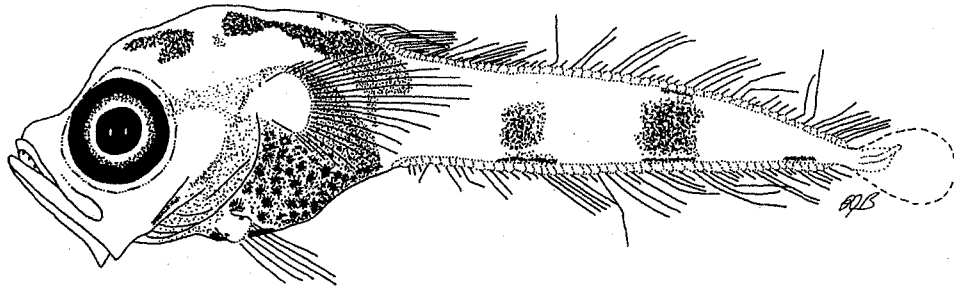




PRELIMINARY GUIDE TO THE IDENTIFICATION OF THE EARLY LIFE HISTORY STAGES OF THE
FISHES OF THE FAMILY MORIDAE OF THE WESTERN CENTRAL NORTH ATLANTIC

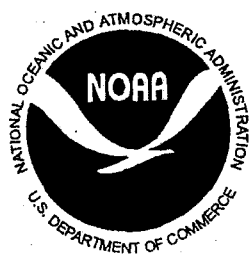
BY

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Moras are relatively small (<70 cm) benthopelagic or demersal fishes found worldwide on outer continental shelves to lower slopes. The family consists of about 100 species in approximately 18 genera (McEachran and Fechhelm, 1998). Morids are characterized by having a swim bladder-auditory capsule connection, a caudal skeleton with 4 or 5 hypurals and X-Y bones, and a fusion of the first neural spine to the skull (Cohen, 1984). In addition, the sagittal otoliths of morids are distinct in that the posterior portion of the sulcus is bifurcate and deeply channeled (Karrer, 1971; Paulin, 1989a). The body of adults is moderately fusiform and tapered posteriorly to a narrow caudal peduncle and a small caudal fin that frequently has more inferior than superior procurrent fin rays (Fahay and Markle, 1984). Pelvic fins are jugular, and in several species the number of pelvic fin rays are reduced during ontogeny. Both anal and dorsal fins are soft rayed and have a long base, and the dorsal fin is divided into a short-based anterior section and a long-based posterior section. The distinction between the first and second dorsal fins is not clear during the larval stage. Morids rarely possess three dorsal fins or two anal fins (Cohen et al. 1990). The mouth is terminal or subterminal, and a chin barbel is usually present although is lacking in *Gadella* (Paulin, 1989b).

Little is known about the early life history stages of morids. Fahay and Markle (1984) listed several studies that have described eggs and larvae of a few species within the genera *Laemonema*, *Mora*, *Physiculus* and *Salilota*. Kitagawa (1985) described eggs and yolk-sac larvae of *P. maximowiczi*, and Ambrose (1992) illustrated the larvae of *Microlepidium verecundum*, *P. nematopus* and *P. rastrelliger*. Larval morids are characterized by having a relatively large head, tapering body, and well developed pelvic fins. The posterior portion of the long-based dorsal and anal fins are often relatively voluminous (Fahay and Markle, 1984). Eggs of the few species described were spherical, possessed a smooth chorion, a homogenous yolk, a single oil globule, and ranged in diameter from 0.7-1.2 mm (De Gaetani, 1928; D=Ancona, 1933; Brownell, 1979; de Ciechowski and Booman, 1981; Kuroda et al., 1982; Kitagawa, 1985). Nine morid species in four genera (*Antimora*, *Gadella*,

Laemonema and *Physiculus*) occur in the western central Atlantic (Table Moridae 1). Larvae of these species are previously undescribed, and illustrations of small juveniles are limited to *L. barbatulum* (Fahay and Markle, 1984 as *Svetovidovia*; Meléndez and Markle, 1997), and *L. melanurum* (Fahay and Markle, 1984 as *Svetovidovia*; Meléndez and Markle, 1997).

Antimora and *Gadella* are each represented by a single species in the western central Atlantic. *Antimora rostrata* occurs worldwide except in semi-enclosed basins which include the Gulf of Mexico and Caribbean Sea, and in the North Pacific (north of 10°N) where it is replaced by *A. microlepis* (Small, 1981). Early stages of *Antimora* are unknown (Ambrose, 1992) but can be distinguished from other morid genera by having a high number of precaudal vertebrae (Paulin, 1989a). In addition, *A. rostrata* has fewer anal fin rays than other morid species found in the western central Atlantic. The ovary from a 512 mm SL female collected during January off the U. S. east coast mid-Atlantic states had eggs ranging in diameter from 0.22 to 0.33 mm. A female (606 mm SL) collected during July in the same area had noticeably swollen ovaries that contained eggs which ranged in diameter from 0.60 to 0.85 mm (Wenner and Musick, 1977).

Gadella and *Physiculus* are the only two morid genera found in the central western Atlantic that as larvae and young juveniles have a dark patch of ventral gut pigment located where the light organ will form. The single species of *Gadella* found in this region, *G. imberbis*, is distinguished from *Physiculus* by having 17 precaudal vertebrae (*Physiculus* 12-16). Larvae and young juveniles of *G. imberbis* and *P. fulvus* are described for the first time.

Table Moridae 1. Selected meristic characters for the morid species that occur in the western central Atlantic Ocean.

Species	Vertebrae			Fin rays					Gill Rakers
	PrCV	CV	Total	1D	2D	A	P ₁	P ₂	
<i>Antimora rostrata</i>	24-25	33-35	57-61	4-7	48-56	36-49	17-25	5-7	
<i>Gadella imberbis</i>	17	33-34	49-51	9-11	54-61	63-66	25-26	6-7	3-4+4-10
<i>Laemonema barbatulum</i>	13-15	37-42	50-56	6(7)	57-63	54-63	19-23	9-11 ^a	3-6+10-13
<i>L. goodebeanorum</i>	15-17	39-43	56-59	5-6	66-73	65-71	19-22		7-9+17-20
<i>L. melanurum</i>	15-16	38-42	53-57	7	53-61	52-59	25-27	7-10 ^a	4-6+12-15
<i>L. yarelli</i>	16-17 ^b	39 ^b	55-56 ^b	6	58-62	57-62	21-25		6-8+14-18
<i>Physiculus fulvus</i>	c		47-50	9-12	57-61	59-68	21-26		2-3+8-11
<i>P. karrerae</i>	c		56	7-8	68-76	73-78	26-27		1-2+7-9
<i>P. kaupi</i>	c		52-54	11-12	57-63	63-67	28-31		2-3+5-9

^a Number of pelvic fin rays found in juveniles. Adults of *Laemonema* have two visible large pelvic fin rays, and ontogenetic reduction of pelvic rays begins around 50-60 mm in *L. barbatulum* and *L. melanurum* (Meléndez and Markle, 1997).

^b Fewer vertebrae are reported from the eastern Atlantic (Meléndez and Markle, 1997); PrCV=15-16, CV=36-38, Total=52-54.

^c 12-16 precaudal vertebrae in genus *Physiculus* (Paulin, 1989a)

Meristics compiled from: Fahay and Markle, 1984; McEachran and Fechhelm, 1998; Meléndez and Markle, 1997; Paulin, 1989a; Paulin, 1989b.

MORIDAE

Gadella imberbis (Vaillant 1888)

MERISTICS

Vertebrae:	
Precaudal	17
Caudal	33-34
Total	49-51
Number of Fin Rays:	
First Dorsal Fin	9-11
Second Dorsal Fin	54-61
Anal Fin	63-66
Pectoral Fin	25-26
Pelvic Fin	
Gill Rakers	3-4+4-10

LIFEHISTORY

Range: Collected in the Gulf of Mexico, Caribbean Sea, the Cape Verde Islands in the central Atlantic, and off the coast of Brazil.

Habitat: Usually found between depths of 100-800m.

Size: Maximum known size is approximately 200mm SL.

ELH Pattern: Oviparous; planktonic larvae

Spawning: The few specimens observed in this study were collected in May and June.

LITERATURE

Goode and Bean 1896

Paulin 1989a,b

Boschung 1992 (as *Brosmiculus imberbis*)

McEachran and Fechhelm 1998

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown.

LARVAE:

Length at Flexion: Unknown, although 5.6 mm specimen showed no flexion, and flexion complete in 10.6 mm specimen.

Sequence of Fin Development: Pectoral and pelvic, dorsal and anal, caudal.

Pigmentation: Scattered pigment on dorsal and posterior regions of gut, and on dorsal surface of head. Dark patch of pigment on ventral surface of gut. Lateral swath of pigment midway between anus and tip of notochord.

Diagnostic Characters: Distinguished from *Antimora* and *Laemonema* by dark patch of pigment on ventral surface of gut. Distinguished from *Physiculus* by having 17 precaudal vertebrae. Usefulness of lateral swath of pigment for identification is not known because of undescribed larvae of other species.

EARLY JUVENILES:

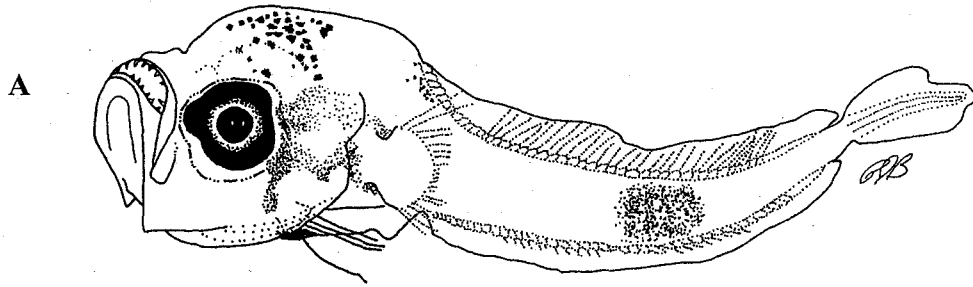
Pigmentation: Lateral swath of pigment midway between anus and posterior tip of body still noticeable in 11.8 mm specimen. Gut pigmented with lightest pigment on anterior lateral surface. Dark patch of pigment on ventral surface of gut. Pigment on dorsal surface of head and nape.

Diagnostic Characters: Distinguished from *Antimora* and *Laemonema* by dark patch of pigment on ventral surface of gut. *Gadella* is distinguished from *Physiculus* by having 17 precaudal vertebrae (*Physiculus* 12-16) and lacking a chin barbel. Size when barbel develops in *Physiculus* not described. The only species of *Gadella* recorded from the western Atlantic is *G. imberbis*.

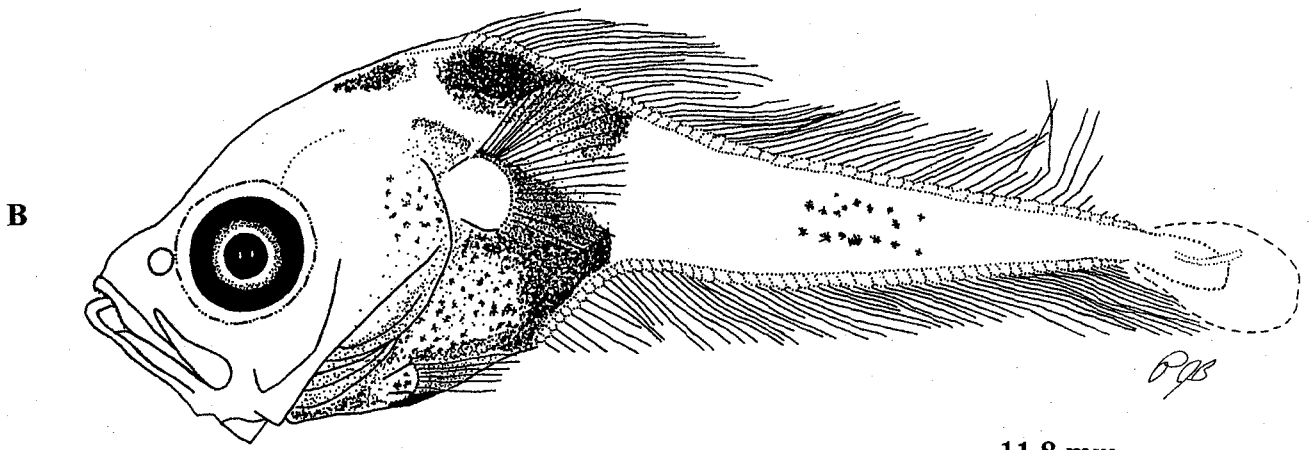
ILLUSTRATIONS

Original

A: 5.7 mm SML93334-000; B: 11.8 mm SML08558-000



5.7 mm



11.8 mm

MORIDAE

Laemonema barbatulum Goode and Bean 1883

MERISTICS

Vertebrae:	
Precaudal	13-15
Caudal	37-42
Total	50-56
Number of Fin Rays:	
First Dorsal Fin	6(7)
Second Dorsal Fin	57-63
Anal Fin	54-63
Pectoral Fin	19-23
Pelvic Fin	9-11(adults 2)
Gill Rakers:	3-6+10-13

LIFE HISTORY

Range: Temperate and tropical western North Atlantic from 40° 17' N to 2° 37' S, including the Gulf of Mexico.

Habitat: Generally continental slope, although have been collected between 50 and 1,620 m.

Size: Maximum known size is approximately 400 mm SL.

ELH Pattern: Oviparous; planktonic larvae

LITERATURE

Bullis and Thompson 1965
Fahay 1983
Fahay and Markle 1984
Goode and Bean 1896
Kuroda et al. 1982
Meléndez and Markle 1997
McEachran and Fechhelm 1998
Springer and Bullis 1956

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown. Eggs from another species within this genus (*L. longipes*) ranged in diameter from 1.00-1.16 mm and had a single oil globule which ranged in diameter from 0.25-0.33 mm.

LARVAE:

Length at Flexion: Unknown.

Sequence of Fin Development: Unknown, although pattern in other morids is pectoral and pelvic, dorsal and anal, caudal.

EARLY JUVENILES:

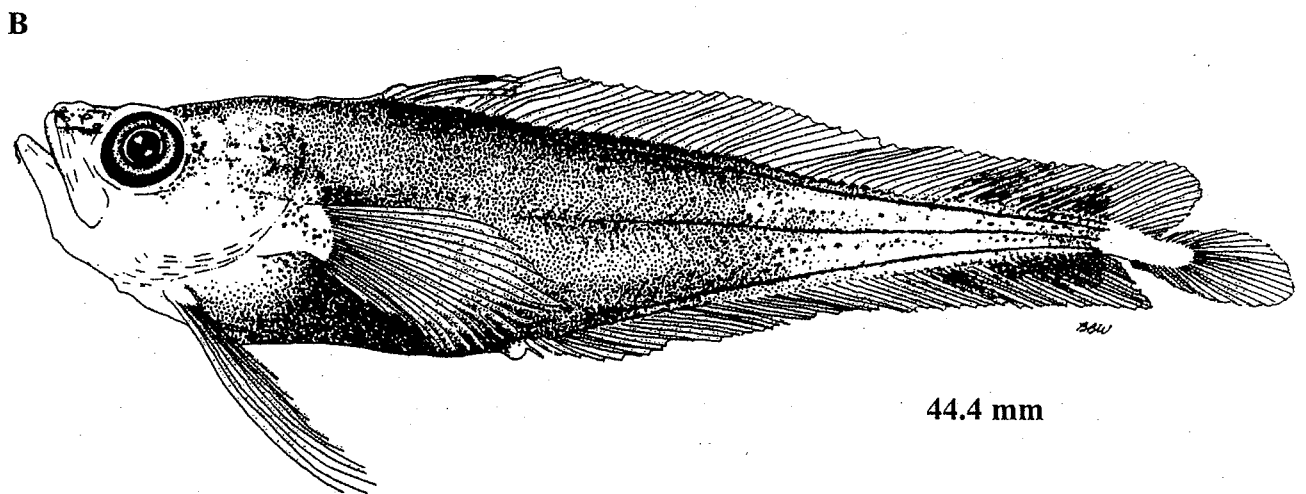
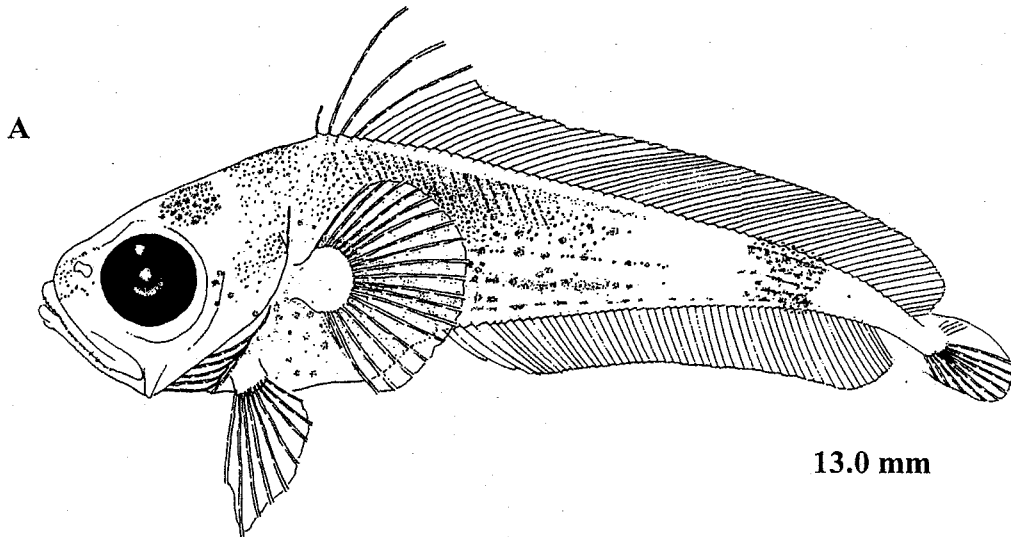
Pigmentation: Observations from 13.0 mm specimen illustrated in Fahay (1983): light pigment scattered over anterior half of body and head; swath of pigment across body located just anterior to caudal peduncle.

Diagnostic Characters: *Laemonema* and *Antimora* are the two morid genera from the western North Atlantic that lack a dark patch of ventral gut pigment. The four species of *Laemonema* from this region are distinguished from *Antimora* by having >50 anal fin rays and ≤17 precaudal vertebrae. *Laemonema barbatulum* is distinguished from *L. goodebeanorum* by having ≤70 total dorsal fin rays, from *L. melanurum* by having <25 pectoral fin rays, and from *L. yarelli* by having <16 precaudal vertebrae.

ILLUSTRATIONS

A. Fahay 1983

B. Reproduced in Meléndez and Markle (1997) from Fahay and Markle (1984).



MORIDAE

Laemonema melanurum Goode and Bean 1896

MERISTICS

Vertebrae:	
Precaudal	15-16
Caudal	38-42
Total	53-57
Number of Fin Rays:	
First Dorsal Fin	7
Second Dorsal Fin	53-61
Anal Fin	52-59
Pectoral Fin	25-27
Pelvic Fin	7-10 (adults 2)
Gill Rakers:	4-6,+2-15

LIFE HISTORY

Range: western North Atlantic
Habitat: Continental slopes. Has been collected at depths of 452-644 m.
ELH Pattern: Oviparous; planktonic larvae

LITERATURE

Fahay and Markle 1984
Kuroda et al. 1982
Meléndez and Markle 1997

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown. Eggs from another species within this genus (*L. longipes*) ranged in diameter from 1.00-1.16 mm and had a single oil globule which ranged in diameter from 0.25-0.33 mm.

LARVAE:

Length at Flexion: Unknown.

Sequence of Fin Development: Unknown, although pattern in other morids is pectoral and pelvic, dorsal and anal, caudal.

EARLY JUVENILES:

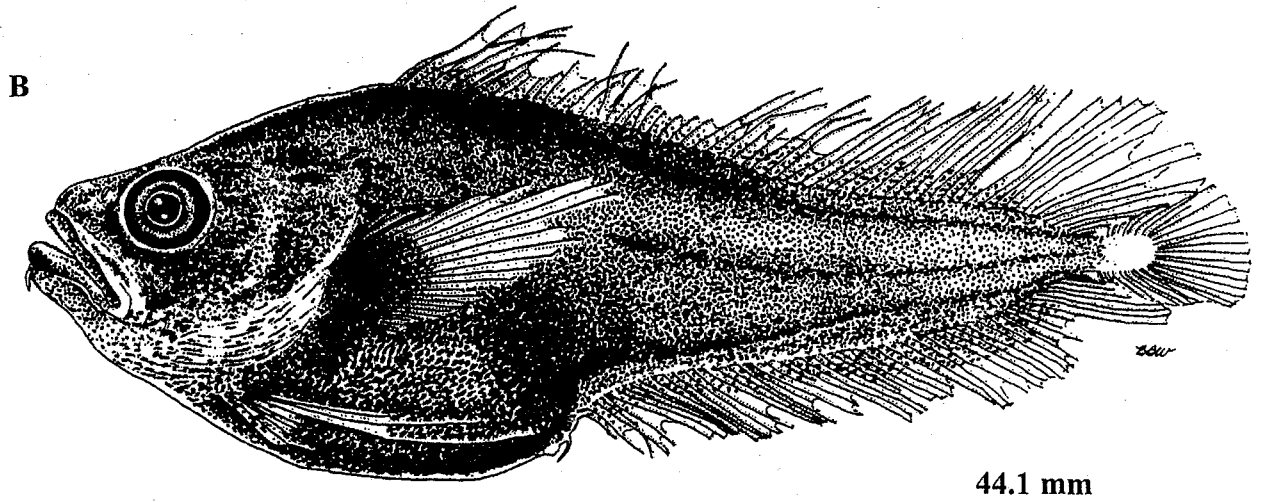
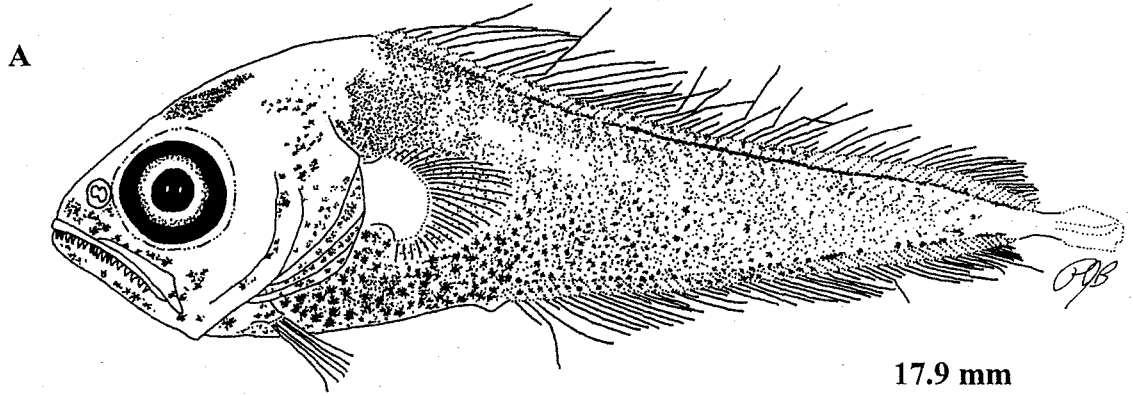
Pigmentation: Highly pigmented except lacks pigment at caudal base.

Diagnostic Characters: *Laemonema* and *Antimora* are the two morid genera from the western North Atlantic that lack a dark patch of ventral gut pigment. The four species of *Laemonema* from this region are distinguished from *Antimora* by having >50 anal fin rays and ≤17 precaudal vertebrae. *Laemonema melanurum* is distinguished from *L. barbatulum*, *L. goodebeanorum* and most *L. yarelli* by having ≥25 pectoral fin rays. *Laemonema yarelli* has occasionally been reported with 25 pectoral fin rays, but is also distinguished from *L. melanurum* by having 6 first dorsal fin rays (*L. melanurum* has 7).

ILLUSTRATIONS

A. Original. 17.9 mm ARC8707565. Description of specimen given by Meléndez and Markle (1997).

B. Reproduced in Meléndez and Markle (1997) from Fahay and Markle (1984).



MERISTICS

Vertebrae:	
Precaudal	12-16 in genus <i>Physiculus</i>
Caudal	
Total	47-50
Number of Fin Rays:	
First Dorsal Fin	9-12
Second Dorsal Fin	57-61
Anal Fin	59-68
Pectoral Fin	21-26
Pelvic Fin	6-7 (only 3 specimens)
Gill Rakers:	2-3+8-11

LIFE HISTORY

Range: Reported from the Atlantic coast of North America, the Gulf of Mexico, the Caribbean Sea, and off the northeast coast of South America.
 Habitat: Collected at depths of 200-245 m.
 ELH Pattern: Oviparous; planktonic larvae.
 Spawning: Larvae identified in this study were collected during June and July.

LITERATURE

De Gaetani 1928
 Brownell 1979
 Kitagawa 1985
 Paulin 1989a,b

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown. For three other species of *Physiculus* egg diameter ranged from 0.93 to 1.08 mm, and a single oil globule ranged in diameter from 0.19 to 0.30 mm.

LARVAE:

Length at Flexion: 6-7 mm
 Sequence of Fin Development: P1 & P2, D & A, C.
 Pigmentation: Lateral sides of gut lightly pigmented with dark patch of pigment on ventral surface of gut. Three short strips of pigment located equidistantly along postanal ventral margin. A swath of pigment extends up from each of the two anteriormost strips of pigment giving appearance of two bands along body. Posteriormost small strip of ventral pigment limited to a few small melanophores in specimens as small as 3 or 4 mm. Pigment on dorsal surface extends from nape to over midbrain.

Diagnostic Characters: Distinguished from *Antimora* and *Laemonema* by dark patch of pigment on ventral surface of gut, and from *Gadella* by having two bands of post-anal pigment on body (*Gadella* has one). Although size at development has not been determined, *P. fulvus* has fewer vertebrae than *P. karrerae* or *P. kaupi*.

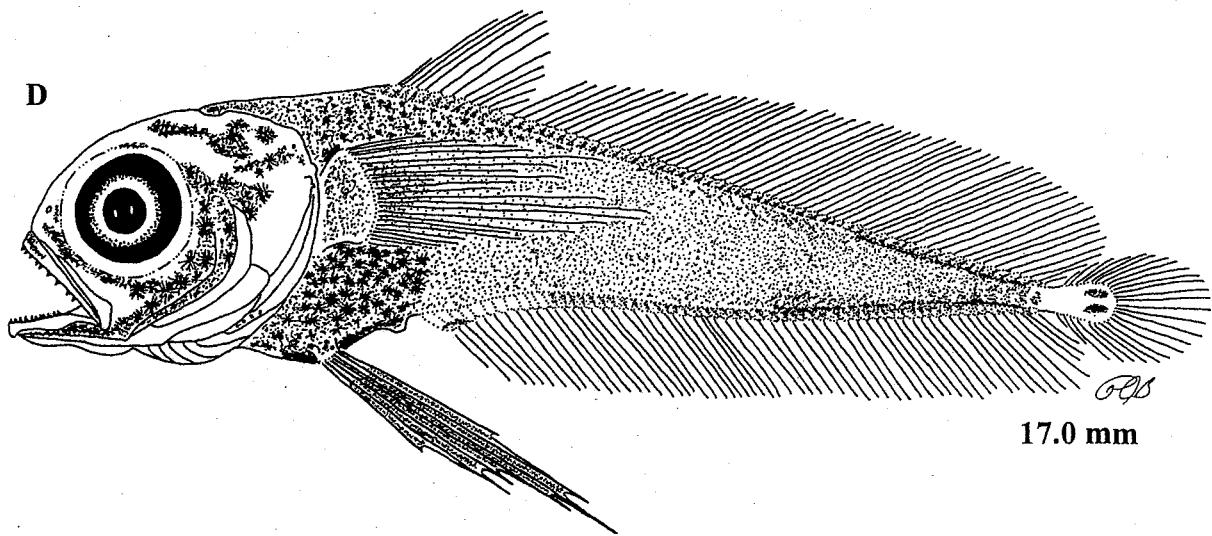
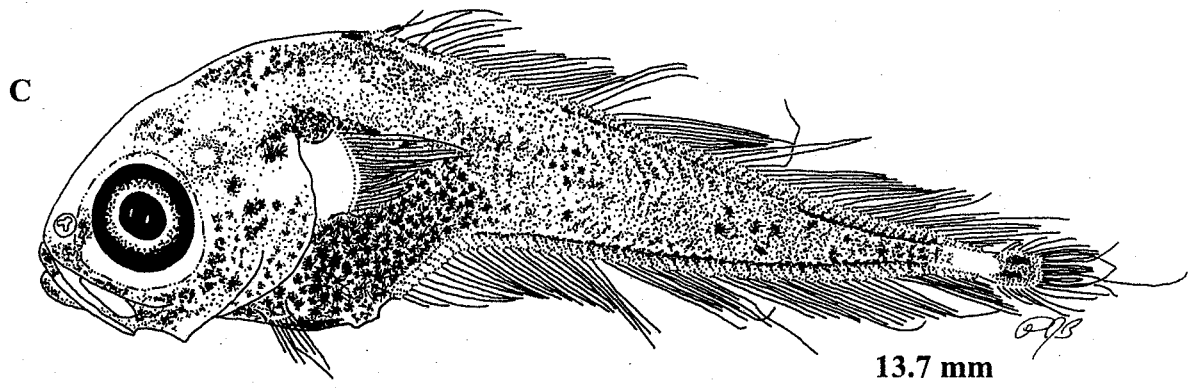
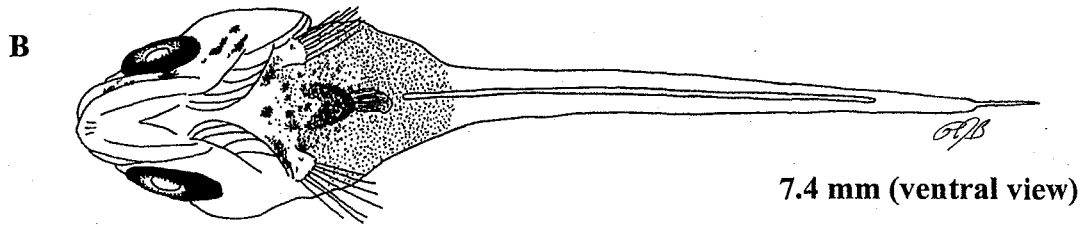
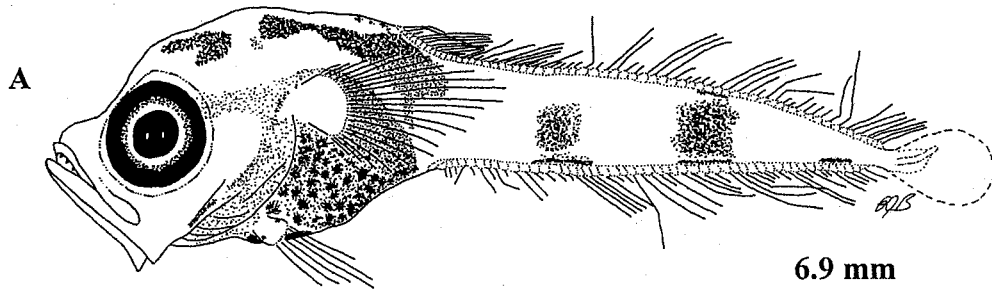
EARLY JUVENILES:

Pigmentation: Two lateral swaths of pigment that are distinctive in larvae become less noticeable by approximately 10 mm. Many small melanophores scattered over body and head. Dark patch of pigment on ventral surface of gut remains distinct. No pigment on caudal peduncle, and small patch of pigment on each side of midline at posterior tip of the body.

Diagnostic Characters: *Physiculus* and *Gadella* are the only two morid genera from the western central Atlantic that have a dark patch of ventral gut pigment. *Physiculus* is distinguished from *Gadella* by having 12-16 precaudal vertebrae (*Gadella* 17) and possessing a chin barbel (size at development not described). *P. fulvus* distinguished from *P. karrerae* and *P. kaupi* by having no more than 50 vertebrae. In addition, *P. fulvus* has fewer dorsal and anal fin rays than *P. karrerae*, and fewer pectoral fin rays than *P. kaupi*.

ILLUSTRATIONS

Original. A: 6.8 mm SML08565-000; B: 7.4 mm SML23628-000; C: 13.7 mm SML23632-000; D: 17.0mmORII166-45402R6B3(III.#308)



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