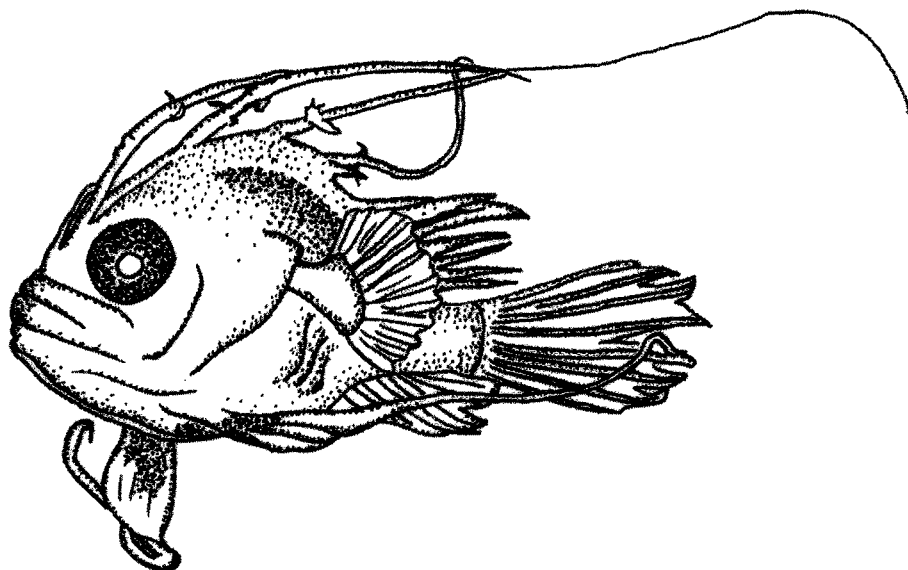




PRELIMINARY GUIDE TO THE IDENTIFICATION OF THE EARLY LIFE STAGES  
OF LOPHIID FISHES OF THE WESTERN CENTRAL NORTH ATLANTIC



BY

A. W. Everly & J. H. Caruso

U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Southeast Fisheries Science Center  
75 Virginia Beach Drive  
Miami, Florida 33149

December 2003



PRELIMINARY GUIDE TO THE IDENTIFICATION OF THE EARLY LIFE STAGES  
OF LOPHIID FISHES OF THE WESTERN CENTRAL NORTH ATLANTIC

BY

A. W. Everly & J. H. Caruso

U.S. DEPARTMENT OF COMMERCE  
Donald L. Evans, Secretary

National Oceanic and Atmospheric Administration  
Conrad C. Lautenbacher, Jr., Under Secretary for Oceans and Atmosphere

National Marine Fisheries Service  
William T. Hogarth, Assistant Administrator for Fisheries

December 2003

This Technical Memorandum series is used for documentation and timely communication of preliminary results, interim reports, or similar special-purpose information. Although the memoranda are not subject to complete formal review, editorial control, or detailed editing, they are expected to reflect sound professional work.

## NOTICE

The National Marine Fisheries Service (NMFS) does not approve, recommend or endorse any proprietary product or material mentioned in this publication. No reference shall be made to NMFS or to this publication furnished by NMFS, in any advertising or sales promotion which would imply that NMFS approves, recommends, or endorses any proprietary product or proprietary material mentioned herein or which has as its purpose any intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication.

This report should be cited as follows:

Everly, A. W. & J. H. Caruso. 2003. Preliminary guide to the identification of the early life history stages of lophiid fishes of the western central North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-519, 14 p.

W. J. Richards, Editor. NOAA Fisheries, 75 Virginia Beach Drive, Miami, FL

This report will be posted on the Bethune Cookman College NOAA Cooperative web site in 2004 at <[www4.cookman.edu/noaa/](http://www4.cookman.edu/noaa/)> and also appear on the SEFSC web site at <[www.sefsc.noaa.gov/](http://www.sefsc.noaa.gov/)>

It will be a chapter entitled Lophiidae in "The early life history stages of fishes of the western central North Atlantic".

Copies may be obtained by writing:

the authors

(AWE) Museum of Comparative Zoology

Harvard University

Cambridge, MA 02138

E-mail: <[aeverly@oeb.harvard.edu](mailto:aeverly@oeb.harvard.edu)>

(JHC) Department of Biological Sciences

University of New Orleans

Lakefront

New Orleans, LA 70148-2960

E-Mail: <[jcaruso@uno.edu](mailto:jcaruso@uno.edu)>

or

National Technical Information Center

5825 Port Royal Road

Springfield, VA 22161

(800) 553-6847 or (703) 605-6000

<<http://www.ntis.gov/numbers.htm>>

Goosefishes or monkfishes belong to the family Lophiidae and the order Lophiiformes, the anglerfishes. Members of the order Lophiiformes are characterized in particular by the luring apparatus (illicium) used to attract prey (see Pietsch, 1984, for other synapomorphies of this clade). The illicium is a specialized dorsal fin spine located anterodorsally on the head of juveniles and adults; it often bears a fleshy appendage (the esca) at the tip.

The family Lophiidae consists of 25 species in four genera, and is further characterized by the following: head and body dorsoventrally depressed and very broad; post-cephalic portion of body tapering; maximum size 200 cm, typically 25 to 45 cm; mouth very broad with long, sharp, slender, conical teeth; separate spinous and soft dorsal fins, the spinous portion consisting of 2 or 3 isolated cephalic spines, and 1 to 3 post cephalic spines which are commonly connected by a membrane, especially in the juveniles; skin smooth and scaleless, with fleshy flaps on the head and body; pelvic fins anterior to pectorals on ventral surface of head (Caruso 2003). The various spines and ridges on the dorsal and lateral surfaces of the head, in addition to other osteological characters, pigmentation, and meristics are used in distinguishing species (Caruso 1981, 1983, 1985).

Monkfishes are commonly found at depths exceeding 200 m, occasionally exceeding 1000 m, and tend to inhabit soft bottoms (Caruso; 2002, 2003). *Lophius americanus* is also found at great depths, but in higher latitudes it is known to frequent shallower waters up to the tide line (Bigelow & Schroeder 1953). This makes them easily accessible to commercial trawlers, which exploit them heavily off the New England coast.

There are six lophiid species in 3 genera found in the western Atlantic: *Lophiodes beroe*, *Lophiodes monodi*, *Lophiodes reticulatus*, *Lophius americanus*, *Lophius gastrophysus*, and *Sladenia shaefersi*. The northernmost species is *L. americanus*, overlapping the range of *L. gastrophysus* from the east coast of Florida to the southern New England Slope (Moore et al. 2003). *L. gastrophysus* occurs with the 3 species of *Lophiodes* in the Gulf of Mexico and

Caribbean Sea to the northern coast of South America. *Sladenia shaefersi* is known from only 2 specimens caught off Columbia and Aruba (Caruso & Bullis 1976, Caruso 2003).

In general, the larvae and juveniles of lophiids are characterized by a laterally compressed body relative to the adults, extremely long dorsal fin spines, wing-like pectoral fins, elongate pelvic fins, large eyes, and a series of large melanophores along the caudal region. The early life history of lophiids in the western Atlantic is known mainly from specimens of *L. americanus* (see Agassiz 1882, Agassiz & Whitman 1885, Berrill 1929, Connolly 1920, Eaton 1942, Everly 2002, Fahay 1983, Martin & Drewry 1978, Procter et al. 1928). Eggs of western Atlantic lophiids are known in the literature only for *L. americanus*. Other larvae of the genus *Lophius* have been described in varying detail (see Everly 2002, for literature review). Larvae of *L. gastrophysus* are well known from the Gulf of Mexico and South America (Matsuura & Yoneda 1986, 1987). The larvae of *Lophiodes* are known from the Gulf of Mexico and beyond, but material is limited. Eggs are not known for this genus, though it is assumed, based on the ovarian morphology of adult females, that they have a similar reproductive pattern to *Lophius*. It is possible that the reason no eggs have been recorded for the genus *Lophiodes*, is because the egg masses, known as veils, may not be epipelagic as in *Lophius*. Nothing is known of the early life history of *Sladenia shaefersi*.

Species accounts are provided for the six species and illustrations for three species. We also include an illustration of the *Lophiodes mutilus* species group to which *L. beroe* & *L. monodi* belong. Meristic characters are given in Table Lophiidae 1.

Table Lophiidae 1. Meristic characters of the lophiid fishes from the western central North Atlantic

Species	Fin counts					Vertebrae
	Dorsal	Anal	Pectoral	Pelvic	Caudal	
<i>Lophius</i>						
<i>americanus</i>	VI,9-12	8-10	26(25-28)	1,5	8	26-31
<i>gastrophysus</i>	VI,9-10	8-9	22-26	1,5	8	26-27
<i>Lophiodes</i>						
<i>beroe</i>	V,8	6	18-21	1,5	8	19
<i>monodi</i>	V,8	6	17-21	1,5	8	19
<i>reticulatus</i>	VI,8	6-7	14-16	1,5	8	18
<i>Sladenia</i>						
<i>schaefersi</i>	III,8-9	6	18	1,5	8	19

**MERISTICS**

Vertebrae:	
Total	26-31
Number of Fin Spines and Rays:	
Dorsal	VI,9-12
Anal	8-10
Pectoral	25-28 (commonly 26)
Pelvic	I,5
Caudal	8

**LIFE HISTORY**

Range: Nova Scotia to the East coast of Florida.

Habitat: Adults are bottom dwellers frequenting depths from the tide line to over 800 m; substrate preference includes hard sand, pebble, gravel, broken shells, & soft mud; adults have been observed both in the wild & in captivity to achieve nearly perfect crypsis with the combined aid of the mottled skin color & the use of the paired fins to push sand around the edges of the flattened body.

ELH Pattern: Eggs & larvae are pelagic. Pelagic larvae metamorphose into pelagic juvenile phase. Morphological changes during metamorphosis are likely correlated with change from pelagic larval phase to benthic lifestyle of adults.

Spawning: Oviparous; eggs spawned in large mucoidal masses called egg veils which are neutrally bouyant. The number of eggs per veil varies in the hundereds of thousands to over a million; 1-2 eggs contained in separate chambers. Veils range in size but can attain a length of 12 m & width of 1.5 m, the thickness not exceeding a couple centimeters.

Season: Spring, summer and early autumn, depending on the latitude; April off Cape Lookout, NC, & typically June to August in New England (based on capture of eggs and larvae).

**LITERATURE**

Berrill 1929, Bigelow & Schroeder 1953, Caruso 1983, 2002, 2003, Everly 2002, Martin & Drewry 1978, Proctor et al. 1928.

**EARLY LIFE HISTORY DESCRIPTION****EGGS:**

Diameter: 1.5 mm

No. of Oil Globules: 1-2

Yolk: opaque

Shell: transparent

Incubation: Variable, depending on water temperature, approximately 14 days in temperatures ranging between 16-22° C (in laboratory).

Pigmentation: Lightly pigmented, giving a purple appearance.

**LARVAE:**

Pigmentation: Three melanophores along caudal region; melanophore on distal edge of P<sub>2</sub> rays.

Sequence of Fin Development: C, P<sub>1</sub>, P<sub>2</sub>, D, A

Sequence of Dorsal Fin Spine Development: II, III, IV, V, VI, I; the presumptive illicium, is the last to develop; I-III are cephalic, IV-VI are post cephalic.

Diagnostic Characters: *L. americanus* larvae can be distinguished from *L. gastrophysus* by the melanophore located on the distal edge of the P<sub>2</sub>. Older larvae & juveniles of *L. americanus* can be distiguished by the higher meristic counts. In general, larvae & juveniles of *Lophius* can be distinguished from *Lophiodes* by the following: *Lophius americanus* & *L. gastrophysus* have large, wing like P<sub>1</sub> compared to *Lophiodes*; P<sub>2</sub> are more elongate, & the D<sub>1</sub> spines are smooth & evenly tapered in appearance.

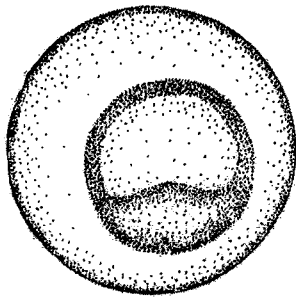
**ILLUSTRATIONS**

A-F) Appledore Island, NH (from Everly 2002)

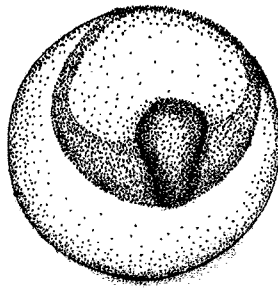
Original: G) Slope Water (MCZ 93220); H) Slope Water (MCZ 93208); I) Slope Water (MCZ 93215); J) Slope Water (MCZ 93219); K) Slope Water (MCZ 93204).

**LOPHIIDAE**

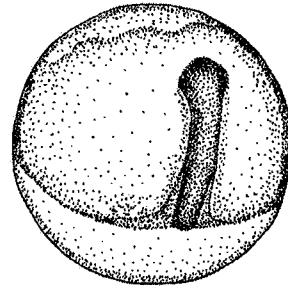
*Lophius americanus* Valenciennes  
(in Cuvier & Valenciennes, 1837)



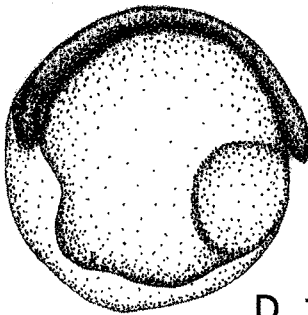
A. 1.6mm



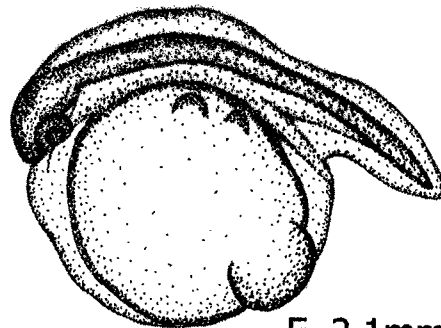
B. 1.5mm



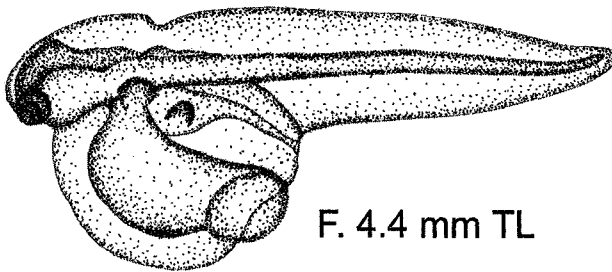
C. 1.5mm



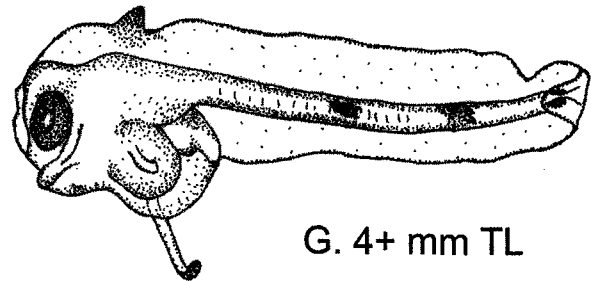
D. 1.4mm



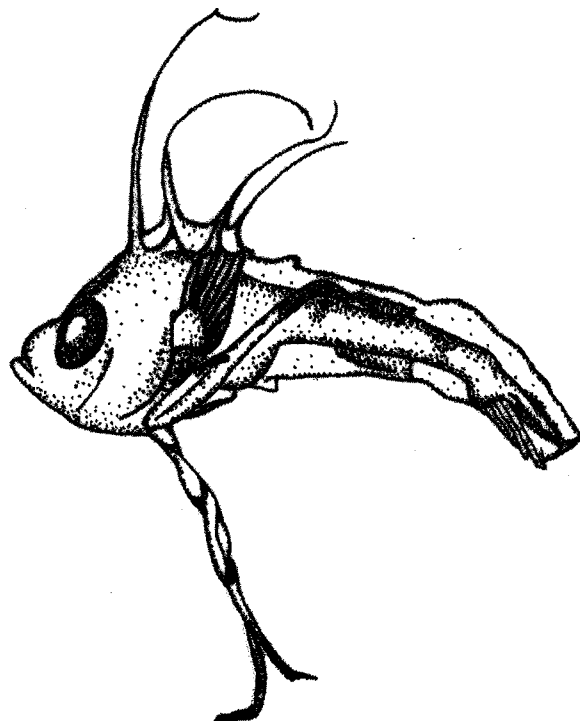
E. 2.1mm TL



F. 4.4 mm TL



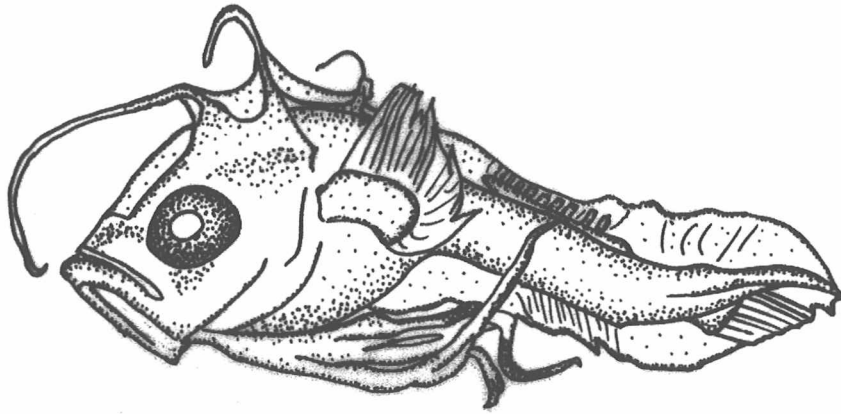
G. 4+ mm TL



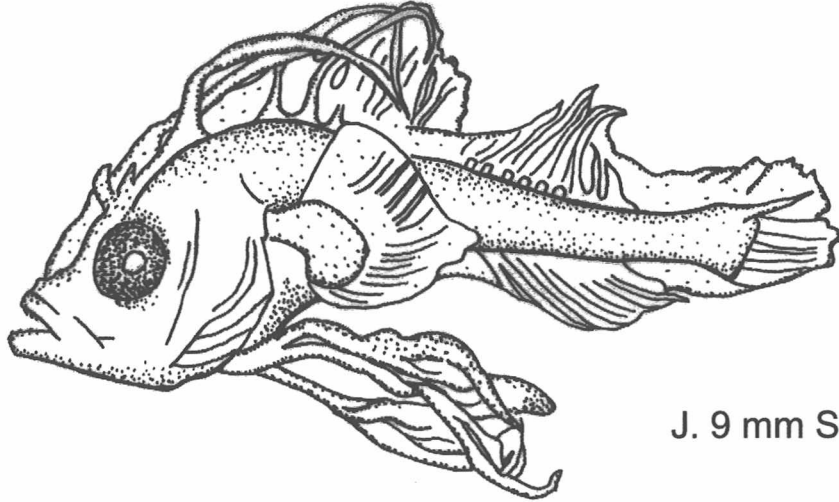
H. 5.4 mm TL

LOPHIIDAE

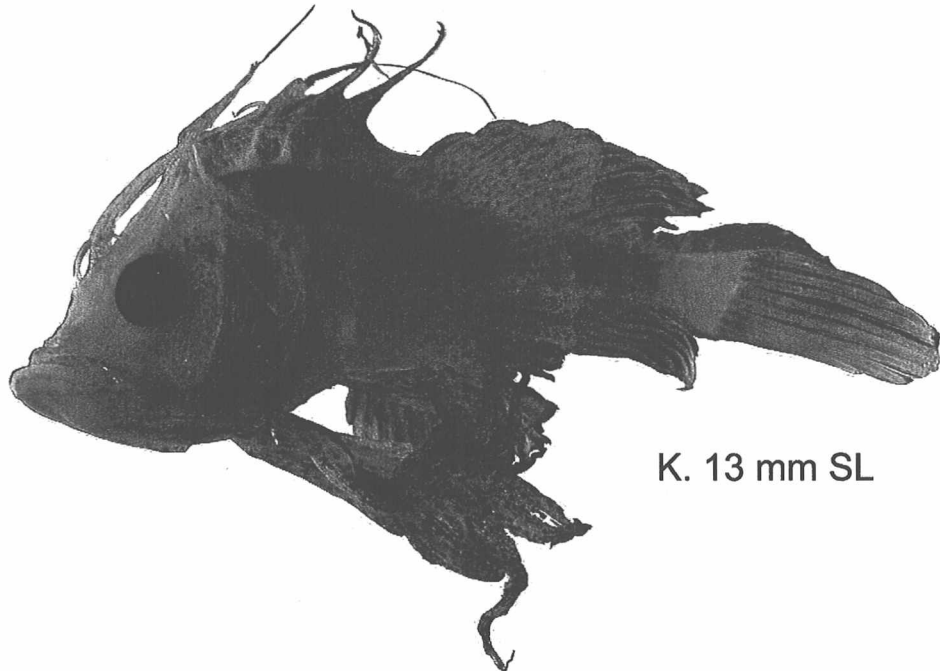
*Lophius americanus* Valenciennes  
(in Cuvier & Valenciennes, 1837)



I. 6.1 mm TL



J. 9 mm SL



K. 13 mm SL



**MERISTICS**

Vertebrae:		
Precaudal		
Caudal		Total
26-27		
Number of Fin Spines and Rays:		
Dorsal	VI, 9-10	
Anal	8-9	
Pectoral	22-26	
Pelvic	1,5	
Caudal	8	

**LIFE HISTORY**

Range: Cape Hatteras south to northern coast of Argentina, range recently extended to the southern New England slope.

Habitat: Adults are bottom dwellers frequenting depths from 200 to 700 m; larvae are pelagic.

ELH Pattern: Similar to that of *L. americanus*.

**LITERATURE**

Caruso 1983, 2003, Matsuura & Yoneda 1986.

**EARLY LIFE HISTORY DESCRIPTION**

**EGGS:** Unknown

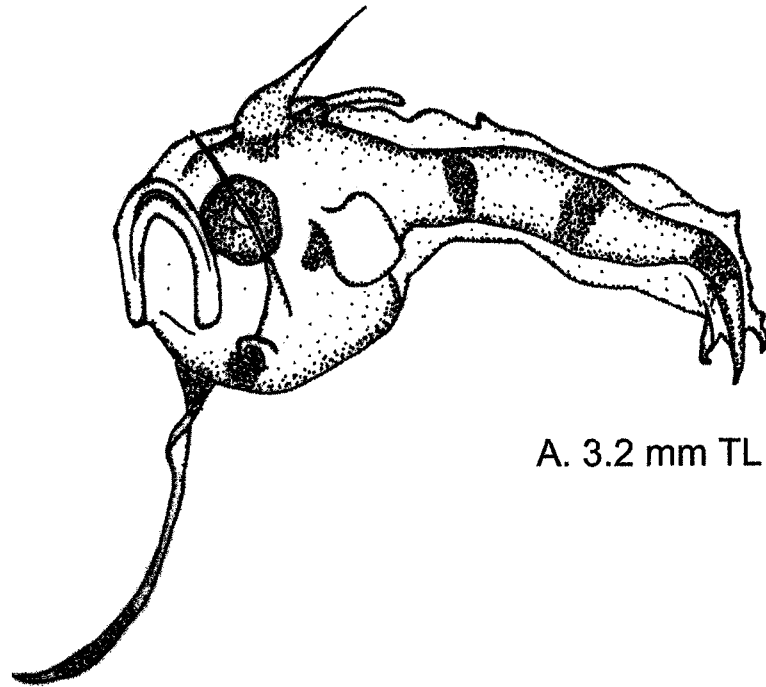
**LARVAE:**

Pigmentation: Three melanophores along caudal region; melanophore of P<sub>2</sub> is ¾ from proximal-most end; light pigmentation in present in the preopercular and suborbital area.

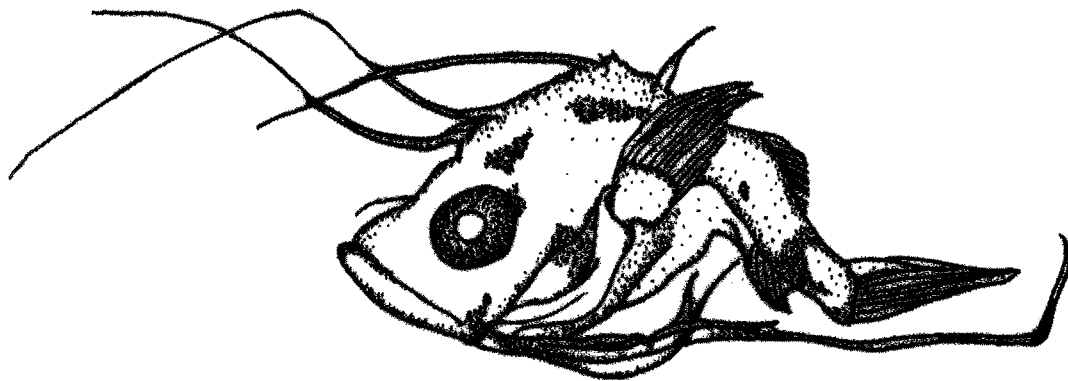
Diagnostic Characters: Larvae very similar to *L. americanus* & are easily confused where these species overlap. Subtle differences in the pigmentation of the P<sub>2</sub> may be used as an identifying feature (melanophore ¾ to distal tip in *L. gastrophysus* vs. extending to end of distal tip in *americanus*). Juveniles may be identified by the lower D, P<sub>1</sub>, & A ray counts. Adults can be distinguished from *L. americanus* by the black posterior margin of the P<sub>1</sub> & D, P<sub>1</sub> & A ray counts.

**ILLUSTRATIONS**

A) Gulf of Mexico (SML 35983); B) Gulf of Mexico (SML 99703). All original.



A. 3.2 mm TL



B. 4.7+ mm SL

## LOPHIIDAE

*Lophiodes reticulatus* Caruso & Suttkus, 1979

### MERISTICS

Vertebrae:	
Total	18
Number of Fin Spines and Rays:	
Dorsal:	VI, 8
Anal:	6-7
Pectoral:	14-16
Pelvic:	I, 5
Caudal:	8

### LIFE HISTORY

Range: Atlantic coast off North Carolina (ca. 33.5°N), the Gulf of Mexico, & Caribbean Sea to South America (ca. 7.25°N).

Habitat: adults are known from depths ranging between 65 to 370 m, & temperatures ranging from 12 to 19°C.

ELH Pattern: Unknown

Spawning: Spawning most likely takes place in the Gulf of Mexico & Caribbean (based on distribution of larvae), but otherwise unknown. Presumably similar in physiology & method to *Lophius*, based on adult ovarian morphology.

### LITERATURE

Caruso 1981, 2003.

### EARLY LIFE HISTORY DESCRIPTION

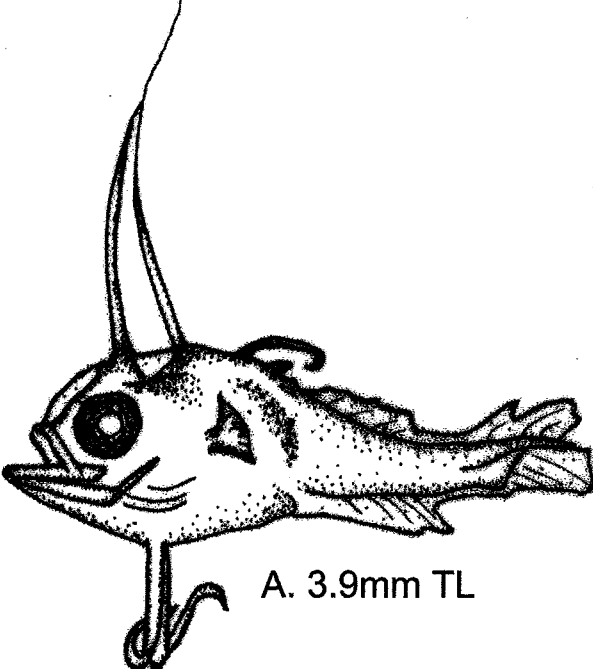
EGGS: Unknown.

#### LARVAE:

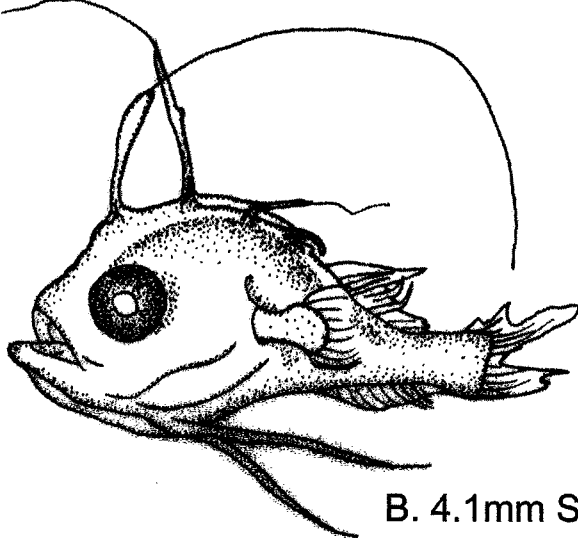
Diagnostic Characters: *Lophiodes reticulatus* may be distinguished from other western Atlantic *Lophiodes* larvae by having 3 post-cephalic D spines (six total). As with other species of *Lophiodes*, very young larvae are difficult to identify.

### ILLUSTRATIONS

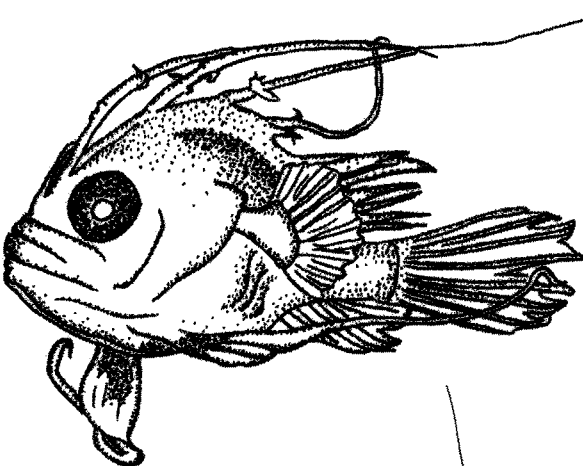
A) Straits of Florida (SEFCAR B911 2706); B) Gulf of Mexico (SML 03314); C) Gulf of Mexico (SML 159875); D) N Sargasso Sea (MCZ 76651). All original.



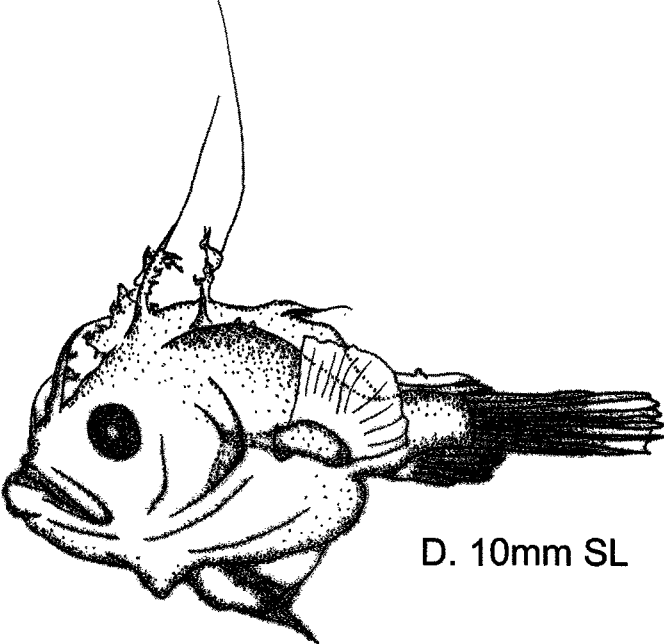
A. 3.9mm TL



B. 4.1mm SL



C. 6.3mm SL



D. 10mm SL

**MERISTICS**

Vertebrae:	
Total	19
Number of Fin Spines and Rays:	
Dorsal:	V, 8
Anal:	6
Pectoral:	18-21
Pelvic	1,5
Caudal	8

**LIFE HISTORY**

Range: Atlantic Ocean off North Carolina (ca. 34.3°N) to northern coast of South America (ca. 7.75°N) including Northeastern Gulf of Mexico & Caribbean Sea.

Habitat: Adult specimens have been collected at depths ranging from ca. 347 to 860 m & bottom temperatures from 9 to 11°C.

ELH Pattern: Unknown.

Spawning: Unknown; presumably similar in physiology & method to species of *Lophius*, based on adult ovarian morphology.

**LITERATURE**

Caruso 1981, 2003, Caruso et al. *in prep*, Watson 1996h.

**EARLY LIFE HISTORY DESCRIPTION**

**EGGS:** Unknown.

**LARVAE:**

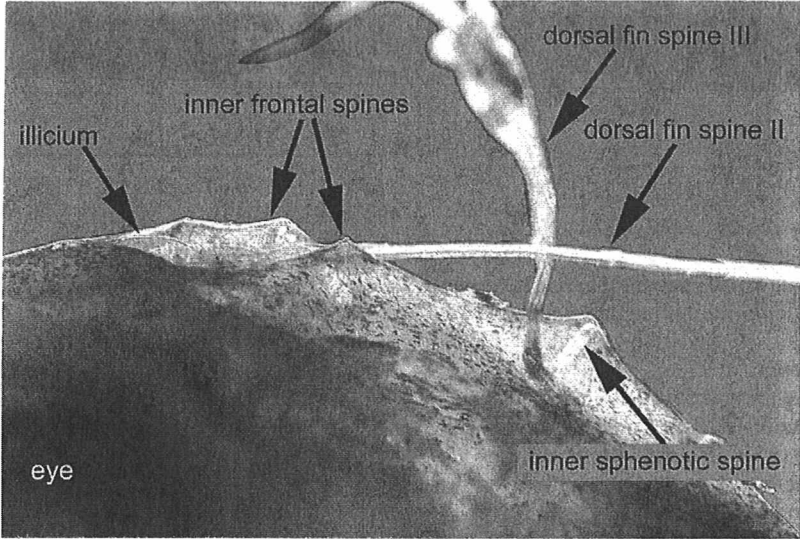
Diagnostic Characters: Small larvae of the genus *Lophiodes* are extremely difficult to identify to species. Also, it is likely that the depths at which *beroe* and *monodi* inhabit make the eggs & larvae relatively difficult to collect. Older larvae & juveniles of *L. beroe* can be distinguished from *L. reticulatus* & the two western Atlantic *Lophius* species by the presence of two rather than three post-cephalic D spines, & by the presence of inner frontal spines (medial to the frontal spines which in turn are medial to the eyes). In general, larvae & juveniles of *Lophiodes* can be distinguished from *Lophius* by the following: larvae of *Lophiodes* have smaller pectoral fins compared to *Lophius*, the P<sub>2</sub> are less elongate, & the D spines have a thicker, more fleshy base with small flaps & the spines protruding more abruptly than in *Lophius*.

**ILLUSTRATIONS**

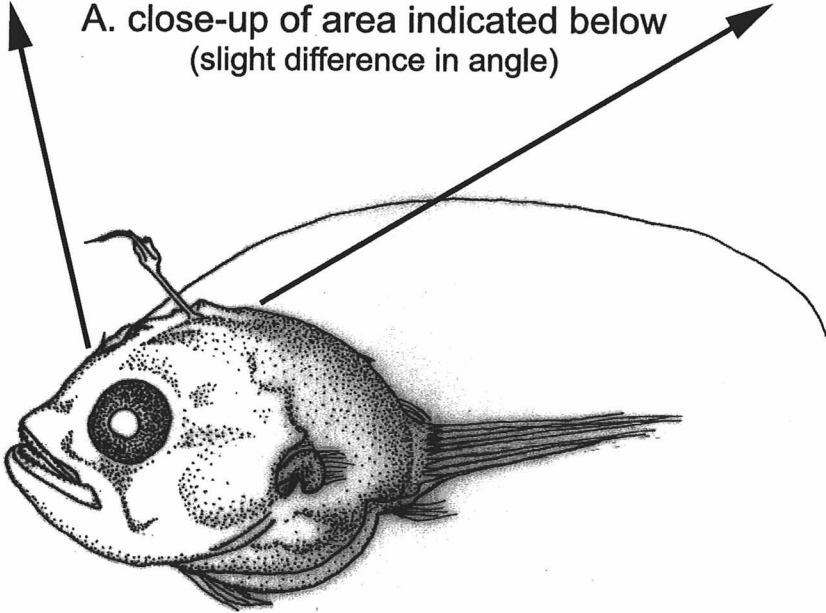
See *Lophiodes* sp. illustration page.

**LOPHIIDAE**

*Lophiodes* sp. (*L. mutilus* species group:  
*beroe* or *monodi*)



A. close-up of area indicated below  
(slight difference in angle)



B. 5.2mm SL

## LOPHIIDAE

## *Lophiodes monodi* (Le Danois, 1971)

### MERISTICS

Vertebrae:	19
Number of Fin Spines and Rays:	
Dorsal	V, 8
Anal	6
Pectoral	17-21
Pelvic	1,5
Caudal	8

### LIFE HISTORY

Range: Atlantic Ocean off North Carolina (ca. 34.3°N) to South America (ca. 7°N) including the Gulf of Mexico & Caribbean Sea.

Habitat: Specimens have been collected between 365 & 550 m.

ELH Pattern: Unknown.

Spawning: Unknown; presumably similar to *Lophius*, based on adult ovarian morphology.

### LITERATURE

Caruso 1981, 2003, Caruso et al. *in prep.*

### EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown.

#### LARVAE:

Diagnostic Characters: Larvae & juveniles can be distinguished from *L. reticulatus* & the two western Atlantic *Lophius* species by the presence of two rather than three post cephalic D spines. It appears that there is no convenient way to distinguish *L. beroe* & *L. monodi* until the esca & pigmentation of the illicium develop.

### ILLUSTRATIONS

See *Lophiodes* sp illustration page.

## LOPHIIDAE

## *Sladenia shaefersi* Caruso & Bullis, 1976

---

### MERISTICS

---

Vertebrae:	
Total	19
Number of Fin Spines and Rays:	
Dorsal	III, 8-9
Anal	6
Pectoral	18
Pelvic	I,5
Caudal	8

### LIFE HISTORY

---

Range: The only 2 known specimens of *Sladenia shaefersi* are from Columbia & Aruba.

Habitat: Collected at depths of 1200 m and 850 m, respectively.

ELH Pattern: Unknown

Spawning: Unknown

### LITERATURE

---

Caruso & Bullis 1976, Caruso 2003.

### EARLY LIFE HISTORY DESCRIPTION

---

**EGGS:** Unknown.

**LARVAE:** Unknown.

Diagnostic Characters: Adult *Sladenia* species can be distinguished from other lophiids by the lack of the third cephalic D spine, the head & body are rounded rather than depressed, & the quadrate, articular, subopercular & humeral spines are absent. These characters may be useful in distinguishing *Sladenia* larvae from those of other lophiids.



### Lophiidae Literature Cited

- Agassiz, A. 1882. On the young stages of some osseous fishes. Proc. Amer. Acad. Arts. Sci., N.S. 9: 271-303.
- Agassiz, A. & C. O. Whitman. 1885. Studies from the Newport Marine Laboratory, XVI. The development of osseous fishes. Part I. The pelagic stages of some young fishes. Mem. Mus. Comp. Zool. 14: 1-56.
- Berrill, N. J. 1929. The validity of *Lophius americanus* Val. as a species distinct from *L. piscatorius* Linn., with notes on the rate of development. Contr. Can. Biol. Fish. New Ser. 4: 143-155.
- Bigelow, H. B. & W. C. Schroeder. 1953. Fishes of the Gulf of Maine. Fish. Bull. U.S. 74: 1-577 p.
- Caruso, J. H. & H. R. Bullis. 1976. A review of the lophiid anglerfish genus *Sladenia* with a description of a new species from the Caribbean Sea. Bull. Mar. Sci. 26: 59-64.
- Caruso, J. H. 1981. The systematics and distribution of the lophiid anglerfishes: I. A revision of the genus *Lophiodes* with the description of two new species. Copeia 1981: 522-549.
- Caruso, J. H. 1983. The systematics and distribution of the lophiid anglerfishes: II. Revisions of the genera *Lophiomus* and *Lophius*. Copeia 1983: 11-30.
- Caruso, J. H. 1985. The systematics and distribution of the lophiid anglerfishes: III. Intergeneric relationships. Copeia 1985: 870-875.
- Caruso, J. H. 2003. Order Lophiiformes: Lophiidae. Pages 1043-1049 in The Living Marine Resources of the Western Central Atlantic. K.E. Carpenter (ed.). FAO Species Identification Guide for Fishery Purposes and Amer. Soc. Ich. Herp. Spec. Publ. 5. FAO, Rome, 2: 601-1374.
- Caruso, J. H. 2002. Goosefishes or Monkfishes. Family Lophiidae. Pages 264-270 in Bigelow and Schroeder's Fishes of the Gulf of Maine, B. B. Collette & G. Klein-MacPhee (eds.). 3<sup>rd</sup> Ed. Smithsonian Institution Press, Washington & London. 748 p.
- Caruso, J. H., K. J. Sulak & S. W. Ross. *In preparation*. Notes on chaunacid and lophiid anglerfishes in the Western North Atlantic (Pisces: Lophiiformes).
- Connolly, C. J. 1920. Histories of new food fishes; III. The angler. Bull. Biol. Bd. Can. 3: 3-17.
- Eaton, T. H. 1942. A young angler-fish, *Lophius piscatorius* Linnaeus. Copeia 1942: 45-47.
- Everly, A. W. 2002. Stages of development of the goosefish, *Lophius americanus*, and comments on the phylogenetic significance of the development of the luring apparatus in Lophiiformes. Env. Biol. Fishes 64: 393-417.
- Fahay, M. P. 1983. Guide to the early stages of marine fishes occurring in the Western North Atlantic Ocean, Cape Hatteras to the Southern Scotian Shelf. J. Northw. Atl. Fish. Sci. 4: 1-423.
- Martin, F. D. & G. E. Drewry. 1978. Development of fishes of the mid-Atlantic Bight. Vol. VI, Stromateidae through Ogocephalidae. FWS/OBS-78/12. 416 p.
- Matsuura, Y. & N. T. Yoneda. 1986. Early development of the lophiid anglerfish, *Lophius gastrophysus*. Fish. Bull. U.S. 84: 429-436.
- Matsuura, Y. & N. T. Yoneda. 1987. Osteological development of the lophiid anglerfish, *Lophius gastrophysus*. Jap. J. Ichthyol. 33: 360-367.
- Pietsch, T. W. 1984. Lophiiformes: development and relationships. Pages 320-325 in Ontogeny and Systematics of Fishes. H.G. Moser et al. (eds.). Amer. Soc. Ichthyol. Herpetol. Spec. Publ. (1): 760 p.
- Procter, W., H. C. Tracy, E. Helwig, C. H. Blake, J. E. Morrison & S. Cohen. 1928. A contribution to the life-history of the angler (*Lophius piscatorius*). Pages 1-29 in Biological Survey of the Mount Desert Island Region, Part 2: Fishes, Wistar Institute of Anatomy and Biology, Philadelphia.
- Watson, W. 1996h. Lophiidae. Pages 553-557 in The early stages of fishes in the California Current Region. H. G. Moser (ed.). CalCOFI Atlas 33: 1505 p.