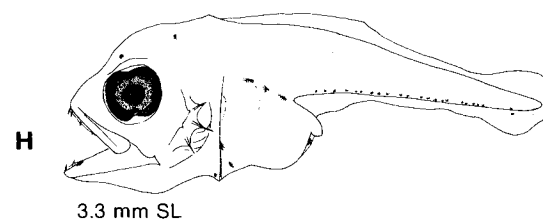
Scomberomorus cavalla* (Cuvier)*Spawning:** April–November, with peaks.**Meristic features**

- | | | |
|---------------|---|---|
| Eggs | — Undescribed. | Myomeres: 41–42
D : XV–XVI, 16–17+8–9
A : II, 14–17+8–10
Piv : I, 5
P : 20–23 |
| Larvae | — Myomere count 42 at 3.3 mm.
— Prominent preopercle spines: 3 at 3.3 mm, 10 at 16.5 mm, and 5 at 31 mm.
— High fin-ray counts; development begins at 7–10 mm SL.
— Pigmentation: spot on ramus of lower jaw as small as 3.3 mm and on cleithral symphysis; ventral row decreases from 29 spots to 4–5 at 7.6 mm SL; dorsal body spots at 7.6 mm and larger spread to form a saddle. | |

Common Features for Both Species

- Larvae**
- Large mouth with prominent teeth; snout elongate (upper jaw may be longer than lower).
 - Flexion begins at 4.2 mm SL.
 - Supraorbital crest, and supraoccipital and pterotic spines present.
 - Pigmentation: spots on snout, tip of lower jaw, and on preanal finfold just anterior to vent; fin pigment restricted to first dorsal.
- Note:**
- (1) Small larvae not likely north of Cape Hatteras; see Richardson and McEachran (1981) for separation of larvae <3 mm SL.
 - (2) See Scombridae introductory pages (p. 306–307).

Fig. — A–N, Wollam 1970.**Ref.** — Devaraj 1975; Collette and Russo 1979.

Scomberomorus maculatus**SCOMBRIDAE*****Scomberomorus cavalla***

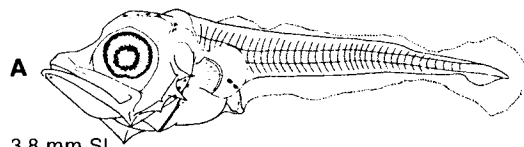
SCOMBRIDAE *Thunnus albacares* (Bonnaterre)**Spawning:** Spring-summer.**Meristic features**

- | | | |
|---------------|--|--|
| Eggs | <ul style="list-style-type: none"> — Pelagic, spherical. — Diameter: 0.90–1.04 mm. — Oil globules: 1. | Myomeres: 39
Vert : 18+21*
D : XIII–XIV, 13–16+8–10
A : 12–15+7–10
Plv : I, 5
P : 33–36 |
| Larvae | <ul style="list-style-type: none"> — Hatching occurs at 2.6 mm TL. — Abdomen triangular, vent points downward. — Preanus length <50% SL at hatching, becoming longer with growth. — Preopercle spines increase from 3 at 3.9 mm to 9 with growth; teeth form at 4.75 mm. — Flexion occurs at about 5 mm SL. — Pelvic fins emerge at 4.75 mm and are complete at 9 mm; 1st dorsal forms at 5.9 mm. — Pigmentation: tip of lower jaw pigmented at 4.5–6.0 mm and tip of upper jaw at 7.0 mm; distal 1st dorsal prominently dark; no spots on cleithral symphysis, and no black pigment on trunk. | * 1st haemal arch on vertebra No. 11. |

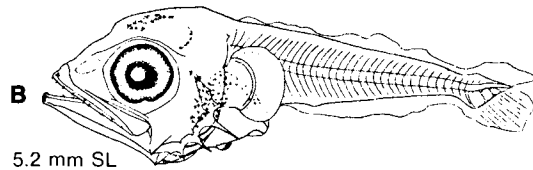
Note: Very similar to *T. alalunga* larvae; see Scombridae introductory pages (p. 306–309)***Thunnus thynnus* (Linnaeus)****Spawning:** Spring-summer.**Meristic features**

- | | | |
|---------------|--|---|
| Eggs | <ul style="list-style-type: none"> — Pelagic, spherical. — Diameter: 0.6(0.94)–1.12 mm. — Shell: sculptured. — Yolk: homogeneous. — Oil globules: 1. — O.G. diameter: 0.18–0.32 mm. | Myomeres: 39
Vert : 18+21*
D : XIII–XIV, 13–15+8–10
A : 13–16+7–9
Plv : I, 5
P : 30–36 |
| Larvae | <ul style="list-style-type: none"> — Hatching occurs at about 2–3 mm. — Preanus length 47% TL at hatching. — Preopercle spines increase from 5 at 3.8 mm to 15 with growth. — Flexion occurs at about 5–6 mm SL. — Pelvic fins complete at 8 mm SL, and 1st dorsal forms at 8 mm SL. — Pigmentation: 2 spots on inner edge of lower jaw tip; 0–2 spots laterally near mid-trunk; 1–3 spots on dorsal edge of trunk (rarely 0 or 4); 1–3 spots on ventral edge of trunk (rarely 4, 5 or 6); 1st dorsal membrane prominently dark; upper jaw tip pigmented at 6–7 mm; internal pigment may be present near vertebral column; no spot on cleithral symphysis. | * 1st haemal arch on vertebra No. 10 |

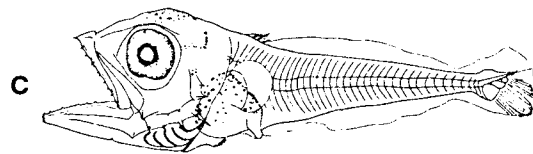
Note: See Scombridae introductory pages (p. 306–309)**Fig.** — A–G, Matsumoto 1958; H–O, Yabe *et al.* 1966.**Ref.** — Potthoff 1974; Richards and Potthoff 1974.

Thunnus albacares**SCOMBRIDAE**

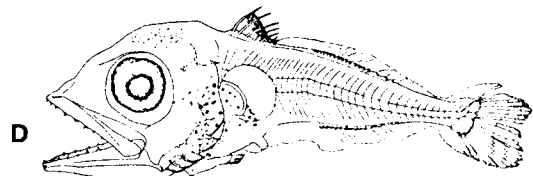
3.8 mm SL



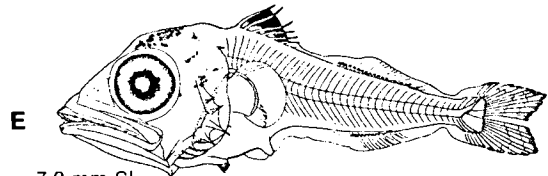
5.2 mm SL



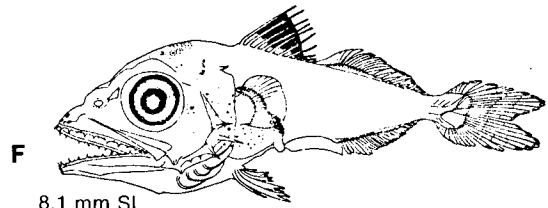
5.9 mm SL



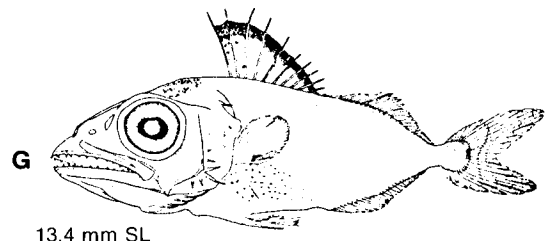
6.5 mm SL



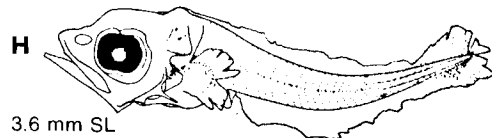
7.2 mm SL



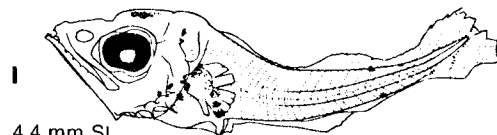
8.1 mm SL



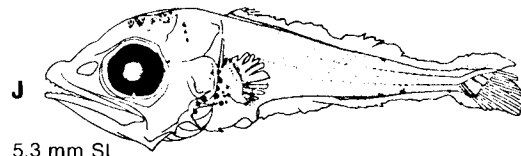
13.4 mm SL

Thunnus thynnus

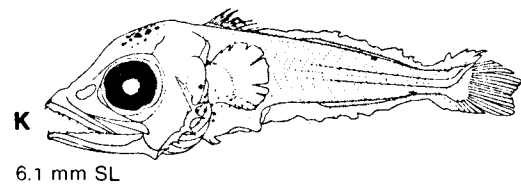
3.6 mm SL



4.4 mm SL



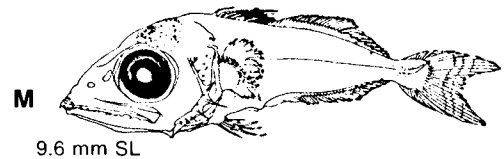
5.3 mm SL



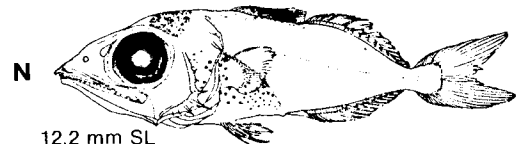
6.1 mm SL



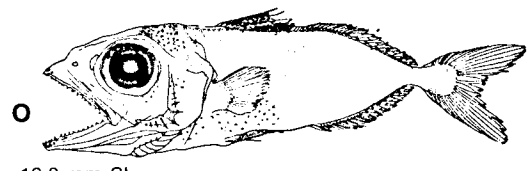
6.6 mm SL



9.6 mm SL



12.2 mm SL



16.8 mm SL

A-O (Pacific material)

XIPHIIDAE***Xiphias gladius* Linnaeus**

Spawning: Gulf Stream, Florida Strait and south, in December-September (peak during April-September).

Eggs — Pelagic, spherical.
 — Diameter: 1.60-1.87 mm.
 — Oil globules: 1.
 — O.G. diameter: 0.50-0.52 mm.

Larvae — Hatching occurs at 4.0-4.5 mm.
 — Body stubby, becoming more elongate with growth.
 — Gut long and thick; anus moves anteriorly with growth.
 — Teeth present at 6.0 mm TL.
 — Flexion occurs at about 12 mm.
 — No pelvic fin.
 — Head spines present on dorsal snout, preorbital ridge, supraorbital ridge, preopercle, posttemporal area, and below angle of jaws; these spines increase with larval growth, and then decrease in juveniles.
 — Spinous scales in rows appear at 12-15 mm.
 — Pigmentation: bars evident on body at about 12 mm; at about 16 mm, pigment absent from spiny ridges and pectoral fins but heavy on dorsal snout, between the eyes and on the head; fin pigment concentrated at posterior end of dorsal and anal fins.

Meristic features

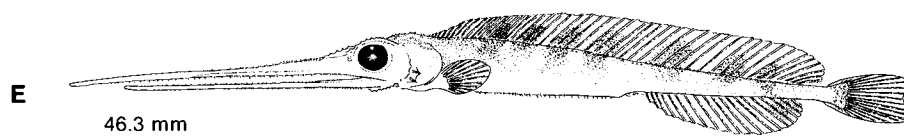
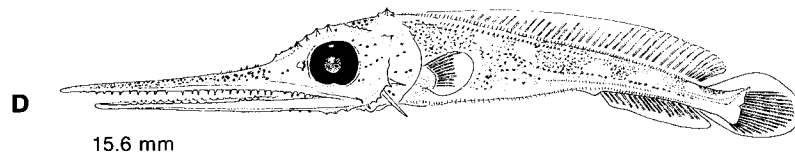
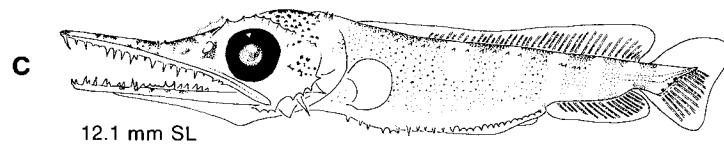
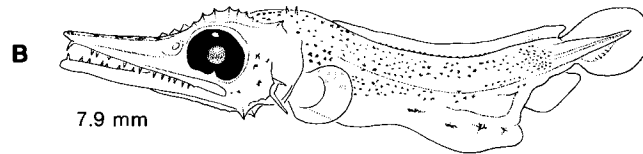
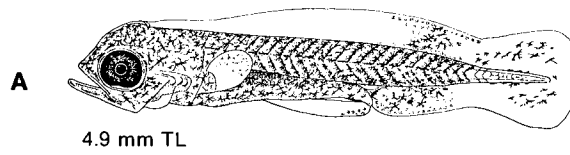
Myomeres: 26
 Vert : 15-16+10-11=26*
 D : 38-49+4-5
 A : 12-18+3-4
 Plv : none
 P : 17-19
 C : 7-9+9+8+7

* Rarely 25 or 27 (Potthoff and Kelley, 1982)

Note: Eggs and newly-hatched larvae of *Xiphias* from Mediterranean Sea are illustrated in Yasuda *et al.* (1978).

Fig. — A, Sanzo 1922; B, D, E, Tåning 1955; C, Arata 1954 (B-E redrawn).

Ref. — Yasuda *et al.* 1978; Potthoff and Kelley 1982.

Xiphias gladius**XIPHIIDAE**

A (Mediterranean specimen)

ISTIPHORIDAE *Istiophorus americanus* (Cuvier)

Spawning: Offshore during spring and summer.

Eggs — Undescribed.

Larvae — 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 3 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 becomes 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.

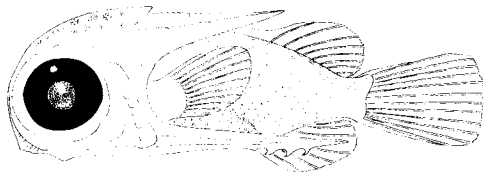
Meristic features

Myomeres: 24
 Vert : 12+12
 D : 37–49+6–8
 A : 8–16+6–8
 Plv : 1, 2
 P : 17–21

Note: Some authors recognize one species worldwide (*I. platypterus*), while others refer Pacific form to *I. platypterus* and Atlantic form to *I. americanus*.

Similar Larvae

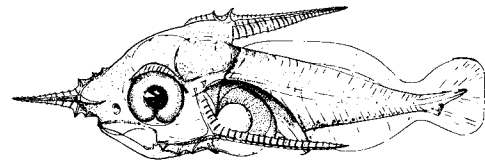
Paired opercle spines,
no rostral spine.



7.4 mm

Dactylopteridae
 (Sanzo 1934)
 (redrawn)

Single spine top of head,
rostral spine present.



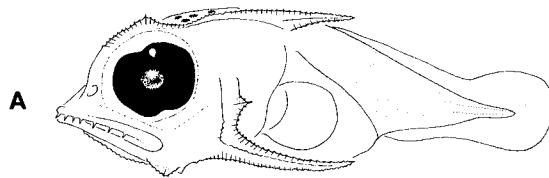
5.0 mm SL

Holocentridae
 (McKenney 1959)

Fig. — **A, C–E**, Gehringer 1956; **B**, Ueyanagi 1963 (all redrawn).

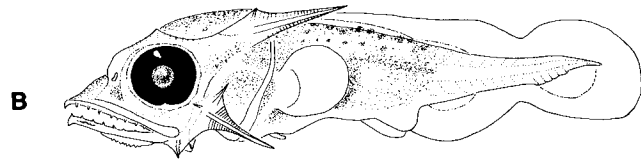
Istiophorus americanus

ISTIOPHORIDAE

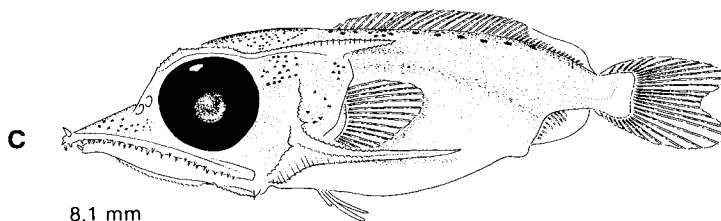


3.6 mm

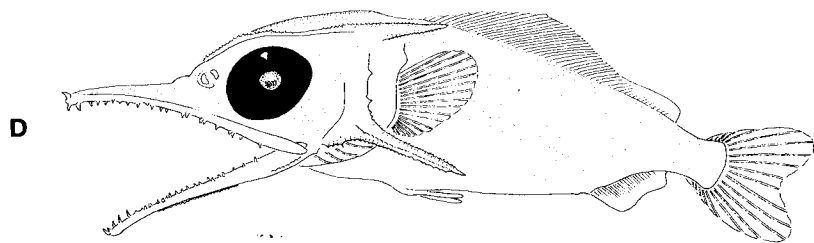
Smaller larvae lack supraorbital ridge,
pteric and preopercle spines



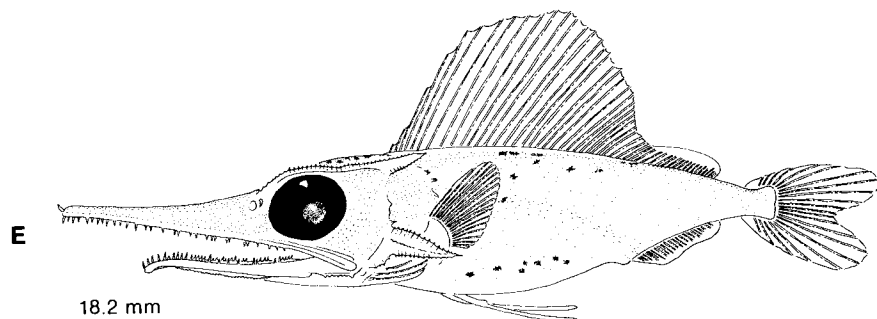
5.1 mm



8.1 mm



11.3 mm



18.2 mm

B (Pacific specimen)

STROMATEOIDEI**Five Families**

Families: Centrolophidae, Nomeidae, Ariommidae, Tetragonuridae, and Stromateidae.

Distribution:

- Most species in these families are highly oceanic and many are circumglobal. Approximately 13 species in 9 genera of stromateoid fishes are known from the western North Atlantic, excluding tropical species and those restricted to the Gulf of Mexico (Haedrich 1967, 1968; Haedrich and Horn 1972; Horn 1970; Ahlstrom *et al.* 1976; Butler 1979). The larvae of 10 of these species have been described.

General characters:

- Pelagic eggs of 4 (and tentatively a 5th) species of Atlantic stromateoids are known. Common characters (also shared with Pacific species) (Ahlstrom *et al.* 1976) include:
 - Shell: spherical, unsculptured, usually colored.
 - Diameter: range 0.7–1.8 mm.
 - Yolk: unsegmented.
 - Oil globules: single (posterior in yolk sac).
 - Perivitelline space: moderate.
 - Pigment: forms in middle and late stages on embryo and oil globules but usually not on yolk.
- Larvae of the families Nomeidae, Ariommidae and Stromateidae are deep-bodied, large-eyed, and have a characteristic rounded snout.
- Larvae of the families Tetragonuridae and Centrolophidae are more elongate but nevertheless retain the characteristic facial appearance of the suborder, the "stromateoid look". As described by Haedrich (1967), "it is a fat-nosed, wide-eyed, stuffed-up look, smug and at the same time apprehensive. Some stromateoids might even be accused of a certain prissiness".
- The airbladder in preflexion larvae is lost during the transition from juvenile to adult stages (Horn 1975).
- In most species, the numbers of rays in the second dorsal and anal fins are about equal. Exceptions are *Peprilus*, in which the number of dorsal fin rays barely outnumber the anal fin rays, and *Centrolophus*, in which there are nearly twice as many dorsal rays as anal rays.
- Tiny spines appear along the preopercle margin at some point during larval development of all species considered here, except *Centrolophus*. Stromateoid larvae, however, never have the large spine at the preopercle angle, which is characteristic of carangids, scorpaenids and some serranids.
- Helpful characters are numbers of myomeres (or vertebrae) and the sequence of fin formation:

Family	Species	Myomeres	Sequence of fin formation
Centrolophidae	<i>Centrolophus niger</i>	25	C, P-D ₂ , A, Plv
Nomeidae	<i>Cubiceps pauciradiatus</i>	31	C, D ₂ -A, P-D ₁ -Plv
	<i>Psenes maculatus</i>	35	Plv, D ₁ -C-D ₂ , A-P
	<i>Psenes cyanophrys</i>	31	Plv-D ₁ -D ₂ , A, C-P
	<i>Psenes pellucidus</i>	40–42	Plv, D ₁ -?
	<i>Nomeus gronovii</i>	41	Plv-?
Ariommidae	<i>Ariomma</i> sp.	30–32	?
Tetragonuridae	<i>Tetragonurus atlanticus</i>	45–48	C-D ₂ , A-D ₁ -P-Plv
Stromateidae	<i>Peprilus triacanthus</i>	30–33	C, D ₂ -A, P (no Plv)
	<i>Peprilus alepidotus</i>	29–31	C, D ₂ -A, P (no Plv)

Five Families**STROMATEOIDEI****Similar larvae:**

- Sciaenidae and Sparidae, but these have fewer myomeres.
- Carangidae, but these have large spine at preopercle angle, stronger anal spines and fewer myomeres.

Note: Precaudal and caudal vertebral counts for the nomeids, described later in this guide under NOMEIDAE, are from Ahlstrom *et al.* (1976). Discrepancies (if any) between these counts and those reported elsewhere may be due to difficulty in determining the position of the first caudal vertebrae, because, in nomeids, the first 1–5 caudal vertebrae bear pleural ribs as well as haemal spines. Furthermore, the first several haemal spines in nomeids are typically crowded together. See discussion in Ahlstrom *et al.* (1976).

CENTROLOPHIDAE *Centrolophus niger* Gmelin**Distribution:** Oceanic species.**Eggs**

- Pelagic, spherical.
- Diameter: 1.2 mm.
- Oil globules: 1 (pigmented).

Larvae

- Hatching occurs at about 4.4 mm, eyes unpigmented and mouth undeveloped.
- Flexion occurs at 5–7 mm SL.
- Preamble length ranges from 56% to 65% SL throughout development.
- Eye diameter decreases slightly from 37% HL at 4.2 mm SL to 33% HL at 14.0 mm SL.
- Head length and body depth at anus increase with development.

Meristic features

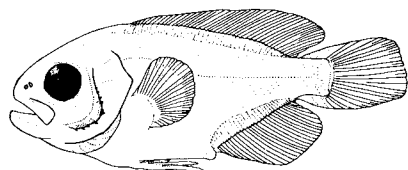
Myomeres: 25
 Vert : 10+15
 D : 37–41*
 A : III, 20–23
 P : 19–22

* Dorsal count includes 3 feeble spines.

mm TL	4.4	5.0	5.6	5.4	6.7	8.3	17.2
mm SL	4.2	4.8	5.3	5.2	6.3	7.0	14.0
HL % SL	18	20	26	33	33	34	34
BD % SL	18	18	20	22	28	30	27

- Fin formation sequence: C, P, D, A, Plv.
- Pigmentation: in early larvae, 4 spots along dorsal margin, 4 along ventral margin, and cluster of spots at caudal tip; body and fin pigment increases at about 14 mm SL; faint bars at dorsal origin, over end of pectoral fin, and across body over midanal fin.

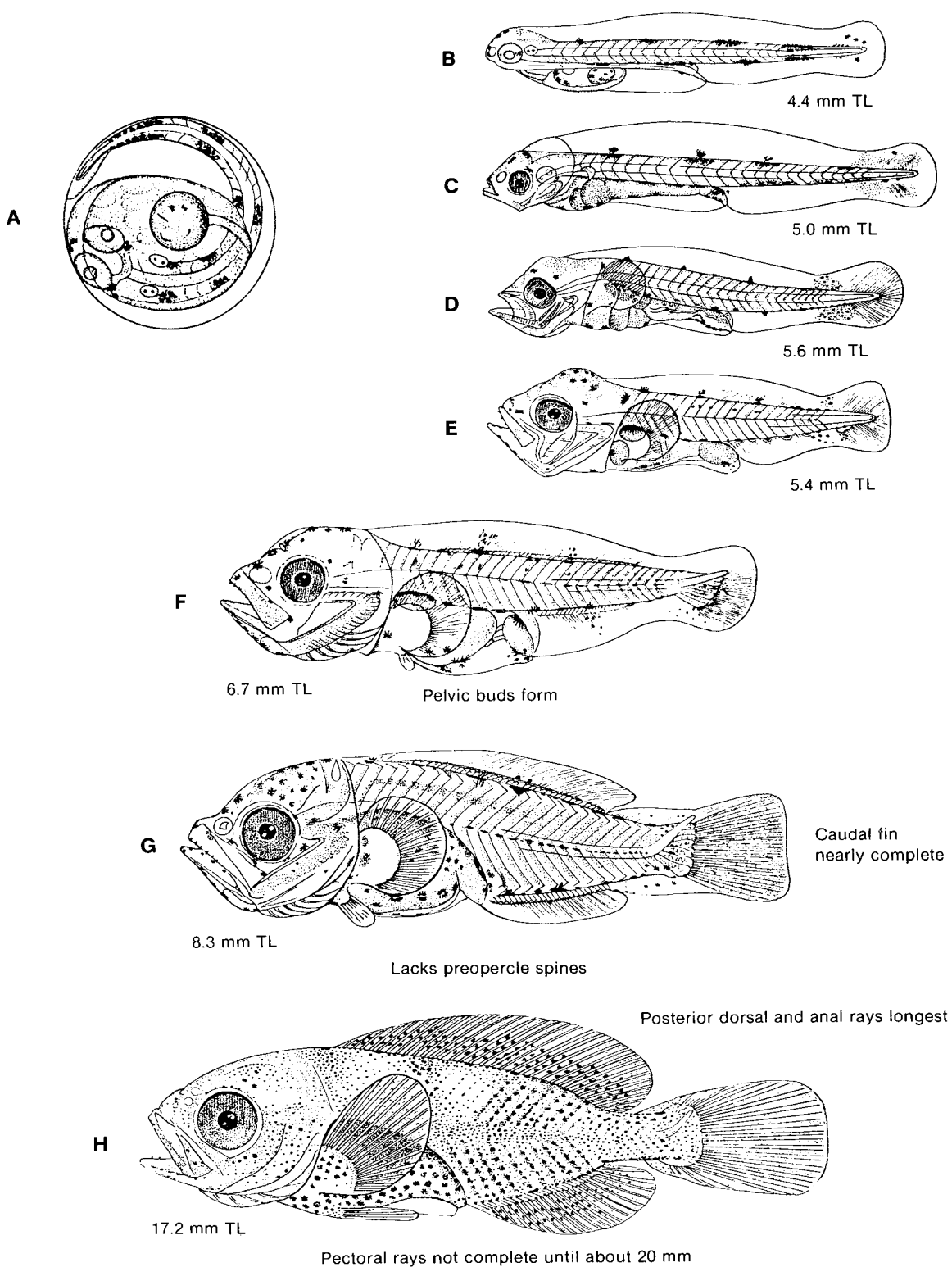
Note: Haedrich (1966) figured a 13 mm *Centrolophus niger* and an 18.5 mm *Schedophilus medusophagus*, the larvae of which are undescribed. In the 13 mm *C. niger*, all fins are apparently complete and body proportions coincide with the values given above. The body is finely speckled with no indication of bars or fin pigment, and preopercle spines are lacking. The 18.5 mm SL *S. medusophagus* (below) has a deeper body, dorsal fin origin is farther anterior, and preopercle spines are present.



Schedophilus medusophagus Cocco
 (Haedrich 1966)

Fig. — A–H, Sanzo 1932b.

Ref. — Haedrich and Horn 1969; Ahlstrom *et al.* 1976.

Centrolophus niger**CENTROLOPHIDAE****A-H** (eastern Atlantic material)

NOMEIDAE***Cubiceps pauciradiatus* (Günther)****Distribution:** Oceanic species.**Meristic features****Eggs**

- Pelagic, spherical.
- Diameter: 0.70–0.80 mm.
- Shell: pinkish tan.
- Yolk: homogeneous.
- Oil globules: 1 (pigmented with 2 opposing patches).
- O.G. diameter: 0.14–0.20 mm.

Myomeres: 31
 Vert : 13+17–18
 D : X–XII, I, 15–17
 A : II, 14–16
 P : 17–20
 C : 8–10+9+8+8–10

Embryo

- Pigment patch on snout and nape, and along mid-dorsal line to tip of notochord (starts as 2 parallel lines).

Larvae

- Hatching occurs at 1.5–2.2 mm; eyes unpigmented.
- Flexion occurs at 3.7–4.3 mm NL.
- Relative body proportions for preflexion and postflexion stages:

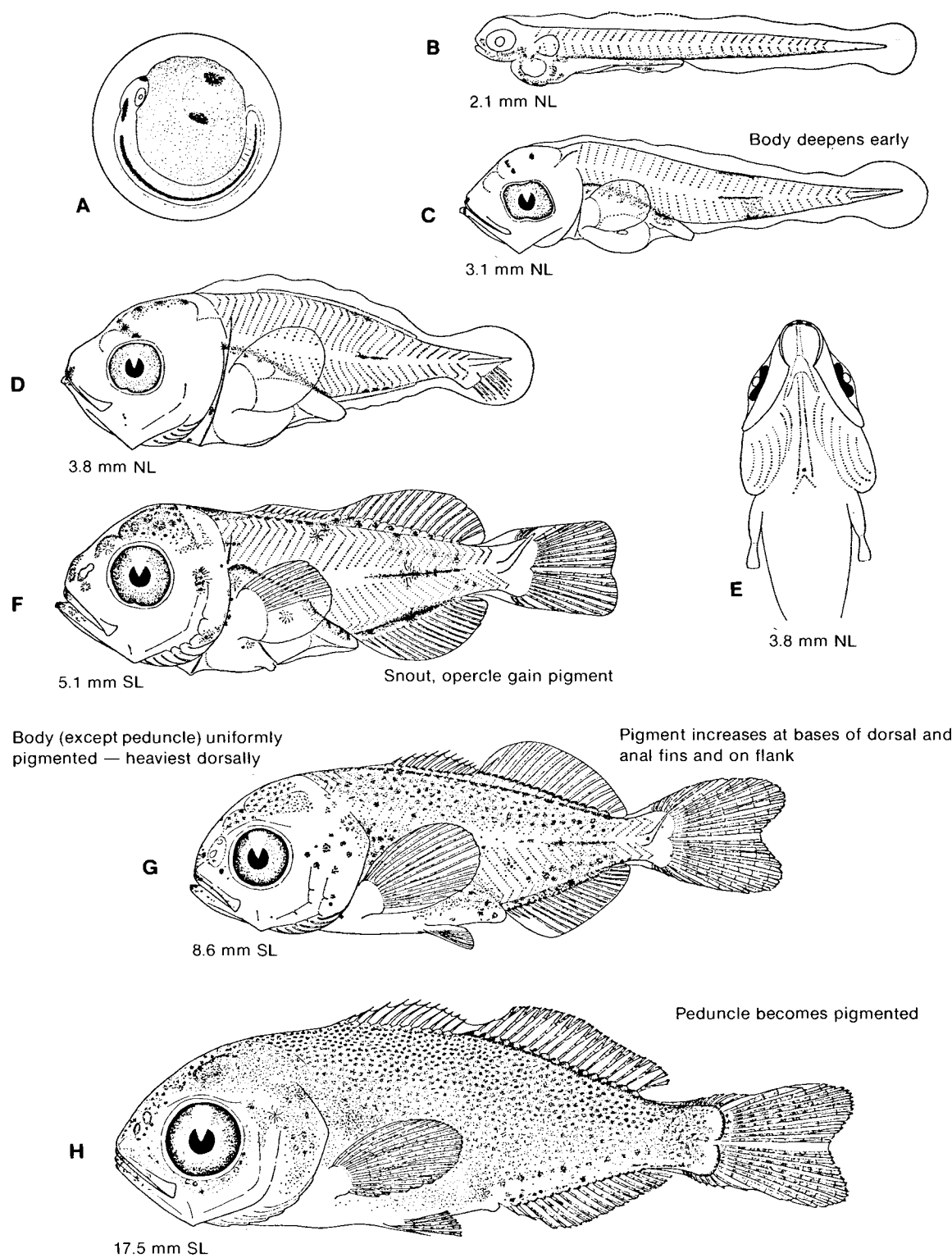
Preanus length	52–59% NL	59–65% SL
Head length	18–29% NL	31–36% SL
Body depth (at pectoral)	9–32% NL	28–38% SL
Eye diameter	32–46% HL	32–37% HL

- Weak preopercle spines (4–5) present at 5–11 mm SL.
- Teeth begin to form at 6.2 mm SL.
- Sizes at beginning of ossification and completion of fin rays and vertebrae:

Vertebrae	3.7 mm NL	6.2 mm SL
Caudal rays	3.7 mm NL	4.5 mm SL
Dorsal rays	4.5 mm SL	5.0 mm SL
Anal rays	4.5 mm SL	6.2 mm SL
Pectoral rays	4.5 mm SL	10.0 mm SL
Dorsal spines	5.0 mm SL	6.2 mm SL
Pelvic rays	6.2 mm SL	8.8 mm SL

- Pigmentation: dorsal line of embryonic pigment moves to ventral edge shortly after hatching; characteristic dorsal, lateral and ventral streaks at myomeres 20–23; single midventral spot anterior to cleithral symphysis (Fig. E); spots on head and body increase with development.

Fig. — A–H, Ahlstrom *et al.* 1976.**Ref.** — Butler 1979.

Cubiceps pauciradiatus**NOMEIDAE**

A-H (Pacific material)

NOMEIDAE***Nomeus gronovii* (Gmelin)****Distribution:** Oceanic species.**Meristic features****Eggs** — Undescribed.

Myomeres: 41

Larvae — Preflexion stage undescribed for the Atlantic.
— Relative body proportions for postflexion larvae:

Vert : 14+27

D : (IX)XI–XII, 24–28

A : II, 24–26(29)

P : 21–23

C : 8–9+9+8+8–9

Preamble length 56–59% SL

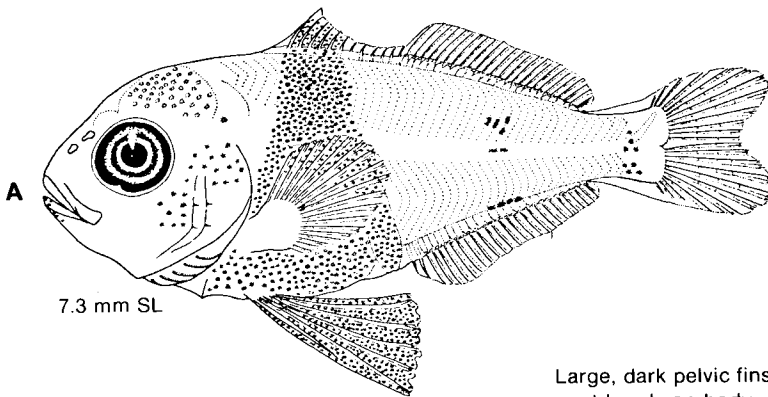
Head length 30–34% SL

Body depth (at pectoral) 37–41% SL

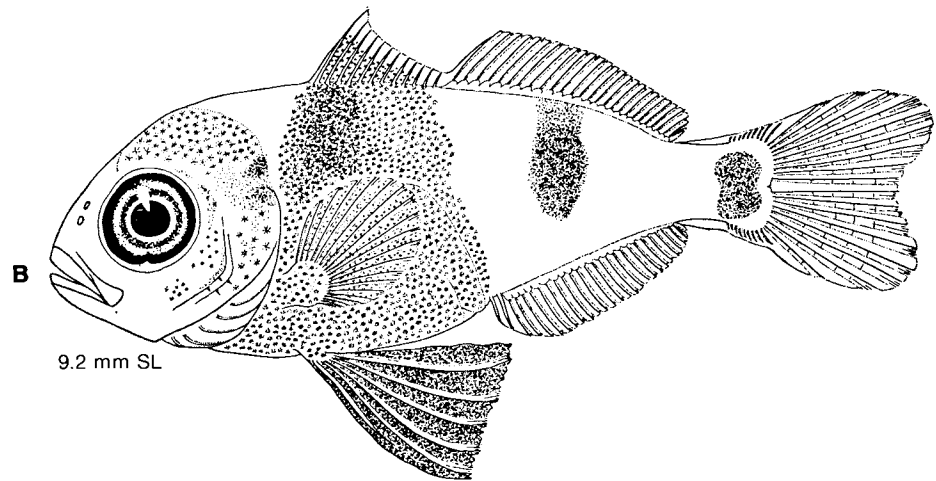
Eye diameter 38–44% HL

- Relative preamble length longer and body depth less than in *Psenes* (p. 336–339).
- Tiny preopercle spines present at 7–9 mm.
- Pigmented pelvic fins well developed (first to form).
- All fin rays and vertebrae complete by 7.3 mm.
- Pigmentation: lateral and ventral spots over midanal fin becomes a blotch under second dorsal fin; spots on hypurals become a prominent blotch; band of pigment spots extends from anterior dorsal fin to gut; nape unpigmented; juvenile is characterized by 4-banded pattern on body, large heavily-pigmented pelvic and first dorsal fins, 2 bands under first dorsal (1 in *Psenes*) and 1 band under second dorsal (2–3 in *Psenes*) which extends onto fin; hyural area well pigmented; nape develops spots; 2 small patches at base of anal fin; ventral edge of abdomen unpigmented.

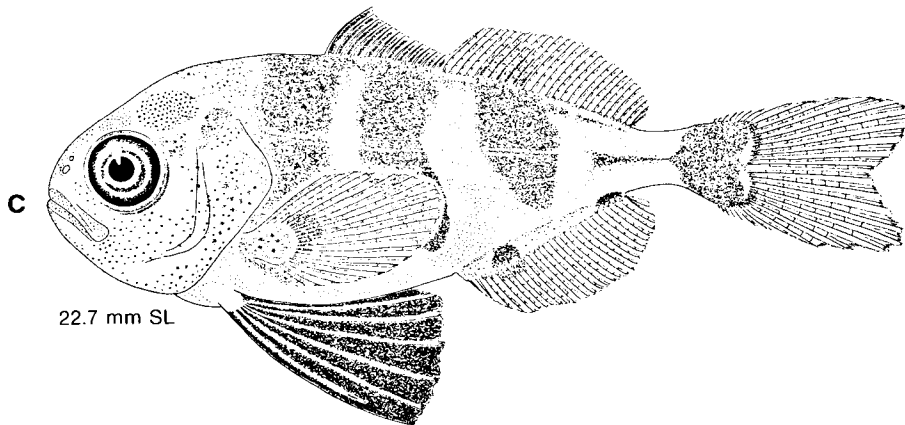
Note: *N. gronovii* of 7–8 mm may resemble *Psenes cyanophrys* (p. 338), but the latter has fewer myomeres and stockier body.**Fig.** — A–C, Ahlstrom *et al.* 1976.**Ref.** — Pertseva-Ostroumova and Rass 1973.

Nomeus gronovii**NOMEIDAE**

Large, dark pelvic fins and prominent bands on body



Anal and caudal fins unpigmented



NOMEIDAE***Psenes maculatus* Ginsburg****Distribution:** Temperate oceanic species.**Eggs** — Undescribed.

Larvae — Flexion occurs at about 4–5 mm NL.
 — Tiny, weak preopercle spines present at 5–9 mm SL.
 — Relative body proportions for preflexion and post-flexion stages:

Preanus length	47% NL	52–57% SL
Head length	29% NL	33–37% SL
Body depth (at pectoral)	32% NL	45–52% SL
Eye diameter	36% HL	34–41% HL

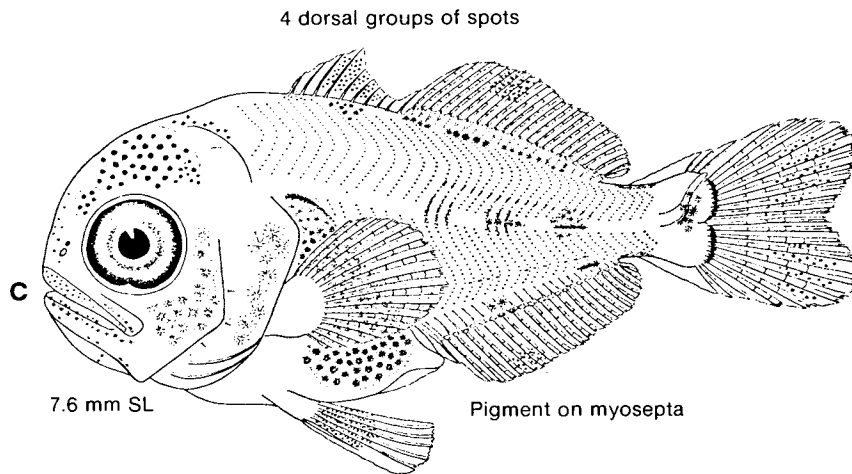
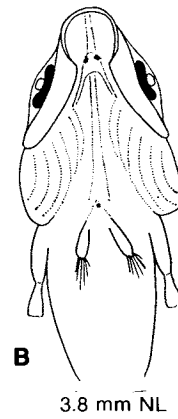
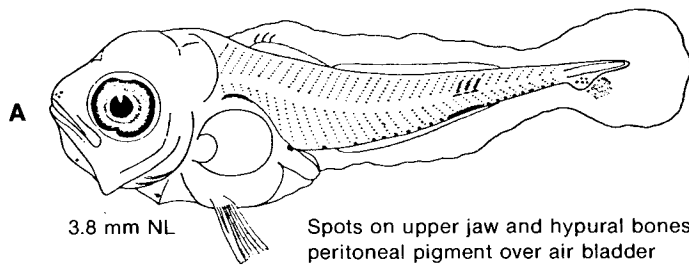
Meristic features

Myomeres:	34–35
Vert :	12+23
D :	X–XI, I, 22–24
A :	III, 21–23
P :	20–22
C :	8+9+8+8–9

- Pelvic fin (pigmented) is well developed before flexion; dorsal spines begin to form early, but they are not elongate.
- Sizes at beginning of ossification and completion of fin rays:

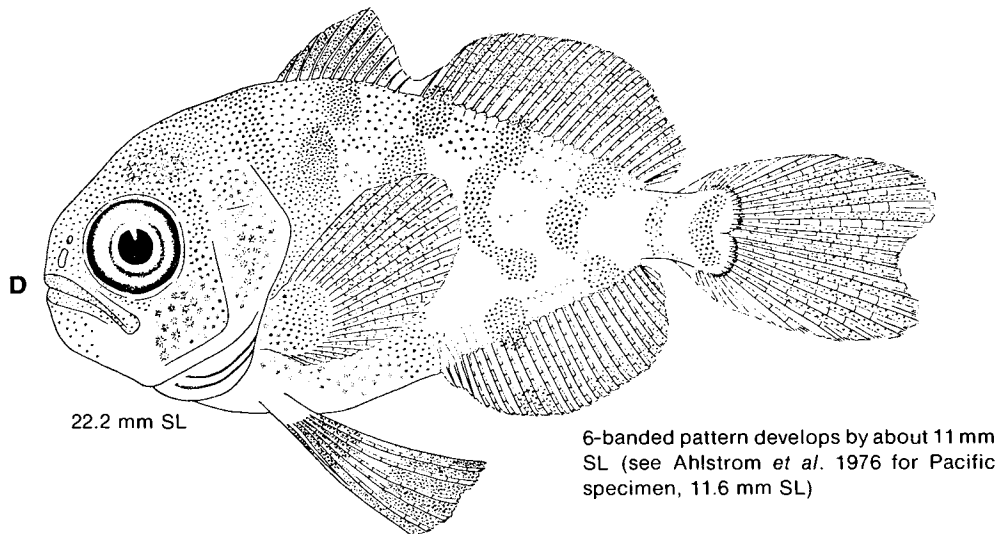
Pelvic rays	?	3.8 mm NL
Dorsal spines	<3.8 mm NL	5.8 mm SL
Caudal rays	?	5.8 mm SL
Dorsal rays	5.8 mm SL	7.8 mm SL
Anal rays	5.8 mm SL	7.8 mm SL
Pectoral rays	5.8 mm SL	9.0 mm SL

- Ossification of vertebrae complete at 5.8 mm SL.
- Pigmentation: early larvae have row of spots along ventral edge with thicker band at myomeres 23–26; lateral spot at myomeres 25–27 with pigment spreading dorsally along myosepta; single spot near cleithral symphysis and 2 spots on isthmus (Fig. B); similar to *P. cyanophrys* but latter lacks midventral row of spots; juveniles develop 6 bands of body pigment, including the 5th on the peduncle (compare to *P. cyanophrys*, p. 338); see illustrations opposite for other pigment.

Psenes maculatus**NOMEIDAE**

Lateral line pigment at myomeres
18-22 and 26-28

2 ventral groups of spots over anal
rays 6-8 and 17-20



NOMEIDAE***Psenes pellucidus* Lütken****Distribution:** Oceanic species.**Meristic features**

- Eggs** — (Tentative identification).
 — Diameter: 1.14–1.28 mm.
 — Shell: brownish rose.
 — Oil globules: 1.
 — O.G. diameter: 0.24–0.28 mm.
 — Embryonic pigment heavy under head, on snout, and back of head; 3 concentrations on body, and posterior part of tail.

Myomeres: 40–42
 Vert: 13+27–29
 D: IX–XII, I, 27–32
 A: III, 26–31
 P: 16–20
 C: 8–10+9+8+8–10

- Larvae** — Flexion occurs at 5.2–5.9 mm NL.
 — Note high myomere count relative to that for *P. cyanophrys* below.
 — See tables below for morphometrics and fin formation.
 — Pigmentation: lateral groups at myomeres 2–3, 16–17, 29–32, and over peduncle.

Psenes cyanophrys* Valenciennes*Distribution:** Oceanic species.**Meristic features**

- Eggs** — Undescribed.

Myomeres: 31
 Vert: 12+19

- Larvae** — Flexion occurs at 3.9–4.2 mm NL.
 — Note low myomere count relative to that for *P. pellucidus* above.
 — See tables below for morphometrics and fin formation.
 — Pigmentation: early stages (Pacific) lack ventral row of postanal spots and have no spots on top of head and upper jaw; peritoneal pigment present over air bladder, lateral and ventral streaks at about myomeres 20–23, and a spot under notochord tip; during flexion, lateral and notochord tip pigment spreads dorsally, becomes heavy after flexion.

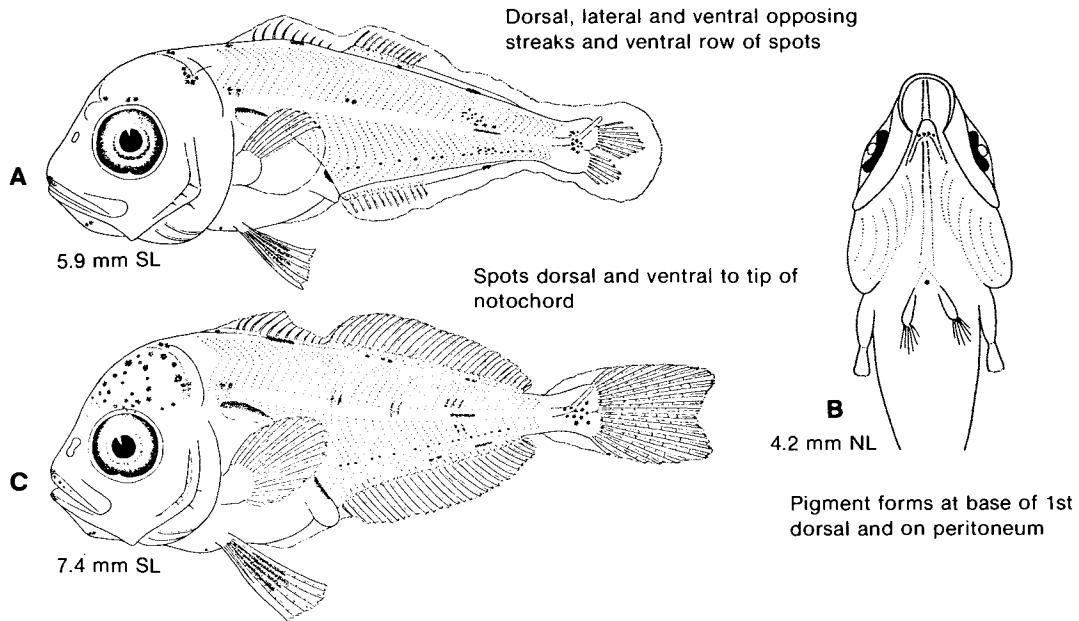
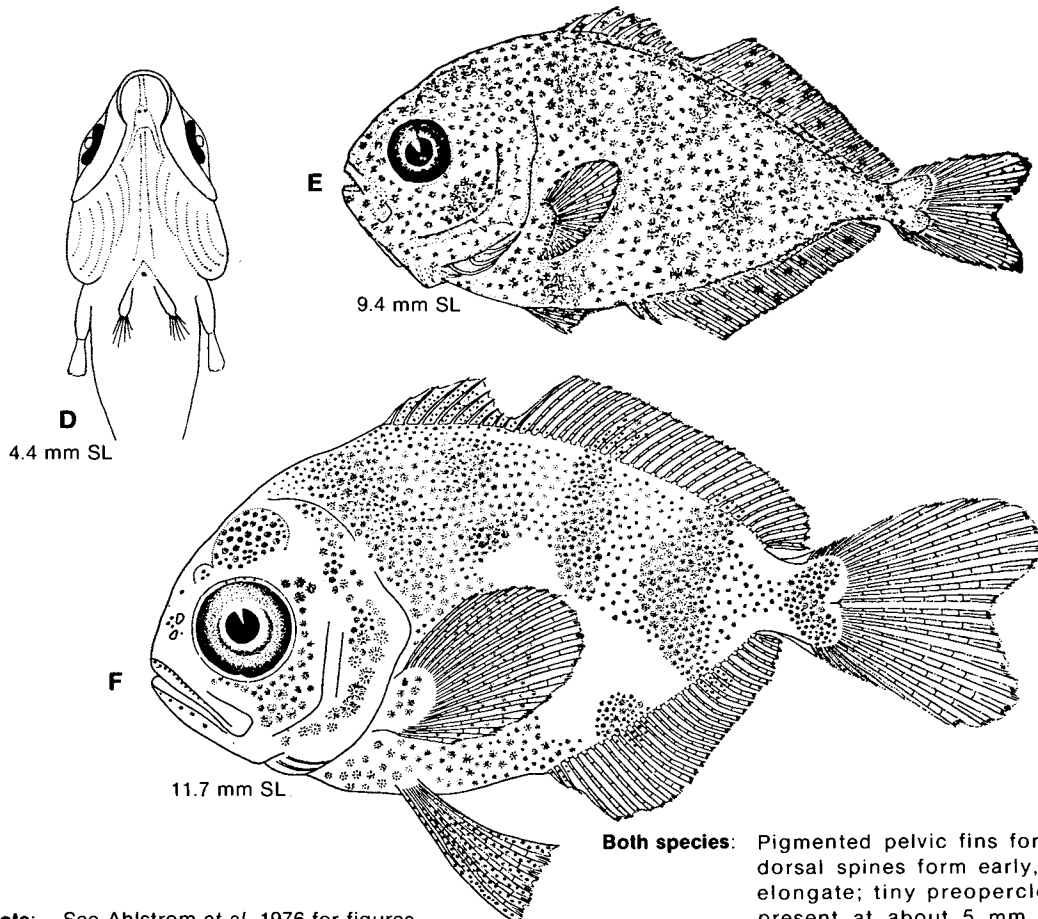
D: IX–X, I, 23–28
 A: III, 23–28
 P: 17–20
 C: 7–9+9+8+7–9

Morphometrics and Fin Formation

	<i>P. pellucidus</i>		<i>P. cyanophrys</i>	
	Preflexion	Postflexion	Preflexion	Postflexion
Preanus length	39–45% NL	46–53% SL	48–54% NL	50–59% SL
Head length	24% NL	27–33% SL	24–27% NL	31–39% SL
Body depth	20–24% NL	43–57% SL	24–29% NL	44–55% SL
Eye diameter	37–40% HL	35–44% HL	39–42% HL	37–47% HL

	<i>P. pellucidus</i>		<i>P. cyanophrys</i>	
	Begin to ossify	Complete	Begin to ossify	Complete
Pelvic rays	?	3.8 mm NL	2.7 mm NL	3.6 mm NL
Dorsal spines	5.2 mm NL	<9.7 mm SL	3.6 mm NL	4.7 mm SL
Dorsal rays	5.2 mm NL	<9.7 mm SL	4.2 mm SL	4.7 mm SL
Pectoral rays	5.2 mm SL	<9.7 mm SL	4.7 mm SL	9.7 mm SL
Caudal rays	5.9 mm SL	9.7–10.0 mm SL	4.2 mm SL	4.7 mm SL
Anal rays	5.9 mm SL	9.7–10.0 mm SL	4.2 mm SL	4.7 mm SL
Anal spines	5.5 mm SL	>12.0 mm SL	4.2 mm SL	6.9 mm SL
Vertebrae	5.5 mm SL	12.0 mm SL	3.6 mm SL	4.7 mm SL

Fig. — **A–D, F**, Ahlstrom *et al.* 1976; **E**, Legaspi 1956.

Psenes pellucidus**NOMEIDAE*****Psenes cyanophrys***

Both species: Pigmented pelvic fins form early; dorsal spines form early, but not elongate; tiny preopercle spines present at about 5 mm, become embedded at about 9 mm.

Note: See Ahlstrom *et al.* 1976 for figures of early stages from the Pacific

ARIOMMIDAE***Ariomma* sp.**

- Species** — The oceanic and coastal genus *Ariomma* is represented in the western North Atlantic by a deep-bodied species, *A. regulus*, and two closely-related, more elongate species, *A. bondi* and *A. melanum* (Haedrich and Horn 1972; Horn 1972).
- McKenney (1961) in his description of *A. regulus* larvae, acknowledged that both the deep-bodied form and one or both of the elongate forms were included in his series. Examination of the illustrations and body depth measurements in table 2 of McKenney (1961) indicates that the 7.0 and 39.7 mm specimens, as well as four other specimens (46.0–120.5 mm), may represent the deep-bodied form, whereas the remaining examples may represent developing elongate aroimmids.
- Pigment** — As many as 6 bars from dorsal fin origin to caudal fin base (may be broken into blotches).
- No pigment on abdomen and ventrum of head.
- Pelvic fin pigment gradually acquired (none at 5.3 mm).
- Dorsal spines pigmented in larvae >10 mm, becoming denser with development.

Meristic and other characters of adults

	<i>A. regulus</i> (Poey)	<i>A. melanum</i> (Ginsburg)	<i>A. bondi</i> Fowler
Vertebrae	30–32	30–31	30–31
Dorsal fin	XI–XII, 14–15	XI, 15–18	XI, 14–17
Anal fin	III, 14–15 (total 17–18)	III, 13–16 (total 16–19)	III, 12–16 (total 15–19)
Pectoral fin rays	21–24	21–23	20–23
Body depth	>33% SL	<28% SL	<28% SL
Lateral line scales		50–65	30–45
Depth range (m)		200–600	<200

Comparison with other larvae

- Nomeus* — Larger and darker pelvic fins, anterior dorsal spines longest, and more myomeres (p. 334).
- Psenes* — Ventrums of head pigmented, and pelvic fins pigmented early (p. 336, 338).
- Cubiceps* — Slimmer body, and late-forming pelvic fins (p. 332).
- Centrolophus* — Slimmer body, fewer myomeres, and late forming pelvic fins (p. 330).
- Tetragonurus* — Slimmer body, more myomeres, long peduncle, and late-forming pelvic fins (p. 342).

Fig. — A–E, McKenney 1961.

Ref. — Haedrich 1968; Haedrich and Horn 1972; Horn 1972.

Ariomma* sp.*ARIOMMIDAE**

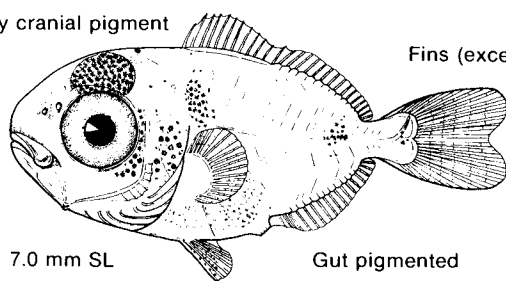
Heavy cranial pigment

Fins (except pelvic) unpigmented

A

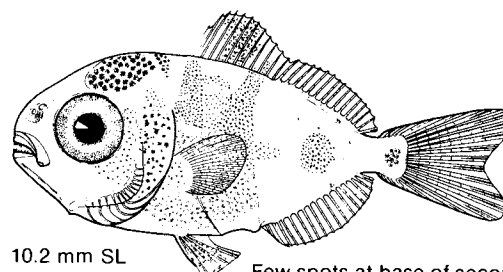
7.0 mm SL

Gut pigmented

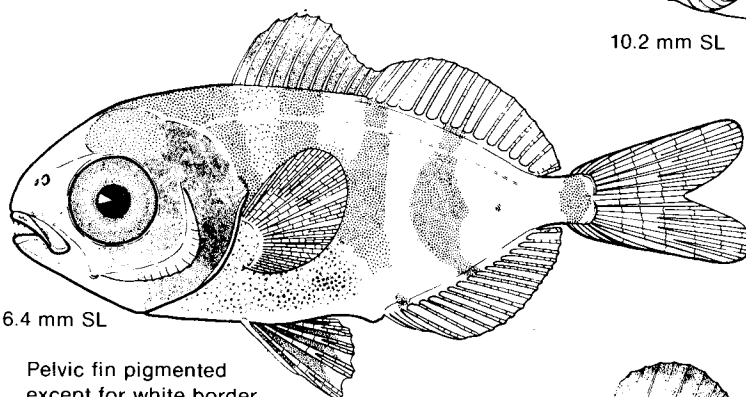
**B**

10.2 mm SL

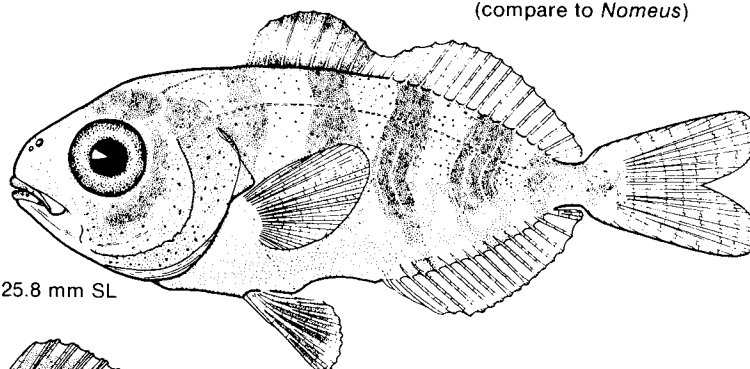
Few spots at base of second dorsal and anal fins

**C**

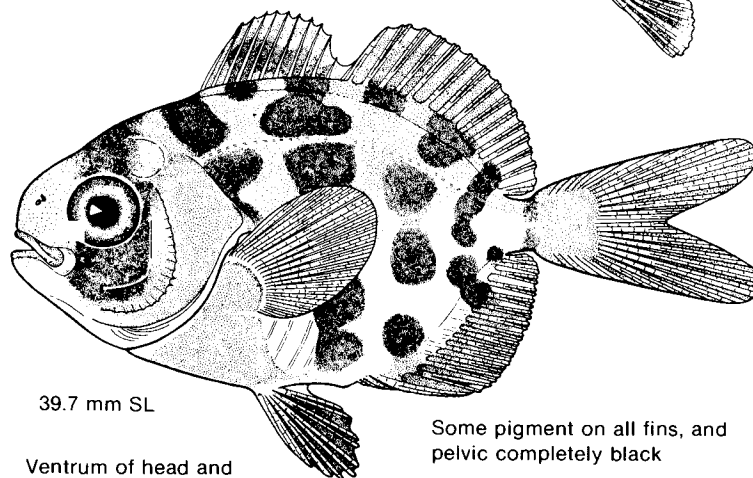
16.4 mm SL

Pelvic fin pigmented
except for white borderMiddle dorsal spines longest
(compare to *Nomeus*)**D**

25.8 mm SL

**E**

39.7 mm SL

Ventrum of head and
abdomen unpigmentedSome pigment on all fins, and
pelvic completely black

Preopercle weakly serrate

TETRAGONURIDAE***Tetragonurus atlanticus* Lowe**

Distribution: Oceanic species.

Spawning: Winter-spring in Sargasso Sea and Caribbean Sea.

Meristic features

- Eggs**
- Pelagic, spherical.
 - Diameter: 1.10 mm.
 - Shell: smooth (golden-pink).
 - Yolk: homogeneous.
 - Oil globules: 1.
 - O.G. diameter: 0.24 mm.
 - Perivitelline space: moderate.
 - Embryonic pigment similar to 3.0 mm NL larva plus patch on snout.
- Larvae**
- Gut long and straight, and peduncle long.
 - Flexion occurs at about 5–8 mm NL.
 - Relative morphometric characters during preflexion and postflexion stages:

Myomeres: 45–48
 Vert: 45–48
 D: XIV–XVII, 10–13
 A: I, 9–12
 P: 14–18
 C: 9–10+9+8+9–10

Preanus length	63–69% NL	64–71% SL
Head length	14–26% NL	30–35% SL
Body depth (at pectoral)	13–20% NL	24–28% SL
Eye diameter	24–48% HL	29–34% HL

- Tiny preopercle spines present from about 7 mm to juvenile stage.
- Sizes at beginning of ossification and completion of fin rays:

Caudal rays	7.2 mm NL*	8.6 mm SL
Dorsal and anal rays	7.2 mm NL*	8.6 mm SL
Dorsal spines	~8.0 mm SL	10.5 mm SL
Pectoral rays	8.0 mm SL	13.2 mm SL
Pelvic rays (bud at 6 mm)	8.5 mm SL	13.2 mm SL

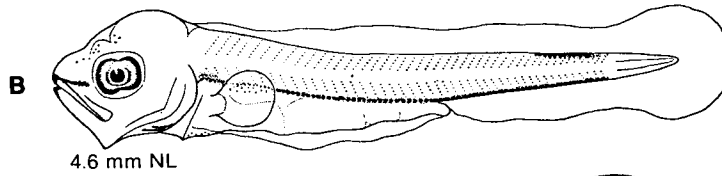
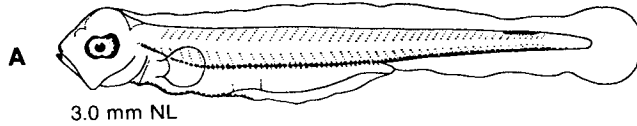
* 5.3 mm SL according to Grey (1955).

- Dorsal spines shorter than rays; dorsal fin origin over middle or anterior half of pectoral fin.
- Anal fin origin slightly posterior to 2nd dorsal fin origin; pelvic fin origin under pectoral fin base.
- Pigmentation: Tip of tail (preflexion) and peduncle (postflexion) unpigmented; dorsal pigment confined to last 8–12 myomeres through flexion; conspicuous line of pigment on upper gut and ventral edge of tail during preflexion.

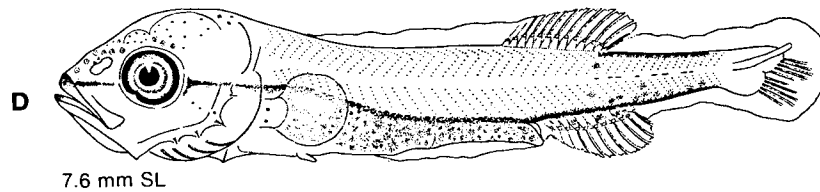
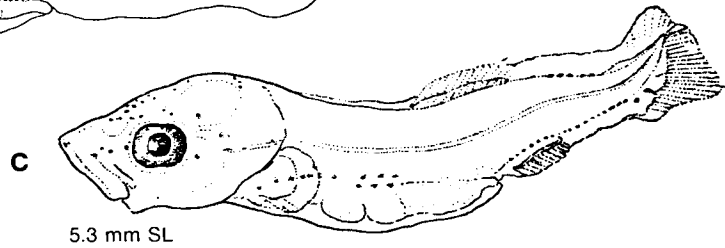
- Note:**
- (1) Egg description based on Pacific material.
 - (2) Larvae of *T. cuvieri* (eastern Atlantic) are more elongate and relatively less developed at similar sizes than *T. atlanticus*; they have pigment on tip of notochord and on peduncle; myomeres = 51–57.

Tetragonurus atlanticus

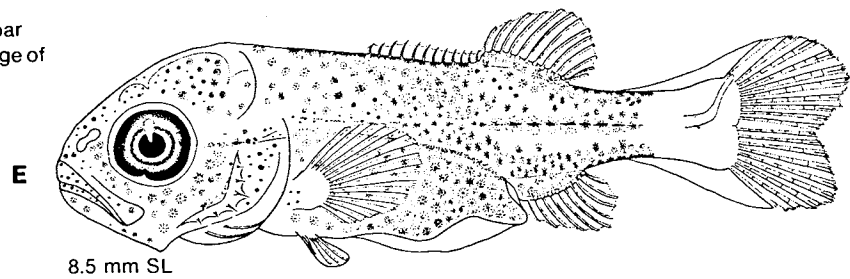
TETRAGONURIDAE



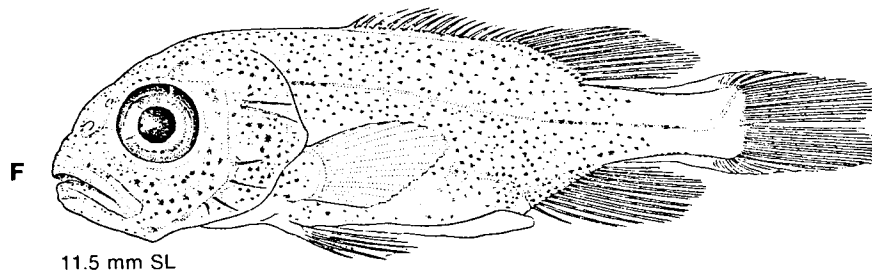
Line of pigment from snout
to anterior eye



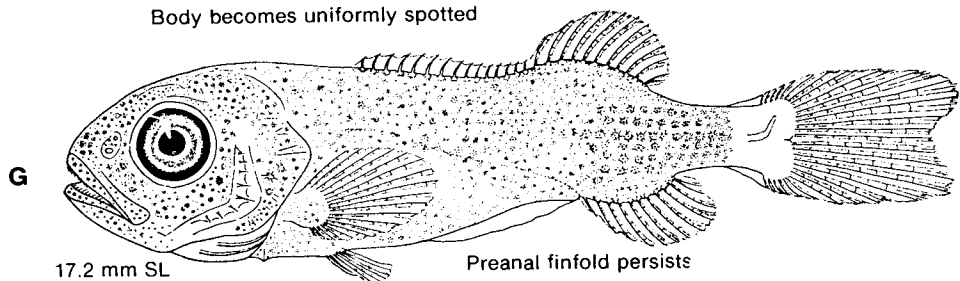
Scattered head spots; bar
forms through eye to edge of
opercle



Dorsal pigment spreads anteriorly



Body becomes uniformly spotted



Preanal finfold persists

A, B, D, E, G (Pacific material)

STROMATEIDAE *Peprilus triacanthus* (Peck)

Spawning: Summer along the coasts of Middle Atlantic Bight and Gulf of Maine (coastal species).

Eggs — Pelagic, spherical.
 — Diameter: 0.68–0.82 mm.
 — Shell: smooth and transparent.
 — Yolk: homogeneous and unpigmented (amber).
 — Oil globules: 1 (usually).
 — O.G. diameter: 0.17–0.21 mm.
 — Perivitelline space: narrow.

Larvae — Hatching occurs at 1.68–1.75 mm TL; eyes unpigmented.
 — Body deepens early in development; preanus length about 50% TL; small terminal mouth.
 — Tiny opercle spines (3) present at about 7 mm (not illustrated).
 — Dorsal and anal 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 develop on top of head and on opercle margin; ventral margin of gut pigmented (like a solid line of "stitching").

Meristic features

Myomeres: 32(30–33)
 Vert: 13+17–20
 D: II–IV, 40–48
 A: II–III, 37–44
 Piv: None
 P: 17–22
 C: 7–9+9+8+7–8

Peprilus alepidotus (Linnaeus) (= *Peprilus paru*)

Spawning: Delaware Bay to Brazil (coastal species).

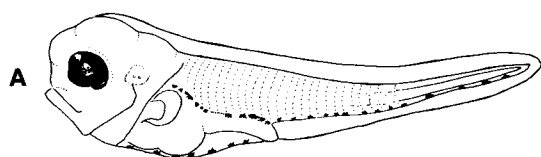
Larvae — Note pigment on body in early larvae; trunk heavily pigmented in later larvae (7 mm), but lacks ventral row of spots present in *P. triacanthus*.

Meristic features

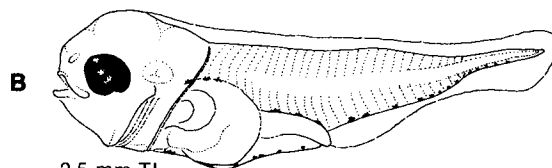
Myomeres: 30(29–31)
 Vert: (12)13+16–18
 D: II–IV, 38–47
 A: II–III, 35–45
 Piv: None
 P: 18–24
 C: 7–9+9+8+7–8

Fig. — A–E, Lippson and Moran 1974; F–I, Pearson 1941 (A–H redrawn).

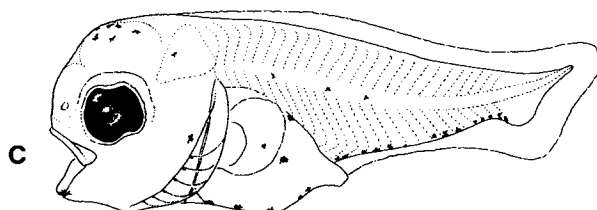
Ref. — Colton and Honey 1963; Horn 1970; Ditty MS 1981.

Peprilus triacanthus**STROMATEIDAE**

2.3 mm TL

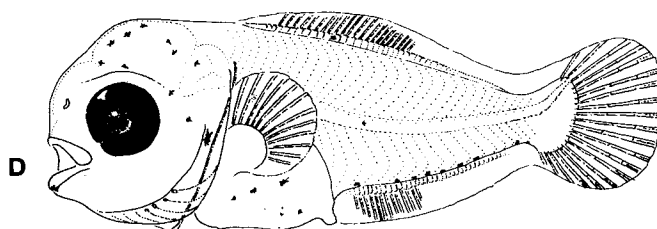


2.5 mm TL

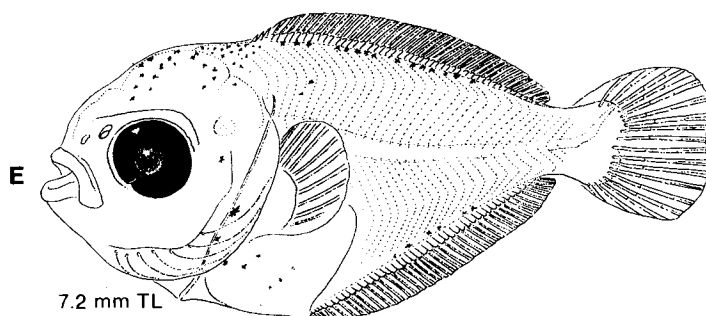


3.8 mm TL

Ventral spots separate, not 1 per
myomere as in *Stenotomus*
chrysops (p. 264)



4.5 mm TL



7.2 mm TL

Peprilus alepidotus

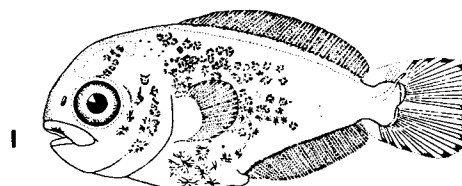
1.8 mm TL



3.5 mm TL



2.5 mm TL



7.0 mm

PLEURONECTIFORMES**Flatfishes**

This section of the guide includes 21 species in five families of Pleuronectiformes which occur in the western North Atlantic (see table, p. 347).

Larval characteristics

- Larval stage can be prolonged; some reach large size before transformation.
- Midbrain protrudes dorsally to varying degrees.
- Gut coiled, bulging out from body outline; preanus length usually <50% SL.
- Dorsal and anal fins usually long-rayed and long-based, with high ray counts; dorsal fin extends from head to base of caudal fin.
- Other special characters include elongate rays, spines on head, preopercle, opercle and scales.
- Body symmetrical and compressed, then marked transformation during which one eye migrates to other side of head, gut is pulled to within ventral body outline, pectoral fin shrinks and pectoral rays form, and pigment increases on eyed (ocular) side.

Family differences

	Bothidae- Scophthalmidae	Pleuronectidae	Soleidae	Cynoglossidae
Oil globules	1 to 2-3	None	Multiple	Multiple
Elongate rays	Often	None	Possible	Possible
Preanus length	About 50% TL (decreases)	About 40% TL (most)	40 to about 50% TL	About 40% TL
Protruding midbrain	Slight (most)	Slight (most)	Prominent	Prominent
Mouth	Terminal	Terminal	Lateral	Oblique, twisted
Eye migration	Right to left	Left to right	Left to right	Right to left
Transformation size	Most <15 mm, (few larger S. of 35° N)	18-35 mm ^a 7-16 mm ^b	3-5 mm	About 10 mm

^a Boreal-temperate species.

^b Temperate species.

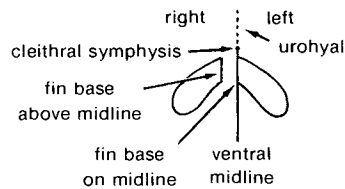
Flatfishes**PLEURONECTIFORMES****Meristic and other characters**

Family/Species	Vertebrae	Fin rays		Larval size (mm)		
		Dorsal	Anal	At hatch	At flexion	At trans-formation
Scophthalmidae						
<i>Scophthalmus aquosus</i>	34–36	63–73	46–56	~2.0	~5.5	~6.5+
Bothidae						
<i>Hippoglossina oblonga</i> ^a	41–42	71–86	58–72	~2.9	6–8	10–12+
<i>Paralichthys dentatus</i>	41–42	80–96	61–73	~2.5	9–10	9–13
<i>Citharichthys arctifrons</i>	36–39	75–87	58–71	... ^b	5–9	13–15
<i>Etropus microstomus</i>	34–35	67–84	50–63	... ^b	5–7	10–12
<i>Syacium papillosum</i>	35–36	79–94	62–75	... ^b	5–7	15–22
<i>Cyclopsetta fimbriata</i>	36–37	78–87	59–67	... ^b	5–8	14–15
<i>Bothus ocellata</i>	35–37	76–91	58–68	... ^b	6–7	9–42 ^c
<i>Monolene sessilicauda</i>	45–48	92–109	76–89	... ^b	8–12	>33
<i>Engyophrys senta</i>	37–39	71–85	60–69	... ^b	4.5–6.5	19–20
<i>Trichopsetta ventralis</i>	40–41	89–95	69–75	... ^b	6–10	28–36
Pleuronectidae						
<i>Glytocephalus cynoglossus</i>	58–60	97–117	86–102	4–6	14–20	22–35
<i>Hippoglossoides platessoides</i>	45–48	78–98	60–79	4–6	9–19	18–34
<i>Hippoglossus hippoglossus</i>	50–51	98–106	69–84	6–7	13–24	20–34
<i>Reinhardtius hippoglossoides</i>	61–63	92–104	66–80	≥7	17–36	≥30
<i>Limanda ferruginea</i>	40–44	73–91	51–68	2.0–3.5	5–10	~14
<i>Liopsetta putnami</i>	34–38	48–59	35–41	3.0–3.6	~6–7	7–13
<i>Pseudopleuronectes americanus</i>	34–40	60–76	44–58	~2.4	5.0–7.6	7–13
Soleidae						
<i>Trinectes maculatus</i>	28–29	50–56	36–46	1.7–1.9	~3.8	<5
<i>Achirus lineatus</i>	25–27	47–58	35–44	<2	3–4	3–5
Cynoglossidae						
<i>Symphurus plagiusa</i>	46–48	85–92	69–78	<1.3	6.0–8.5	~10

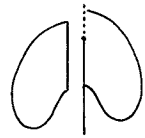
^a (= *Paralichthys oblongus*).^b Egg and hatchling undescribed.^c Most transform at 16–21 mm.

PLEURONECTIFORMES**Flatfishes****Position of pelvic fins at flexion in 17 genera**

Key (ventral view)



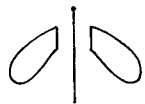
Scophthalmus: both pelvic fin bases long, both origins on urohyal, left base on midline, right base above midline.



Bothus: left pelvic fin base longer than right, left origin on urohyal, left base on midline; right base above midline.



Paralichthys, *Hippoglossina*: left and right pelvic fin bases equal, both origins posterior to cleithral symphysis, both bases above midline.



Engyophrys, *Trichopsetta*, *Monolepis*: left pelvic fin base slightly longer than right, left origin slightly anterior to cleithral symphysis, right origin at cleithral symphysis, left base on midline, right base above midline.



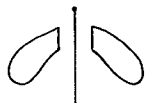
Syacium, *Etropus*, *Citharichthys*: left pelvic fin base longer than right, right origin anterior to left, both posterior to cleithral symphysis, left base on midline, right base above midline.



Cyclopsetta: left and right pelvic fin bases equal, both origins posterior to cleithral symphysis, left base on midline, right base above midline.



Limanda, *Glyptocephalus*, *Pseudopleuronectes*: left and right pelvic fin bases equal, both origins posterior to cleithral symphysis, both bases above midline (other pleuronectids the same).



Symphurus: right pelvic fin lost at transformation, left base posterior to cleithral symphysis, left base on midline.



Trinectes, *Achirus*: right pelvic fin base longer than left, right origin anterior to left, right base on midline, left base above midline.



Flatfishes**PLEURONECTIFORMES****Larval characters in genera of family Bothidae**

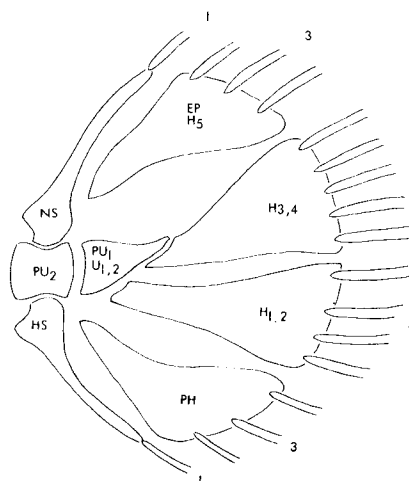
	<i>Citharichthys</i> , <i>Etropus</i> , <i>Cyclopsetta</i> , <i>Paralichthys</i> , <i>Hippoglossina</i> , <i>Syacium</i>	<i>Bothus</i> , <i>Trichopsetta</i> , <i>Engyophrys</i> , <i>Monolene</i>
Body	Relatively thick, short	Thin, diaphanous
Transformation size	<15 mm	>15 mm
Air bladder disappears	During transformation	Before transformation
Eye migrates	Anterior to dorsal fin origin (except <i>Cyclopsetta</i>)	Under dorsal fin origin (includes <i>Cyclopsetta</i>)
Spines	Opercle; sometimes post- temporals and frontals	Absent or only urohyal, basipterygia, cleithra, otic
Elongate rays	0–11 anterior dorsal rays, usually pigmented sheath	1st or 2nd dorsal ray; some- times pigmented sheath
Pigment	Relatively heavy	Relatively light
Posterior basipterygium process	Short	Long, extending almost to vent

Caudal formulae in genera of family Bothidae

Counts are ventral to dorsal. Each number indicates number of principal rays associated with the haemal spine of PU₂, each of the four hypural elements (four hypurals plus one epural in *Paralichthys* and *Hippoglossina* where H₅ and EP not fused), and the neural spine of PU₂.

Genus	Formula						
<i>Paralichthys</i>	1	2	5	6	2	1	1
<i>Hippoglossina</i>	1	3	4	5	3	1	1
<i>Citharichthys</i>	0	4	4	5	4	0	
<i>Etropus</i>	0	4	4	5	4	0	
<i>Syacium</i>	0	4	4	5	4	0	
<i>Cyclopsetta</i>	0	4	4	5	4	0	
<i>Bothus</i>	1	4	3	4	4	1	
<i>Engyophrys</i>	1	3	4	5	3	1*	
<i>Trichopsetta</i>	1	3	4	5	3	1*	
<i>Monolene</i>	1	3	4	5	3	1*	

* Illustrated diagrammatically.

**Temporal and spatial distribution** (Smith *et al.* 1975)

Most species spawn within narrow temperature ranges. Spawning in spring proceeds from south to north, and spawning in autumn from north to south. Bothids have longer spawning seasons than pleuronectids. Most bothids spawn in southern part of Middle Atlantic Bight from spring through autumn, whereas pleuronectids spawn in the northern part of the bight in spring.

Ref. — Woolcott *et al.* 1968; Guthertz 1970; Richardson and Joseph 1973; Evseenko 1977a; Futch 1977; Hensley 1977.

PLEURONECTIFORMES**Flatfishes****Temporal and spatial distribution (cont'd)****Scophthalmidae**

- *Scophthalmus aquosus*. Spawning in spring and also in autumn south of Chesapeake Bay, summer to fall peak off New Jersey, into December from southern New England to Virginia, with most late spawning activity off New Jersey. Most larvae are collected over inshore half of continental shelf off New Jersey, but larvae are present throughout entire Middle Atlantic Bight at certain times of the year.

Bothidae

- *Hippoglossina oblonga*. Spawning from May through summer into autumn. Most larvae are found from southern New England to New Jersey over mid-depths on continental shelf.
- *Paralichthys dentatus*. Spawning occurs from late summer to mid-winter. Larvae are concentrated from Southern New England to New Jersey, mostly over inshore half of continental shelf but extend to shelf edge.
- *Citharichthys arctifrons*. Spawning from spring through summer into autumn. Larvae are found over offshore half of continental shelf with concentrations from southern New England to Virginia. Also, larvae found on the Scotian Shelf (Markle *et al.* 1980).
- *Etropus microstomus*. Spawning from June into autumn north of Cape Hatteras and throughout the year south of Cape Hatteras. Most larvae found off Virginia Capes and near Cape Hatteras over mid-depths on continental shelf, but some extend into southern New England waters.
- *Syacium papillosum*. Spawning from spring through summer into autumn. Larvae found over offshore edge of continental shelf and Gulf Stream waters near Cape Hatteras.
- *Cyclopsetta fimbriata*. Spawning from April to autumn with peaks in June and September. Larvae common near Cape Hatteras.
- *Bothus ocellatus*. Spawning throughout the year. Most larvae found between Chesapeake Bay and Cape Hatteras, but few more northerly near continental shelf edge and in Gulf Stream waters.
- *Monolene sessilicauda*. No spawning north of Cape Hatteras, although adults range to New England. Larvae collected during spring and summer near Cape Hatteras.
- *Engyophrys senta* and *Trichopsetta ventralis*. No evidence of spawning north of Cape Hatteras, but larvae may occur as strays carried by the Gulf Stream.

Pleuronectidae

- *Glyptocephalus cynoglossus*. Spawning from May to August on Georges Bank, and from March to April north to Newfoundland. In Middle Atlantic Bight, most larvae over offshore part of continental shelf off Long Island.
- *Hippoglossoides platessoides*. Spawning in spring. Larvae in Middle Atlantic Bight restricted to southern New England waters.
- *Hippoglossus hippoglossus*. Spawning from January to June. Larvae occur from Georges Bank north to subarctic waters.
- *Reinhardtius hippoglossoides*. Spawning from spring through summer. Larvae occur from Georges Bank north to subarctic waters.
- *Limanda ferruginea*. Spawning from spring through summer. Larvae abundant from western Gulf of Maine south to New Jersey.
- *Liopsetta putnami*. Spawning in late winter to early spring. Larvae occur in estuaries and coastal areas from Rhode Island to northern Labrador.

Flatfishes**PLEURONECTIFORMES**

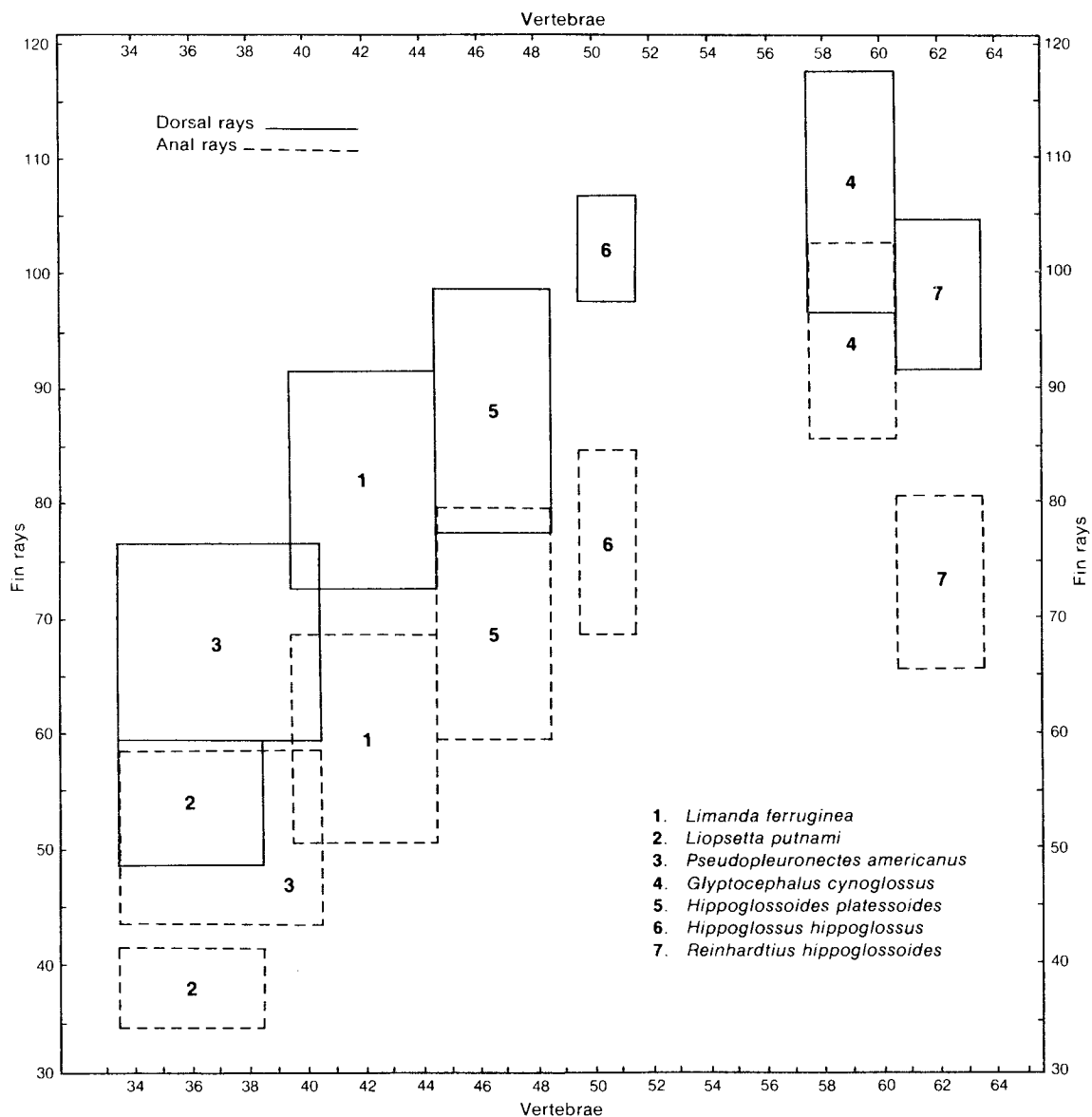
- *Pseudopleuronectes americanus*. Spawning in late winter to spring. In Middle Atlantic Bight, larvae found nearshore from southern New England to Chesapeake Bay.

Soleidae and Cynoglossidae

- Larvae of these families occur near Cape Hatteras, are presumably spawned in the South Atlantic Bight and transported north by the Gulf Stream; *Trinectes* spawns in estuaries.

Family Pleuronectidae

The figure below illustrates correlation of ranges of dorsal and anal fin ray and vertebral counts. Species numbered 1–3 exhibit relatively low numbers of dorsal and anal fin rays and vertebrae, and small sizes at flexion and transformation. Species numbered 4–7 have higher numbers of dorsal and anal fin rays and vertebrae, and larger sizes at flexion and transformation. A similar figure for Bothidae was not prepared due to overlapping meristic characters in most species.



SCOPHTHALMIDAE *Scophthalmus aquosus* (Mitchill)

Spawning: Spring to autumn.

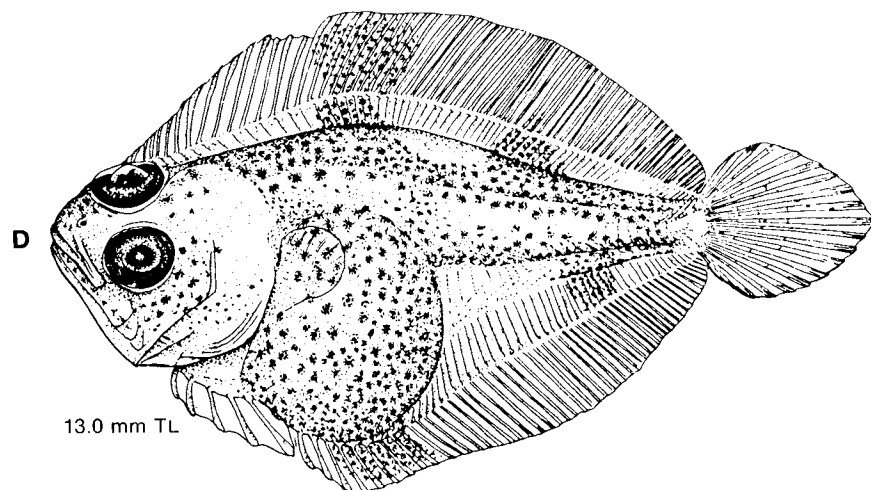
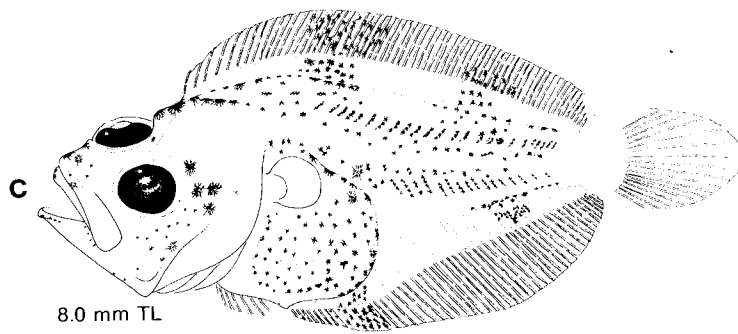
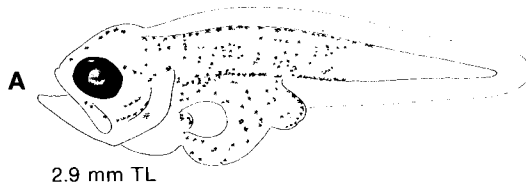
Meristic features

- Eggs**
- Pelagic, spherical.
 - Diameter: 0.95–1.05 mm.
 - Shell: smooth.
 - Yolk: homogeneous.
 - Oil globules: 1 or multiple.
 - O.G. diameter: 0.16–0.20 (when 1).
 - Perivitelline space: narrow.

Myomeres : 34–36
 Vert : 11+23–25
 D : 63–73
 A : 46–56
 Piv : 6/6
 P : 11

- Larvae**
- Hatching occurs at about 2 mm.
 - Body deep, especially in gut area, and compressed; preanus length <50% TL.
 - Flexion begins at about 5.5 mm; transformation occurs at relatively small size, beginning at about 6.5 mm TL.
 - Pectoral fin rays form after transformation; all fin rays complete at about 8.5 mm TL; no elongate rays.
 - Pelvic fins unequal in size, both bases long with left longer, both origins on urohyal, left base on ventral midline, right base above midline.
 - Pigmentation: early larvae heavily pigmented from head to midtail, with posterior 1/3 unpigmented; in late larvae, bars of pigment form and extend onto fins, with pronounced contrast between pigmented and unpigmented areas; compare to early stages of *Tautoga onitis* (Labridae, p. 292).



Scophthalmus aquosus**SCOPHTHALMIDAE**

BOTHIDAE***Hippoglossina oblonga* (Mitchill)****Spawning:** Summer into autumn.**Meristic features****Eggs**

- Pelagic, spherical.
- Diameter: 0.86–0.98 mm.
- Shell: smooth.
- Yolk: homogeneous.
- Oil globules: 1.
- O.G. diameter: 0.10–0.19 mm.
- Perivitelline space: narrow.

Myomeres: 41–42
 Vert : 11+30–31
 D : 71–86
 A : 58–72
 Piv : 6/6
 P : 10–12

Larvae

- Hatching occurs at about 2.9 mm; eyes unpigmented; preanus length about 50% TL.
- Head and gut deep and compressed
- Preanus length <50% NL at 4.2 mm; anus shifts anteriorly in later larvae.
- Few serrations appear on preopercle at 4.2 mm, and disappear by about 7 mm.
- Flexion occurs between 6 and 8 mm.
- Transformation begins at about 10 mm and is complete at >12 mm (right eye migrates over middorsal ridge; dorsal fin origin moves anteriorly and is deflected to right side).
- Sizes at beginning of ossification and completion of fin rays and vertebrae:

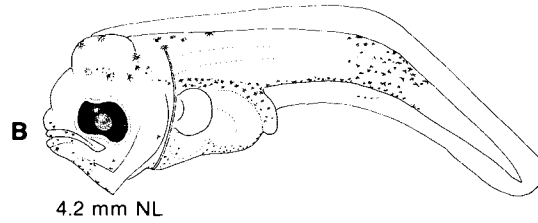
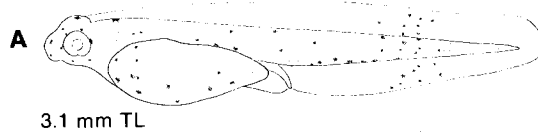
	6–8 mm NL	8 mm SL
Caudal rays	~6	9–10
Dorsal and anal rays	(buds) ~8	11
Pelvic rays	—	~9
Vertebrae	—	—

- Anterior dorsal fin rays may be slightly elongate.
- Pelvic fins equal in size, with both bases above midline and both origins posterior to cleithral symphysis.

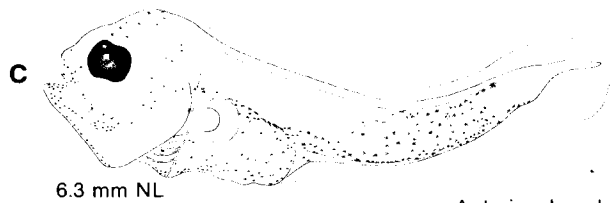


- Pigmentation: in early larvae, spots evenly scattered over head, trunk and yolk sac; no pigment posterior to midtail bar which extends onto finfolds; in late larvae, midtail bar restricted to body, spreading anteriorly and posteriorly; unpigmented areas remain at caudal base and a zone on side over pectoral fin; at transformation, round ocellated spots form on body postanally.

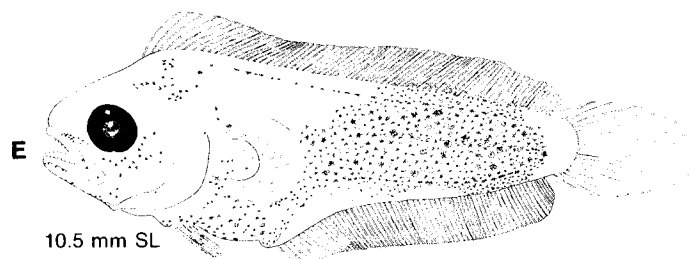
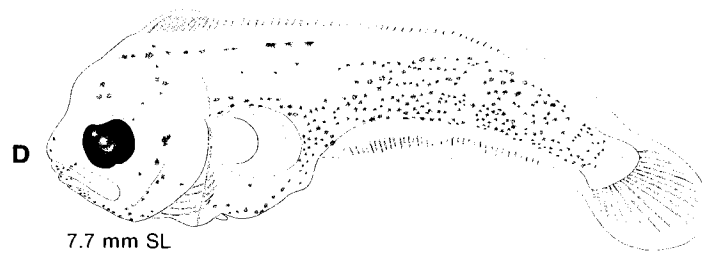
Note: This species is referred to as *Paralichthys oblongus* by some authors (see Robins *et al.* 1980).

*Hippoglossina oblonga***BOTHIDAE**

Ventral row of spots from gut to mid-tail bar spreads dorsally in later stages



Anterior dorsal and anal rays form first



BOTHIDAE***Paralichthys dentatus* (Linnaeus)****Spawning:** Autumn into winter.**Meristic features**

- Eggs**
- Pelagic, spherical.
 - Diameter: 0.95–1.03 mm.
 - Shell: smooth and transparent.
 - Yolk: homogeneous.
 - Oil globules: 1.
 - O.G. diameter: 0.17–0.23 mm.
 - Perivitelline space: narrow.
- Meristic features**
- Myomeres: 41–42
 - Vert : 11+30–31
 - D : 80–96
 - A : 61–73
 - Piv : 6/6
 - P : 12–13

- Larvae**
- Hatching occurs at about 2.4–2.8 mm NL; eyes unpigmented; mouth not formed; oil globule posterior in yolk.
 - Head length 23–27% NL/SL throughout development.
 - Preanus length decreases from 48% NL to 30% SL; body depth increases from 14% NL to 45% SL at transformation.
 - Flexion occurs at 9–10 mm SL; transformation begins at about 9.5 mm SL and is complete at 12–13 mm SL.
 - Teeth first visible at about 9.5 mm SL.
 - Spines: 1 cranial spine on each side near dorsum at hatching, increases to 2–3 per side, directed anteriorly; 5–7 preopercle spines at 4.5–9.5 mm SL; 2–5 opercle spines at 8.6–9.5 mm SL; all spines disappear during transformation.
 - Ossification of vertebrae complete at about 9.5 mm SL.
 - Sizes at beginning of ossification and completion of fin rays:

Dorsal rays	6.0 mm NL	10.5–11.0 mm SL
Caudal rays	7.0	10.0
Anal rays	8.0	10.5–11.0
Pelvic rays	9.5 (buds)	12.0

- Anterior dorsal fin rays (4th–8th) may be elongate.
- Pelvic fins equal in size, with both bases above midline and both origins posterior to cleithral symphysis.
- Pigmentation: in early larvae, anterior 3/4 of body and finfold with scattered spots; in late larvae, row of 10–13 spots forms on ventral edge; spots scattered on ventral gut, throat, lower jaw, and dorsum of head; 6–8 well-separated spots on dorsal edge.



Note: Meristic characters in three *Paralichthys* found south of Cape Hatteras are as follows:

Species	Vertebrae	Dorsal	Anal
<i>P. squamilentus</i>	10+27–29	76–85	59–65
<i>P. lethostigma</i>	10–11+27–28	80–95	63–74
<i>P. albigutta</i>	10+27	71–85	53–63

Fig. — A–E, Smith and Fahay 1970 (redrawn).

Ref. — Deubler 1958; Rothschild and Deubler 1960; Guthertz 1967; Woolcott *et al.* 1968.

*Paralichthys dentatus***BOTHIDAE**

2.8 mm NL

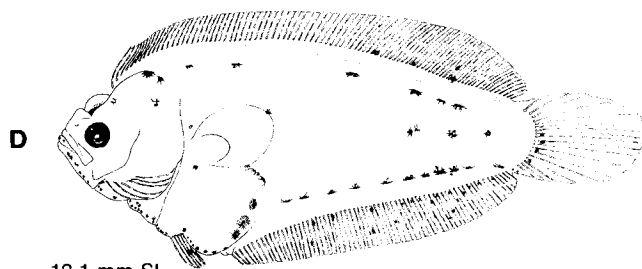


3.2 mm NL

Edge of preanal finfold pigmented

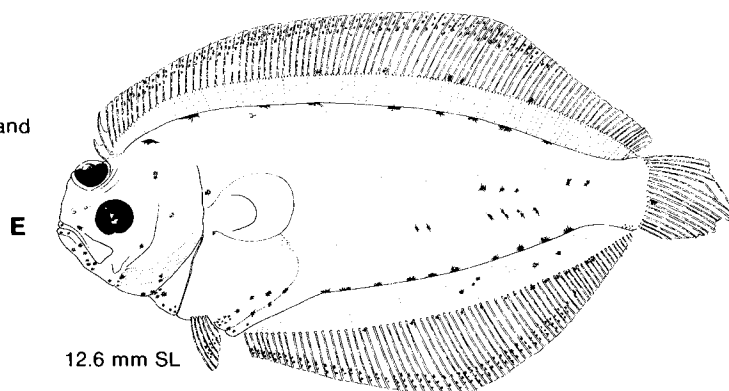
Spot forms at lateral midline
posterior to cleithrum

9.5 mm NL



12.1 mm SL

3 spots at posterior midline

Spots form on dorsal and
anal fins near margin

12.6 mm SL

BOTHIDAE***Citharichthys arctifrons* Goode****Spawning:** Summer-autumn (mostly July–October).**Meristic features****Eggs** — Undescribed.

Myomeres: 34–35

Larvae — Head length 19–25% SL in early larvae, and 26–30% SL at transformation.

Vert: 10–11+26–28

D: 75–87

A: 58–71

Piv: 6/6

P: 9–11

— Preanus length 36–42% SL in early larvae, and 35–40% SL at transformation.

— Body depth 18–25% SL in early larvae and 34–39% SL at transformation; relative depth less than in similar sizes of *Etropus microstomus* (p. 360).

— Flexion occurs at 5–9 mm, and transformation at 13–15 mm.

— No preopercle spines; 2nd, 3rd and 4th dorsal fin rays elongate in larvae 4.5–12.0 mm SL.

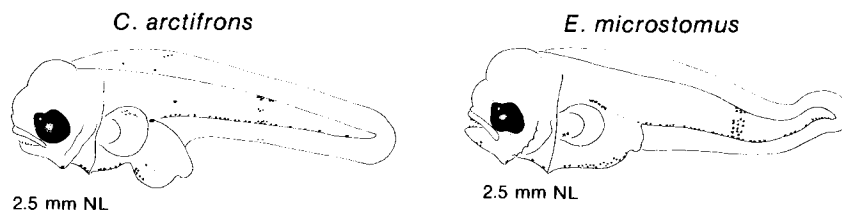
— Sizes at beginning of ossification and completion of fin rays and vertebrae:

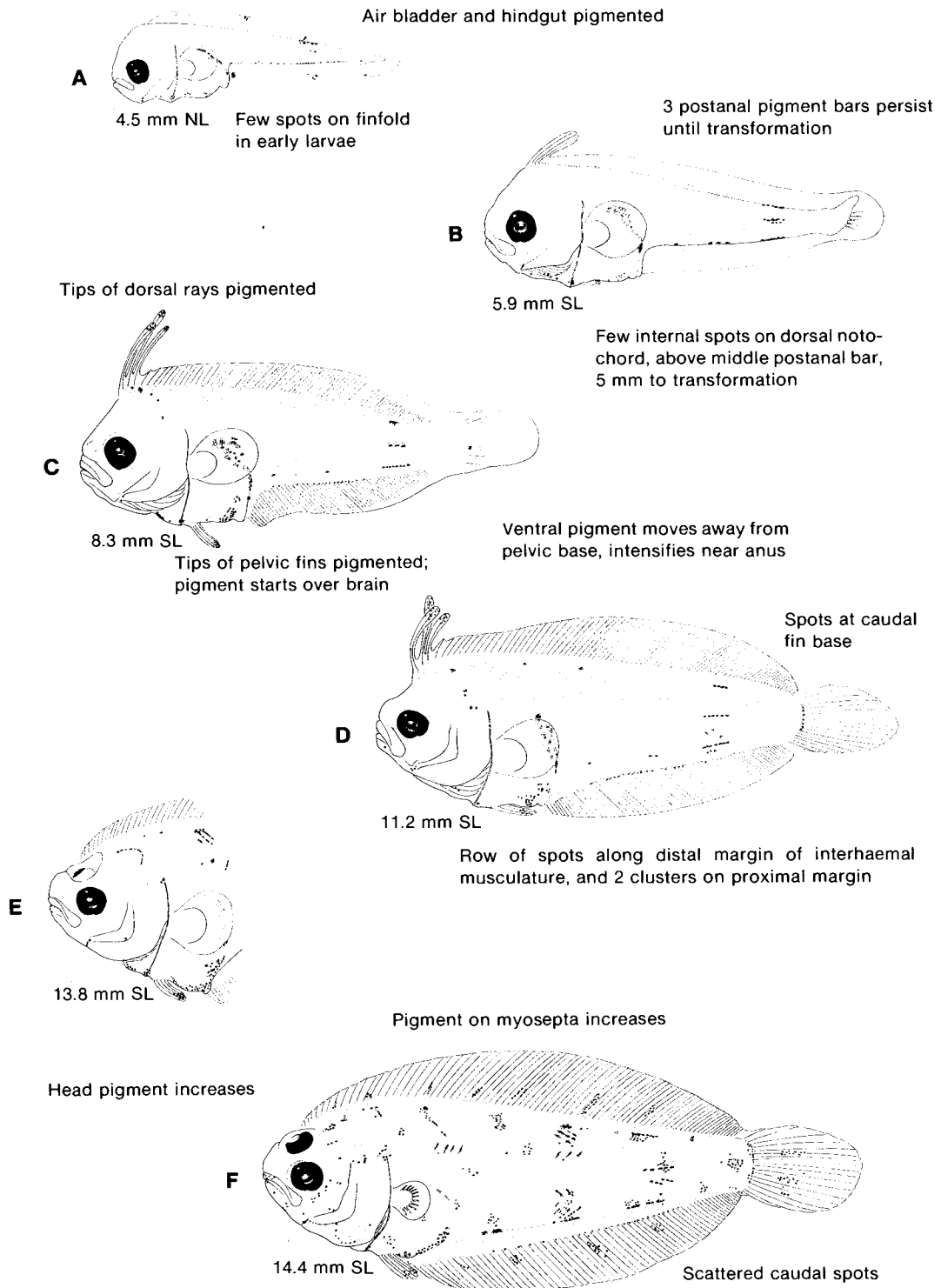
Caudal rays	5 mm SL	9 mm SL
Dorsal and anal rays	6	10
Pelvic rays	5 (buds)	12+
Vertebrae	6–7	10+

— Pelvic fins: left base longer than right; right origin anterior to left, both posterior to cleithral symphysis; left base on midline, and right base above midline.

— Pigmentation: 3 postanal, horizontal bars >4–5 mm; internal spots on notochord only near the 3 postanal bars in sizes >5 mm; no prominent ventral edge clusters between anus and preanal bars, but an irregular row of spots instead; less overall pigment than in *Etropus microstomus* (p. 360).**Pigment Comparison in Early Larvae of Two Species**

Pigment	<i>C. arctifrons</i>	<i>E. microstomus</i>
Lower jaw	Absent	Present
Air bladder	Present	Present
Ventral edge (tail)	Present	Present
Finfold	May be present	Absent
Mid-tail	3 bars at about 3 mm	2–3 bars at <3 mm
Ventral gut anterior to anus	Absent	Present

(Richardson and Joseph 1973)
(redrawn)**Fig.** — A–F, Richardson and Joseph 1973 (redrawn).**Ref.** — Markle *et al.* 1980; Tucker 1982.

*Citharichthys arctifrons***BOTHIDAE**

BOTHIDAE***Etropus microstomus* (Gill)****Spawning:** Summer-autumn (mostly July-October).**Meristic features****Eggs** — Undescribed (see note (1) below).

Myomeres: 31-33

Larvae — Head length 21-25% SL in early larvae, and 25-27% SL at transformation.

Vert : 10+24-25

D : 67-84

A : 50-63

Plv : 6/6

P : 9-12

— Preanus length 36-43% SL in early larvae, and 33-35% SL at transformation.

— Body depth 20-26% SL in early larvae and 36-41% SL at transformation; relative depth greater than in similar sizes of *Citharichthys arctifrons* (p. 358).

— Flexion occurs at 5-7 mm, and transformation at 10-12 mm.

— Preopercle spines prominent from 2.5 to 8.0 mm and disappear by 10 mm; no elongate fin rays.

— Sizes at beginning of ossification and completion of fin rays and vertebrae:

Caudal rays	5 mm SL	7 mm SL
Dorsal and anal rays	5	8
Pelvic rays	5 (buds)	11-12
Vertebrae	5	9

— Pelvic fins: same position as in *Citharichthys arctifrons* (p. 358).

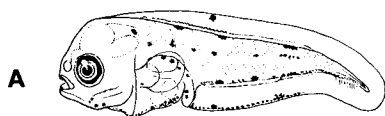
— Pigmentation: 3 postanal, horizontal bars >3-4 mm; internal spots along length of notochord >4 mm; 2 prominent ventral edge clusters between anus and post-anal bars at sizes >4 mm; 1-2 spots on pectoral fin base.

- Note:**
- (1) Scherer and Bourne (1980) provide a description of egg development, but it may not adequately account for the presumably similar egg of *Citharichthys arctifrons*.
 - (2) For comparison with early larvae of *C. arctifrons*, see p. 358.
 - (3) Of the several western North Atlantic species in the genera *Etropus* and *Citharichthys*, only *E. microstomus* and *C. arctifrons* occur commonly north of Cape Hatteras.

**Fig. — A-F,** Richardson and Joseph 1973 (redrawn by Barbara Sumida MacCall).**Ref. —** Tucker 1982.

Etropus microstomus**BOTHIDAE**

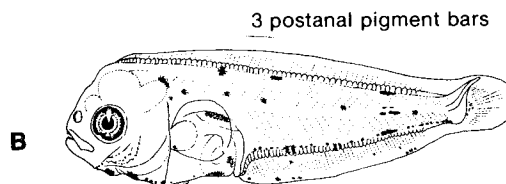
Spots along dorsal edge



4.5 mm NL

Air bladder pigmented

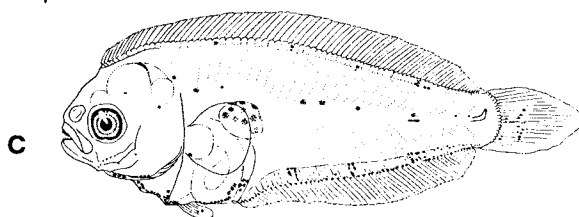
Finfold spots may appear but gone by 5 mm



5.9 mm SL

Spots at base of flexing urostyle

Ventral pigment concentrated on posterior gut, moves away from pelvic base

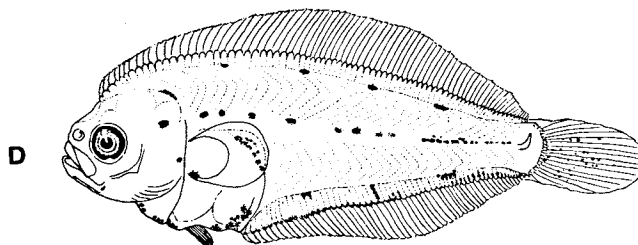


8.3 mm SL

Few spots on pelvic fin

Few internal spots on dorsal notochord above gut persist until transformation

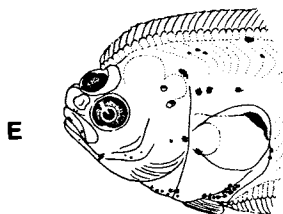
Internal spot under hind-brain in larvae larger than 8 mm SL



10.6 mm SL

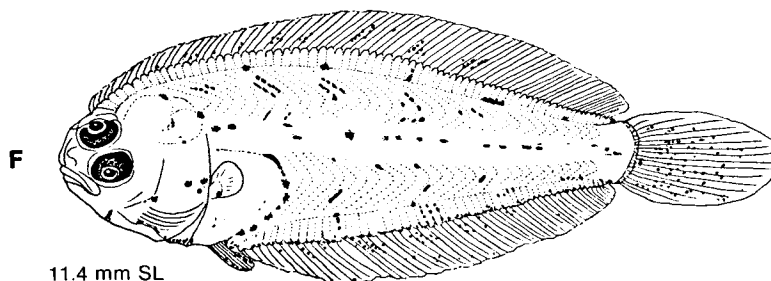
Spot on opercle

Scattered caudal spots



10.9 mm SL

Pigment forms on myosepta



11.4 mm SL

Fine pigment forms on fins at transformation

BOTHIDAE***Syacium papillosum* (Linnaeus)****Spawning:** April–November (Florida west coast).**Meristic features****Eggs** — Undescribed.

Myomeres: 33–36

Larvae — Teeth visible at about 3 mm SL.

Vert : 10+25–26

— Bulge in forehead profile at 4–6 mm SL.

D : 79–94

— Head length 26–34%; preanus length 48–39% (decreases), and body depth 24–43% (increases).

A : 62–75

— Flexion occurs at 5–7 mm SL, and transformation at 15–22 mm SL.

Plv : 6/6

P : 11–12

— Cranial spines (1 per side, large) at 2–8 mm SL.

— Preopercle spines 4–7; large angle spine develops a spur.

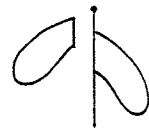
— Sizes at beginning of ossification and completion of fin rays and vertebrae:

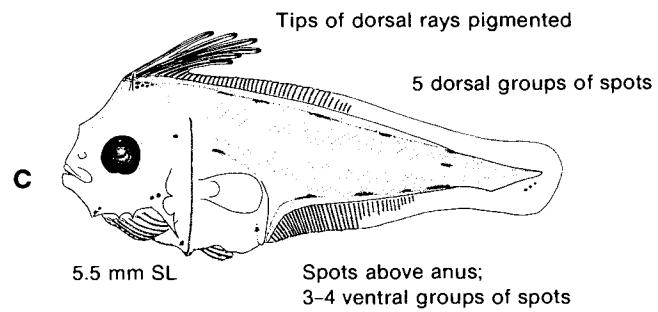
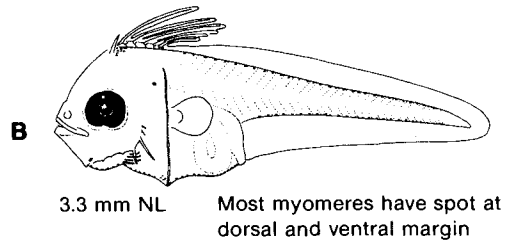
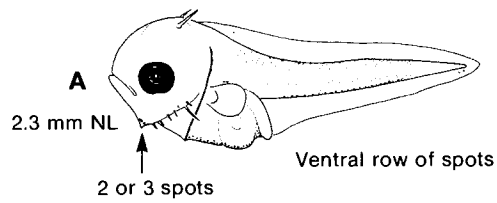
Dorsal rays	3 mm SL	10–13 mm SL
Pelvic rays	~4 (buds)	7
Caudal rays	5	6–7
Anal rays	5	10–13
Vertebrae	?	6

— Anterior 5–8 dorsal rays elongate (form about 3 mm); no elongate pelvic rays, but left fin longer than right until transformation.

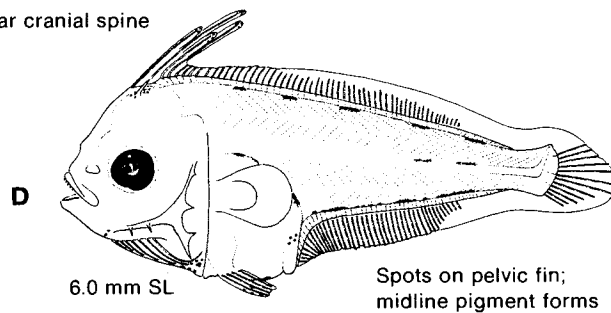
— Pelvic fins: left base longer than right; right origin anterior to left; left base on midline and right base above midline.

— Pigmentation: note spots on distal 1/3 of pelvic fin (see illustrations opposite).

**Fig.** — A–D, Futch and Hoff 1971 (redrawn).**Ref.** — Evseenko 1979.

Syacium papillosum**BOTHIDAE**

Spots near cranial spine



BOTHIDAE *Cyclopsetta fimbriata* (Goode and Bean)**Spawning:** April–October (south of Cape Hatteras).**Eggs** — Undescribed.

Larvae — Head length 27–34% SL; preanus length 50–40% SL (decreases); body depth 30–42% SL (increases).
 — Flexion occurs at 5–8 mm SL, and transformation at 14–15 mm SL.

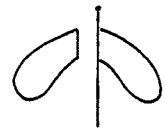
- Right eye moves under dorsal fin at transformation.
- Cranial spines (1 per side, small) until transformation.
- Preopercle spines 4–6 (smaller than in *Syacium*); angle spine develops a spur.
- Sizes at beginning of ossification and completion of fin rays:

Dorsal rays	2.1 mm SL	~8 mm SL
Pelvic rays	~3 (left)	~7
Caudal rays	~5	~8
Anal rays	~6	~8

Meristic features

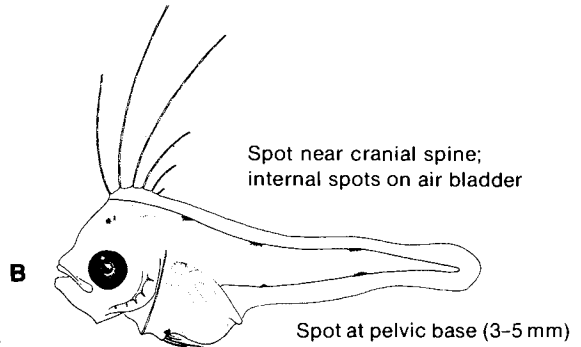
Myomeres: 36–37
 Vert : 10+26–27
 D : 78–87
 A : 59–67
 Piv : 6/6
 P : 11–12

- Anterior 3 dorsal rays elongate (from about 2.1 mm) and then 8–11 become elongate; 1–3 pelvic rays elongate on left side at about 3 mm and rays on right side form at 5.3 mm SL.
- Pelvic fins: left and right bases equal and origins even; left base on midline and right base above midline.
- Pigmentation: 3 dorsal and 2 ventral clusters at 3 mm; 1 dorsal and 1 ventral cluster added at about 5 mm; 1 dorsal cluster added at about 7 mm (see illustrations opposite for other pigment).

**Note:** See Evseenko (1979) for description of *C. chittendeni*.**Fig.** — A–D, Guthertz 1970 (A–C redrawn).**Ref.** — Evseenko 1979.

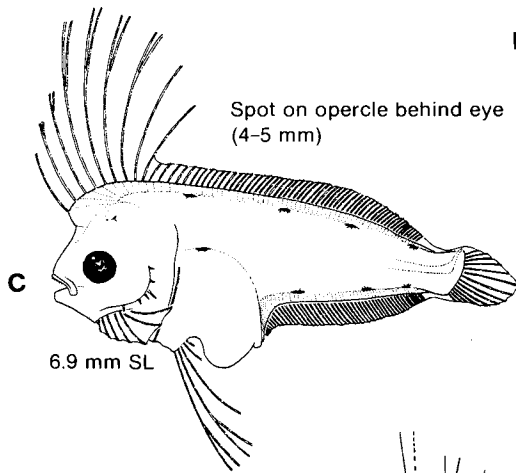
Cyclopsetta fimbriata**BOTHIDAE**

1.9 mm NL

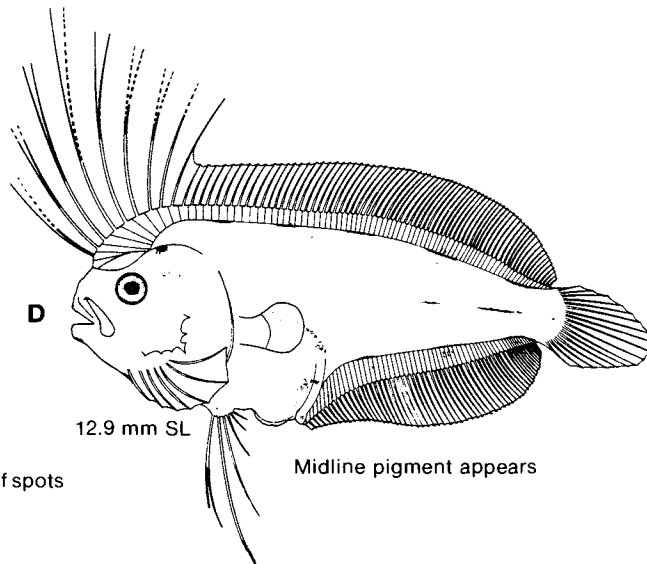


3.0 mm NL

Ventral row of small spots anterior to anus



6.9 mm SL

Dorsal and ventral groups of spots
added in later stages

BOTHIDAE***Bothus ocellatus* (Agassiz)****Spawning:** Year round, with possible peak in July.**Eggs** — Undescribed.

- Larvae** — Blunt profile, with well-developed jaws.
 — Flexion occurs at 6–7 mm, and transformation in most at 16–21 mm (extreme range 9–42 mm).
 — Right eye migrates through head under dorsal fin during transformation.
 — At 14 mm SL, head length = 25% SL, preanus length = 26% SL, and body depth = 59% SL.
 — First dorsal ray elongate at 3–13 mm.
 — Pelvic fins: left base much longer than right; left origin on urohyal, and right origin posterior to cleithral symphysis; left base on midline, and right base above midline.
 — Pigmentation: few spots on elongate dorsal ray, on caudal fin, and on posterior dorsal and anal finfolds in early larvae, but no pigment at sizes >10 mm.

Meristic features

Myomeres: 35–37
 Vert : 10+25–27
 D : 76–91
 A : 58–68
 Plv : 6/6
 P : 8–10

***Monolene sessilicauda* Goode (see Notes below)****Spawning:** Possibly in summer (larvae taken near edge of continental shelf).**Eggs** — Undescribed.

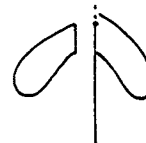
- Larvae** — Body very thin and transparent.
 — Head length 17–23% SL, preanus length 31–43% SL, and body depth 25–42% SL.
 — Flexion occurs at 8–12 mm SL, and transformation at >33 mm SL.
 — Right eye migrates through head under dorsal fin during transformation.
 — First dorsal fin ray elongate.
 — Sizes at beginning of ossification and completion of fin rays and vertebrae:

Meristic features

Myomeres: 45–46
 Vert : 10–11+35–38
 D : 92–109
 A : 76–89
 Plv : 6/6
 P : 11–14

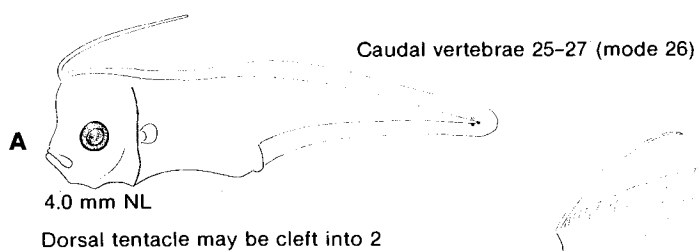
Dorsal and anal rays	~7.3 mm SL	~14 mm SL
Caudal rays	~7.9	14.3
Pelvic rays	11.6	14.3
Vertebrae	~7.3	14.3

- Pelvic fins: left base long, with origin anterior to cleithral symphysis; right base shorter with origin posterior to cleithral symphysis; left base on midline, and right base above midline.
 — Pigmentation: sparse and irregular; light spots on head and 1st dorsal ray sheath, and few internal gut spots.

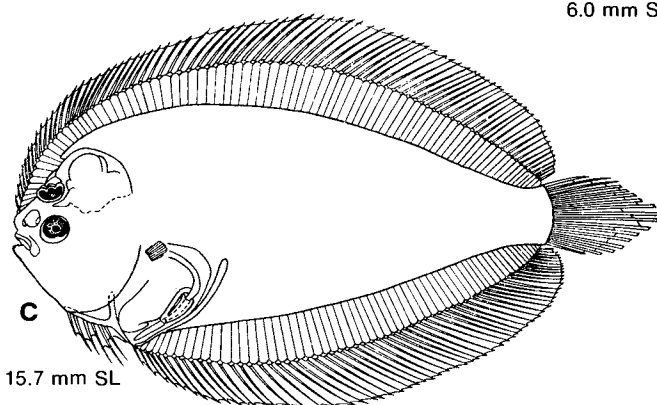


- Note:** (1) Description may include *M. antillarum* Norman, unless latter is synonymous (Evseenko, 1977a); larval evidence supports two species (D. F. Markle, 1982, pers. comm.; S. A. Evseenko, 1982, pers. comm.).
 (2) *Monolene* and *Bothus* larvae may drift north with Gulf Stream to the Scotian Shelf.

Fig. — A–B, Jutare MS 1962; C, Evseenko 1978; D–E, Futch 1971 (A, B, D, E redrawn).**Ref.** — Colton 1961; Evseenko 1977a.

Bothus ocellatus**BOTHIDAE**

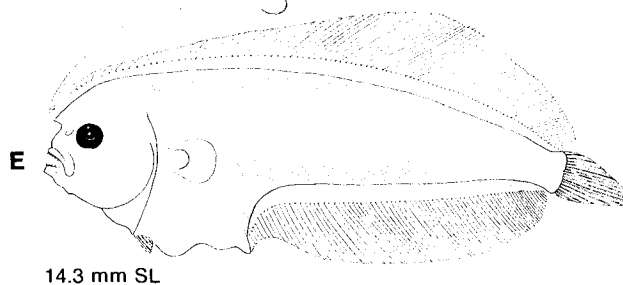
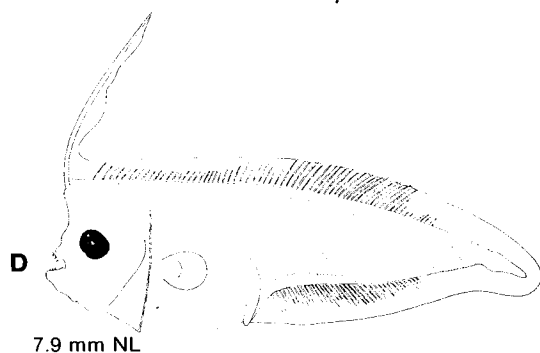
Body very thin and transparent



Note: For positive identification, meristics of 3 similar species must be counted.

	Vertebrae		Fin rays	
	Total	Caudal*	D	A
<i>B. ocellatus</i>	35-37	26	76-91	58-68
<i>B. robinsi</i>	36-38	27	78-90	59-68
<i>B. lunatus</i>	40	30	91-99	71-76

* Modal count

Monolene sessilicauda

BOTHIDAE***Engyophrys senta* Ginsburg****Spawning:** Gulf of Mexico (may drift north via Florida Current).**Meristic features****Eggs** — Undescribed.

Myomeres: 37-39

Larvae — Body deep and compressed; head profile concave.

Vert : 10+27-29

- Head length 33-22% SL (decreases); preanus length 51-22% SL (decreases); body depth 55-65-55% SL (increases then decreases).

D : 71-85

A : 60-69

Plv : 6/6

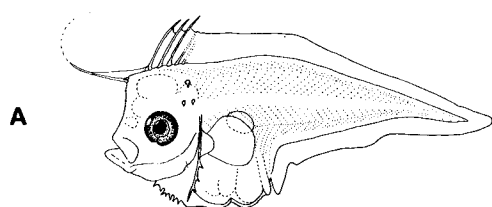
P : 8-10

- Flexion occurs at 4.5-6.5 mm SL, and transformation at 19-20 mm SL.
- Otic spines: increase from 3 in early larvae to 4 at >8 mm.
- Cleithral spines: increase from 3-4 in early larvae to 10-12.
- Urohyal spines: increase from 7-10 in early larvae to 20-27.
- Basipterygial spines: increase from 3-6 in early larvae to 14-18.
- All spines lost at transformation.
- Papillae develop over eyes at about 15 mm.
- Right eye migrates through body under anterior dorsal fin.
- Sizes at beginning of ossification and completion of fin rays:

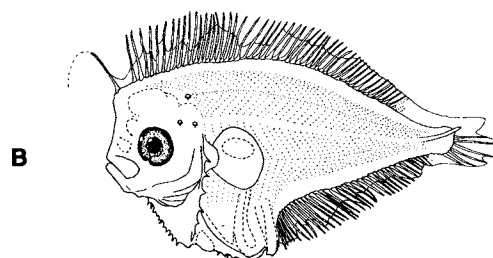
Dorsal rays	3.3 mm SL	~6.5 mm SL
Anal rays	4.0	~6.5
Caudal rays	4.5	~6.5
Pelvic rays	4.5 (buds)	~13.0

- Second dorsal ray elongate.
- Pelvic fins: left base slightly longer than right; left origin just anterior to cleithral symphysis; left base on midline, and right base above midline.
- Pigmentation: except for few tiny spots on lower head, near anus and cleithral symphysis in early larvae, no pigment until transformation.

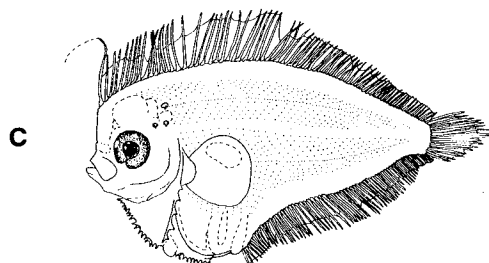
**Fig.** — A-E, Hensley 1977.**Ref.** — Evseenko 1977b; Futch 1977.

Engyophrys senta**BOTHIDAE**

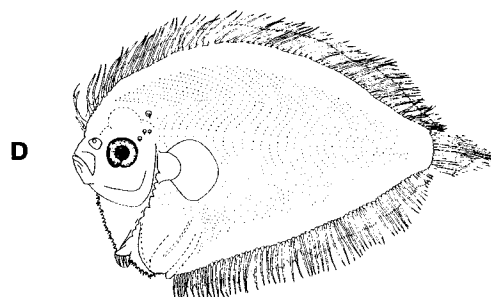
3.3 mm SL



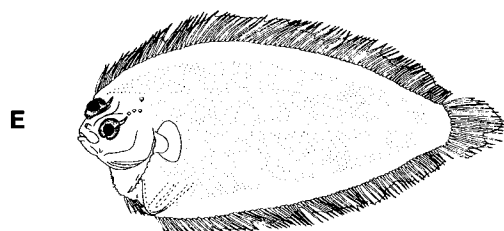
4.5 mm SL



6.5 mm SL



12.3 mm SL



19.6 mm SL

BOTHIDAE *Trichopsetta ventralis* (Goode and Bean)**Spawning:** Gulf of Mexico (may drift north via Florida Current).**Meristic features****Eggs** — Undescribed.

Myomeres: 40-41

Larvae — Body deep and compressed; head profile concave.

Vert : 10+30-31

— Head length 29-19% SL (decreases); preanus length 50-19% SL (decreases); body depth 39-61% SL (increases).

D : 89-95

A : 69-75

Plv : 6/6

P : 12-13

— Flexion occurs at 6-10 mm SL, and transformation at 28.5-35.7 mm SL.

— Otic spines: increase from 2 in early larvae to 3.

— Cleithral spines: increase from none in early larvae to 1 at 7-9 mm and then to 3-8.

— Urohyal spines: increase from 0-10 at 10-12 mm to 10-15.

— Basipterygial spines: increase from 2-5 at 13-20 mm to 5-15.

— All spines lost during transformation.

— Right eye migrates through body under anterior dorsal fin.

— Sizes at beginning of ossification and completion of fin rays and vertebrae:

Dorsal and anal rays	<6 mm SL	9-10 mm SL
Caudal	<6	~10
Pelvic rays	6 (buds)	~10
Vertebrae	?	~26

— Anterior few rays of dorsal fin become slightly elongate.

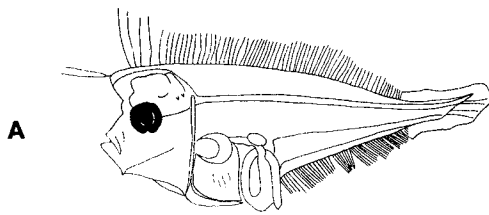
— Pelvic fins: same as in *Engyophrys senta* (p. 368).

— Pigmentation: in larvae >17 mm, series of spots on dorsal and ventral edges, and on midline of left side only, retained after transformation.

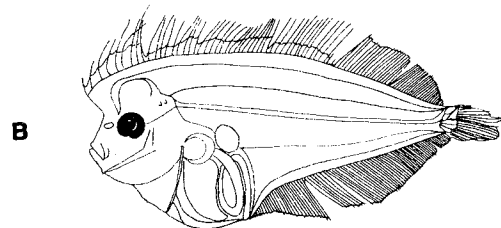


Note: *T. orbisculus* (larvae undescribed) shares vertebral and fin-ray counts with *T. ventralis* and is only distinguished by a lower limb gillraker count of 7-8 (9-11 in *T. ventralis*) (Anderson and Guthertz 1967); *T. orbisculus* range off Nicaragua and Venezuela but young stages taken on Scotian Shelf (D. F. Markle, 1982, pers. comm.).

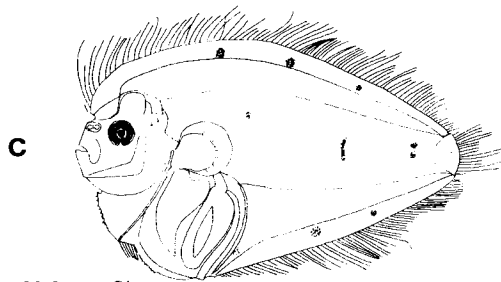
Fig. — Futch 1977.**Ref.** — Anderson and Guthertz 1967; Hensley 1977.

*Trichopsetta ventralis***BOTHIDAE**

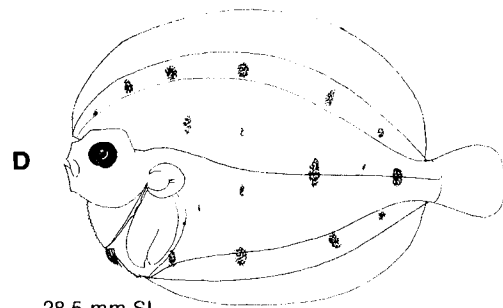
6.4 mm SL



9.0 mm SL



20.6 mm SL



28.5 mm SL

PLEURONECTIDAE***Glyptocephalus cynoglossus* (Linnaeus)**

Spawning: May–August on Georges Bank, March–April in northern areas on continental slope.

Meristic features

- Eggs**
- Pelagic, spherical.
 - Diameter: 1.25–1.35 mm.
 - Shell: smooth.
 - Yolk: homogeneous.
 - Oil globules: none.
 - Perivitelline space: narrow.

Myomeres: 58–60
 Vert: 11–12+45–47
 D: 97–117
 A: 86–102
 Plv: 6/6
 P: 9–13

- Larvae**
- Hatching occurs at 4–6 mm; eyes unpigmented.
 - Body long, thin and transparent; preanus length (<33% TL) shorter than in *Hippoglossoides* and *Hippoglossus*.
 - Body proportions inferred from figures (Ehrenbaum 1905):

mm SL	5.9	12.0	15.5	25.5	42.0
Head length (% SL)	~13	20	23	22	22
Preanus length (% SL)	30	30	32	31	29
Body depth (% SL)	9	12	20	27	30

- Flexion occurs at 14–20 mm, and transformation at 22–35 mm (sometimes delayed to larger sizes).
- Preopercle spines: 3–4 on posterior edge, and 5–6 on anterior parts at about 16 mm, increasing to 17–19 spines (not shown in figures).
- Sizes at beginning of ossification and completion of fin rays:

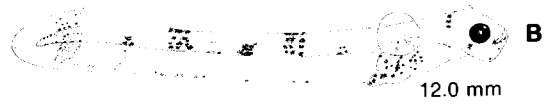
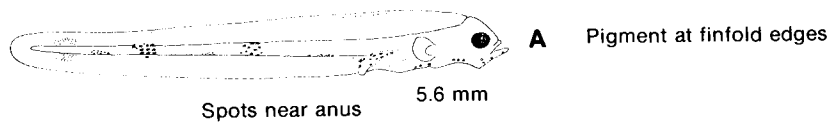
Dorsal and anal rays	~15 mm TL	>20 mm TL
Caudal rays	~15	<25
Pelvic rays	~22	

- Pigmentation: intensifies with development; 6 bands on body and fins, 3 prominent and 3 less so (3 bars do not extend onto finfold in *Hippoglossoides*).

Note: Early eggs are similar to *Gadus morhua* (p. 178) and *Melanogrammus aeglefinus* (p. 182).

Fig. — **A**, Holt 1895; **B**, Ehrenbaum 1905; **C**, **E**, Petersen 1904; **D**, Holt and Byrne 1903 (all redrawn).

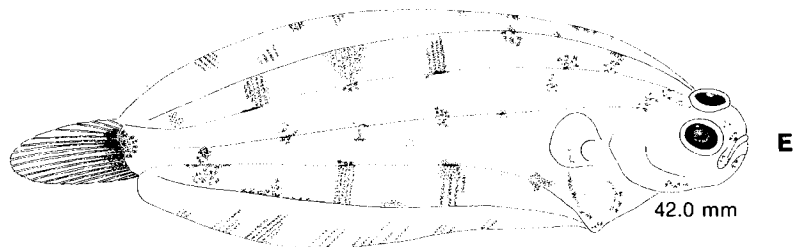
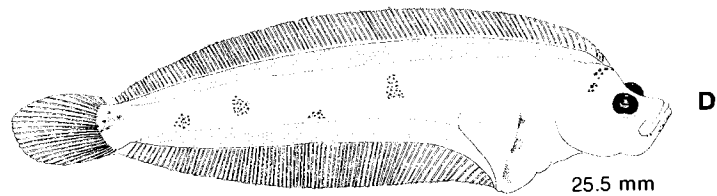
Ref. — Norman 1934; Nichols 1971; Evseenko and Nevinsky 1975.

***Glyptocephalus cynoglossus* PLEURONECTIDAE**

Prominent bars alternate with less prominent bars



Note concave outline anterior to anus



A-E (eastern Atlantic material)

PLEURONECTIDAE *Hippoglossoides platessoides* (Fabricius)

Spawning: March–May.

Meristic features

Eggs

- Spherical.
- Diameter: 1.5–2.8 mm (to 3.5 mm?).
- Shell: smooth.
- Yolk: homogeneous.
- Oil globules: none.
- Perivitelline space: wide (see note below).

Myomeres: 44–47
 Vert : 13–14+32–35
 D : 78–98
 A : 60–79
 Plv : 6/6
 P : 9–12

Larvae

- Hatching occurs at about 4–6 mm, light pigment scattered over body.
- Body not as elongate and preanus length (>33% TL) longer than in *Glyptocephalus* (p. 372).
- Body proportions (% SL) inferred from figures (Ehrenbaum 1905):

mm SL	7.2	9.0	11.3	19.0	31.5
Head length	<20	20	25	25	23
Preanus length	35	36	40	41	35
Body depth	12	18	19	25	42

- Flexion occurs at 9–19 mm, and transformation at 18–34 mm (usually >25 mm SL).
- Preanal finfold retained until about 10 mm.
- Sizes at beginning of ossification and completion of fin rays:

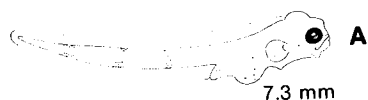
Caudal rays	12–13 mm TL	18 mm TL
Dorsal and anal rays	12–13	18
Pelvic rays	~24 (buds)	~30

- Pigmentation: early larvae develop 5 clusters which do not extend onto finfold (1 over gut, 1 at anus, and 3 postanal); scattered spots between clusters; at 12–13 mm, clusters split into dorsal and ventral pairs; spots appear on fins.

Note: This is the only pleuronectid genus known with a wide perivitelline space.

Fig. — A, Nichols 1971: B–D, Petersen 1904 (all redrawn).

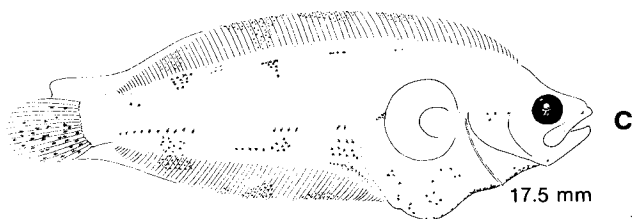
Ref. — Norman 1934; Colton and Marak MS 1969; Van Guelpen 1980.

***Hippoglossoides platessoides* PLEURONECTIDAE**

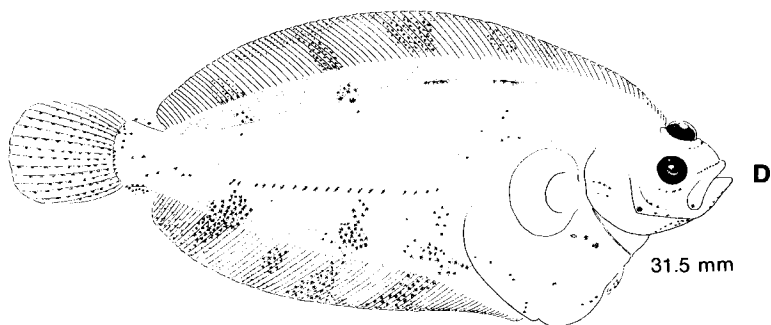
Preal anal finfold between anus and yolk mass (not in *Glyptocephalus*)



Often few spots between anus and first ventral cluster on tail



Line of spots similar to *Limanda* between midline and ventral edge



Scattered spots on caudal fin

PLEURONECTIDAE *Hippoglossus hippoglossus* (Linnaeus)**Spawning:** January–June (and into summer) on continental slope.**Meristic features**

- Eggs**
- Spherical and buoyant (but float at depths, ~90 m)
 - Diameter: 3.0–3.8 mm (to 4+ mm).
 - Shell: smooth and thick.
 - Yolk: homogeneous.
 - Oil globules: none.
 - Perivitelline space: narrow.

Myomeres: 50–51
 Vert : 16+34–35
 D : 98–106
 A : 69–84
 Plv : 6/6
 P : 15–17

- Larvae**
- Hatching occurs at 6–7 mm; eye unpigmented, no body pigment.
 - Large head with upturned snout, and long straight lower jaw.
 - Peduncle short (compare to other pleuronectids).
 - Body proportions (% SL) inferred from illustrations (Schmidt 1904):

mm SL	13.5	16.4	18.0	22.0	27.0	34.0
Head length	21	25	27	27	31	29
Preanus length	40	45	44	43	38	32
Body depth	20	27	30	36	44	38

- No spines on head or preopercle.
- Flexion occurs at 13–24 mm, and transformation at 20 to >34 mm.
- Sizes at beginning of ossification and completion of fin rays:

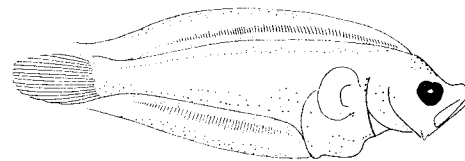
Caudal rays	~13 mm TL	~25 mm TL
Dorsal and anal rays	~18	20–22
Pelvic rays	~20 (buds)	~24

- Pigmentation: in 13 mm larvae, faint undulating rows of spots on body, none along midline, faint spots near dorsal and anal margins, row of fine spots along preanal ventral midline; in 20–22 mm larvae, 3 dorsal and 3 ventral clusters develop on body and spread onto fins, 2 undulating rows remain, double ventral rows anterior to anus, converge at isthmus; in 34 mm larvae, 2 clusters form on proximal part of caudal fin, 1 dorsal and 1 ventral to midline.

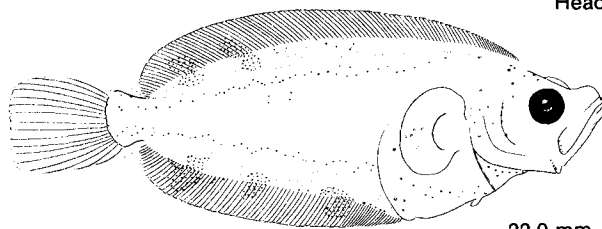
Fig. — A–D, Schmidt 1904 (redrawn).**Ref.** — Cox 1924; Bigelow and Schroeder 1953; Nichols 1971.

***Hippoglossus hippoglossus* PLEURONECTIDAE****A**

13.5 mm

**B**

18.0 mm

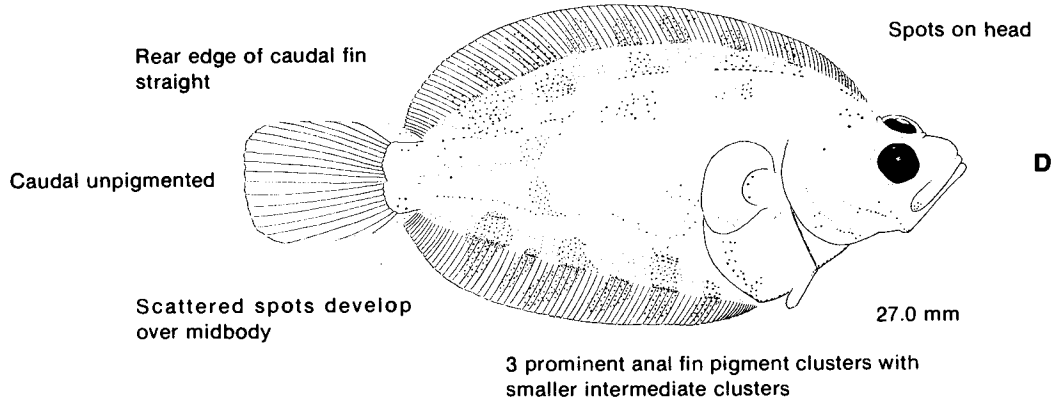


Head stout

C

22.0 mm

3 clusters along anal fin

5 prominent dorsal fin pigment clusters
with smaller intermediate clusters

Spots on head

D

27.0 mm

Rear edge of caudal fin
straight

Caudal unpigmented

Scattered spots develop
over midbody3 prominent anal fin pigment clusters with
smaller intermediate clusters**A-D** (eastern Atlantic material)

PLEURONECTIDAE *Reinhardtius hippoglossoides* (Walbaum)

Spawning: May–September in depths to 600 m (Greenland to Georges Bank).

Meristic features

- Eggs**
- Spherical, buoyant, but float at depths.
 - Diameter: 4.0–4.5 mm.
 - Shell: smooth.
 - Yolk: homogeneous.
 - Oil globules: none.
 - Perivitelline space: narrow.

Myomeres: 61–63
 Vert : 17–19+43–45
 D : 92–104
 A : 66–80
 Plv : 6/6
 P : 13–15

- Larvae**
- Hatching occurs at 7+ mm.
 - Body elongate; very long lower jaw; no spines on head or preopercle.
 - Peduncle much longer than wide (compare to other pleuronectids).
 - Body proportions (% SL) inferred from illustrations (Schmidt 1904; Nichols 1971):

mm SL	17	27	34	36.5	45	51	65
Head length	16	23	23	25	26	27	28
Preanus length	38	41	37	38	36	37	31
Body depth	12	16	13	19	26	22	32

- Flexion occurs at 17–36 mm, and transformation at 30+ mm; juveniles pelagic until about 70 mm.
- Sizes at beginning of ossification and completion of fin rays:

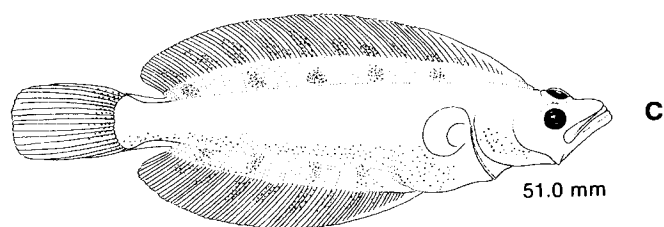
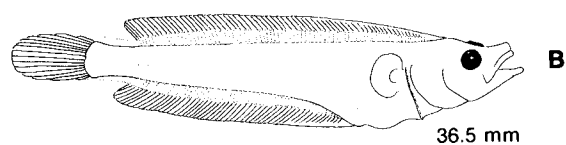
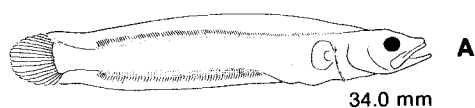
Caudal rays	~25 mm TL	36.5 mm TL
Dorsal and anal rays	~32	36.5

- Left eye completes migration to final position on mid-dorsal ridge at about 73 mm.
- Pigmentation; in early larvae, body and marginal fin pigment very light, no bands or patches on body and fins; in late stages, myosepta become pigmented and indistinct bands form on fins.

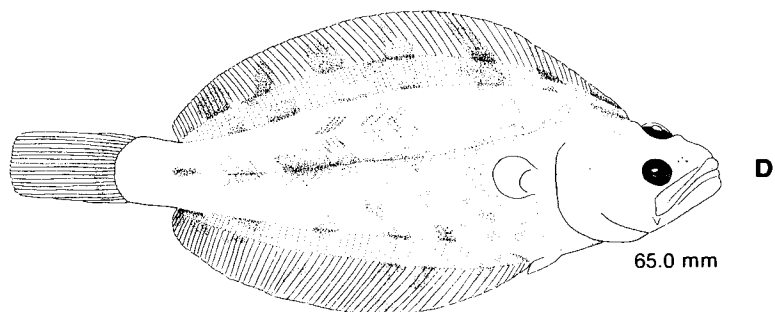
- Note:**
- (1) Number of vertebrae and body shape will separate this species and *Hippoglossus* (p. 376)
 - (2) Preanus length >33% SL (compare to *Glyptocephalus*, p. 372).

Fig. — A–C, Schmidt 1904; D, Jensen 1935 (all redrawn).

Ref. — Ehrenbaum 1905; Andriyashev 1954; Nichols 1971.

***Reinhardtius hippoglossoides* PLEURONECTIDAE**

Pigment band forms near caudal fin base



A-D (eastern Atlantic material)

PLEURONECTIDAE *Limanda ferruginea* (Storer)

Spawning: March–September, in western Gulf of Maine to southern New England.

Meristic features

- Eggs**
- Pelagic, spherical.
 - Diameter: 0.80–0.90 mm.
 - Shell: smooth.
 - Yolk: homogeneous.
 - Oil globules: none.
 - Perivitelline space: narrow.

Myomeres: 38–42
 Vert : 10–12+30–33
 D : 73–91
 A : 51–68
 Piv : 6/6
 P : 10

- Larvae**
- Hatching occurs at 2.0–3.5 mm; eyes unpigmented.
 - Body proportions (% NL or SL) inferred from illustrations (Miller MS 1958; Bigelow and Welsh 1925):

	5.9 mm NL	10.3 mm SL	14.0 mm SL
Head length	20	22	32
Preamble length	36	38	39
Body depth	20	22	40

- Flexion occurs from about 5 to 10+ mm NL, and transformation at 11.6–16.0 mm SL (most about 14 mm SL).
- Sizes at beginning of ossification and completion of fin rays:

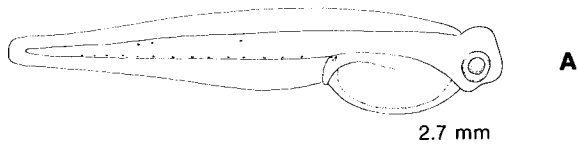
Caudal rays	~5 mm TL	~14 mm TL
Dorsal and anal rays	<10	~14

- Pigmentation: significant row of spots develops along body between midline and ventral edge (on myosepta).

Note: Early eggs similar to *Tautoglabrus adspersus* (p. 292).

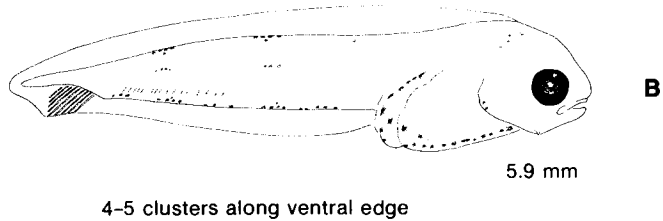
Fig. — **A–B**, Miller MS 1958; **C–D**, Bigelow and Welsh 1925 (all redrawn).

Ref. — Colton and Marak MS 1969; Van Guelpen 1980; Evseenko and Nevinsky 1981.

Limanda ferruginea**PLEURONECTIDAE**

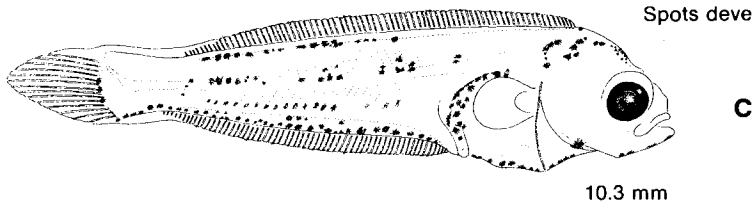
Row of spots along ventral edge, 2-3 spots
on dorsal edge, spots over anus

2 clusters along dorsal edge

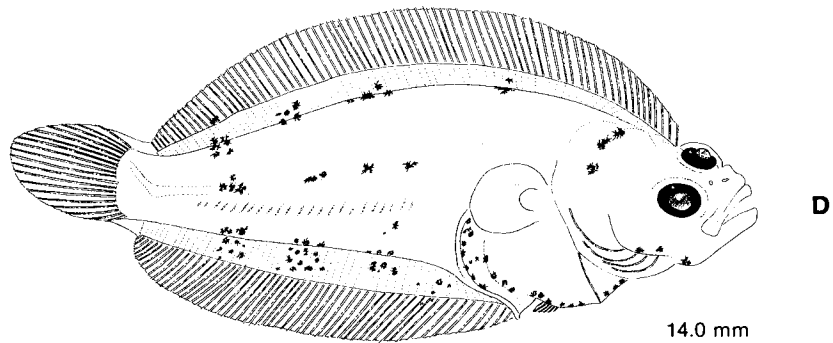


Dorsal gut pigment

Spots develop on head



Ventral row of preanal pigment



Row of spots forms between midline and ventral edge

PLEURONECTIDAE***Liopsetta putnami* (Gill)****Spawning:** Late winter to early spring in nearshore waters.**Meristic features**

- Eggs**
- Demersal, non-adhesive.
 - Diameter: 1.1–1.4 mm.
 - Oil globules: none.
 - Perivitelline space: narrow.

Myomeres: 34–38
 Vert : 34–38
 D : 48–59
 A : 35–41
 Plv : 6/6
 P : 10–11

- Larvae**
- Hatching occurs at 3.1–3.6 mm NL; eyes pigmented.
 - Relative body proportions:

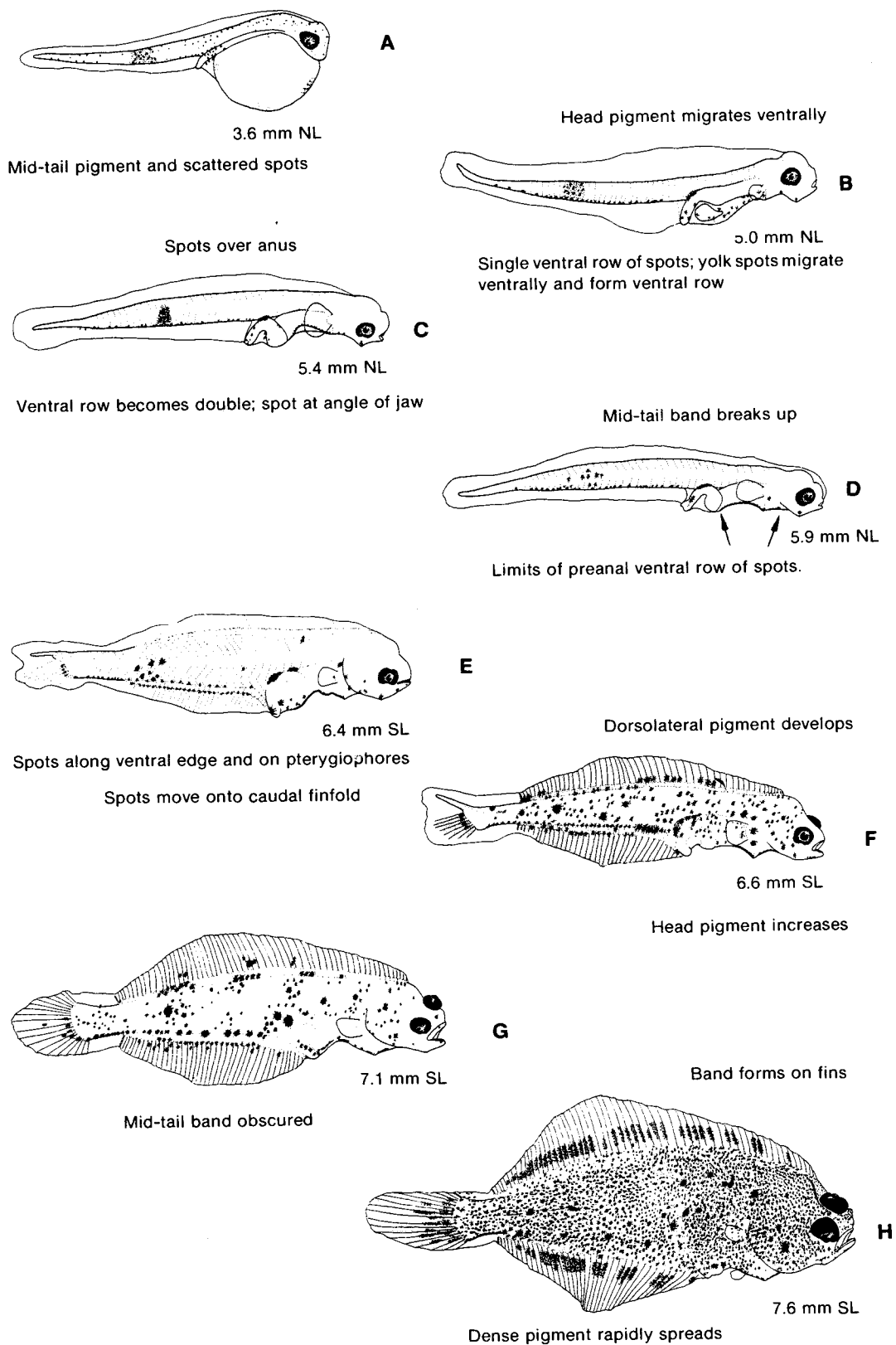
	Yolk-sac	Preflexion	Flexion	Postflexion
Head length	12–14% NL	14–19% NL	15–21% NL	21–28% SL
Preanus length	39–50	38–46	37–44	36–37
Body depth	5–12	6–15	11–17	21–32

- Flexion occurs at 5.9–7.1 mm NL, and transformation at 7–13 mm NL.
- Dorsal, anal and caudal fin rays begin to ossify at about 6.5 mm NL, and all are complete by 13 mm SL.
- Pigmentation: (see illustrations opposite).

Note: See table of comparative characteristics of *L. putnami* and *Pseudopleuronectes americanus* (p. 384).

Liopsetta putnami

PLEURONECTIDAE



PLEURONECTIDAE *Pseudopleuronectes americanus* (Walbaum)**Spawning:** Late winter to early spring in nearshore waters.**Meristic features**

- Eggs** — Spherical, demersal, adhesive.
 — Diameter: 0.71–0.96 mm.
 — Yolk: homogeneous.
 — Oil globules: none.
 — Perivitelline space: narrow.

Myomeres: 34–40
 Vert : 10+26
 D : 60–76
 A : 44–58
 Plv : 6/6
 P : 10–11

- Larvae** — Hatching occurs at about 2.4 mm SL; eyes unpigmented.
 — Relative body proportions:

	Yolk-sac	Preflexion	Flexion	Postflexion
Head length	12–16% NL	16–22% NL	18–25% NL	24–29% SL
Preanus length	30–38	34–41	32–41	31–40
Body length	4–6	5–14	11–23	23–34

- Flexion occurs at 5.0–7.6 mm, and transformation at 7.0–13.0 mm.
 — Fin rays begin to ossify at about 7 mm, and all are complete by 13 mm SL.
 — Pigmentation: (see illustrations opposite).

Note: Larvae strongly bottom-oriented from yolk-sac stage through transformation.

Comparison of Two Species

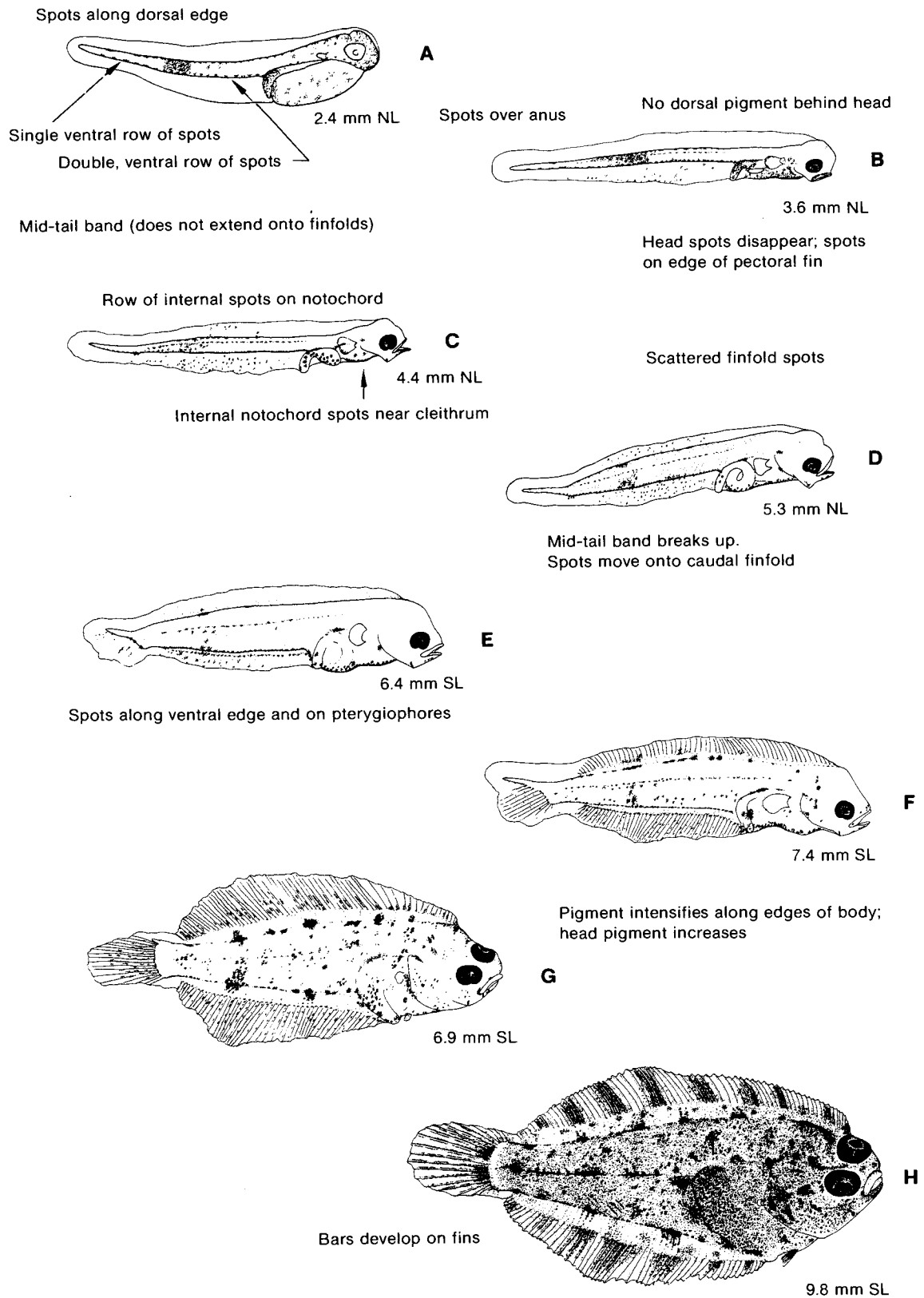
	<i>Liopsetta putnami</i>	<i>Pseudopleuronectes americanus</i>
Vertebrae/myomeres	34–38	34–40
Dorsal fin rays	48–59	60–76
Anal fin rays	35–41	44–58
Hatch length (mm NL)	3.1–3.6	~2.4
Eyes at hatch	Pigmented	Unpigmented
Yolk absorbed (mm NL)	5.2	3.7
Gut forms loop (mm NL)	~5.5	4.2–4.4
Flexion size (mm SL)	5.9–7.1	5.0–7.6
Transformation size (mm SL)	<7–13	7–13
Fins formed (mm SL)	8–13	7–13
Mean preanus length (yolk sac)	43.6% NL	33.3% NL
Mean preanus length (preflexion)	41.2% NL	37.6% NL
Pigment — Anal finfold	None until postflexion	Scattered at ~3.6 mm
— Internal notochord	Absent	Present
— Median fins (post-flexion)	Broken proximal band	Bars form

Fig. — A–H, Laroche 1981.

Ref. — Sullivan 1915; Pearcy 1962.

Pseudopleuronectes americanus

PLEURONECTIDAE



SOLEIDAE *Trinectes maculatus* (Bloch and Schneider)**Spawning:** May–September, in inshore waters and estuaries.**Meristic features**

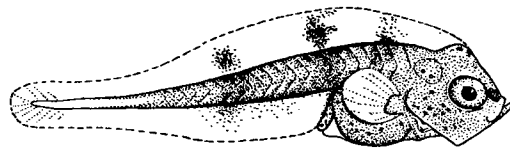
- Eggs**
- Spherical to slightly oval, buoyant in oceanic salinities but demersal in lower salinities.
 - Diameter: 0.67–1.22 mm (smaller in higher salinities).
 - Shell: smooth (greenish).
 - Oil globules: multiple.
 - O.G. diameter: <0.06 mm.
 - Perivitelline space: very narrow.
- Larvae**
- Hatching occurs at 1.7–1.9 mm; eyes unpigmented, prominent hump on head, and slender body.
 - Body becomes deep and laterally compressed at about 3.8 mm.
 - Mouth prominent, with projecting lower jaw.
 - Flexion occurs at about 3.8 mm, and transformation at <5.0 mm.
 - Left eye migrates through notch formed anterior to right eye at transformation.
 - Fin rays begin to form at about 3.8 mm and are complete by about 5 mm; no dorsal tentacle.
 - Pectoral fins lost at transformation.
 - Pelvic fins: right pelvic base longer than left, right origin anterior to left, right base on midline, left base above midline.
 - Pigmentation: in early larvae, scattered spots on head and body; in later larvae, bars form on body and fins.

Myomeres: 28–29
 Vert : 9+19–20
 D : 50–56
 A : 36–46
 Plv : 5/5
 P : None

**Fig.** — A–E, Hildebrand and Cable 1938 (Fig. A and C reversed).**Ref.** — Dovel *et al.* 1969.

Trinectes maculatus

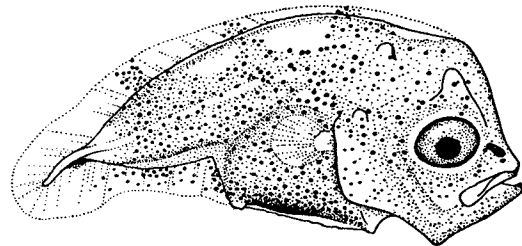
SOLEIDAE



A

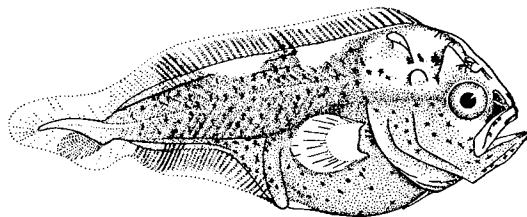
3.0 mm

Blotches in finfolds composed
of greenish pigment



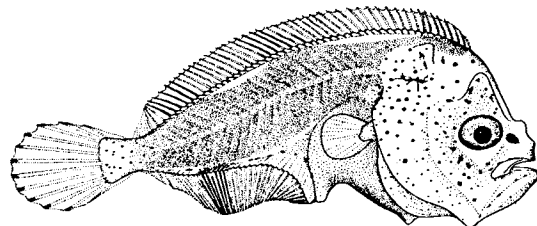
B

3.8 mm



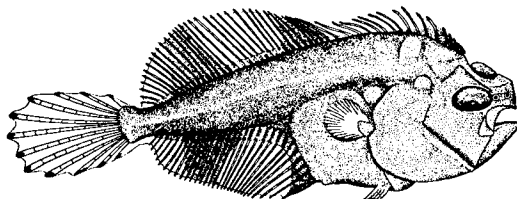
C

3.5 mm



D

3.0 mm



E

5.0 mm

Note: Sizes inferred from discussion (Hildebrand and Cable 1938)

SOLEIDAE***Achirus lineatus* (Linnaeus)****Spawning:** Florida and south.**Eggs**

- Pelagic, spherical.
- Diameter: 0.71–0.76 mm.
- Shell: smooth and thin.
- Yolk: homogeneous.
- Oil globules: multiple.
- O.G. diameter: 0.02–0.09 mm.
- Perivitelline space: moderate.

Larvae

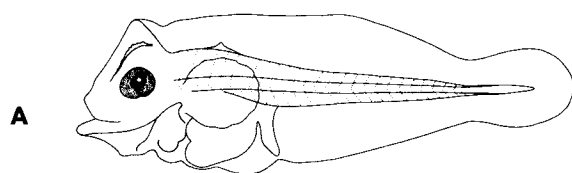
- Hatching occurs at <2 mm; eyes unpigmented; wide finfold.
- Body deep and laterally compressed; head with prominent hump and steep vertical forehead.
- Head length increases from about 20% to 40% SL; preanus length decreases from <60% to about 44% SL; body depth increases from 38–46% to about 50% SL (includes width of dorsal fin).
- Head has 3 spiny ridges, and body has 4 rows of spinous scales.
- Flexion occurs at <3 to 4 mm, and transformation at 3–5 mm.
- Left eye migrates across midline under hook formed by dorsal fin at transformation.
- Dorsal fin tentacle develops as fleshy appendage, and is later supported by a ray.
- Caudal, dorsal and anal rays begin to form at about 3 mm and are complete at 4–5 mm; pelvic fin buds form at 2.5 mm and are complete by 3.3 mm.
- Left pectoral fin disappears after transformation.
- Pelvic fins: right pelvic base longer than left, right origin anterior to left, right base on midline, left base above midline.
- Pigmentation: none at hatching (see illustrations opposite).

Meristic features

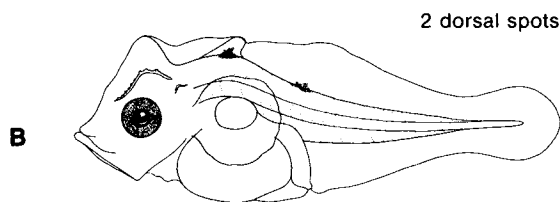
Myomeres: 25–27
 Vert : 25–27
 D : 47–58
 A : 35–44
 Plv : 5/5
 P : 4–6*

* Right fin only;
 left fin present
 until transformation.

**Fig.** — A–F, Houde *et al.* 1970.**Ref.** — Dovel *et al.* 1969.

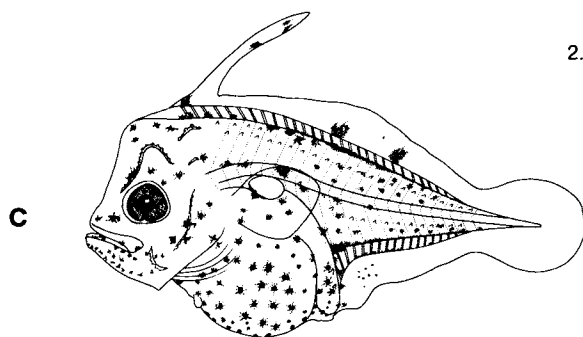
Achirus lineatus**SOLEIDAE**

2.0 mm SL



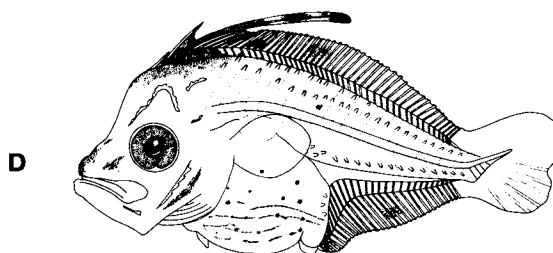
2 dorsal spots

2.3 mm SL

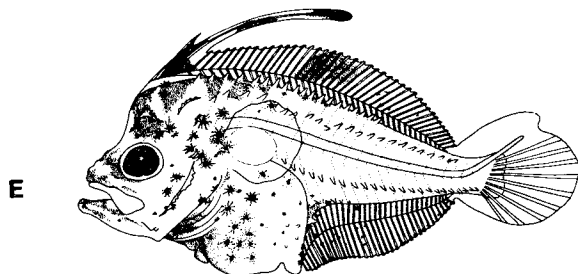


2.9 mm SL

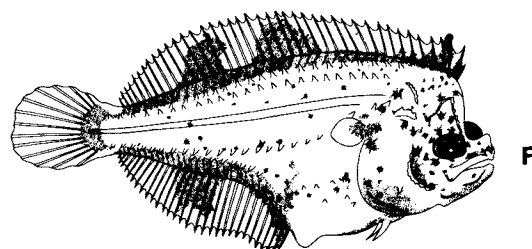
Dorsal tentacle pigmented

Pigment spreads over body
and onto fins

3.4 mm SL



3.6 mm SL



3.7 mm SL

CYNOGLOSSIDAE *Symphurus plagiusa* (Linnaeus)**Spawning:** Summer.**Eggs** — Undescribed.

- Larvae** — Hatching occurs at <1.3 mm NL.
 — Body tapered, gut protrudes, mouth large and oblique, eyes small in large larvae.
 — Hump on dorsal edge over cleithra in early larvae.
 — Head length 18–22% NL; preanus length <50–35% NL (decreases); body depth 15–27% NL (increases).
 — Flexion occurs at 6.2–8.5 mm SL, and transformation at about 10 mm.
 — Sizes at begining of ossification and completion of fin rays:

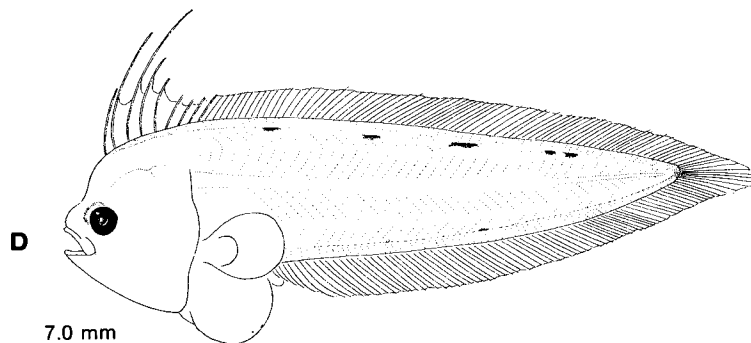
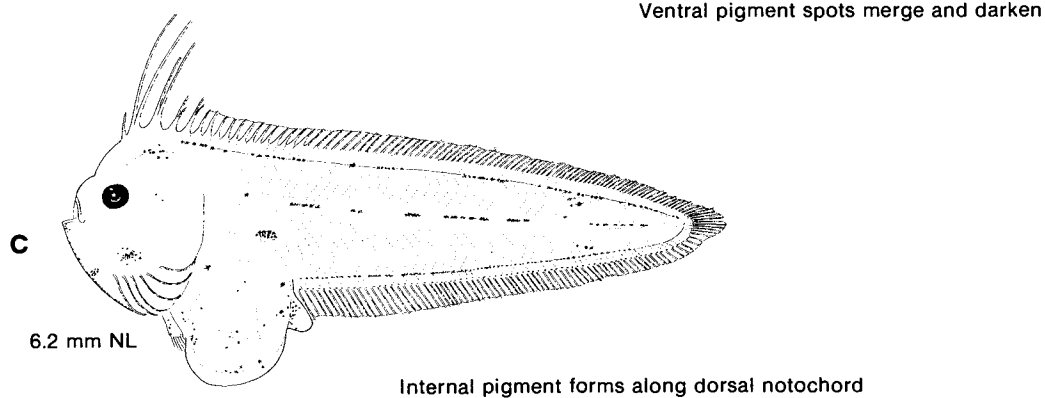
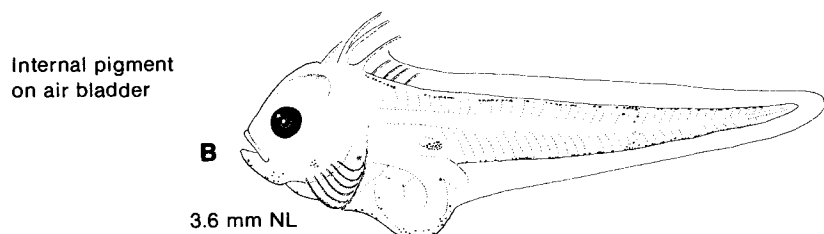
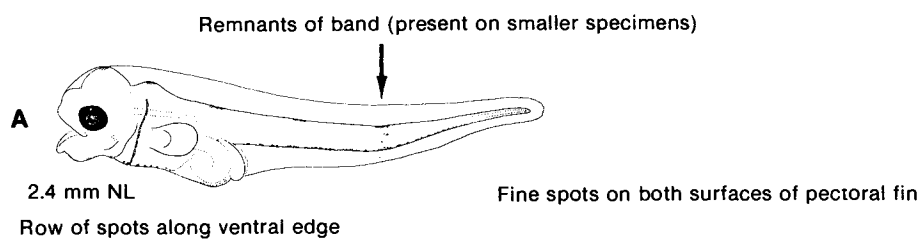
Dorsal rays	<3 mm NL	~6 mm NL
Anal rays	~4	~6
Caudal rays	~6	~8.5
Pelvic rays	~6	

Meristic features

Myomeres: 46–48
 Vert : 9+37–39
 D : 85–92
 A : 69–78
 Piv : 4/0
 P : None

- Pectoral fins and right pelvic fin lost at transformation; anterior few dorsal rays elongate.
 — Pigmentation: in early larvae, spots on brain and cleithral hump, 3 indistinct concentratons along dorsal edge, ventral row of spots from gut to isthmus and double row of ventral spots postanally; in late larvae, dorsal edge pigment increases, internal spots form along dorsal notochord, single spot appears at base of each anal ray.



Symphurus plaglusa**CYNOGLOSSIDAE**

BALISTIDAE***Monacanthus hispidus* (Linnaeus)**

Spawning: Prolonged, possibly year-round south of Cape Hatteras.

Eggs — Undescribed.

Larvae — Deep-bodied with narrow peduncle.
 — Mouth very small and terminal.
 — Adult body shape assumed at about 5 mm.
 — Pelvic and dorsal spines develop early, the latter with secondary barbs.
 — Fin rays well developed by about 8 mm.

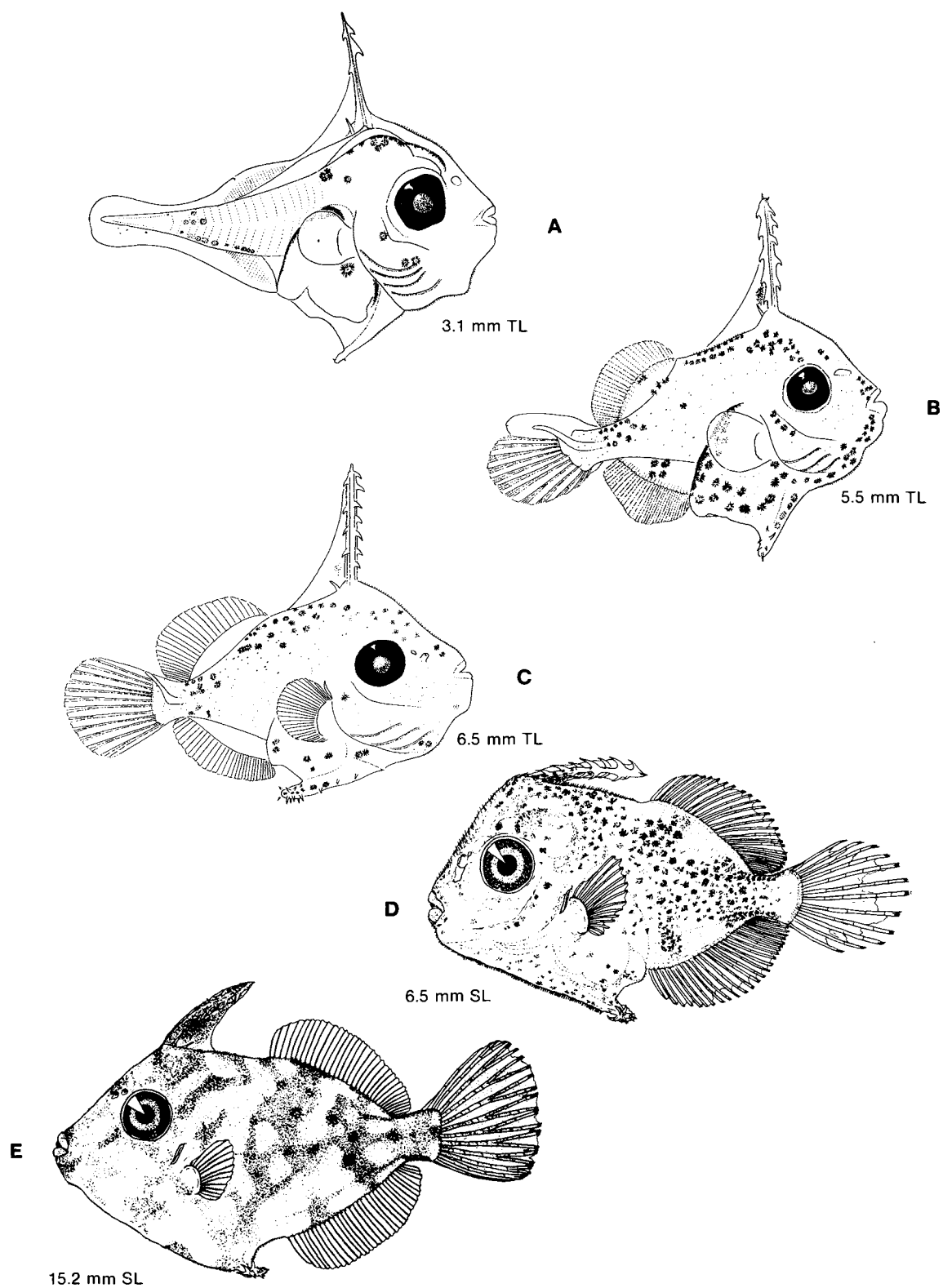
Meristic features

Myomeres : 19
 Vert : 7+12
 D : II, 29-35
 A : 28-35
 Piv : I
 P : 12-15
 C : 0+6+6+0

Note: Filefishes have 1 large dorsal spine and many dorsal and anal rays; triggerfishes have 3 dorsal spines (1 large) and fewer dorsal and anal rays.

**Dorsal and Anal Fin-ray Counts for Western
North Atlantic Filefishes**

Species	Dorsal	Anal
<i>Monacanthus hispidus</i> (Linnaeus)	29-35	28-35
<i>Monacanthus setifer</i> Bennett	27-30	26-30
<i>Monacanthus ciliatus</i> (Mitchill)	29-37	28-36
<i>Monacanthus tuckeri</i> Bean	32-37	31-36
<i>Cantherhines pullus</i> (Ranzani)	33-37	29-32
<i>Aluterus schoepfi</i> (Walbaum)	32-39	35-41
<i>Aluterus heudeloti</i> Hollard	36-41	39-44
<i>Aluterus scriptus</i> (Osbeck)	43-49	46-52
<i>Aluterus monoceros</i> (Linnaeus)	46-50	47-52

Monacanthus hispidus**BALISTIDAE****A-C (eastern Atlantic material)**

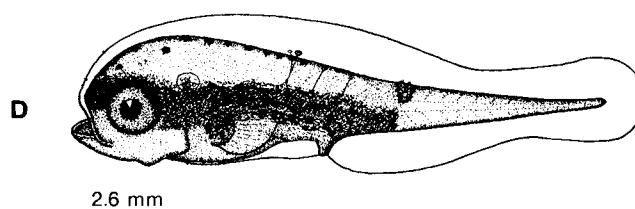
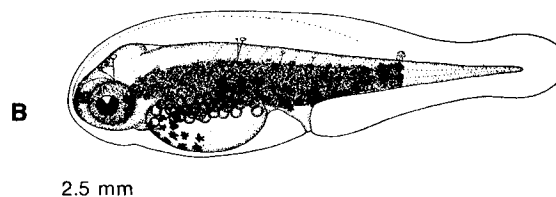
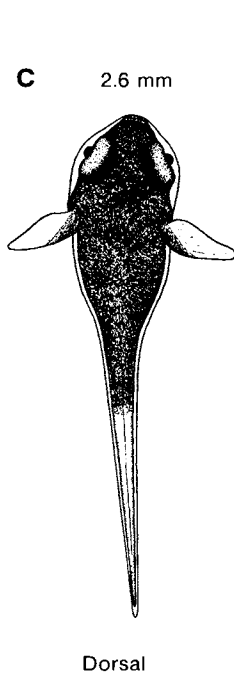
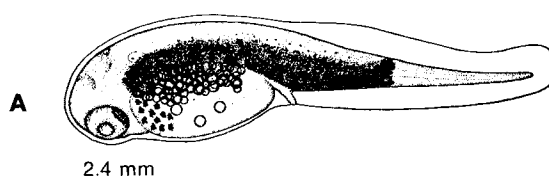
TETRAODONTIDAE *Sphoeroides maculatus* (Bloch and Schneider)**Spawning:** Spring-summer.

- Eggs** — Spherical, demersal, adhesive.
 — Diameter: 0.85-0.91 mm.
 — Shell: reticulated.
 — Oil globules: many.

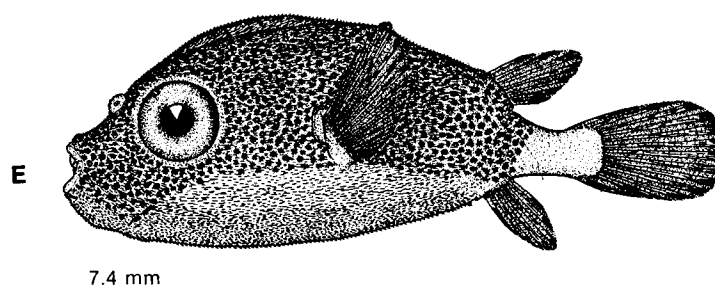
- Larvae** — Hatching occurs at about 2.4 mm, eyes unpigmented.
 — Chunky body, with low number of myomeres.
 — Small tubercles present over body.
 — Fin rays complete at 7.4 mm.
 — Caudal fin-ray count unique; rays last to form (unusual in teleost larvae).
 — No pelvic fin.
 — Heavily pigmented except last one-third of body.

Meristic features

Myomeres: 19
Vert : 8+11
D : 8
A : 7
Plv : None
P : 15-16
C : 0+5+6+0

***Sphoeroides maculatus* TETRAODONTIDAE**

Small opercle spine present

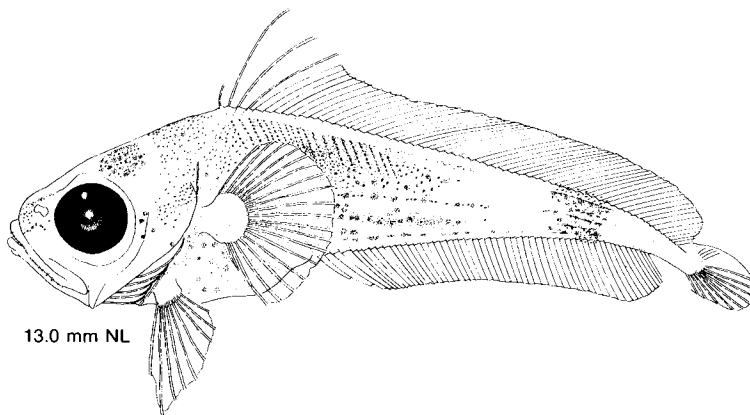


MISCELLANEOUS**Other Larvae**

The larvae in this section are distinctive and most are well-known, but they are either inadequately described, described from areas other than the western North Atlantic, or rarely caught in the geographic area encompassed by this guide.

Moridae (see table on p. 169)

- Found on continental slope and deeper.
- Two dorsal fins (anterior part of fin elevated in larvae, divides later).
- One anal fin (may be divided by low midsection).
- Pelvic fin develops early, moderately elongate; 6–9 rays (number increases with development, then may decrease at transformation).
- Body tapers to narrow caudal peduncle; caudal fin very small.
- Barbel forms on lower jaw in some species.

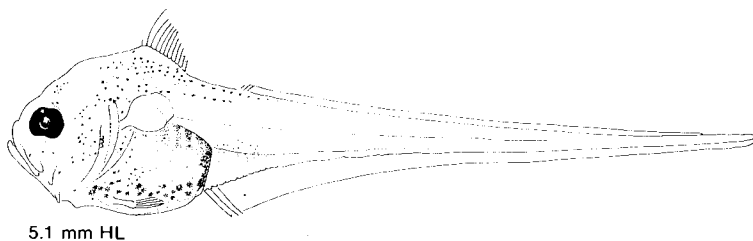


Species unidentified
M. P. Fahay (see p. 11)

Ref. — deGaetani 1928; d'Ancona 1933; Leim and Scott 1966; Cohen 1978.

Macrouridae (see table on p. 169)

- Found on continental slope and deeper.
- Two dorsal fins (first very short, second long with many rays).
- One long anal fin; no caudal fin.
- Pectoral and pelvic fins develop on stalks; 5–17 pelvic fin rays.
- Body long and tapered; 10–16 precaudal plus 70–100+ caudal vertebrae.
- Barbel forms on lower jaw in most genera.



Coryphaenoides rupestris Gunnerus
(Merrett 1978) (redrawn)

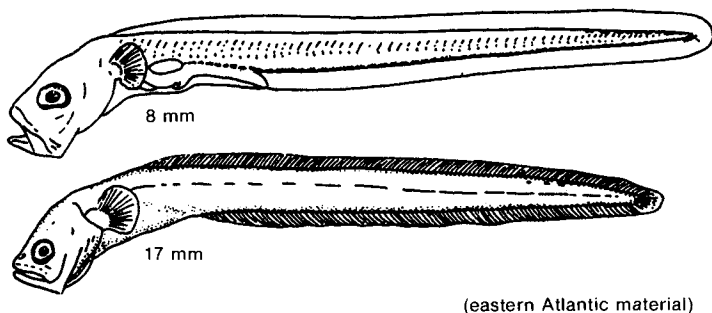
Ref. — Sanzo 1933a; Marshall 1965, 1973.

Other Larvae

MISCELLANEOUS

Ophidiidae

- Body elongate, preanus length <50% SL.
- Range in myomere counts ~50–80 in western North Atlantic.
- Long dorsal and anal fins with high numbers of rays; confluent with caudal fin.
- Elongate pelvic rays positioned on chin.
- Angle of jaw typically protrudes ventrally in larvae.
- Air bladder conspicuous in larvae.
- Pigment light and scattered in most species.
- Adult taxonomy not resolved in western North Atlantic.
- Superficially-similar Zoarcidae are oviparous (European species are viviparous), the larvae hatching at 30+ mm; vertebral numbers are high (i.e. 131–144).



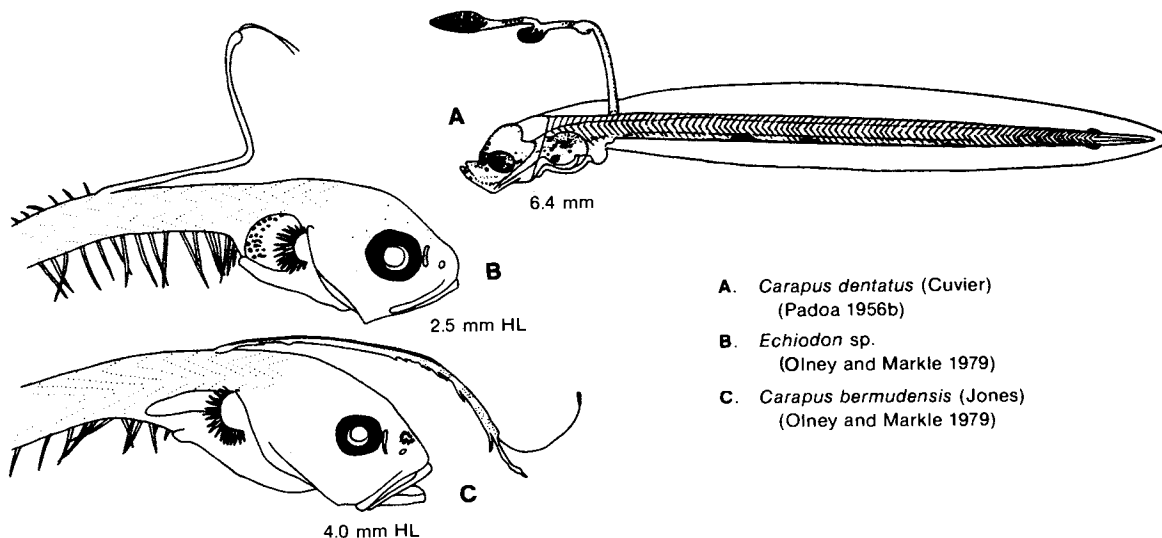
Ophidion vassali (Risso)
(Padoa 1956c)

(eastern Atlantic material)

Ref. — Cohen and Nielsen 1978.

Carapidae

- Body elongate and tapered, with very short preanus length; 100+ myomeres.
- Long filamentous structure anterior to dorsal fin; location of attachment varies among species.
- Long dorsal and anal fins with high numbers of rays; anal rays longer than dorsal rays; no pelvic fins.
- Air bladder conspicuous in larvae; pigment sparse.



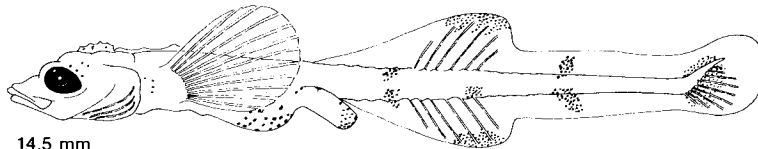
- A. *Carapus dentatus* (Cuvier)
(Padoa 1956b)
- B. *Echiodon* sp.
(Olney and Markle 1979)
- C. *Carapus bermudensis* (Jones)
(Olney and Markle 1979)

A (eastern Atlantic specimen)

Ref. — Sparta 1926; Arnold 1956; Strasburg 1961, 1965; Robertson 1975; Cohen and Nielsen 1978.

MISCELLANEOUS**Other Larvae****Agonidae**

- *Aspidophoroides monopterygius* (Bloch) ranges south of Scotian Shelf.
- Body elongate and shallow; preanus length <50% SL; anus moves anteriorly with development.
- Characteristic constriction in gut.
- One or 2 dorsal fins with few rays (2 fins in *Agonus*, 1 in *Aspidophoroides*).
- Dorsal and anal fins directly opposite each other (or dorsal slightly posterior to anal in some species).
- Large fan-shaped pectoral fin.
- Spinous scales develop on body and spiny crest on head.
- Bands of pigment cross body and enter onto fins.



14.5 mm

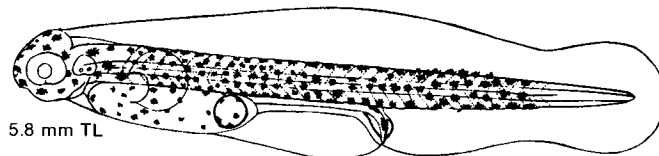
Aspidophoroides olriki Lütken
(Rass 1949) (redrawn)

(Barents Sea specimen)

Ref. — Steenstrup and Lütken 1862; Ehrenbaum 1905; Schmidt 1908; Jensen 1942; Dunbar 1947; Leim and Scott 1966; Russell 1976.

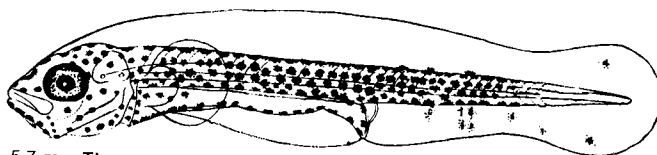
Coryphaenidae

- Most collections from the Gulf Stream.
- Eye large, forehead blunt, preanus length >50% TL.
- Head spines develop after 10 mm SL; sphenotic, supratemporal, preopercle (in 2 groups), supraorbital and at angle of lower jaw.
- Scattered dark pigment spots cover entire head and body (except peduncle area) in early larvae.
- Pigment pattern differs between 2 species in later larvae:
 - *C. hippurus*: alternating light and dark bands cross body and fins, pelvic fin darkly pigmented, caudal fin dark except for white tips of lobes.
 - *C. equiselis*: body uniformly dark, pelvic fin unpigmented, entire posterior margin of caudal fin white. (Some specimens barred on body, especially over anal fin.)
- Vertebral counts differ in the 2 species.
 - *C. hippurus*: 13-14+17-18 = 30-31
 - *C. equiselis*: 13-14+19-21 = 33-34



5.8 mm TL

Coryphaena hippurus Linnaeus
(Mito 1960)



5.7 mm TL

(Pacific material)

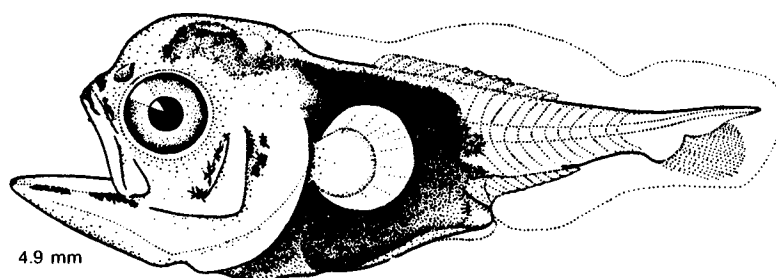
Ref. — Gibbs and Collette 1959; Collette *et al.* 1969; Potthoff 1971, 1980.

Other Larvae

MISCELLANEOUS

Uranoscopidae

- Body deep anterior to anus; mouth large.
- Dense pigment between head and anus.
- Eyes migrate dorsally at 20+ mm, mouth becomes more vertical.
- Rounded protuberances project from temporal regions of head.
- Myomeres: 25.

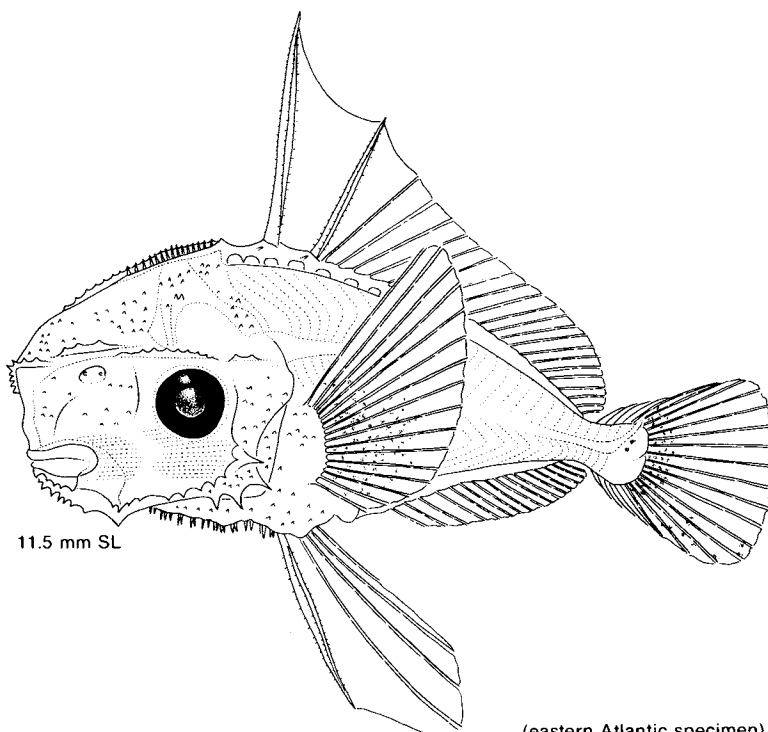


Astroscopus guttatus Abbott
(Pearson 1941)

Ref. — Berry and Anderson 1961.

Luvaridae

- Rare oceanic scombroid (?); ordinal position in doubt.
- Head large with flat area between eye and small terminal mouth.
- Spines and ridges on head and preopercle.
- Serrated dorsal and pelvic spines.
- Myomeres: 22.



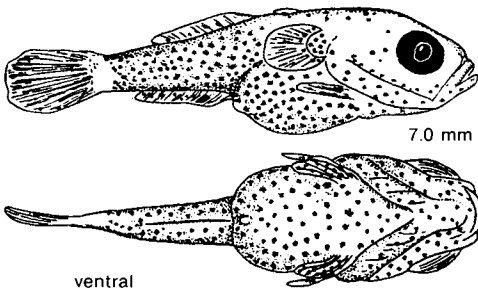
Luvarus imperialis Ratinesque
(Blache 1964) (redrawn)

(eastern Atlantic specimen)

Ref. — Roule 1924; deGaetani 1930.

MISCELLANEOUS**Other Larvae****Callionymidae**

- Body tadpole-shaped, with small terminal mouth.
- Well-developed, branched preopercle spines.
- Short-based second dorsal and anal fins opposite each other; few rays.
- Notochord tip remains in caudal finfold after flexion.
- Postanal pigment usually heavy.
- Early larvae may resemble *Menticirrhus* sp. (Sciaenidae) larvae, but mouth larger in sciaenids and early callionymids very small (~1 mm) in total length.
- *Callionymus bairdi* and *C. pauciradiatus* may occur near Cape Hatteras or Scotian Shelf.



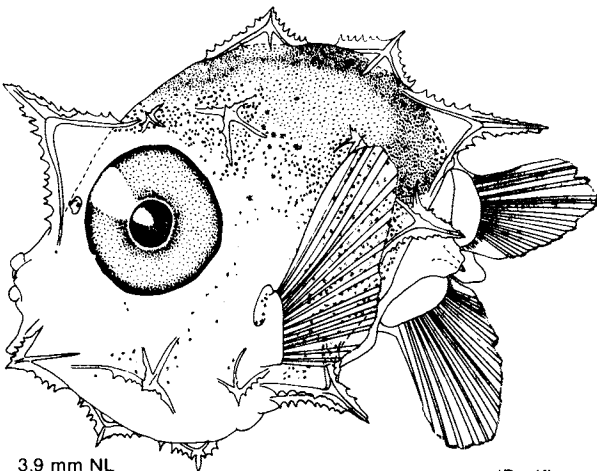
Callionymus maculatus Rafinesque-Schmaltz
(Fage 1918)

(eastern Atlantic material)

Ref. — Ehrenbaum 1905; Padoa 1956a; Davis 1966; Demir 1976; Markle *et al.* 1980; J. E. Olney and G. R. Sedberry (pers. comm., 1982); E. D. Houde (pers. comm., 1982).

Molidae

- Body inflated, with depth subequal to length in early stages.
- Series of spines form early over head and body (spines decrease in size after formation of dorsal and anal fin rays).
- Pectoral fin rays first to form; caudal fin rays last to form.
- Unique caudal fin structure, the "clavus".
- Low myomere number (8+11 = 19 in *Ranzania laevis*)



Ranzania laevis (Pennant)
(Leis 1977)

(Pacific specimen)

Note: See Leis (1978) for description of larval *Diodon holocanthus*, in which the body is covered with small spines, not arranged in serrated ridges as in molids.

Ref. — Schmidt 1921a, 1921b; Tortonese 1956.

Selected Meristic Characters

Taxa described in this guide are ordered in the following table by the lower limit of the range of myomeres or vertebrae. Counts in parentheses are rare extremes. Spines are indicated by Roman numerals and rays by arabic numerals. Finlets follow a plus (+) sign. Fin formulae for anguilliform families are not included. The column "adipose fin" indicates the presence, when applicable, of a dorsal adipose fin posterior to the dorsal fin.

Taxon	Myomeres or Vertebrae(v)	Dorsal fin(s)	Anal fin(s)	Adipose fin
<i>Histrio histrio</i>	18-19	3,11-13	7-8	
Ceratioidei	18-22	(2)3-29	(2)3-19	
<i>Monacanthus hispidus</i>	19	II,29-35	28-35	
<i>Sphoeroides maculatus</i>	19	8	7	
<i>Ranzania laevis</i>	19	18-19	18-19	
Callionymidae	21-23	III-IV,6-15	4-13	
<i>Luvarus imperialis</i>	22	O-II,13-22	14-18	
<i>Leiostomus xanthurus</i>	23-25	IX-XI,1,29-35	II,12-13	
<i>Micropogonias undulatus</i>	23-26	X,I,27-30	II,8-9	
<i>Scopeloberyx</i> sp.	23-27	II-III,10-13	I,7-9	
<i>Scopelogadus</i> sp.	23-27	I-II,10-12	I,7-9	
Sciaenidae	23-27	IX-XII,1,19-35	I-II,5-13	
Serraninae	24(v)	X,11-15	III,6-8	
Epinephelinae	24(v)	IX-XI,13-20	III,7-12	
<i>Centropristis striata</i>	24	X,11	III,7	
<i>Lopholatilus chamaeleonticeps</i>	24	VII,15	I,13-14	
<i>Stenotomus chrysops</i>	24	XII,12	III,11-12	
<i>Lagodon rhomboides</i>	24	XII,11	III,11	
<i>Archosargus probatocephalus</i>	24	XII,10-12	III,9-10	
<i>Pogonias cromis</i>	24	X,I,19-23	II,5-7	
<i>Chaetodipterus faber</i>	24	IX,21-23	III,17-20	
<i>Mugil cephalus</i>	24	IV,I,7-8	III,8	
<i>Mugil curema</i>	24	IV,I,8	II,10	
<i>Sphyræna borealis</i>	24	V-VI,I,8-9	I-II,8-9	
<i>Sphyræna barracuda</i>	24	V,I,9	II,8	
<i>Istiophorus americanus</i>	24	37-49+6-8	8-16+6-8	
<i>Gonioplectrus hispanus</i>	24(v)	VIII,13	III,7	
<i>Caranx bartholomaei</i>	24	VIII,I,25-28	II,I,21-24	
<i>Caranx hippos-latus</i>	24	VIII,I,19-22	II,I,16-18	
<i>Elagatis bipinnulatus</i>	24	V-VI,I,25-30	II,18-22	
<i>Selene vomer</i>	24	VII-VIII,I,21-23	II,I,18-20	
<i>Seriola zonata</i>	24	VII-VIII,I,33-40	II,I,19-21	
<i>Trachinotus carolinus</i>	24	V-VI,I,22-27	II,I,20-23	
<i>Trachinotus falcatus</i>	24	VI,I,17-21	II,I,16-19	
<i>Trachinotus goodei</i>	24	VI,I,19-20	II,I,16-18	
<i>Cynoscion regalis</i>	24-25	X,I,24-29	II,10-13	
Grammistinae	24-25(v)	II-VIII,12-26	O-III,7-17	
<i>Helicolenus dactylopterus</i>	24-25	XII,11-13	III,5	
Carangidae	24-26	III-VIII,I,17-40	O-II,I,15-31	
Uranoscopidae	25	O-V,13-15	O,12-17	
<i>Bairdiella chrysoura</i>	25	X-XI,I,19-23	II,8-10	
<i>Cynoscion nebulosus</i>	25(v)	IX-X,25-28	II,10-12	
<i>Larimus fasciatus</i>	25	X,I,24-27	II,6-8	
<i>Menticirrhus</i> sp.	25	X,I,19-27	I,6-9	
<i>Sciaenops ocellatus</i>	25	X,I,23-25	II,7-9	
<i>Stellifer lanceolatus</i>	25	XI-XII,I,20-24	II,7-9	

Selected Meristic Characters (cont'd)

Taxon	Myomeres or Vertebrae(v)	Dorsal fin(s)	Anal fin(s)	Adipose fin
<i>Caranx crysos</i>	25	VIII,I,22-25	II,I,19-21	
<i>Decapterus punctatus</i>	25	VIII,I,27-34	II,I,24-30	
<i>Naucrates ductor</i>	25	III-IV,I-II,26-28	II,II,15-16	
<i>Centrolophus niger</i>	25	37-41	III,20-23	
<i>Achirus lineatus</i>	25-27	47-58	35-44	
<i>Poromitra</i> sp.	25-29	II-III,10-14	I,8-11	
<i>Melamphaes</i> sp.	25-31	III,13-18	I,7-9	
<i>Oligoplites saurus</i>	26	V-VI,I,19-21	II,I,18-21	
<i>Anthiinae</i>	26(v)	X,13-20	III,7-8	
<i>Pomatomus saltatrix</i>	26	VII-IX,23-28	II-III,24-29	
<i>Orthopristis chrysoptera</i>	26	XII-XIII,15-17	III,12-13	
<i>Gobionellus boleosoma</i>	26	VI,11	11-13	
<i>Xiphias gladius</i>	26	38-49+4-5	12-18+3-4	
<i>Gobiosoma bosci</i>	27	VI-VIII,12-14	10-12	
<i>Trinectes maculatus</i>	28-29	50-56	36-46	
<i>Notolychnus valdiviae</i>	28-30(v)	10-12	12-14	yes
<i>Lophius americanus</i>	28-30	6,11-12	9-10	
<i>Gonostomatidae</i>	28-42(~85)	7-20	11-34(68)	yes/no
<i>Sebastes fasciatus</i>	29(x̄)	XIV-XVI,12-15	III,6-8	
<i>Sebastes viviparus</i>	29-31	XIV-XVI,12-15	III,7-9	
<i>Peprilus alepidotus</i>	29-31	II-IV,38-47	II-III,35-45	
<i>Scopelogadus tristicus</i>	29-32	11-13	12-14	yes
<i>Cyclothone braueri</i>	29-33	12-15	16-21	
<i>Sebastes mentella</i>	30(x̄)	XIV-XVI,14-15	III,8-9	
<i>Coryphaena hippurus</i>	30-31	58-60	27-28	
<i>Sebastes marinus</i>	30-32	XIV-XVI,12-15	III,7-9	
<i>Ariomma</i> sp.	30-32	XI-XII,14-18	III,13-16	
<i>Peprilus triacanthus</i>	30-33	II-IV,40-48	II-III,37-44	
<i>Myoxocephalus aeneus</i>	30-35	VIII-XI,12-17	8-14	
<i>Scomber japonicus</i>	31	X-XI,12+4-5	II,11+5	
<i>Scomber scombrus</i>	31	XII-XVII,11+5	II,11+5	
<i>Cubiceps pauciradiatus</i>	31	X-XII,I,15-17	II,14-16	
<i>Psenes cyanophrys</i>	31	IX-X,I,23-28	III,23-28	
<i>Etropus microstomus</i>	31-33	67-84	50-63	
<i>Scombridae</i>	31-66	X-XXVII,9-19+4-11	11-21+4-10	
<i>Electrona risso</i>	32-34(v)	13-14	18-19	yes
<i>Lampanyctus pusillus</i>	32-34(v)	12-13	14-16	yes
<i>Diaphus holti</i>	32-34(v)	13-14	12-14	yes
<i>Valencienellus tripunctulatus</i>	32-35	7-8	23-25	yes
<i>Diogenichthys atlanticus</i>	32-35(v)	11-12	15-16	yes
<i>Blenniidae</i>	32-35	XII,13-15	II,16-17	
<i>Myoxocephalus scorpius</i>	32-41	VII-XII,12-20	9-16	
<i>Coryphaena equiselis</i>	33-34	51-54	24-27	
<i>Diaphus rafinesquii</i>	33-34(v)	13-14	13-15	yes
<i>Maurollicus muelleri</i>	33-35	10-11	19-22	yes
<i>Lobianchia dofleini</i>	33-35(v)	15-17	13-15	yes
<i>Syacium papillosum</i>	33-36	79-94	62-75	
<i>Margrethia obtusirostra</i>	~34	15-16	21-26	yes
<i>Benthoosema suborbitale</i>	34(v)	11-14	16-17	yes
<i>Tautoga onitis</i>	34-35	XVI-XVII,10-11	III,7-8	
<i>Citharichthys arctifrons</i>	34-35	75-87	58-71	
<i>Benthoosema glaciale</i>	34-36(v)	12-14	17-19	yes
<i>Taaningichthys bathyphilus</i>	34-36(v)	11-14	12-14	yes

Selected Meristic Characters (cont'd)

Taxon	Myomeres or Vertebrae(v)	Dorsal fin(s)	Anal fin(s)	Adipose fin
<i>Scopthalmus aquosus</i>	34-36	63-73	46-56	
<i>Liopsetta putnami</i>	34-38	48-59	35-41	
<i>Pseudopleuronectes americanus</i> ..	34-40	60-76	44-58	
<i>Myoxocephalus octodecemspinosus</i>	34-44	VII-X,15-17	12-15	
<i>Psenes maculatus</i>	35(v)	X-XI,1,22-24	III,21-23	
<i>Hygophum benoiti</i>	35-36(v)	12-14	19-21	yes
<i>Taaningichthys paurolychnus</i>	35-36(v)	11-13	11-14	yes
<i>Bothus ocellatus</i>	35-37	76-91	58-68	
<i>Myctophum asperum</i>	35-38(v)	12-14	17-18	yes
<i>Ceratoscopelus maderensis</i>	35-38(v)	13-14	13-15	yes
<i>Lampadena anomela</i>	36(v)	14-16	13-14	yes
<i>Lobianchia gemellarii</i>	36(v)	17-18	13-15	yes
<i>Notoscopelus caudispinosus</i>	36(v)	25-27	20-21	yes
<i>Tautoglabrus adspersus</i>	36	XVIII,9-10	III,8-9	
<i>Nesiarchus nasutus</i>	36	XXII-XXIII,22-23+2	III,18-19+2	
<i>Hygophym hygomii</i>	36-37(v)	13-15	20-22	yes
<i>Lampanyctus crocodilus</i>	36-37(v)	13-15	17-18	yes
<i>Lampadena luminosa</i>	36-37(v)	14-15	13-15	yes
<i>Notoscopelus resplendens</i>	36-37(v)	21-23	18-20	yes
<i>Cyclopsetta fimbriata</i>	36-37	78-87	59-67	
<i>Lampadena urophaos</i>	36-38(v)	15-16	14	yes
<i>Brama caribbea</i>	36-38(v)	32-35	27-30	
<i>Protomyctophum</i> sp.	36-41(v)	11-13	21-24	yes
<i>Bonapartia pedaliota</i>	~37	17-20	29-31	
<i>Paralichthys albigutta</i>	37	71-85	53-63	
<i>Argyroleucus hemigymnus</i>	37-38	8	6+5	
<i>Lampadena chavesi</i>	37-38(v)	13-15	12-14	yes
<i>Notoscopelus bolini</i>	37-38(v)	23-26	19-20	yes
<i>Myctophum nitidulum</i>	37-39(v)	13-14	19-20	yes
<i>Loweina rara</i>	37-39(v)	11-13	15-16	yes
<i>Paralichthys squamilentus</i>	37-39	76-85	59-65	
<i>Paralichthys lethostigma</i>	37-39	80-95	63-74	
<i>Engyophrys senta</i>	37-39	74-83	60-67	
<i>Gonostoma atlanticum</i>	~38	16-18	28-30	
<i>Parasudis truculentis</i>	38	10	8-9	yes
<i>Hygophum reinhardtii</i>	38-39(v)	13-14	22-24	yes
<i>Hemitripterus americanus</i>	38-39	XVI-XVII,1,12	13-14	
<i>Vinciguerria poweriae</i>	38-39(v)	13-15	12-14	yes
<i>Lampadena speculigera</i>	38-40(v)	13-15	14-15	yes
<i>Jenkinsia lamprotaenia</i>	38-42	10-13	13-15	
<i>Ichthyococcus ovatus</i>	38-42	11-12	15-17	yes
<i>Limanda ferruginea</i>	38-42	73-91	51-68	
<i>Anchoa mitchilli</i>	38-44	13-17	24-30	
<i>Bathophilus</i> sp.	38-45(v)	9-18	9-18	
<i>Auxis</i> sp.	39	X-XII,10-12+8-9	12-14+7-8	
<i>Euthynnus alletteratus</i>	39	XV-XVI,11-12+7	12+7	
<i>Thunnus albacares</i>	39	XIII-XIV,13-16+8-10	12-15+7-10	
<i>Thunnus thynnus</i>	39	XIII-XIV,13-15+8-10	13-16+7-9	
<i>Gonostoma elongatum</i>	39-40	12-14	29-32	yes
<i>Symbolophorus veranyi</i>	39-40(v)	12-14	21-23	yes
<i>Notoscopelus elongatus</i>	39-40(v)	21-22	18-20	yes
<i>Omosudis lowei</i>	39-41	9-11	13-14	yes

Selected Meristic Characters (cont'd)

Taxon	Myomeres or Vertebrae(v)	Dorsal fin(s)	Anal fin(s)	Adipose fin
<i>Harengula jaguana</i>	39-42	17-19	17-18	
Exocoetidae	39-50	9-15	7-14	
<i>Myctophum punctatum</i>	40(v)	13-14	20-22	yes
<i>Vinciguerria attenuata</i>	40-41(v)	13-15	14-16	yes
<i>Gonichthys cocco</i>	40-41(v)	11-12	20-23	yes
<i>Taaningichthys minimus</i>	40-41(v)	11-13	11-14	yes
<i>Trichopsetta ventralis</i>	40-41	89-95	69-75	
<i>Vinciguerria nimbaria</i>	40-42(v)	14-15	13-15	yes
<i>Psenes pellucidus</i>	40-42	IX-XII, I, 27-32	III, 26-31	
<i>Anchoa hepsetus</i>	40-44	13-17	18-23	
<i>Scopelarchus michaelisarsii</i>	40-44(v)	7-9	18-21	yes
<i>Scopelarchus</i> sp.	40-50	7-9	18-29	yes
<i>Katsuwonus pelamis</i>	41	XV-XVI, 12-16+7-8	14-18+6-8	
<i>Nomeus gronovii</i>	41	(IX)XI-XII, 24-28	II, 24-26(29)	
<i>Scomberomorus cavalla</i>	41-42	XV-XVI, 16-17+8-9	II, 14-17+8-10	
<i>Hippoglossina oblonga</i>	41-42	71-86	58-72	
<i>Paralichthys dentatus</i>	41-42	80-96	61-73	
<i>Exocoetus volitans</i>	42-45	13-15	13-14	
<i>Urophycis regia</i>	42-49	8-9, 43-51	41-50	
<i>Nansenia groenlandica</i>	43-44	10-11	9-11	
<i>Engraulis eurystole</i>	43-45	13-16	15-18	
<i>Triglops murrayi</i>	43-46	X-XII, 18-24	19-23	
<i>Bathylagus euryops</i>	44-46(v)	9-11	16-19	yes
<i>Synodus poeyi</i>	44-46	10-13	9-12	yes
<i>Hippoglossoides platessoides</i>	44-47	78-98	60-79	
<i>Scopelarchus analis</i>	44-49(v)	7-9	21-26	yes
<i>Microstoma microstoma</i>	45-46	11-12	8-9	
<i>Argyripnus atlanticus</i>	45-46	11-12	13-15+9	yes
<i>Cypselurus furcatus</i>	45-46	13-14	10	
<i>Monolene sessilicauda</i>	45-46	92-107	76-84	
<i>Brevoortia smithi</i>	45-47	19-20	21-24	
<i>Sardinella aurita</i>	45-48	15-20	14-19	
<i>Pollichthys maui</i>	45-48	10-12	25-26	yes
<i>Tetragonurus atlanticus</i>	45-48	XIV-XVII, 10-13	I, 9-12	
<i>Ophisthonema oglinum</i>	45-49	17-22	20-25	
<i>Ulvaria subbifurcata</i>	45-49	43-44	II, 30-31	
<i>Brevoortia tyrannus</i>	45-50	18-24	18-24	
<i>Urophycis chuss</i>	45-50	9-11, 53-64	45-56	
<i>Chlorophthalmus agassizi</i>	46-48	10-11	7-9	yes
<i>Symphurus plagiusa</i>	46-48	85-92	69-78	
<i>Saurida brasiliensis</i>	46-50	10-13	9-12	yes
<i>Scopelarchus guentheri</i>	46-50(v)	7-8	24-29	yes
<i>Synodus intermedius</i>	47-50	10-13	9-12	yes
<i>Ahliesaurus berryi</i>	47-50	(See Scopelosauridae)		
<i>Argentina striata</i>	47-51	10-12	11-13	yes
<i>Bregmaceros</i> sp.	47-59(v)	44-65	44-68	
Scopelosauridae	47-61	10-13	16-21	yes
<i>Bathylagus longirostris</i>	48(v)	11-12	19-21	yes
<i>Bathylagus bericoides</i>	48-49(v)	10-11	18-22	yes
<i>Etrumeus teres</i>	48-50	16-22	10-12	
<i>Pterycombus brama</i>	48-51(v)	48-53	38-43	
<i>Taractichthys longipinnis</i>	48-51(v)	33-38	27-30	

Selected Meristic Characters (cont'd)

Taxon	Myomeres or Vertebrae(v)	Dorsal fin(s)	Anal fin(s)	Adipose fin
<i>Oxyporhamphus micropterus</i>	49-51	13-15	13-16	
<i>Saurida normani</i>	49-52	10-13	9-12	yes
<i>Saurida suspicio</i>	49-52	10-13	9-12	yes
<i>Pteraclis carolinus</i>	49-52(v)	48-54	42-47	
<i>Gadus morhua</i>	49-53	13-16,16-25,18-21	20-24,17-22	
<i>Hyporhamphus unifasciatus</i>	49-53	12-16	14-18	
<i>Gempylus serpens</i>	49-53	XXX-XXXII,I-II, 10-12+5-7	II,I,9-13+5-7	
<i>Bathypterois</i> sp.	49-61	12-16	7-13	yes
<i>Photoneustes parvimanus</i>	49-64(v)	15-22	15-24	
<i>Alepisaurus</i> sp.	~50	36-48	13-18	yes
<i>Hippoglossus hippoglossus</i>	50-51	98-106	69-84	
<i>Scomberomorus maculatus</i>	50-53	XVI-XVIII,15-18+8-9	II,14-17+8-10	
<i>Sarda sarda</i>	50-55	XX-XXIII,13-18+6-9	14-17+6-8	
<i>Melanogrammus aeglefinus</i>	50-57	14-17,20-24,19-22	21-25,20-24	
<i>Bathylagus compsus</i>	51(v)	10-11	19-20	yes
<i>Enchelyopus cimbrius</i>	51-55	1,~50,45-55	39-49	
<i>Stichæus punctatus</i>	51-55	46-49	I-II,32-35	
<i>Chauliodus danae</i>	51-58	(5)-6	10-11(12)	yes
<i>Hemiramphus brasiliensis</i>	52-55	12-15	11-15	
<i>Saurida caribbea</i>	52-58	10-13	9-12	yes
<i>Clupea harengus</i>	52-62	16-22	15-21	
<i>Sudis atrox</i>	53-54	10-12	20-21	yes
<i>Merluccius albidus</i>	53-55	10-13,35-41	35-42	
<i>Scopelosaurus smithii</i>	53-56	(See Scopelosauridae)		
<i>Pollachius virens</i>	53-57	13-14,21-22,24-28	24-28,20-21	
<i>Merluccius bilinearis</i>	54-56	11-14,36-42	37-42	
<i>Hemiramphus balao</i>	54-56	13-14	11-13	
<i>Megalops atlanticus</i>	54-57	13-16	22-25	
<i>Synodus synodus</i>	54-57	10-13	8-9	yes
<i>Trachinocephalus myops</i>	54-57	10-13	14-15	yes
<i>Scopelosaurus argenteus</i>	54-57	(See Scopelosauridae)		
<i>Scopelosaurus mauli</i>	55-57	(See Scopelosauridae)		
<i>Synodus saurus</i>	55-58	10-13	9-12	yes
<i>Eustomias</i> sp.	55-78(v)	20-30	32-46	
Ophidiidae	~55-80	102-158	82-124	
<i>Synodus foetens</i>	56-61	10-13	9-12	yes
<i>Chauliodus sloani</i>	57-58	5-7	10-13	yes
<i>Glyptocephalus cynoglossus</i>	58-60	97-117	86-102	
<i>Scopelosaurus lepidus</i>	58-61	(See Scopelosauridae)		
<i>Diplospinus multistriatus</i>	58-61	XXX-XXXIV,36-42	II,29-32	
<i>Sudis hyalina</i>	59-60(v)	12-16	21-24	yes
<i>Ammodytes</i> sp.	59-78	51-67	23-35	
<i>Paralepis atlantica</i>	60-73(v)	9-11	20-26	yes
<i>Reinhardtius hippoglossoides</i>	61-63	92-104	66-80	
<i>Ammodytes americanus</i>	61-68(v)			
<i>Ammodytes hexapterus</i>	61-73(v)	51-62	23-33	
<i>Osmerus mordax</i>	62-64	10-11	15-17	yes
<i>Acanthocybium solanderi</i>	62-66	XXI-XXVII,12+9	12-13+9	
<i>Mallotus villosus</i>	62-73	12-14	17-22	yes
<i>Brosme brosme</i>	64-66	85-105	71-76	
<i>Argentina silus</i>	64-67	11-13	13-17	yes

Selected Meristic Characters (cont'd)

Taxon	Myomeres or Vertebrae(v)	Dorsal fin(s)	Anal fin(s)	Adipose fin
<i>Stomias brevibarbus</i>	64-68(v)	16-20	19-22	
<i>Scomberesox saurus</i>	64-68	9-12	12-13	
<i>Ammodytes dubius</i>	64-75(v)	55-67	26-35	
<i>Flagellostomias boureei</i>	~65(v)	14-17	21-26	
<i>Paralepis elongata</i>	65-67(v)	10-12	20-25	yes
<i>Albula vulpes</i>	65-72	17-19	8-10	
<i>Stomias affinis</i>	66-71(v)	17-20	18-23	
<i>Stomias colubrinus</i>	66-72(v)	17-22	21-25	
<i>Lumpenus maculatus</i>	66-72	57-64	1,34-40	
<i>Paralepis coregonoides</i>	68-74(v)	9-11	22-26	yes
<i>Strongylura marina</i>	69-77	14-17	16-20	
<i>Euleptorhamphus velox</i>	71-73	22	23	
<i>Elops saurus</i>	72-82	25-29	16-19	
<i>Stomias boa</i>	75-78(v)	?	18-21	
<i>Leptostomias gladiator</i>	75-83(v)	16-22	20-29	
<i>Lestidiops affinis</i>	75-85(v)	8-10	27-30	yes
<i>Lestidium atlanticum</i>	75-87(v)	9-11	26-32	yes
<i>Lestidiops jayakari</i>	76-85(v)	10	27-31	yes
<i>Idiacanthus fasciola</i>	~78	54-74	38-49	
Cyemidae	~80			
<i>Tylosurus crocodilus</i>	80-84	21-23	18-22	
<i>Notolepis rissoi</i>	80-85(v)	8-11	31-34	yes
<i>Lumpenus lumpretaeformis</i>	80-85	68-76	1,46-53	
Macrouridae	80-116+	8-13(15),many	many	
<i>Stomias ferox</i>	81-84	17-21	19-23	
<i>Macroparalepis breve</i>	81-86(v)	11-13	19-24	yes
<i>Diplophos taenia</i>	~85	10-11	68	
<i>Pholis gunnellus</i>	86-89	80-83	11,42-44	
<i>Tylosurus acus</i>	90-95	22-26	20-24	
<i>Lestrolepis intermedia</i>	91-98(v)	9	41-44	yes
<i>Ablennes hians</i>	93-97	23-26	24-28	
<i>Macroparalepis affine</i>	96-103(v)	10-14	25-28	yes
Moringuidae	96-102			
Xenocoelidae	98-141			
Ophichthidae	100+			
Carapidae	100+			
Congridae	100+-200+			
Saccopharyngoidei	100-250			
<i>Anguilla rostrata</i>	102-111			
Anguillidae	102-119			
Muraenidae	107-174			
Heterenchelyidae	~108-109			
<i>Anguilla anguilla</i>	111-119			
<i>Stemonosudis intermedia</i>	111-121(v)	9-10	41-47	yes
Synphobranchidae	119-204			
Derichthyidae	126-159			
<i>Ophichthus cruentifer</i>	142-162			
Serrivomeridae	150-170			
Nemichthyidae	170-300+			
Muraenesocidae	175-200+			
Nettastomatidae	190-250			

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