

Paralepididae

General Characters

Eleven genera and about 50 species in this family occur worldwide, many in tropical waters. Seventeen species in 11 genera occur as adults or larvae in the present study area. Eggs and rate of growth are undescribed. See Aulopiformes Introductory Table for meristic characters.

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 caudal peduncle
- Number of peritoneal pigment patches and size at which they develop

Larval characters contrasted with larvae of other aulopiform families

Paralepididae	Other Aulopiformes
Body compressed	Round and segmented in Chlorophthalmidae and Scopelosauridae
Head pointed; top of head not angular	Top of head angular in <i>Omosudis</i>
Snout and jaws not "duckbilled"	"Duckbilled" jaws in Chlorophthalmidae and Scopelosauridae
Lower jaw slender (not deep)	Massive lower jaw in <i>Omosudis</i> and other Alepisauridae
Toothless margin of upper jaw at symphysis	
Both jaws relatively straight	Jaw margins strongly curved in some Scopelarchidae
No teeth on tongue	Hooked teeth present on tongue in some Scopelarchidae
Palatine teeth do not enter mouth profile when mouth open	Teeth do enter mouth profile in Evermannellidae
Distinct, slender teeth in 1–2 rows	
Eye large, lateral, round or slightly squared	
Dorsal and pelvic fins posterior (at about mid-trunk)	Both fins anteriorly placed in <i>Omosudis</i> , Scopelarchidae and Evermannellidae
Dorsal fin small	Dorsal fin larger in Ipnopidae and Alepisauridae
Anal fin far posterior (and usually the most prominent fin)	
Anterior anal fin rays the longest	
Gut lengthens gradually during larval development	In Scopelarchidae, gut lengthens suddenly at transformation
Peritoneal pigment patches form sequentially during development	In Scopelarchidae, peritoneal pigment patches form simultaneously
Transformation occurs at large size	

Paralepididae

General Characters

Distribution:

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

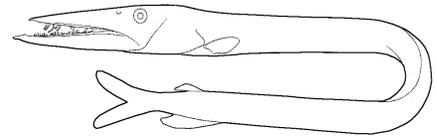
Diagnosis of western North Atlantic paralepidid larvae 10–40 mm (after Rofen, 1966a)

Taxa	Characters
<i>Anototopterus pharao</i>	Peritoneal pigment uniform on dorsum of gut; not in patches
<i>Sudis atrox</i> , <i>Sudis hyalina</i>	Pectoral fins elongate; body short, head large, snout long, preopercle spines present
<i>Uncisudis advena</i>	Pelvic fins elongate
<i>Paralepis</i> species	Pectoral fins short; body short, head large, snout long (except <i>P. elongata</i>)
<i>Macroparalepis</i> species	Body elongate, head very small, intestine curved under head (<10 mm); caudal fin spotted with melanophores; 10 or fewer peritoneal pigment patches (except 12 in western Atlantic <i>M. affinis</i>)
<i>Stemonosudis</i> species	Body and head elongate; intestine behind head; caudal fin unpigmented; 10 or more peritoneal pigment patches; highest vertebral counts in family
<i>Paralepis coregonoides</i> <i>Lestidiops affinis</i>	One or more lines of melanophores on side of body
<i>Arctozenus risso</i> (<i>krøyeri</i>) <i>Lestidiops jayakari</i> (<i>jayakari</i>) <i>Lestidium atlanticum</i>	Numerous oblique lines of melanophores above and below vertebral column on caudal peduncle in larger larvae
<i>Magnisudis atlantica</i> <i>Lestrolepis intermedia</i>	One vertical pigment band on body above anal fin Single curved line of melanophores on top of head; scattered spots on caudal region
<i>Macroparalepis affinis</i> (<i>americana</i>) <i>Macroparalepis brevis</i>	Numerous minute melanophores on caudal fin Large melanophores on caudal fin

In the species accounts that follow, the sequential development of peritoneal pigment patches is indicated in brief tabular form, with the number of pigment patches in the top row and the size at which that number is first observed in the lower row. (*Anotopterus pharao* lacks peritoneal pigment patches.) The following example pertains to *Paralepis coregonoides*:

Peritoneal 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

***Anotopterus pharao* Zugmayer, 1911**
Paralepididae
 Daggertooth



Range: Worldwide in temperate waters of both hemispheres, reaching to near poles in Atlantic and Pacific oceans; in the western North Atlantic from Davis Strait to Georgia

Habitat: Meso- to bathypelagic, mostly in depths of 500–2,000 m; adults occur more poleward than young stages

Spawning: Hermaphroditic; otherwise reproductive biology undescribed

Eggs: – Undescribed

Larvae:

- Body thin and slender
- Large head with pointed snout; large canine teeth on each palatine bone
- Cartilaginous tabs on tips of both jaws; tab on lower jaw persists into adult stages
- Long gut extends to beyond mid-body
- Preanus length about 65% SL, but increases at transformation
- Fin rays formed by about 25 mm, but sequence of fin ray formation undescribed
- Dorsal fin lacking; adipose fin present
- Anal fin short-based (compared to other paralepidids)
- Light pigment scattered on snout, tips of jaws, dorsum of body, near tip of notochord; dorsum of gut uniformly pigmented

Meristic Characters

Myomeres:	76–80
Vertebrae:	78–83
Dorsal fin rays:	none
Anal fin rays:	14–16
Pectoral fin rays:	12–15
Pelvic fin rays:	9–11
Caudal fin rays:	10+9 (PrC)

Note:

1. Most direct pattern of development in the Aulopiformes (Okiyama, 1984a; 1984b)
2. Peritoneal pigment patches absent in this species

Early Juvenile:



B. 50.0 mmSL

- Juvenile stages silvery; adults blackish over-all

Figures: Adult: William F. Stone (Rofen, 1966c); **A:** Okiyama, 1984a; **B:** Janet R. Canning (Rofen, 1966c)

References: Okiyama, 1984a; 1984b; Post 1984c; Scott and Scott, 1988

Anotopterus pharao



A. 14.2 mmSL

Arctozenus risso* (Bonaparte, 1840)*Paralepididae****White barracudina**

Range: Worldwide from arctic to antarctic waters; both sides of the Atlantic Ocean; in the western North Atlantic from Greenland and Flemish Cap through Gulf of St. Lawrence, south to Georgia

Habitat: Mesopelagic in colder waters, in depths of 200–1,000 m; larvae and juveniles generally in shallower and warmer water than adults; larvae common over Scotian Shelf and Georges Bank

Spawning: Occurs in temperate to subtropical waters, probably from winter to fall, with a peak in spring (May)

Eggs: – Undescribed

Larvae:

- Body elongate, snout becomes more elongate with development
- Eye may be slightly oval, horizontally elongate
- Flexion occurs at about 12–24 mm
- Pelvic fin forms under dorsal fin at about 28 mm; origin is posterior to dorsal fin origin after transformation
- Caudal fin rays formed by 20.5 mm; dorsal fin rays by 30 mm; anal fin rays by 28 mm
- Pigment includes 5 melanophores over posterior anal fin at 20.5 mm; these increase to 2 lines of spots, one dorsal, one ventral to posterior end of notochord
- Pigment also occurs at tip of snout, lower jaw, top of head behind eyes (absent in preflexion)
- 4 melanophores at anal fin origin at 23 mm, become more intense
- Large melanophores develop along base of dorsal fin, become more prominent at 38.8 mm
- Development of 1 to 12 peritoneal pigment patches as follows:

Peritoneal 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

Meristic Characters

Myomeres:	about 80–85
Vertebrae:	80–85 (38–41 precaudal)
Dorsal fin rays:	8–11
Anal fin rays:	31–34
Pectoral fin rays:	10–13
Pelvic fin rays:	9 (8–12)
Caudal fin rays:	10+9 (PrC)

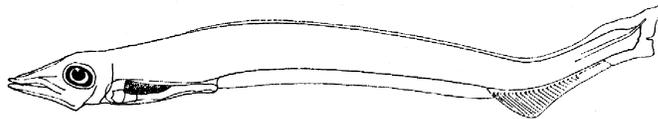
Figures: Adult: A. Post (Post, 1989); A–F: Ege, 1930

References: Ege, 1930; Rofen, 1966a; Post, 1984c

Arctozenus risso



A. 9.5 mmSL



B. 18.0 mmSL



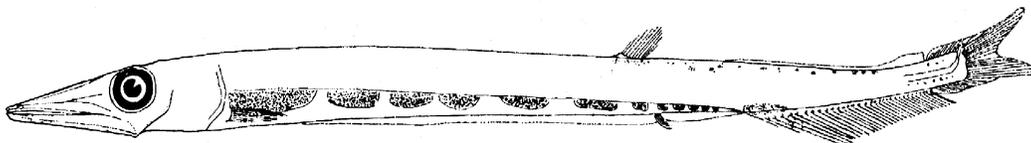
C. 23.0 mmSL



D. 30.0 mmSL



E. 38.0 mmSL



F. 45.0 mmSL

Lestidiops affinis* (Ege, 1930)*Paralepididae**

No common name



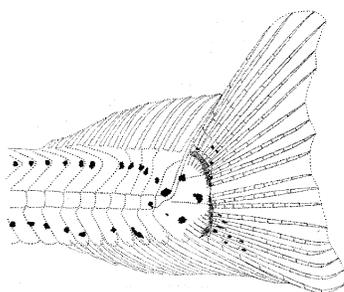
- Range:** Atlantic Ocean in tropical and warm temperate waters; in the western North Atlantic from Grand Bank to Brazil
- Habitat:** Meso- and bathypelagic in depths to 2,000 m (usually <600 m); larvae and juveniles in shallower layers (<200 m)
- Spawning:** Year-round in tropics and subtropics; mainly May–Oct in western North Atlantic
- Eggs:** – Undescribed

Meristic Characters

Myomeres:	about 75–85
Vertebrae:	75–85 (30–35 precaudal)
Dorsal fin rays:	8–10
Anal fin rays:	27–30
Pectoral fin rays:	10–12
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

- Larvae:**
- Body long and slender
 - Head short and deep, with blunt snout; nostrils at mid-length of upper jaw
 - Anus and pelvic fin farther anterior (relative to dorsal fin) than in larvae of *L. jayakari* or *Macroparalepis affinis*
 - Pelvic fin well anterior to dorsal fin
 - Most anal fin rays formed at about 30 mm; caudal fin rays by 30 mm; all fin rays formed by 43 mm
 - Pigmentation includes 2 widely separated mid-ventral spots (posterior half of body) by 8.5 mm; these become doubled at 10–15 mm
 - Mid-ventral row and 2 lines of spots develop on side of caudal peduncle at 15–80 mm (Fig. G)
 - Few spots on top of head (about 17 mm)
 - Internal pigment present between vertebrae over anal fin origin at 36.5 mm
 - Development of 2 to 12 peritoneal pigment patches as follows:

Peritoneal 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	43.0

**G. 44.4 mmSL**

Figures: Adult: Post, 1984c; **A–F:** Ege, 1930; **G:** Rofen, 1966a

References: Ege, 1930; 1953; Rofen, 1966a; Post, 1984c

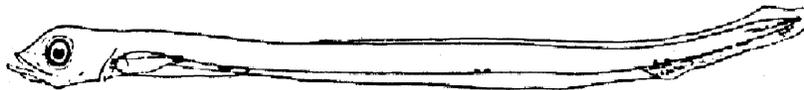
Lestidiops affinis



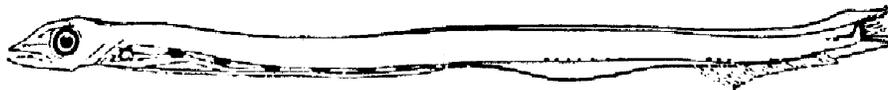
A. 4.3 mmSL No pigment except in eye in early stages



B. 8.5 mmSL



C. 13.5 mmSL Melanophores at caudal fin base, but not on caudal peduncle in larvae <18 mm

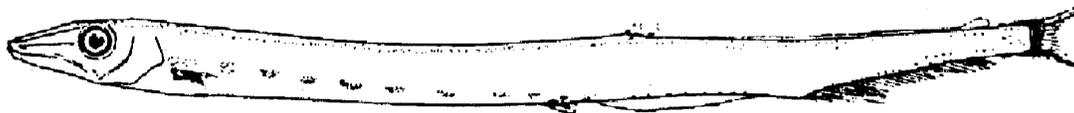


D. 17.5 mmSL Note 7 melanophores between anus and anal fin, and 3 over anterior anal fin; the latter 3 disappear at 30 mm



E. 43.0 mmSL

Larvae similar to those of *Macroparalepis affinis*



F. 76.0 mmSL

Lestidiops jayakari* (Boulenger, 1889)*Paralepididae**

No common name



Range: Atlantic, Indian and western Pacific oceans; most common in the western North Atlantic from Grand Bank to Gulf of Mexico

Habitat: Meso- to bathypelagic in depths of 200–2,000 m; larvae usually in shallower layers (<200 m)

Spawning: Year-round in tropical and subtropical waters

Eggs: – Undescribed

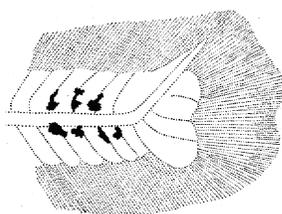
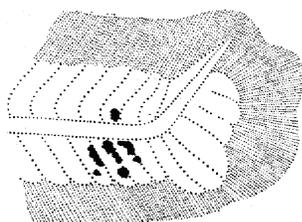
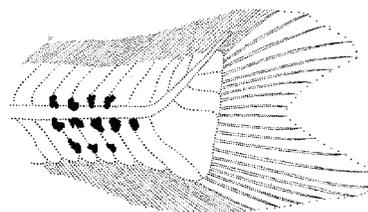
Larvae:

- Body long and slender
- Head short and deep in small larvae, becomes longer, more pointed with development
- Anus reaches final position under dorsal fin at about 20 mm
- Pelvic fin forms well anterior to dorsal fin; pelvic fin rays complete at about 25 mm
- Anal fin rays complete at about 20 mm; dorsal fin rays complete at about 25 mm

– Development of 2 to 12 peritoneal pigment patches as follows:

Peritoneal Patches	2	4	5	5	7	9	10	9	10	12	12
Larval Sizes (mm)	8.0	12.0	12.2	13.0	15.0	15.6	16.5	18.0	20.6	25	37

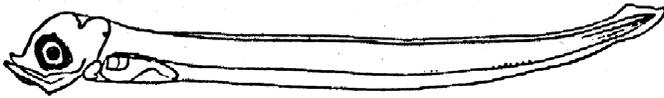
– Caudal peduncle pigment patterns (in 2 subspecies):

**I. 13.0 mmSL***L. j. jayakari***J. 13.6 mmSL***L. j. pseudosphyraenoides* (Ege)**K. 15.6 mmSL***L. j. pseudosphyraenoides* (Ege)

Figures: Adult: Post, 1984c; **A–B, D, F–H:** Ege, 1930; **C, E:** Ozawa, 1986f; **I–K:** Rofen, 1966a

References: Ege, 1930; 1953; Rofen, 1966a; Post, 1984c; Ozawa, 1986f; Olivar and Fortuño, 1991

Lestidiops jayakari

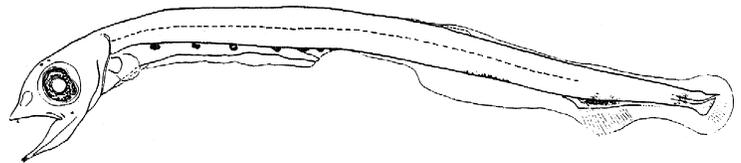


A. 8.0 mmSL

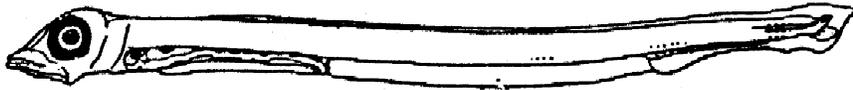


B. 12.0 mmSL

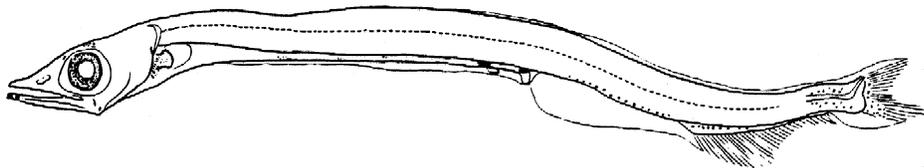
- 3 diagnostic groups of melanophores:
- ventral row between anus and anal fin origin
- ventral row over anterior anal fin
- midlateral rows on caudal peduncle



C. 12.3 mmSL



D. 15.0 mmSL



E. 15.9 mmSL



F. 16.5 mmSL



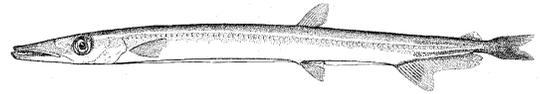
G. 25.0 mmSL



H. 37.0 mmSL

Lestidium atlanticum* Borodin, 1928*Paralepididae**

No common name



Range: Atlantic, Indian and western Pacific oceans in tropical to warm temperate waters; in the western North Atlantic from south of Georges Bank to Brazil

Habitat: Mesopelagic in depths of 0–1,200 m

Spawning: Mainly Nov–Apr, centered in Caribbean Sea

Eggs: – Undescribed

Larvae:

- Body elongate and slender
- Snout blunt in early larvae, becomes more pointed with development
- Head deep in early larvae, with eye nearly square (eye becomes round at about 10 mm)
- Anus migrates posteriorly with development; reaches final position under posterior end of dorsal fin at 17 mm
- Preanus length about 65% SL by 16 mm
- Flexion complete at about 13 mm
- Pelvic fin forms under or slightly anterior to first dorsal fin ray
- Dorsal, anal and pelvic fin rays fully formed by 22–23 mm
- Pigmentation is light on the body
- A single, prominent spot present above the end of the notochord in smallest larvae to those of 31.5 mm
- Melanophores present along base of developing anal fin
- No pigment on pectoral fins
- Scattered pigment develops on top of head, tip of lower jaw
- Development of 8 peritoneal pigment patches as follows:

Peritoneal Patches	0	4	7	8	8	**	**
Larval Size (mm)	6.0	10.5	10.6	17.0	22.3	31.5	43.5

** Pigment patches become indistinct

– 2 peritoneal patches present in 4.6 mm larva from Pacific Ocean (Ozawa, 1986f)

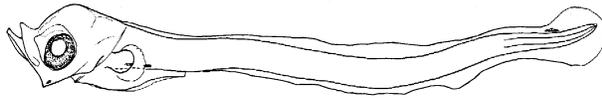
Meristic Characters

Myomeres: about 80–83
 Vertebrae: 80–83
 Dorsal fin rays: 9–10
 Anal fin rays: 29–30
 Pectoral fin rays: 12
 Pelvic fin rays: 9
 Caudal fin rays: 10+9 (PrC)

Figures: Adult: Eva Maria Soule (Rofen, 1966a); **A, D–E:** Ozawa, 1986f; **B–C, F–I:** Ege, 1930

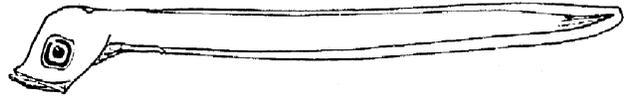
References: Ege, 1930; 1953; Rofen, 1966a; Ozawa, 1986f

Lestidium atlanticum



A. 4.6 mmSL

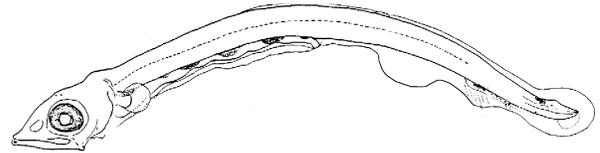
Few melanophores on top of head



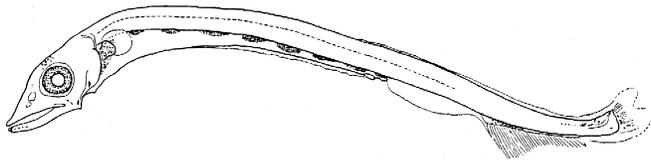
B. 6.0 mmSL



C. 10.5 mmSL



D. 10.6 mmSL



E. 15.9 mmSL

F. 17.0 mmSL



G. 22.3 mmSL

Oblique streaks of pigment along myosepta of caudal peduncle



H. 31.5 mmSL

Peritoneal pigment patches become indistinct



I. 43.5 mmSL

Oblique myoseptum pigment fades

Lestrolepis intermedia* (Poey, 1868)*Paralepididae**

No common name



Range: Worldwide in tropical to warm temperate waters; in the western North Atlantic from southern flank of Georges Bank to northern Brazil; larvae and juveniles have been collected from the Gulf Stream as far east as 60°W

Habitat: Mesopelagic

Spawning: Centered in the Caribbean Sea, mainly during Dec–Apr

Eggs: – Undescribed

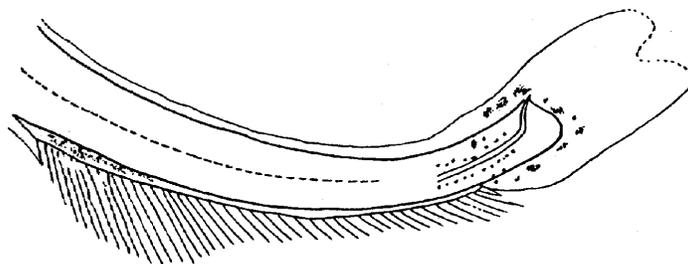
Larvae:

- Body long and slender
- Head fairly large and deep in early larvae
- Anus moves posteriorly with development, reaching final position at about 20 mm
- Pelvic fin located well anterior to dorsal fin
- Anal and caudal fin rays formed at about 26 mm; all fin rays complete by 43.5 mm
- Numerous melanophores form early on dorsal and ventral finfolds near caudal fin
- Pigmentation includes parallel lines of spots on side of caudal peduncle (Fig. I); in addition to finfold spots, 4 parallel rows of spots form near tip of notochord; upper and lower rows become indistinct, leaving a single row above, and a single row below the midline of the caudal peduncle
- Few melanophores near angle of lower jaw in early larvae; single, curved line of spots on top of head
- Development of 1 to 8 peritoneal pigment patches as follows:

Peritoneal Patches	1	5	7	8	8
Larval Size (mm)	8.2	11.3	13.5	20.5	26.0

Meristic Characters

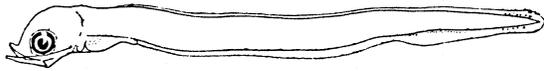
Myomeres:	about 91–93
Vertebrae:	91–93 (29 precaudal)
Dorsal fin rays:	9
Anal fin rays:	41–42
Pectoral fin rays:	11
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

**I. 19.5 mmSL**

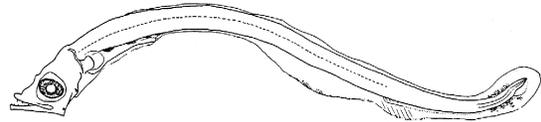
Figures: Adult: Eva Maria Soule (Rofen, 1966a); **A, C, E–H:** Ege, 1930; **B, D, I:** Ozawa, 1986f

References: Ege, 1930; Rofen, 1966a; Ozawa, 1986f

Lestrolepis intermedia



A. 8.2 mmSL

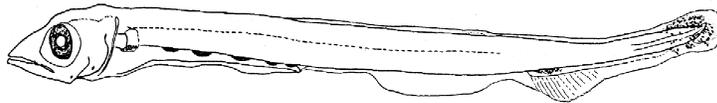


B. 9.1 mmSL



C. 11.3 mmSL

In addition to finfold melanophores, 4 parallel rows of spots form near tip of notochord (see Fig. I)



D. 12.2 mmSL



E. 13.5 mmSL



F. 20.5 mmSL



G. 26.0 mmSL

Spots over anterior anal fin base



H. 43.5 mmSL

Macroparalepis affinis* Ege, 1933*Paralepididae**

No common name



Range: Temperate and tropical North Atlantic, South Atlantic and Pacific; in the western North Atlantic from the southern slope of Georges Bank and vicinity of Hudson Canyon to the Bahamas and Sargasso Sea

Habitat: Meso- to bathypelagic in depths of 400–2,000 m; larvae shallower

Spawning: Year-round, with lower activity during summer

Eggs: – Undescribed

Larvae:

- Body very long and slender
- Snout relatively short; eye nearly square in shape in early larvae
- Coiled gut positioned under head in early larvae, becomes elongate in later larvae
- Pelvic fin forms anterior to dorsal fin
- Pigmentation includes series of melanophores on ventral edge of body behind anus; these decrease in number with development
- A single melanophore forms under the eye at 14.8 mm (in western Atlantic form); becomes 2 spots at about 26 mm
- Melanophores form an arc on top of head at about 17.7 mm (in western Atlantic form); increase in number
- Uniform pigment covers caudal fin (Fig. F); compare to pattern in *Macroparalepis brevis* and *Lestidiops affinis*
- Development of 2–12 peritoneal pigment patches as follows:

Meristic Characters

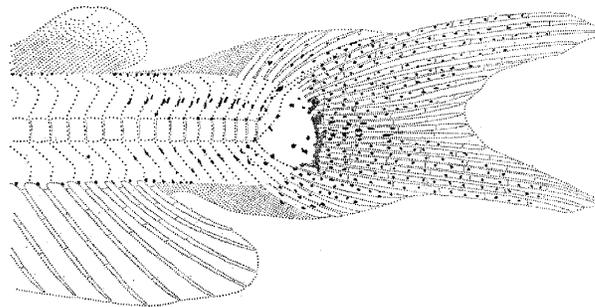
Myomeres:	about 96–103
Vertebrae:	96–103
Dorsal fin rays:	10–14
Anal fin rays:	25–28
Pectoral fin rays:	11
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

Peritoneal 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

* pertain to western North Atlantic form where maximum number is 12; maximum number is 10 in eastern North Atlantic

Note: 1. Two subspecies occur in the North Atlantic: text and description refers to *M. affinis americana* from the western North Atlantic, illustrations opposite pertain to *M. affinis affinis* from the eastern North Atlantic

F. 30.6 mm
M. affinis americana



Figures: Adult: Post, 1984c; A–E: Ege, 1957; F: Vyvien J. Wynne (Rofen, 1966a)

References: Ege, 1957; Rofen, 1966a; Post, 1984c

Macroparalepis affinis



A. 8.0 mmSL

About 20 postanal spots along ventral edge, last 2 widely spaced



B. 14.0 mmSL

Pigment on caudal fin begins



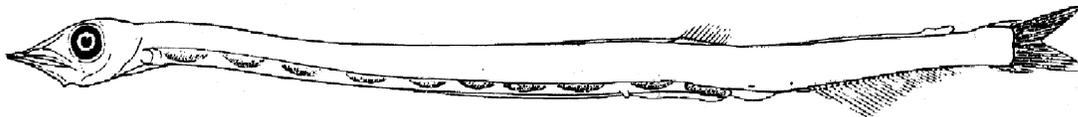
C. 15.5 mmSL

About 12 postanal spots along ventral edge in western Atlantic form



D. 18.5 mmSL

About 8 postanal spots along ventral edge in western Atlantic form at 17.7 mm, 4 spots at 20.2 mm, 5 spots at 26.1 mm

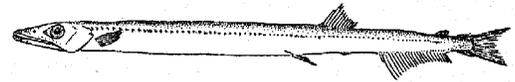


E. 28.0 mmSL

2 postanal spots remain along ventral edge

Macroparalepis brevis* Ege, 1933*Paralepididae**

No common name



Range: Antitropical pattern in the North and South Atlantic oceans; in the western North Atlantic from vicinity of Bear Seamount south to about 15°N

Habitat: Mesopelagic in depths of 0–650 m

Spawning: Year-round (Sargasso Sea) with peak in Feb–Jun

Eggs: – Undescribed

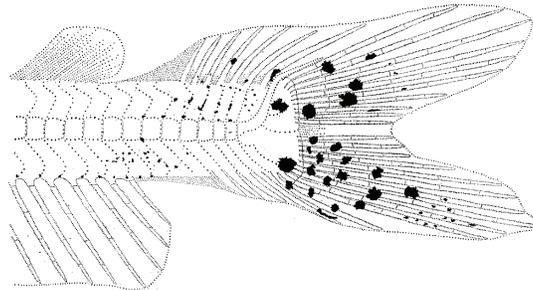
Larvae:

- Body elongate, but less so than in *Macroparalepis affinis*
- Snout relatively short, elongates later in development
- Eye nearly square in early larvae
- Coiled gut positioned under head in early larvae, elongates in later larvae
- Dorsal and anal fin rays complete at about 27.5 mm
- Pigmentation includes a series of melanophores along ventral edge of body from anus to anterior one-third of anal fin; number decreases with development
- Melanophores develop over anterior end of anal fin at about 12 mm
- Conspicuous spots on caudal fin present throughout development (Fig. G)
(Compare to pattern in *Macroparalepis affinis* and *Lestidiops affinis*)
- Development of 0–7 peritoneal pigment patches as follows:

Meristic Characters

Myomeres:	about 81–86
Vertebrae:	81–86
Dorsal fin rays:	11–13
Anal fin rays:	19–24
Pectoral fin rays:	11
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

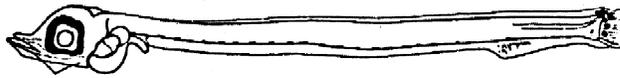
Peritoneal Patches	0	0	4	7	8	7	8	8	7	7
Larval Size (mm)	7.5	10.0	12.0	14.5	15.5	17.0	21.5	27.5	30.5	30.7

**G. 27.5 mm**

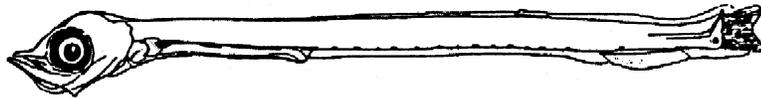
Figures: Adult: Post, 1984c; A–F: Ege, 1957; G: Vyvien J. Wynne (Rofen, 1966a)

References: Ege, 1957; Rofen, 1966a; Post, 1984c; Moore *et al.*, 2003

Macroparalepis brevis



A. 10.0 mmSL



B. 12.0 mmSL



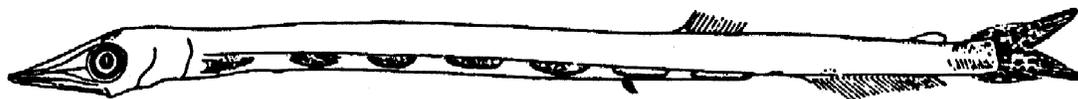
C. 14.5 mmSL Melanophores on lower jaw and top of head



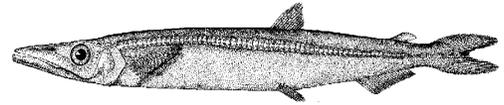
D. 17.0 mmSL Oblique row of spots forms under eye



E. 30.5 mmSL Melanophores develop along myosepta on caudal peduncle



F. 42.0 mmSL

Magnisudis atlantica* (Krøyer, 1868)*Paralepididae****Duckbill barracudina**

Range: Worldwide (except Mediterranean Sea) in boreal to tropical waters; in the western North Atlantic from Greenland to Brazil; abundant in Sargasso Sea

Habitat: Meso- to bathypelagic in depths of 66–2,166 m (mostly between 230 and 1,100 m)

Spawning: Year-round in temperate and tropical waters; mostly Mar–Jun in Sargasso Sea and near Bermuda

Eggs: – Undescribed

Larvae:

- Body less slender and head deeper than in larvae of *Paralepis coregonoides*; also fewer myomeres
- Head and snout longer than in *Paralepis elongata*
- Flexion complete at about 10 mm
- Anus moves posteriorly early in development, reaching final position (67–72% SL) by 13–15 mm (compare to similar development in other paralepidid species)
- Pelvic fin forms under dorsal fin
- All fin rays (except pelvic) formed by 14.6 mm
- Pigmentation includes deep melanophores between adipose and anal fins; begin as 2 spots above and below end of notochord at 10.5 mm
- Melanophores at origin of dorsal and anal fins form at 10.5 mm; spots present on lower caudal fin rays
- Development of 1–3 peritoneal pigment patches as follows:

Peritoneal 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

– Only 2 peritoneal pigment patches anterior to level of dorsal fin

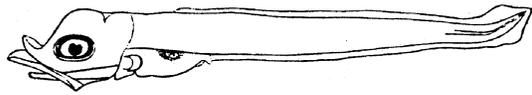
Meristic Characters

Myomeres:	63–66
Vertebrae:	63–66 (31–35 precaudal)
Dorsal fin rays:	9–11
Anal fin rays:	20–26
Pectoral fin rays:	15–17
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

Figures: Adult: D. R. Harriott (Scott and Scott, 1988); **A–H:** Ege, 1930

References: Post, 1984c; Scott and Scott, 1988; Okamura *et al.*, 1995

Magnisudis atlantica



A. 5.8 mmSL



B. 8.2 mmSL

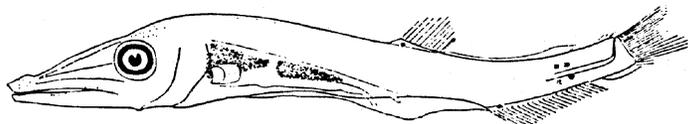
C. 9.8 mmSL



D. 11.7 mmSL



Few pigment spots
on top of head



E. 14.3 mmSL

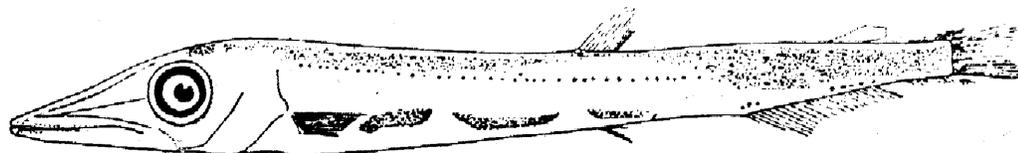


F. 19.3 mmSL

Snout about 50% of head length



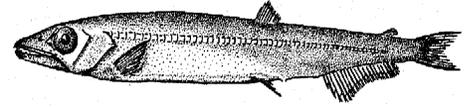
G. 28.0 mmSL



H. 54.5 mmSL

Paralepis brevirostris* (Parr, 1928)*Paralepididae**

No common name



Range: Adults only known from Atlantic Ocean; young stages reported from tropical and subtropical waters of the Atlantic and Indian oceans as well as around Philippines and South China Sea; in the western North Atlantic from 38°N to Caribbean Sea; one larva from as far north as 39°27'N, 65°35'W (MCZ 130828)

Habitat: Mesopelagic in depths >1,000 m

Spawning: Year-round in tropical and subtropical waters

Eggs: – Undescribed

Larvae:

- Body elongate, but similar in depth to larvae of *Paralepis elongata*
- Head and snout moderately pointed
- Flexion complete before 13 mm
- Anus and pelvic fin forms under mid-dorsal fin
- All fin rays complete (except pelvic fin rays) by 13.1 mm
- Pigmentation includes dense melanophores scattered on top of head and few spots on opercle
- 9 peritoneal pigment patches all anterior to level of dorsal fin
- Anterior peritoneal pigment patches very large, size tapers to very small patches over anus
- Development of 9 peritoneal pigment patches as follows:

Peritoneal Patches	9	9	6	5	9
Larval Size (mm)	13.1	13.4	23.4	31.5	43.4

Meristic Characters

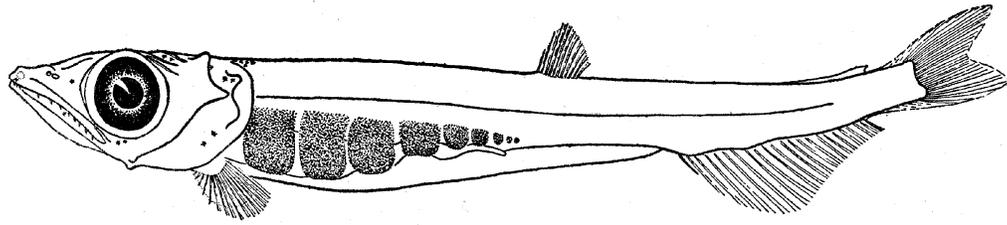
Myomeres:	about 64–67
Vertebrae:	64–67
Dorsal fin rays:	10–12
Anal fin rays:	22–24
Pectoral fin rays:	16–17
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

- Note:**
1. As described by Harry (1951) the numbers of peritoneal pigment patches decrease, then increase in larvae and juveniles. Possibly more than one species involved in the description. Only the 13.4-mm specimen was illustrated.
 2. *Paralepis brevirostris* (Parr, 1928) was referred to the synonymy of *P. elongata* (Brauer, 1906) by Rofen (1966a); Post (1984c) considered *P. brevirostris* (but not *P. elongata*) from the eastern Atlantic; Moore *et al.* (2003) and Thompson (2003) consider both *P. brevirostris* and *P. elongata* as valid
 3. Also note that R. R. Harry (1951) and R. R. Rofen (1966a) are the same author

Figures: Adult: Post, 1984c; A: Harry, 1951

References: Harry, 1951; Ege, 1930; 1953; Rofen, 1966a

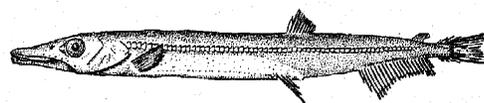
Paralepis brevirostris



A. 13.4 mmSL

Paralepis coregonoides* Risso*Paralepididae**

No common name



Range: North Atlantic Ocean and Mediterranean Sea; in the western North Atlantic from Davis Strait to the Bahamas

Habitat: Meso- to bathypelagic in depths of 3–1,500 m; larvae and juveniles collected from shallower layers than adults; larvae commonly collected near edge of continental shelf and deeper

Spawning: Spring through summer (later than *Arctozenus risso*)

Eggs: – Undescribed

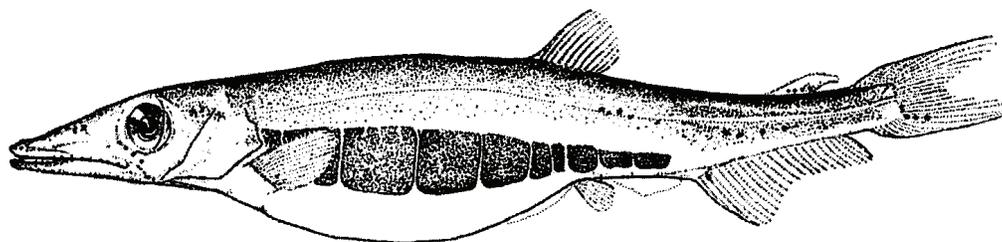
Larvae: – Body elongate, snout relatively long (compare to *Paralepis elongata*)
 – Head smaller, snout shorter, and peritoneal pigment patches more numerous than in larvae of *Magnisudis atlantica*
 – Pelvic fin forms under dorsal fin at about midbody
 – Most caudal and anal fin rays formed by 15.5 mm; all rays complete by 30.5 mm
 – Pigmentation includes U-shaped line of melanophores on interorbital (rounded side anterior); forms at 14–16 mm
 – Note increase in number of melanophores above and below terminus of notochord
 – Development of 1 to 9 peritoneal pigment patches as follows:

Peritoneal 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 Characters

Myomeres:	about 68–74
Vertebrae:	68–74 (32–37 precaudal)
Dorsal fin rays:	9–11
Anal fin rays:	22–26
Pectoral fin rays:	14–15
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

- Note:**
1. The subspecies *P. coregonoides barracudina*, with 69–75 myomeres (mode 72–73), occurs in western Atlantic
 2. Number of peritoneal pigment patches increases from 3 to 9 at sizes 15 to 30 mmSL. Illustrations inaccurately imply a different schedule.

Early Juvenile:**F. 30.5 mmSL**

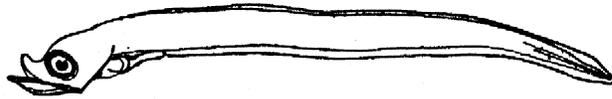
Note remnant finfolds around pelvic fin

Figures: Adult: Post, 1984c; A–F: Ege, 1930

References: Ege, 1930; 1953; Rofen, 1966a

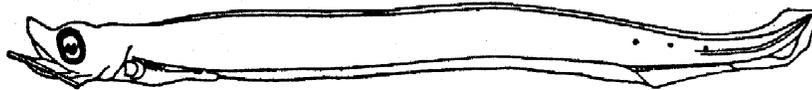
Paralepis coregonoides

1 deep pigment spot above notochord tip

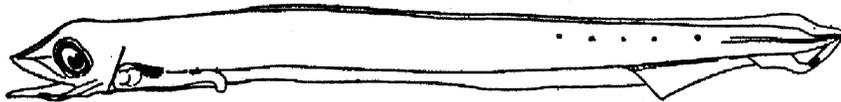


A. 6.0 mmSL

1 peritoneal pigment patch
3 deep pigment spots above posterior notochord



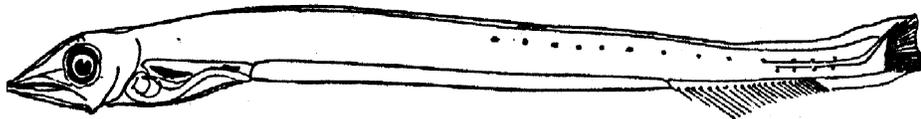
B. 11.8 mmSL



C. 13.5 mmSL

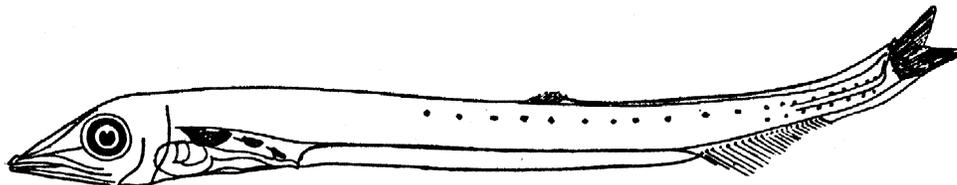
Top of head finely spotted >15 mm

3 deep spots above, 4 below posterior notochord



D. 18.0 mmSL

Row of melanophores on upper sides
increase in number anteriorly

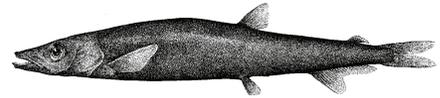


E. 22.0 mmSL

Number of deep spots above and below
posterior notochord increases with development

Paralepis elongata* (Brauer, 1906)*Paralepididae**

No common name



Range: Both sides of the North Atlantic Ocean, Indian Ocean and East Indies; in the western North Atlantic found between latitudes 38°N and 20°N

Habitat: Open ocean in temperate and tropical waters; meso- to bathypelagic in depths to 3,000 m

Spawning: Larvae may be present in study area year-round with a peak in May

Eggs: – Undescribed

Larvae:

- Body elongate, becomes deep anteriorly
- Later larvae and juveniles somewhat 'humpbacked' in appearance
- Snout relatively short, deep and conical
- Pelvic fin forms under dorsal fin at about midbody
- Anus located under posterior dorsal fin rays
- Caudal and anal fin rays formed by 14.4 mm, dorsal fin rays by 15.6 mm, and pelvic fin rays by 22.0 mm
- Pigment totally lacking on posterior body in early stages (compare to *Arctozenus* and other *Paralepis* species)
- Row of melanophores forms along anal fin base
- Characteristic pattern of stellate melanophores on occiput, nape and interorbital, develops at 12–14 mm and spreads posteriorly with development
- 5 or 6 large peritoneal pigment patches located anterior to level of dorsal fin origin (only 2 such patches in *Magnisudis atlantica*)
- Development of 1 to 12 peritoneal pigment patches as follows:

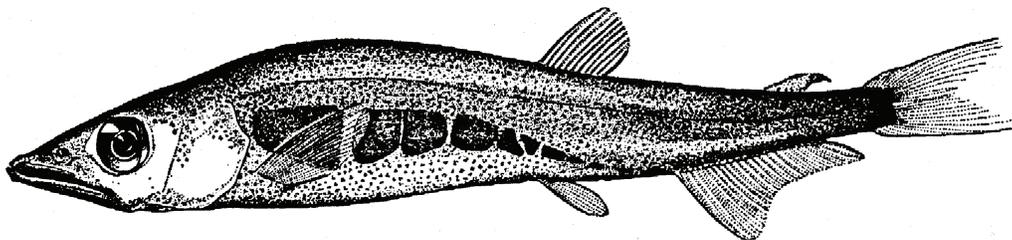
Peritoneal Patches	3	6	8	6	9	11–12
Larval Size (mm)	14.4	16.7	15.6	20.0	22.0	25.0

Meristic Characters

Myomeres:	about 65–67
Vertebrae:	65–67 (32–36 precaudal)
Dorsal fin rays:	10–12
Anal fin rays:	20–25
Pectoral fin rays:	15–17
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

Note: 1. Scales cover entire body by 44 mmSL

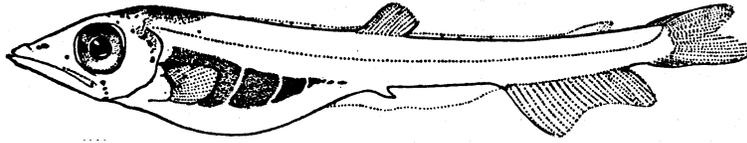
Early Juvenile:



D. 44.1 mmSL

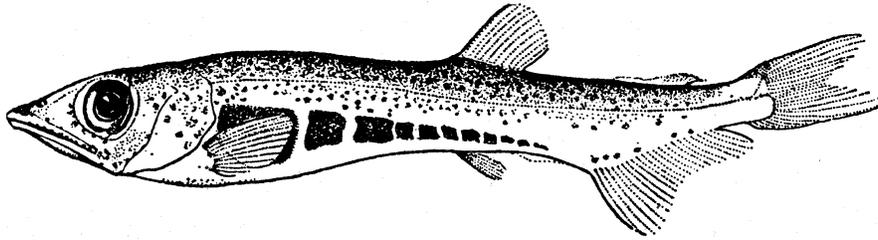
Figures: Adult and A–D: Eva Maria Soule (Rofen, 1966a)

References: Ege, 1930; 1933; 1953; Rofen, 1966a

Paralepis elongata**A. 16.7 mmSL**

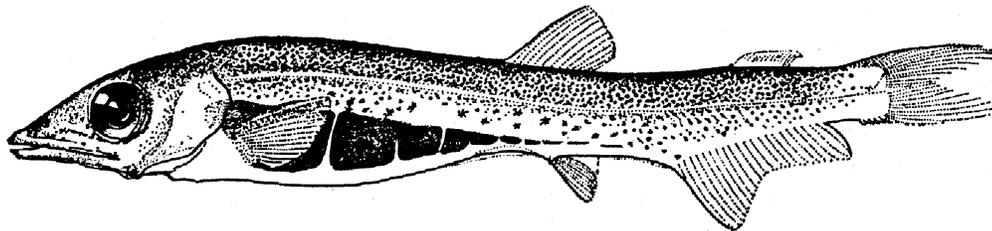
Snout unpigmented;
few spots at jaw angle

Few melanophores on pectoral fin;
other fins unpigmented

**B. 22.0 mmSL**

Row of melanophores along anal fin base

Dorsal pigment spreads posteriorly

**C. 25.0 mmSL**

A series of larvae 13.7 to 35.0 mm was also described and illustrated by Ege (1933). Although Rofen (1966a) did not refer to, or comment on, Ege's series, there are significant differences between the two. The larvae described by Ege (1933) are more elongate and shallow-bodied (at least in larvae <35.0 mm), have an intestine that elongates at a much larger size, have a different pigment pattern on the caudal peduncle, lack the 'humpbacked' appearance, and have a different schedule of peritoneal pigment patch acquisition. Unless all of these characters are subject to wide variability, it must be assumed that the involvement of more than one species in these two series is a possibility.

Stemonosudis intermedia* (Ege, 1933)*Paralepididae**

No common name



Range: North Atlantic Ocean in temperate to tropical waters; in the western North Atlantic from Grand Bank to Gulf of Mexico and Caribbean Sea. Two larvae reported from the Pacific Ocean (Ozawa, 1986f)

Habitat: Mesopelagic in depths to 1,000 m

Spawning: Undescribed; larval collections distributed throughout the year

Eggs: – Undescribed

Larvae:

- Body very elongate and slender
- Head shallow, elongate and jaws very pointed
- Pelvic fin develops well anterior to dorsal fin
- Preanus length very long (60% SL) in smallest larvae examined
- All fin rays formed by 34 mm
- Pigmentation includes melanophores on lower jaw tip
- Row of melanophores over top of head
- 3–4 long patches of pigment dorsally and ventrally on tail posterior to dorsal fin
- Dense pigment develops on caudal fin at about 20 mm
- Development of 16–18 peritoneal pigment patches as follows:

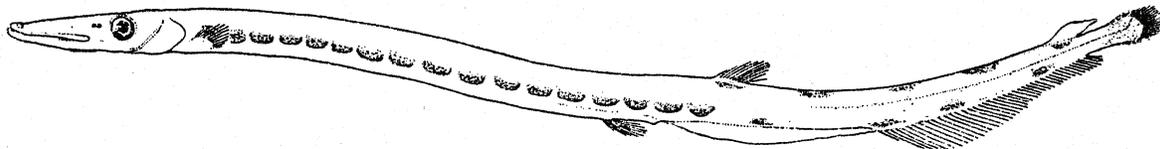
Peritoneal Patches	16	16	18
Larval Size (mm)	17.5	20.2	34.3

Meristic Characters

Myomeres:	111–121
Vertebrae:	111–121
Dorsal fin rays:	9–10
Anal fin rays:	41–47
Pectoral fin rays:	11–12
Pelvic fin rays:	8–9
Caudal fin rays:	10+9 (PrC)

Note: 1. Sixteen peritoneal pigment patches already formed in smallest larva examined

Early Juvenile:

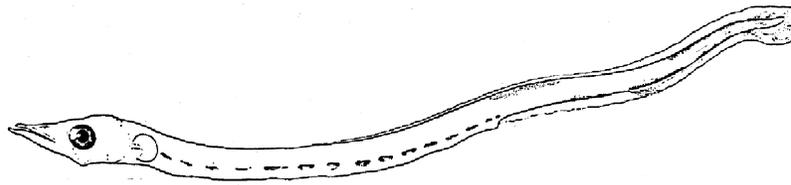


F. 138.0 mmSL

Figures: Adult: Eva Maria Soule (Rofen, 1966a); **A–B, D, F:** Ege, 1957; **C:** Ozawa, 1986f; **E:** Eva Maria Soule (Rofen, 1966a)

References: Rofen, 1966a; Ozawa, 1986f

Stemonosudis intermedia



A. 17.5 mmSL



B. 20.2 mmSL



C. 20.6 mmSL (Pacific specimen)



D. 77.0 mmSL

Lower jaw protrudes

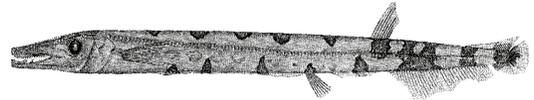


E. 118.5 mmSL

***Stemonosudis rothschildi* Richards, 1967**

Paralepididae

No common name



Range: Atlantic, Pacific and Indian oceans; in the western North Atlantic from slope of Georges Bank to Caribbean Sea

Habitat: Mesopelagic

Spawning: Undescribed

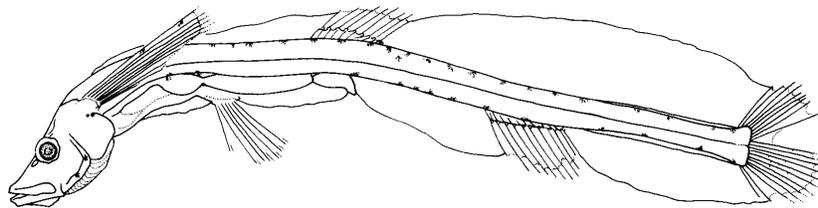
Eggs: – Undescribed

- Larvae:**
- Body elongate and slender
 - Head shallow and elongate with pointed jaws, slightly elliptical eye
 - Anus at mid-body in early larvae, migrates posteriorly with development
 - Relative head length increases with development
 - Dorsal fin has early forming, elongate rays (first fin to form rays); full complement of rays by 8 mm
 - Anal fin begins forming rays at anterior end at about 8 mm
 - Pelvic fin begins development at about 10 mm
 - Pigmentation includes 5 blotches situated along dorsal edge of body, increasing to 9 in larger larvae
 - Tips of both jaws pigmented; scattered pigment on head, opercle
 - Short series of spots forms along ventral edge of body, beginning with a single spot near anal fin origin
 - Development of peritoneal pigment patches as follows:

Meristic Characters	
Myomeres:	92–95
Vertebrae:	86–91
Dorsal fin rays:	8–9
Anal fin rays:	31–34
Pectoral fin rays:	10–12
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

Peritoneal Patches	7	11	11	??	11	11
Larval Size (mm)	7.5	10.6	20.2	34.1	55.5	108.3

The larvae of *Stemonosudis rothschildi* are superficially similar to those of *Bathymicrops* (family Ipnopidae). However, note positions of dorsal and anal fins and elongated fin rays in pectoral and pelvic fins in the latter. *Bathymicrops regis* occurs in the tropical western Atlantic, south of Florida, and the eastern North Atlantic. *Bathymicrops brevianalis* (Fig. D) occurs in the tropical Pacific Ocean. Both species occur in abyssal depths.



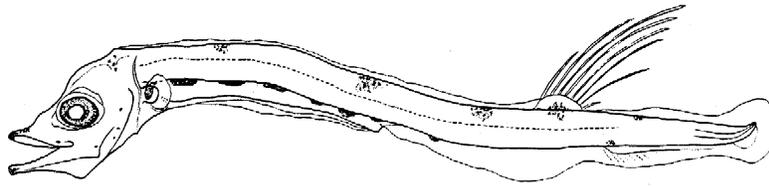
D. 70.0 mmSL

A 20-mm larva described as *Stomiatella* B (Roule and Angel, 1930) is *Bathymicrops regis* (Okiyama, 1984a).

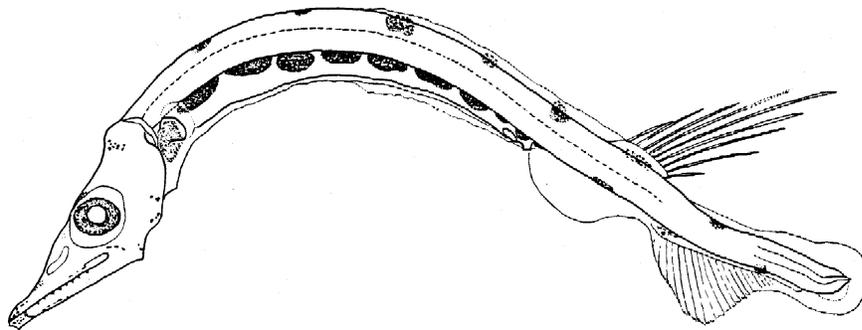
Figures: Adult: Grady Reinert (Richards, 1967); **A–C:** Ozawa, 1986f; **D:** Okiyama, 1984a

References: Post, 1971; Uyeno *et al.*, 1983; Okiyama, 1984a; Ozawa, 1986f; Nielsen and Merrett, 1992

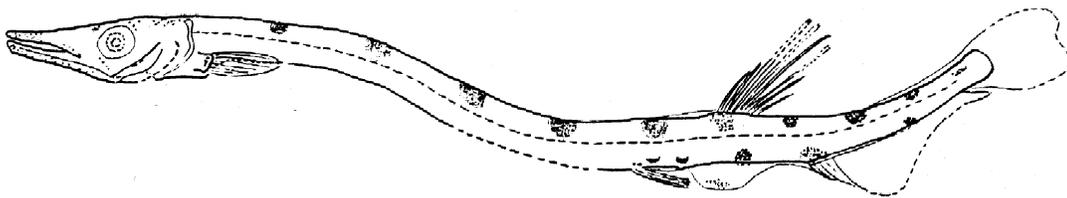
Stemonosudis rothschildi



A. 7.5 mmSL



B. 10.6 mmSL



C. 34.1 mmSL

Gut damaged; number of peritoneal pigment patches can not be determined

Sudis atrox* Rofen, 1963*Paralepididae**

No common name

Adult Image Unavailable

Range: Western Atlantic and eastern Pacific oceans; in the western North Atlantic from 41°36'N, 52°21'W to southern Brazil; most records based on larvae (maximum described size 75 mm)

Habitat: Meso- to bathypelagic in depths of 30–2,250 m

Spawning: Undescribed

Eggs: – Undescribed

Larvae:

- Body elongate and compressed, but not as elongate as larvae of other paralepidid genera
- Head small in early larvae, becomes proportionately larger with development
- Snout becomes more pointed with development; gape entirely anterior to level of eye throughout development
- Eyes initially large, elliptical and inclined forward (with small, pigmented, choroid tissue on lower edge)
- Anus begins slightly anterior to mid-point of body, migrates to 2/3 of the length in later larvae
- 3 large spines develop on preopercle; serrated ridge forms above eye; serrated ridge forms on upper snout; lower jaw also forms a serrated ridge of spines
- Preopercle spines form in 2 rows: outer row with 4 spines; inner row with 2 spines; spine at angle of preopercle becomes very large and serrated along its edge (Fig. E)
- Caudal fin rays first to form; dorsal fin forms at mid-point of body; pelvic fins form below the origin of the dorsal fin; all fin rays formed by 14 mm
- Pectoral fin rays become elongate during juvenile stage (ca 15 mm)
- Pigmentation includes a spot at the angle of both the inner and outer row of preopercle spines
- Development of 3 to 6 peritoneal pigment patches as follows:

Peritoneal Patches	3	5	6	10
Larval Size (mm)	2.4	5.4	9.2	21.5

- A maximum number of 6 peritoneal patches is reported for the 9.2-mm larva (Ozawa, 1986f), 4 anterior to the anus, 2 posterior to it. However, the 21.5 mm specimen (Berry and Perkins, 1966) is illustrated with 10 peritoneal pigment patches, some of which extend well posterior to the anus (Fig. F).

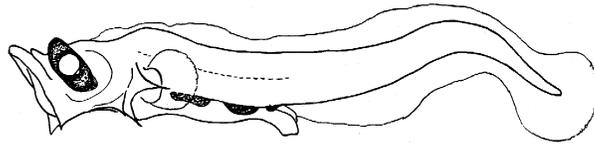
Meristic Characters

Myomeres:	50–55
Vertebrae:	53–54
Dorsal fin rays:	11
Anal fin rays:	21
Pectoral fin rays:	14
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

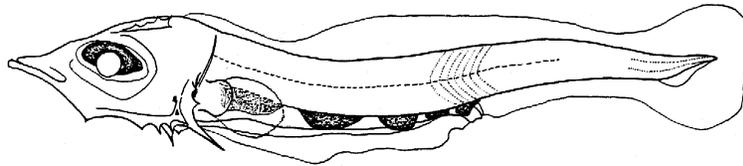
Figures: **A–C:** Ozawa, 1986f; **D–E:** Shores, 1969; **F:** Berry and Perkins, 1966

References: Belyanina, 1981; Okiyama, 1984a; 1984b; Ozawa, 1986f

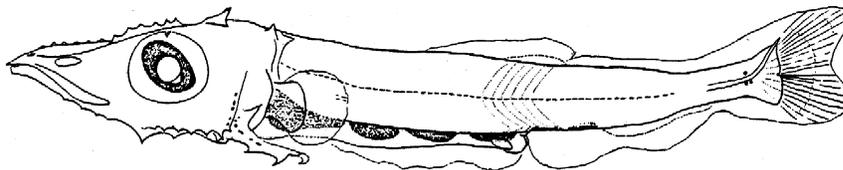
Sudis atrox



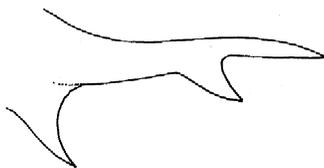
A. 2.4 mmSL



B. 5.4 mmSL

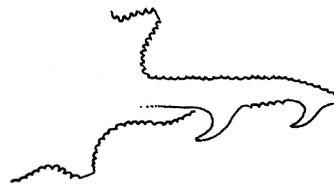


C. 9.2 mmSL



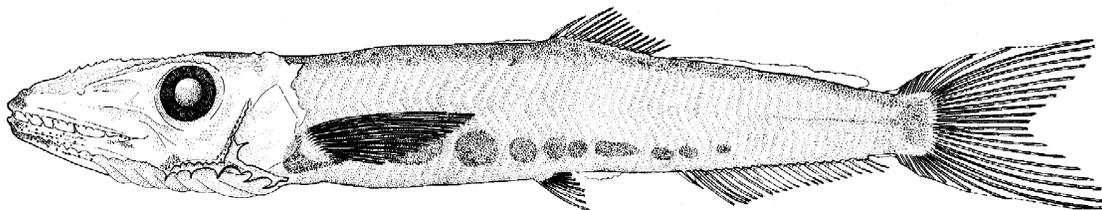
D. *Sudis hyalina* 16.1 mmSL

Preopercle angle spine
Smooth-edged with 1 retrorse hook



E. *Sudis atrox* 9.0 mmSL

Preopercle angle spine
Serrated edge with 1 or more
antorse hooks

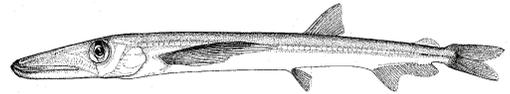


F. 21.5 mmSL

Note serrated ridges along top of snout and lower jaw,
and large spine with secondary barbs at angle of preopercle

Sudis hyalina* Rafinesque, 1810*Paralepididae**

No common name



Range: North Atlantic Ocean as far north as 50°N, South Atlantic Ocean to 40°S; in the western North Atlantic from Grand Bank to southern Brazil; also Mediterranean Sea

Habitat: Meso- to bathypelagic in depths of 200–2,000 m

Spawning: Undescribed

Eggs: – Undescribed

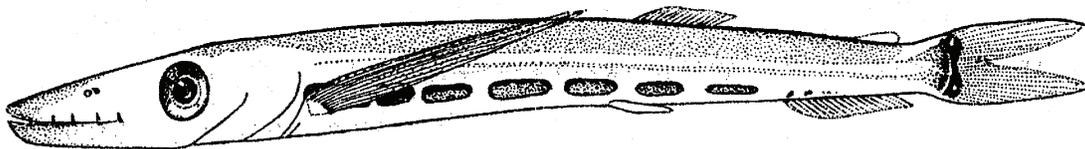
Larvae:

- Body elongate, but shorter and stockier than larvae of other paralepidid genera
- Head large and deep
- Long upper and lower jaws increase with development
- Spines form over eye and along preopercle at about 25 mm
- Long pectoral fins reach pelvic fins by 9 mm; extend beyond anus at larger sizes (Figs. C and E)
- Pelvic fin forms anterior to level of dorsal fin
- All fin rays (except pelvic) formed by 25.4 mm
- Pigmentation includes distinct melanophores at anterior and mid-dorsal fin base, over mid-anal fin base and at base of caudal fin; spots also form on pectoral fin rays; saddles form along dorsum in later larvae
- Development of 7–8 peritoneal pigment patches as follows:

Peritoneal Patches	4	6	8	7	7	7
Larval Size (mm)	6.5	15.6	16.1	25.4	43.1	100.2

Meristic Characters

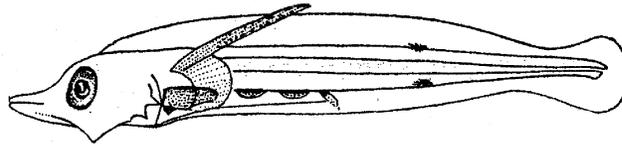
Myomeres:	59–60
Vertebrae:	59–60
Dorsal fin rays:	13
Anal fin rays:	21–23
Pectoral fin rays:	14–15
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

Early Juvenile:**G. 100.2 mmSL**

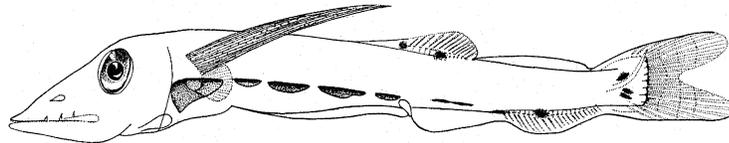
Figures: Adult: Eva Maria Soule (Rofen, 1966a); **A–B, D, F–G:** Sanzo, 1917; **C:** Shores, 1969; **E:** Eva Maria Soule (Rofen, 1966a)

References: Rofen, 1966a; Shores, 1969; Okiyama, 1984a; 1984b

Sudis hyalina

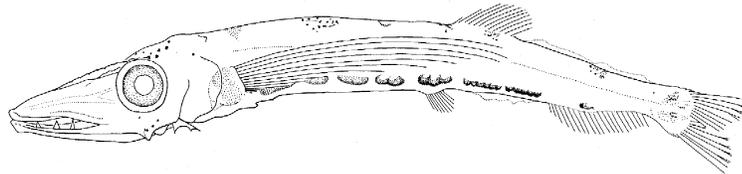


A. 6.5 mmSL



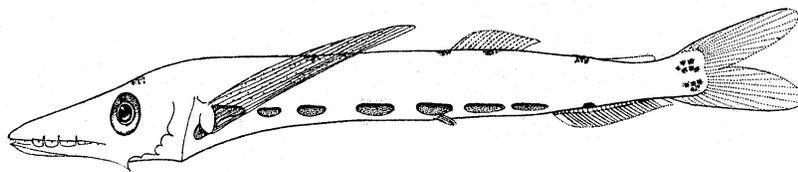
B. 15.6 mmSL

See *Sudis atrox* page for comparison of preopercle spines

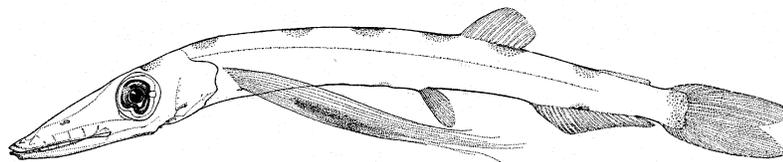


C. 16.1 mmSL

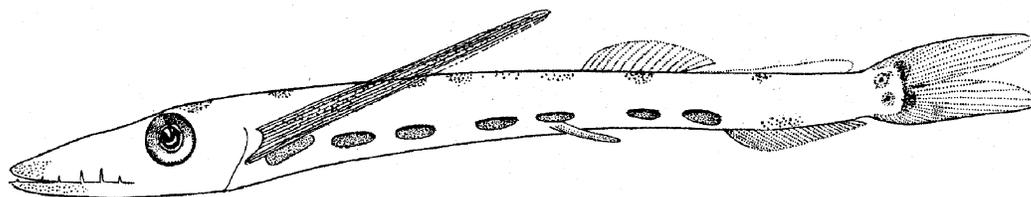
6 saddles of pigment develop along dorsal edge of body



D. 25.4 mmSL



E. 25.4 mmSL



F. 43.1 mmSL

Uncisudis advena* (Rofen, 1963)*Paralepididae**

No common name

Adult Undescribed

Range: Western North Atlantic Ocean from Atlantic coast of Florida and Gulf of Mexico; young stages drift north in Gulf Stream and are known from Grand Bank (as far north as 42°35'N) to Cape Hatteras

Habitat: Mesopelagic, in depths to 997 m

Spawning: Undescribed, but larvae occur in winter and possibly year-round

Eggs: – Undescribed

Larvae:

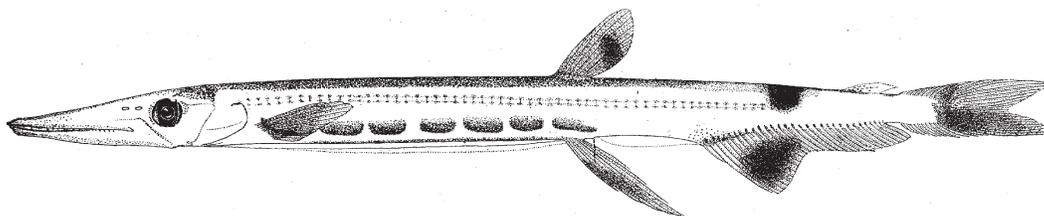
- Body elongate, depth uniform throughout length
- Snout initially short, becomes longer with development
- Flexion complete at about 14 mm
- Pelvic fin forms under mid-dorsal fin; both fins located slightly posterior to mid-body
- Anus located immediately behind pelvic fins
- Dorsal fin rays form first; formed by 7.5 mm; rays become elongate
- Pelvic, anal and caudal fin rays form later; pelvic fin rays become elongate; pectoral fin rays form late
- Pigment includes a saddle of melanophores on dorsal edge of body over middle of anal fin; this pigment persists throughout development, at least into early juvenile stage (Fig. D)
- Anterior lobe of anal fin and pelvic fin rays pigmented from larval into early juvenile stages
- Development of 5 to 7 peritoneal pigment patches as follows:

Peritoneal Patches	5	7	7	7	7
Larval Size (mm)	7.5	10.0	12.2	17.4	62.0

Meristic Characters

Myomeres:	about 78
Vertebrae:	75–78
Dorsal fin rays:	9–10
Anal fin rays:	30–31
Pectoral fin rays:	12–13
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

Note: 1. This species is based on larvae and a single transforming juvenile, 62.0 mmSL (below); adults are undescribed

Early Juvenile:**D. 62.0 mmSL**

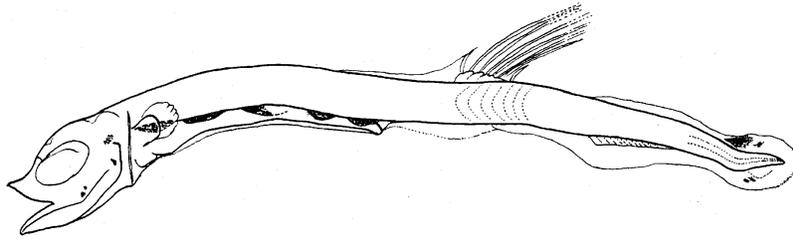
Early stages of *Stemonosudis* also have saddles of black pigment, but the saddles are multiple, not single as in *Uncisudis advena*

Figures: A–C: Ozawa, 1986f; D: Eva Maria Soule (Rofen, 1966a)

References: Rofen, 1966a; Ozawa, 1986f; Moore *et al.*, 2003

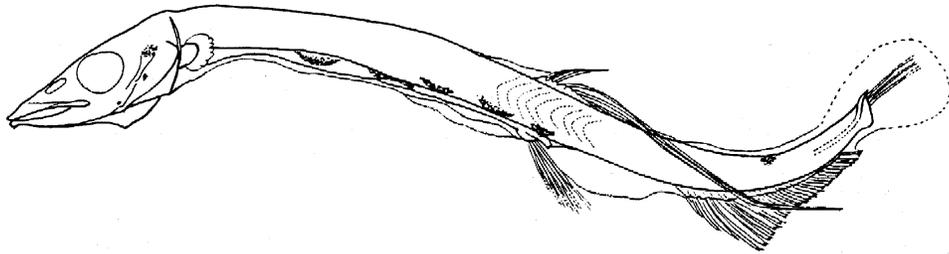
Uncisudis advena

Eye initially
elliptical,
becomes
round



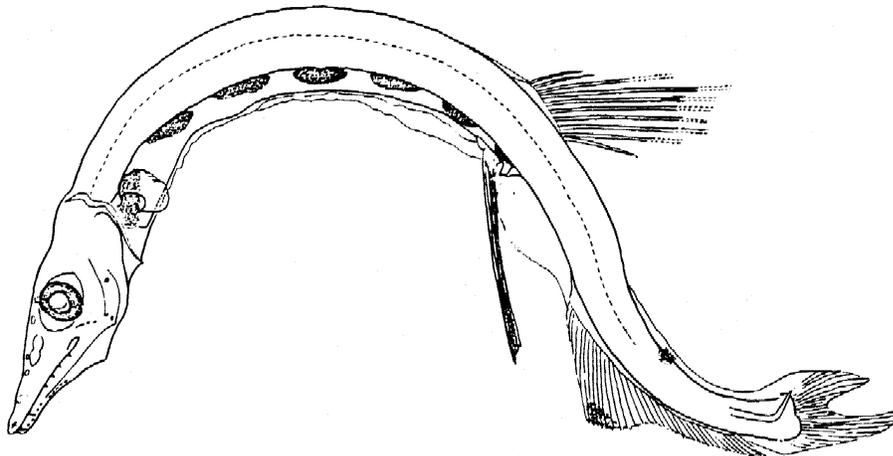
A. 7.5 mmSL

Teeth begin forming on lower jaw



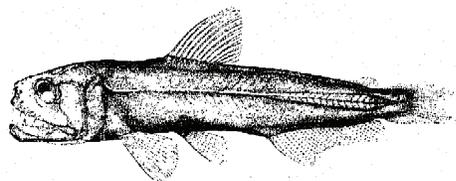
B. 12.2 mmSL

Teeth present in both jaws; those on upper jaw straight,
those on lower jaw curved posteriorly



C. 17.4 mmSL

Note persistent finfolds anterior to dorsal and pelvic fins
and between anus and anal fin origin

Coccorella atlantica* (Parr, 1928)*Evermannellidae****Atlantic sabretooth**

Range: Worldwide in tropical and warm-temperate waters; in the western North Atlantic from Georges Bank to northern South America

Habitat: Mesopelagic in depths of 100 to >500 m; most larvae 50–125 m

Spawning: Larvae collected year-round (rarely); otherwise undescribed

Eggs: – Undescribed

Larvae: – Myomeres are obscured by mid-lateral trunk musculature and are difficult to count
– Stomach is a heavily muscularized blind sac, expanding posteriorly with growth, reaching full extension (just posterior to pelvic fin base) in larvae 20–25 mmSL

– In this species, a pyloric caecum extends anteriorly and enters the head in larger larvae, juveniles and adults; caecum visible initially as a short, bud-like sac on anteroventral margin of intestine (Figs. G–I)

– Adipose fin present

– Sequence of fin ray development: C – D – P₂ – A – P₁

– Pectoral fin positioned low on body (and not divided as in Ipnopidae); pelvic fin origin under dorsal fin

– 3 large peritoneal pigment sections never paired (as in Scopelarchidae); begin as dorsolateral canopy over gut, then spread ventrally until a closed pigment tube forms at about 35 mmSL

– Body pigment begins in small larvae as bands occurring along myosepta in groups, with those between unpigmented (barred appearance)

– Larger larvae display beginning of adult pigment: size of melanophores intermediate between those in *Evermannella* and *Odontostomops*, and not aligned in rows

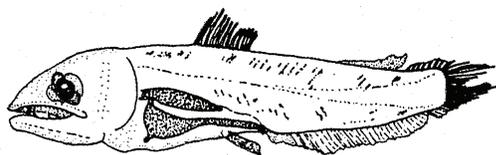
– Pigment absent on basal part of caudal fin

– Transformation is gradual; adult characters acquired individually until about 30 mmSL

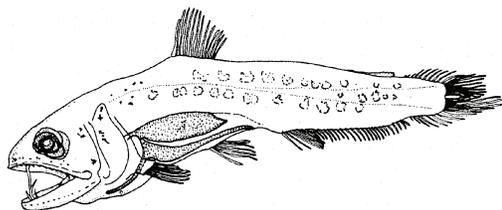
Meristic Characters

Myomeres:	48–53
Vertebrae:	48–50
Dorsal fin rays:	10–13
Anal fin rays:	26–30
Pectoral fin rays:	11–13
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

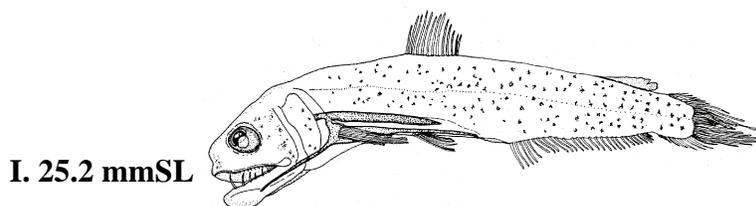
- Note:**
1. Evermannellid specimens <10 mm are difficult to identify to species; may be identifiable only on the basis of capture location and number of peritoneal pigment sections
 2. In Figs. G–I (peritoneal pigment sections omitted), note pyloric caecum beginning as bud-like projection on anterior gut (Fig. G), then extending anteriorly into lower head (Figs. H–I)



G. 12.0 mmSL



H. 18.2 mmSL

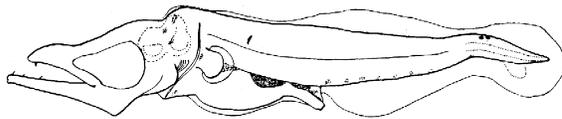


I. 25.2 mmSL

Figures: Adult: R. K. Johnson, 1984c; A–B, D, F: Ozawa, 1986d (B, D, F reversed; C, E, G–I: Wassersug and R. K. Johnson, 1976 (all reversed))

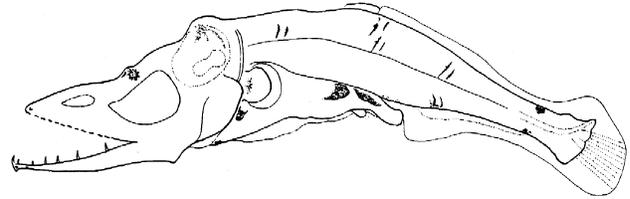
References: Schmidt, 1918; Rofen, 1966d; Wassersug and R. K. Johnson, 1976; R. K. Johnson, 1984c; 1986c; Ozawa, 1986d

Coccorella atlantica

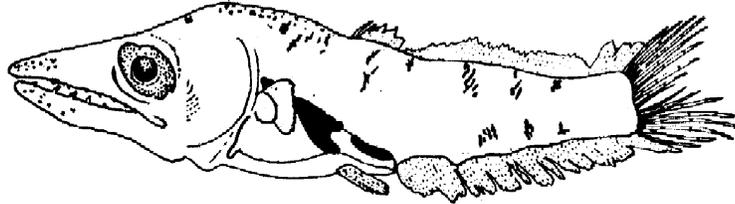


A. 3.6 mmSL

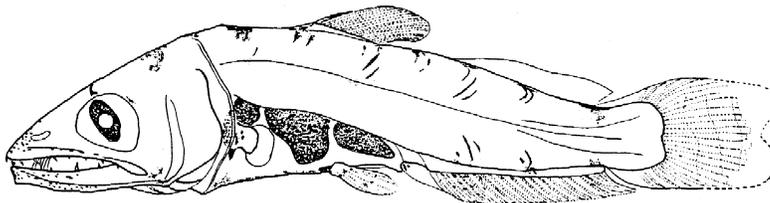
Note pointed snout,
early teeth formation



B. 5.1 mmSL

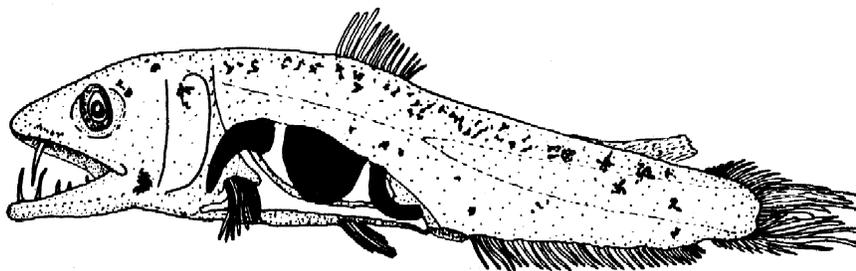


C. 6.3 mmSL



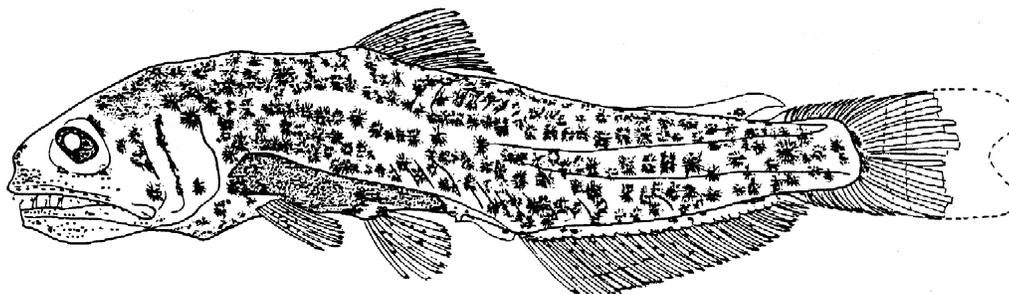
D. 9.8 mmSL

Note 3 peritoneal pigment sections



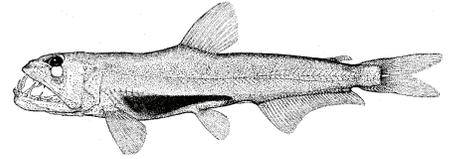
E. 14.0 mmSL

Note off-round eyes inclined anteriorly



F. 19.7 mmSL

Melanophores absent on inner half of caudal fin;
moderately large melanophores scattered over body,
not aligned in rows

Evermannella balbo* (Risso, 1820)*Evermannellidae****Balbo sabretooth**

Range: Worldwide in temperate waters; in the western North Atlantic from Flemish Cap to Bermuda

Habitat: Mesopelagic, in depths of 100–800 m; larvae usually <100 m

Spawning: Larvae collected year-round, except during winter; otherwise undescribed

Eggs: – Undescribed

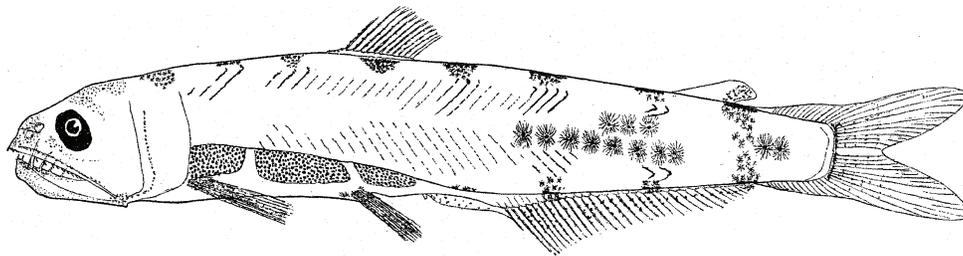
Larvae:

- Myomeres are obscured by mid-lateral trunk musculature and are difficult to count
- Stomach is a heavily muscularized blind sac, expanding posteriorly with growth, reaching full extension (to just posterior to pelvic fin base) in larvae 20–25 mmSL
- Adipose fin present
- Sequence of fin ray development: C – D – P₂ – A – P₁
- Pectoral fin positioned low on body (and not divided as in Ipnopidae); pelvic fin origin under dorsal fin
- 3 large peritoneal pigment sections never paired (as in Scopelarchidae); begin as dorsolateral canopy over gut, then spread ventrally until a closed pigment tube forms at about 35 mmSL
- Body pigment begins in small larvae as bands occurring along myosepta in groups, with those between unpigmented (barred appearance)
- Larger larvae display beginning of adult pigment: size of melanophores larger than those in *Coccorella* and *Odontostomops*, and usually aligned in rows
- Body pigmentation includes rows of very large melanophores, each following the trunk musculature
- Pigment scattered on basal part of caudal fin, sometimes arranged in vertical line across caudal fin base
- Transformation is gradual; adult characters acquired individually until about 30 mmSL

Meristic Characters

Myomeres:	52–54
Vertebrae:	52–54
Dorsal fin rays:	12–13
Anal fin rays:	34–35
Pectoral fin rays:	11–12
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

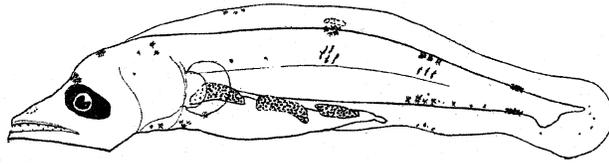
- Note:**
1. Evermannellid specimens <10 mm are difficult to identify to species; may be identifiable only on the basis of capture location and number of peritoneal pigment sections
 2. Larvae very similar to those of *Evermannella indica*; best distinguished by higher numbers of vertebrae and anal fin rays

Early Juvenile:**F. 33.0 mm**

Figures: Adult: Eva Maria Soule (Rofen, 1966d); **A–B, D–F:** Schmidt, 1918; **C:** R. K. Johnson, 1982

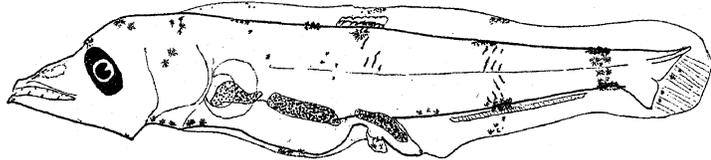
References: Schmidt, 1918; Rofen, 1966d; Wassersug and Johnson, 1976; R.K. Johnson, 1982; 1986c; Ozawa, 1986d

Evermannella balbo

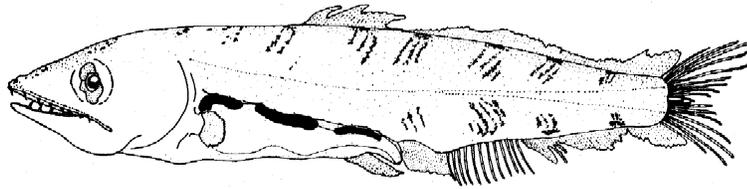


A. 5.8 mm

Note pointed jaws,
early teeth formation

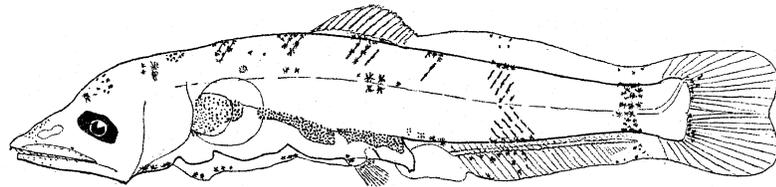


B. 8.0 mm



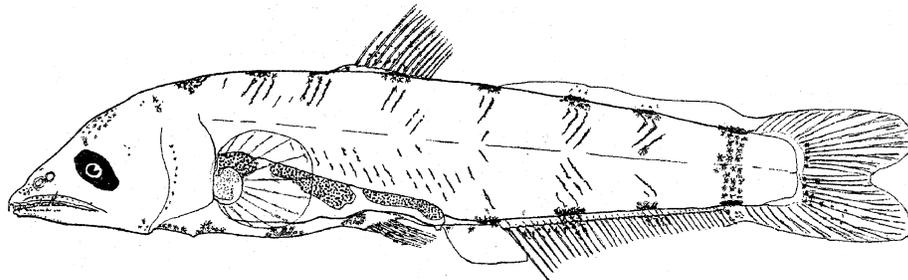
C. 10.8 mm

Note 3 large peritoneal pigment sections

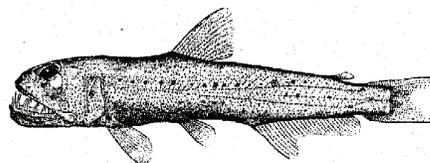


D. 11.5 mm

Note off-round
eyes inclined
anteriorly



E. 14.0 mm Note vertical row of pigment crossing caudal fin base

Evermannella indica* Brauer, 1906*Evermannellidae****Indian sabretooth**

Range: Worldwide in tropical to warm-temperate waters; in the western North Atlantic from south of Grand Bank to northern South America

Habitat: Mesopelagic, in depths of 500–800 m; larvae usually <100 m

Spawning: Larvae collected year-round (rarely); otherwise undescribed

Eggs: – Undescribed

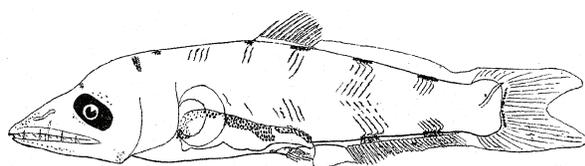
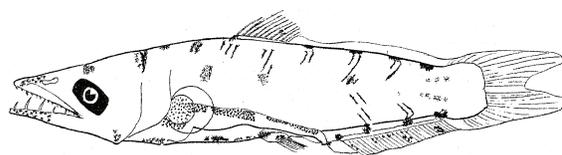
Larvae:

- Myomeres are obscured by mid-lateral trunk musculature and are difficult to count
- Stomach is a heavily muscularized blind sac, expanding posteriorly with growth, reaching full extension (just posterior to pelvic fin base) in larvae 20–25 mmSL
- Adipose fin present
- Sequence of fin ray development: C – D – P₂ – A – P₁
- Pectoral fin positioned low on body (but not divided as in Ipnopidae); pelvic fin origin under dorsal fin
- 3 large peritoneal pigment sections never paired (as in Scopelarchidae); begin as dorsolateral canopy over gut, then spread ventrally until a closed pigment tube forms at about 35 mmSL
- Body pigment begins in small larvae as bands occurring along myosepta in groups, with those between unpigmented (barred appearance)
- Larger larvae display beginning of adult pigment: size of melanophores larger than those in *Coccorella* and *Odontostomops*, and usually aligned in rows
- Body pigmentation includes rows of very large melanophores, each following the trunk musculature
- Pigment scattered on basal part of caudal fin
- Transformation is gradual; adult characters acquired individually until about 30 mmSL

Meristic Characters

Myomeres:	49–50
Vertebrae:	49–50
Dorsal fin rays:	12
Anal fin rays:	27–29
Pectoral fin rays:	11–12
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

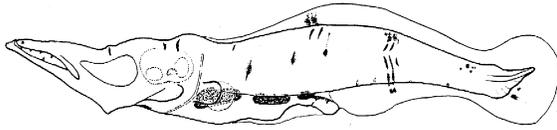
- Note:**
1. Evermannellid specimens <10 mm are difficult to identify to species; may be identifiable only on the basis of capture location and number of peritoneal pigment sections
 2. A congener, *E. balbo*, is known from Flemish Cap to Bermuda; larvae are similar, but vertebral and anal fin ray counts are higher (see Aulopiformes Introductory Table for meristic characters)
 3. Swinney (1994) considers the Atlantic Ocean population of *Evermannella indica* to be a separate species, *Evermannella melanoderma* Parr, 1928.
 3. Two larvae described as "*Odontostomops* sp. a" and "*Odontostomops* sp. b" by Schmidt (1918), are referable to *Evermannella indica*, based on low number of anal fin rays, presence of 3 peritoneal pigment sections, and pigment pattern (Figs. H–I)

**H. 9.0 mm****I. 10.5 mm**

Figures: Adult: Eva Maria Soule (Rofen, 1966d); **A–D:** Ozawa, 1986d (**C** and **D** reversed); **E–F:** Eva Maria Soule (Rofen, 1966d); **G:** R. K. Johnson, 1982; **H–I:** Schmidt, 1918

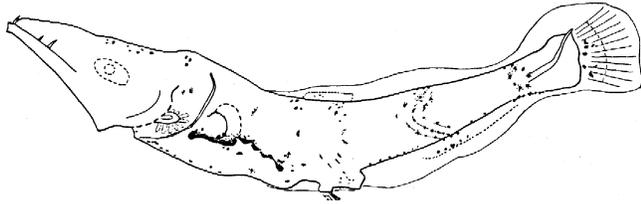
References: Rofen, 1966d; Wassersug and Johnson, 1976; R. K. Johnson, 1982; Ozawa, 1986d; Moore *et al.*, 2003

Evermannella indica

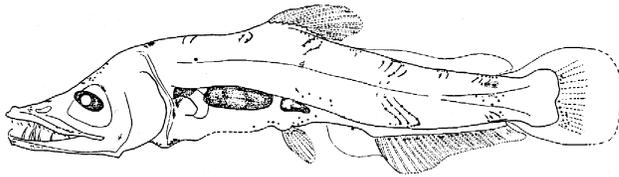


A. 4.4 mmSL

Note pointed jaws,
early teeth formation



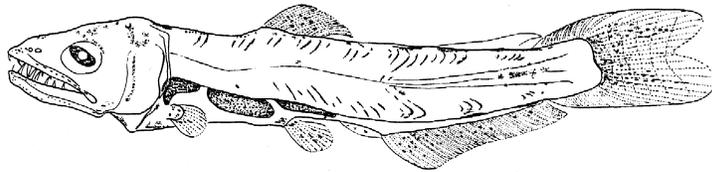
B. 6.3 mmSL



C. 9.1 mmSL

Note off-round
eyes inclined
anteriorly

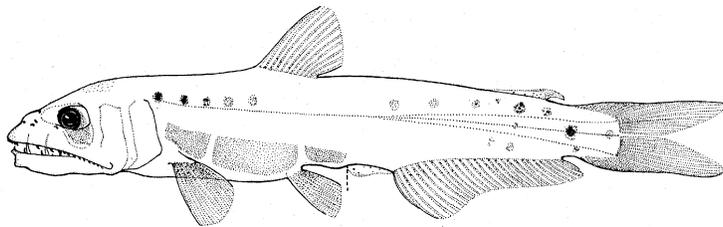
Note 3 large peritoneal pigment sections



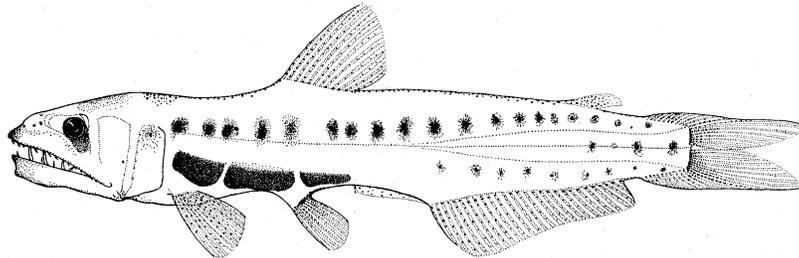
D. 14.6 mmSL

Note pigment scattered on inner half of caudal fin

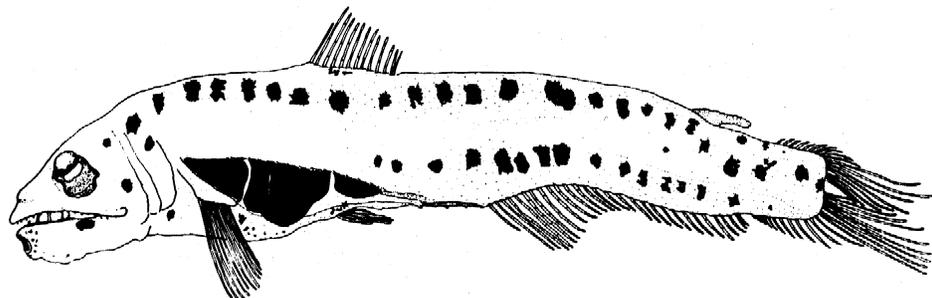
E. 18.6 mmSL

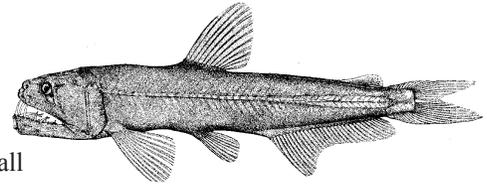


F. 21.7 mmSL



G. 28.0 mmSL



Odontostomops normalops* (Parr, 1928)*Evermannellidae****Undistinguished sabretooth**

Range: Worldwide in tropical to warm-temperate waters; few larvae or small juveniles collected between 39°49'N, 61°34'W and Cape Hatteras

Habitat: Mesopelagic in depths to >400 m; larvae and small juveniles often occur in the upper 50 m of water column

Spawning: Larvae collected year-round; otherwise undescribed

Eggs: – Undescribed

Larvae: – Myomeres are obscured by mid-lateral trunk musculature and are difficult to count
 – Stomach is a heavily muscularized blind sac, expanding posteriorly with growth, reaching full extension (just posterior to pelvic fin base) in larvae 20–25 mmSL
 – Adipose fin present

– Sequence of fin ray development: C – D – P₂ – A – P₁

– Pectoral fin positioned low on body (but not divided as in Ipnopidae); pelvic fin origin under dorsal fin

– 13–15 small peritoneal pigment sections never paired (as in Scopelarchidae); begin as dorsolateral canopy over gut, then spread ventrally until a closed pigment tube forms at about 45 mmSL

– Pigment includes fine melanophores over much of head and body; melanophores outline myosepta in small larvae

– Fine pigment peppers pectoral and caudal fins in larger larvae

Note: 1. Evermannellid specimens <10 mm are difficult to identify to species; may be identifiable only on the basis of capture location and number of peritoneal pigment sections

2. Two larvae described as "*Odontostomops* sp. a" and "*Odontostomops* sp. b" by Schmidt (1918), are referable to *Evermannella indica*, based on low number of anal fin rays, presence of 3 peritoneal pigment sections, and pigment pattern. See Figs. H–I on *Evermannella indica* page.

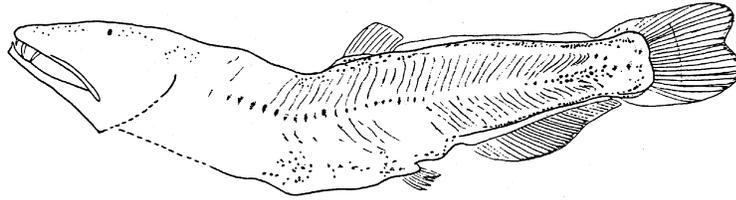
Meristic Characters

Myomeres:	48–52
Vertebrae:	48–52
Dorsal fin rays:	11–13
Anal fin rays:	30–35
Pectoral fin rays:	11–13
Pelvic fin rays:	9–10
Caudal fin rays:	10+9 (PrC)

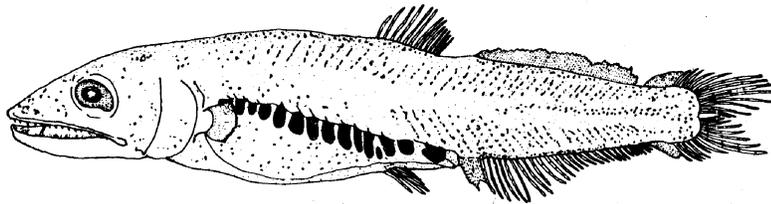
Figures: Adult: Eva Maria Soule (Rofen, 1966d); **A, C–D:** Ozawa, 1986d; **B:** R. K. Johnson, 1982

References: Rofen, 1966d; R.K. Johnson, 1982; Ozawa, 1986d

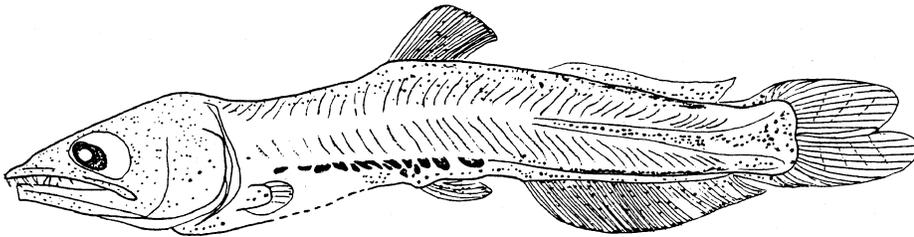
Odontostomops normalops



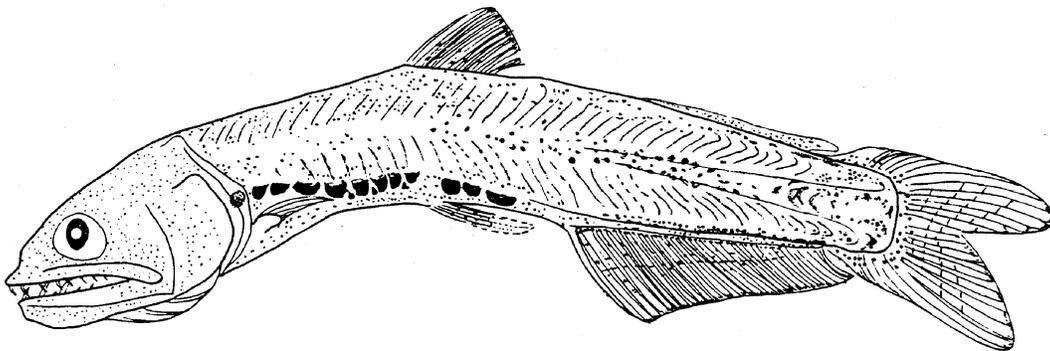
A. 8.7 mmSL Note pointed jaws, early teeth formation



B. 10.5 mmSL Note off-round eyes, inclined anteriorly

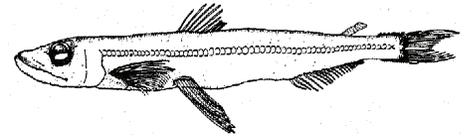


C. 12.3 mmSL Note heavy lower jaw



D. 17.0 mmSL

***Benthalbella infans* Zugmayer, 1911**
Scopelarchidae
 Zugmayer's pearleye



Range: Worldwide (except Mediterranean Sea and eastern Pacific) in tropical and subtropical waters; recorded from eastern central Atlantic as far north as 51°00' N, and west to 36°20' W; included here because it may be collected in the study area in future ichthyoplankton surveys

Habitat: Meso- to bathypelagic in depths >500 m; larvae mostly in depths of 300–600 m

Spawning: Larvae collected year-round; otherwise undescribed

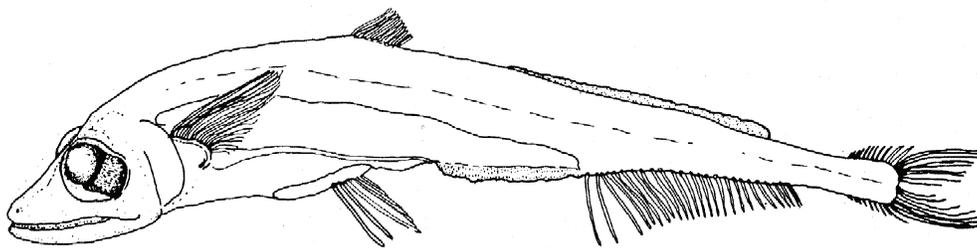
Eggs: – Undescribed

Larvae:

- Body moderately elongate, deep anteriorly, tapers very gradually to caudal peduncle
- Snout elongate, with curved jaws and hooked teeth on tongue
- Eyes initially positioned lateral; lens migrates dorsally in older stages
- Dorsal and pelvic fin origins anterior, with pelvic fin origin well anterior to dorsal fin origin
- Dorsal fin base short
- Anal fin origin at about 60% SL; anal fin base long
- Adipose fin present
- Sequence of fin ray formation: C – D – P₁ (upper rays), A, P₂ – P₁ (lower rays)
- Peritoneal pigment sections absent
- No pigment (except eyes) before transformation
- Transformation abrupt at >50 mm; peritoneal pigment forms on mesentery dorsal to gut from below pectoral fin bases to pelvic fin bases (not in discrete sections)

Note: 1. See discussion of morphological changes at transformation, and the effects of these changes on behavior, feeding and other activity in Merrett, *et al.* (1973).

Early Juvenile:



E. 57.5 mmSL

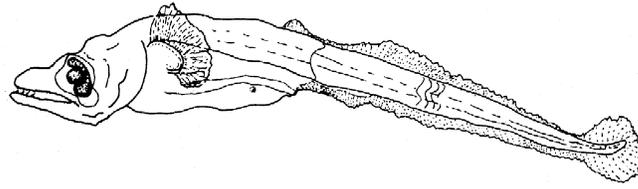
Meristic Characters

Myomeres:	54–56
Vertebrae:	55–58
Dorsal fin rays:	8–10
Anal fin rays:	19–25
Pectoral fin rays:	24–28
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

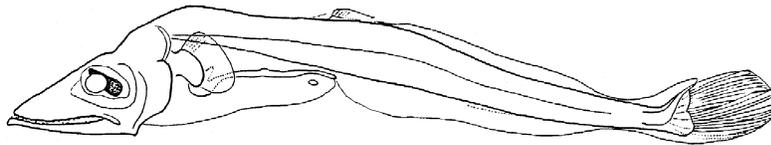
Figures: Adult: R. K. Johnson, 1984a; **A, C, E:** Johnson, 1974b; **B:** Ozawa, 1986e; **D:** Merrett *et al.*, 1973 (modified)

References: Merrett *et al.*, 1973; R. K. Johnson, 1974 a, 1974b, 1984a; 1986a; Ozawa, 1986e

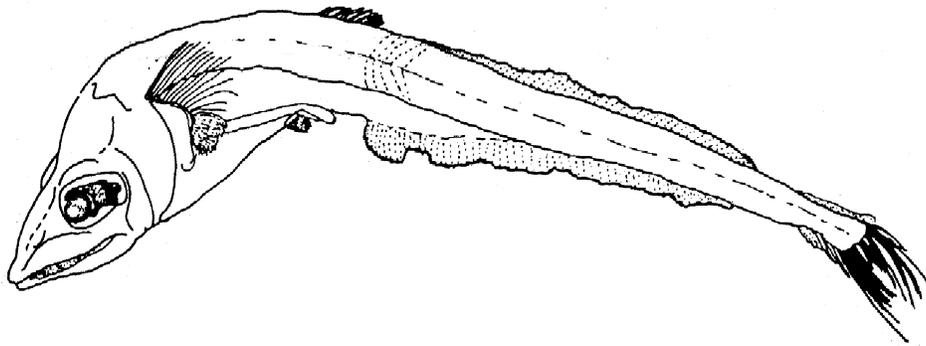
Benthalbella infans



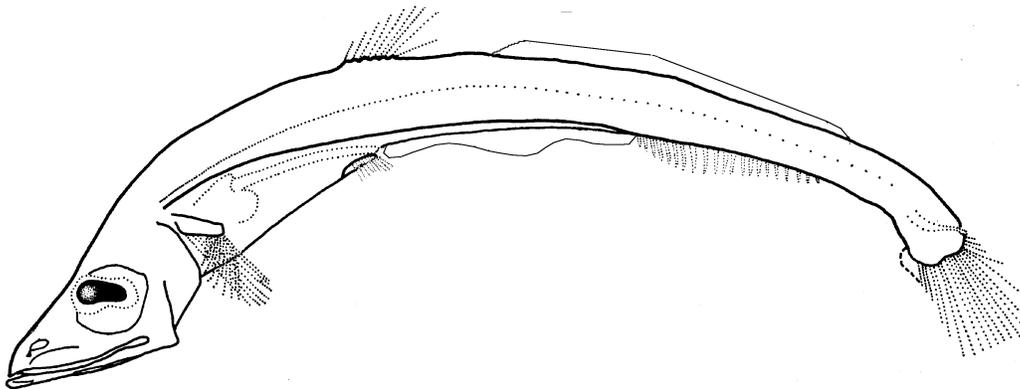
A. 10.4 mmSL



B. 15.5 mmSL



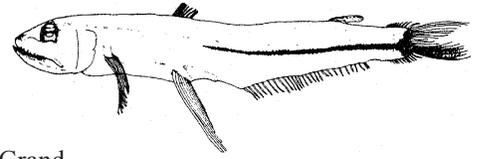
C. 20.0 mmSL Note total lack of pigment



D. 27.0 mmSL Pelvic fin origin well anterior to dorsal fin origin

Scopelarchoides danae* Johnson, 1974*Scopelarchidae**

No common name



Range: Worldwide in tropical waters; in the western North Atlantic from Grand Bank to Caribbean Sea

Habitat: Mesopelagic in depths of 300–800 m

Spawning: Undescribed

Eggs: – Undescribed

Larvae:

- Body moderately elongate, deep anteriorly, tapers gradually to caudal peduncle
- Body moderately humpbacked, with expanded abdomen
- Snout elongate, with large mouth, curved jaws and hooked teeth on tongue
- Eyes slender, with pigmented sliver of choroid tissue on lower margin
- Lens migrates to dorsal margin of eye during transformation
- Dorsal and pelvic fin origins anterior, with pelvic fin origin under dorsal fin and dorsal fin base short
- Anal fin origin at about 50% SL; anal fin base long
- Adipose fin present
- Preanal finfold persists into transformation stage
- Sequence of fin ray formation: C – D – A – P₁ (upper rays), P₂ – P₁ (lower rays)
- Pigmentation includes 1 anterior and 2 paired posterior peritoneal pigment sections; these fuse at transformation
- Pigment also includes distinct melanophores on dorsal caudal peduncle, ventral midline of caudal peduncle, over the gut near anus, and on the base of caudal fin
- Transformation complete by about 50 mmSL

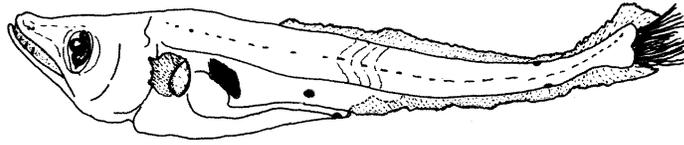
Meristic Characters

Myomeres:	about 48–50
Vertebrae:	48–50
Dorsal fin rays:	7–8
Anal fin rays:	24–27
Pectoral fin rays:	20–22
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

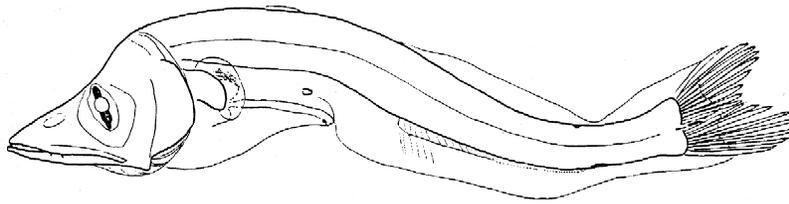
Figures: Adult: R. K. Johnson, 1986; **A, C:** R. K. Johnson, 1974b; **B, D:** Ozawa, 1986e

References: R. K. Johnson, 1974a, 1974b, 1984c; Ozawa, 1986e; Okiyama, 1988

Scopelarchoides danae

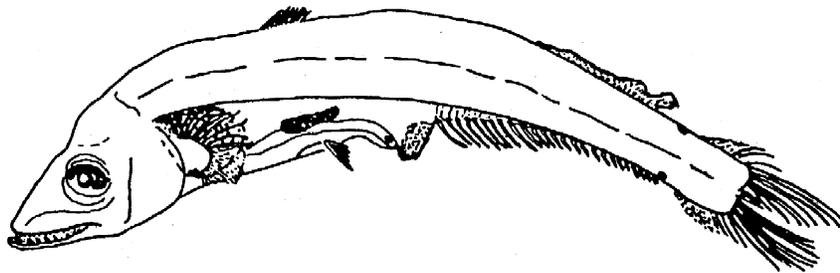


A. 9.7 mmSL

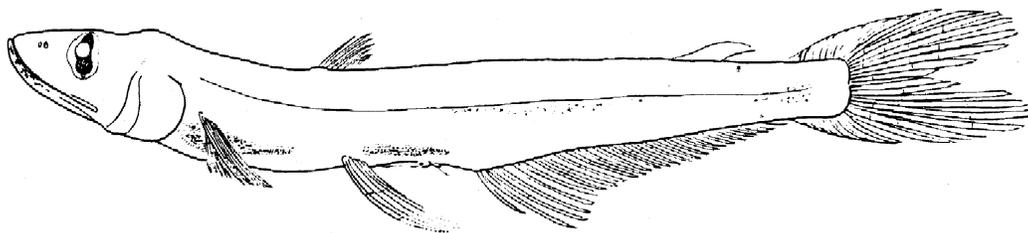


B. 12.0 mmSL

Note pair of melanophores on dorsal and ventral edges of caudal peduncle

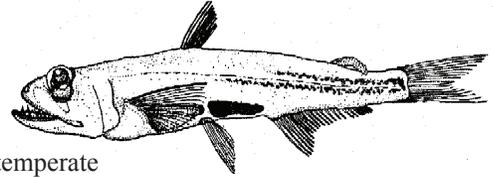


C. 18.0 mmSL



D. 29.0 mmSL

***Scopelarchus analis* (Brauer, 1902)**
Scopelarchidae
 Shortfin pearleye



Range: Worldwide (except Mediterranean Sea) in tropical to warm-temperate waters; in the western North Atlantic from Grand Bank to southern Brazil

Habitat: Mesopelagic in depths of >800 m (shallower at night); larvae usually in depths <100 m

Spawning: Larvae collected year-round; otherwise undescribed

Eggs: – Undescribed

Larvae:

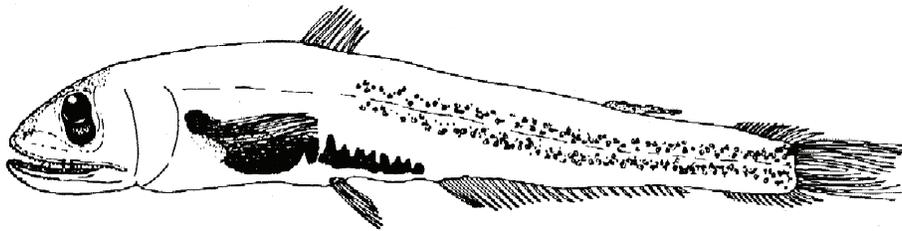
- Body moderately elongate, deep anteriorly, gradually tapers to caudal peduncle
- Snout elongate, with curved jaws and hooked teeth on tongue
- Dorsal and pelvic fin origins anterior, with pelvic fin origin under dorsal fin and dorsal fin base short
- Anal fin origin at about 50% SL; anal fin base long
- Adipose fin present
- Sequence of fin ray formation: C – D, A, P₁ (upper rays) – P₂ – P₁ (lower rays)
- Pigmentation includes 1 anterior and 2 paired posterior peritoneal pigment sections; these fuse at transformation
- Anterior peritoneal pigment section forms at about 16 mm
- Pigment forms along midline, posterior to dorsal fin
- Pigment at tip of snout >26 mmSL
- Transformation complete at 45–55 mmSL

Meristic Characters

Myomeres:	44–49
Vertebrae:	44–49
Dorsal fin rays:	7–9
Anal fin rays:	21–26
Pectoral fin rays:	18–22
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

- Note:**
1. Transforming specimens characterized by row of dense melanophores along midline
 2. The holotype of *Scopelarchus sagax* Rofen is a 38.1 mmSL juvenile of *Scopelarchus analis*
 3. Fig. A described as *Scopelarchus candelops* (Rofen, 1966e); Fig. D described as *S. beebei* (Rofen, 1966e)

Early Juvenile:

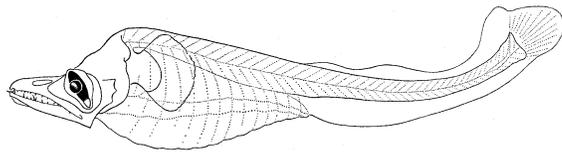


H. 30.5 mmSL

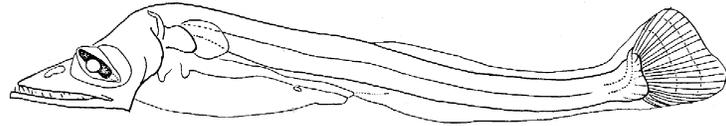
Figures: Adult: R. K. Johnson, 1984a; **A, D:** Eva Maria Soule (Rofen, 1966e); **B–C:** Ozawa, 1986e; **E–F, H:** R. K. Johnson, 1974b; **G:** Ozawa, 1986e

References: R. K. Johnson, 1974a, 1974b; 1984a; Okiyama, 1988; Watson and Sandknop, 1996c

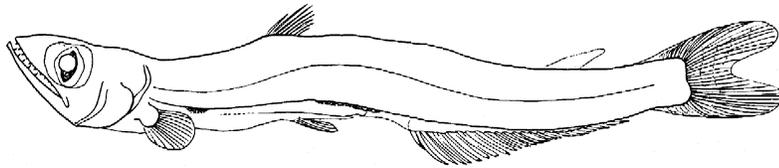
Scopelarchus analis



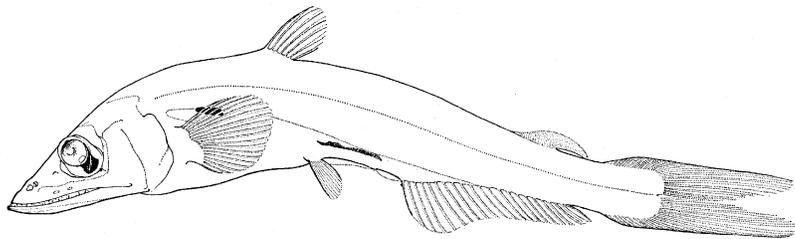
A. 8.8 mmSL



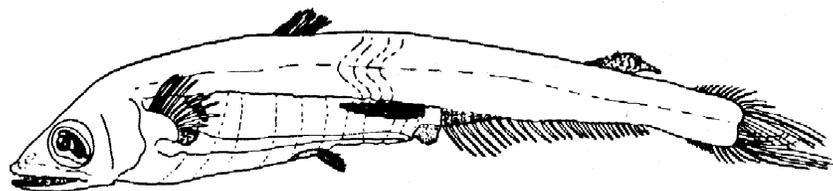
B. 12.6 mmSL



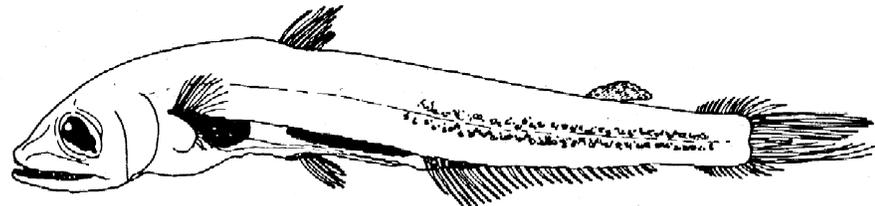
C. 17.8 mmSL



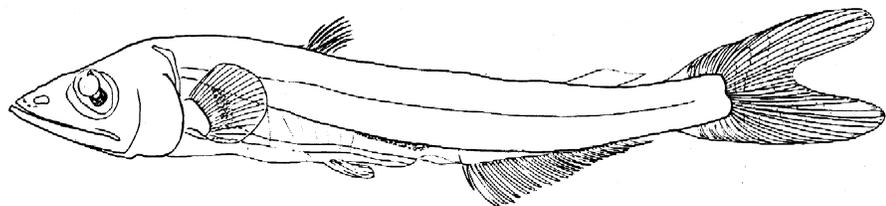
D. 20.4 mmSL



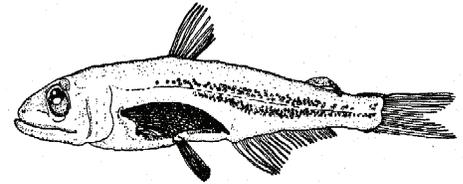
E. 21.0 mmSL



F. 22.0 mmSL



G. 25.0 mmSL

Scopelarchus michaelsarsi* Koefoed, 1955*Scopelarchidae****Bigfin pearlfin**

Range: Western Atlantic, Indian and Pacific oceans; in the western North Atlantic from south of Grand Bank to southern Brazil

Habitat: Mesopelagic in depths of 256–>500 m; larvae in depths <200 m

Spawning: Larvae collected year-round; otherwise undescribed

Eggs: – Undescribed

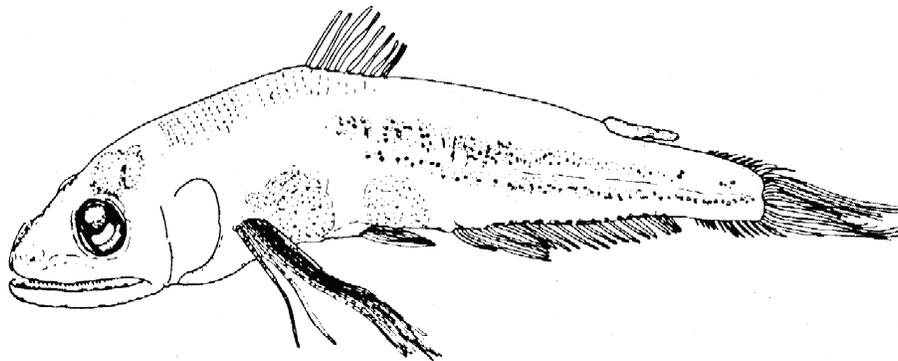
Larvae:

- Body moderately elongate, deep anteriorly, tapers gradually to caudal peduncle
- Snout elongate, with curved jaws and hooked teeth on tongue
- Eyes strongly oval, with upper margin pointed, lower margin rounded; no choroid tissue
- Head length >25% SL (at sizes between 14 and 30 mmSL); compare to smaller head proportion in *S. analis*
- Dorsal and pelvic fin origins anterior, with pelvic fin origin under dorsal fin and dorsal fin base short
- Anal fin origin at about 50% SL; anal fin base long
- Adipose fin present
- Sequence of fin ray formation: C – D, A, P₁ (upper rays) – P₂, P₁ (lower rays)
- Head length >25% SL at 14–30 mm (compare to *Scopelarchus analis*)
- Pigmentation includes 1 anterior and 2 paired posterior peritoneal pigment sections; all 3 sections formed by 9.5 mm; these fuse at transformation
- Pigment forms along midline, posterior to dorsal fin
- Pigment forms on pectoral fin >18 mm
- Transformation complete at 32–35 mm

Meristic Characters

Myomeres:	40–44
Vertebrae:	40–44
Dorsal fin rays:	7–9
Anal fin rays:	18–21
Pectoral fin rays:	18–21
Pelvic fin rays:	9
Caudal fin rays:	10+9 (PrC)

Note: 1. Transforming specimens characterized by subequal pigment stripes above and below midline

Early Juvenile:

F. 25.2 mmSL

Figures: (Juvenile, 30.8 mm): R.K. Johnson, 1984a; **A–C:** Eva Maria Soule (Rofen, 1966e); **D:** Ozawa, 1986e; **E–F:** R.K. Johnson, 1974b

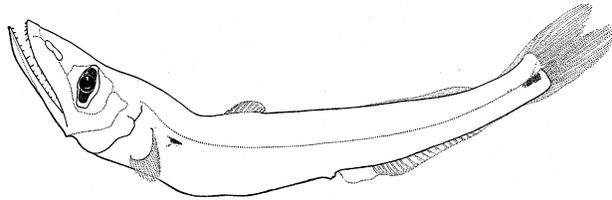
References: R. K. Johnson, 1974a, 1974b, 1984a; Okiyama, 1988

Scopelarchus michaelsarsi

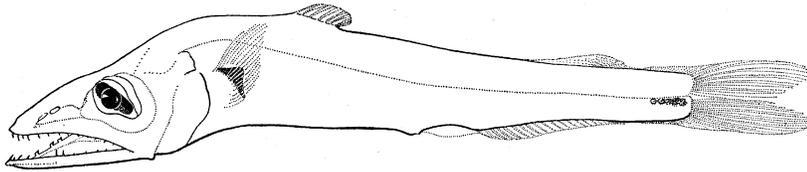


A. 9.5 mmSL

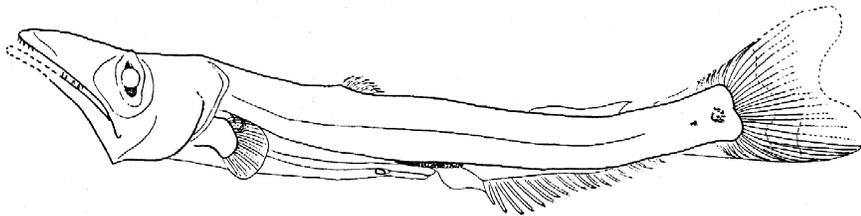
Note melanophores mid-laterally on caudal peduncle



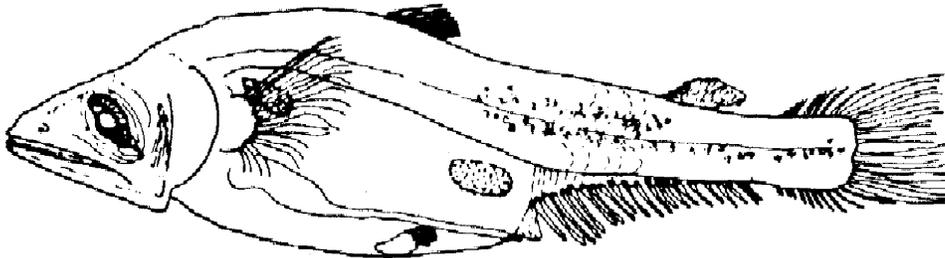
B. 12.5 mmSL



C. 12.8 mmSL



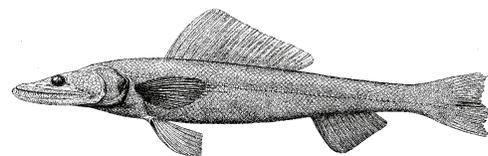
D. 14.5 mmSL



E. 17.9 mmSL

***Bathysaurus ferox* Günther, 1878
and *Bathysaurus mollis* Günther, 1878**
Bathysauridae

No common names



Bathysaurus ferox

Range: *Bathysaurus ferox*: Atlantic and Pacific oceans; in the western North Atlantic from Davis Strait to southern Brazil. *B. mollis*: Worldwide in tropical and temperate waters; in the western North Atlantic from New England (Veatch Canyon) to northern Brazil

Habitat: (Both species): benthic in depths of 1,000–4,800 m and temperatures <4°C (*B. mollis* in slightly deeper part of this range than *B. ferox*)

Spawning: Hermaphroditic; otherwise undescribed

Eggs:

- Undescribed
- Elongate dorsal, pelvic and pectoral fin rays (anal fin rays to a lesser extent)
- Pigmentation includes 6 evenly spaced, unpaired, peritoneal pigment patches
- Pigment also includes lateral bars crossing the body
- Transformation occurs at large sizes (>83 mm); fin rays shorten, gape enlarges, dorsal fin origin shifts posteriorly and body surface, oral cavity and peritoneum darken

Note: 1. An adipose fin is present in *B. mollis*, absent in *B. ferox*. The presence of an adipose fin in the 20.0 mm specimen identifies it as a larval *B. mollis*; however, its myomere count of ca. 60 indicates it is a larval *B. ferox*

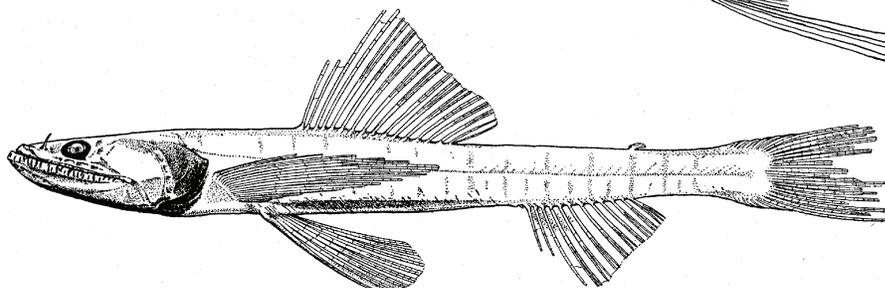
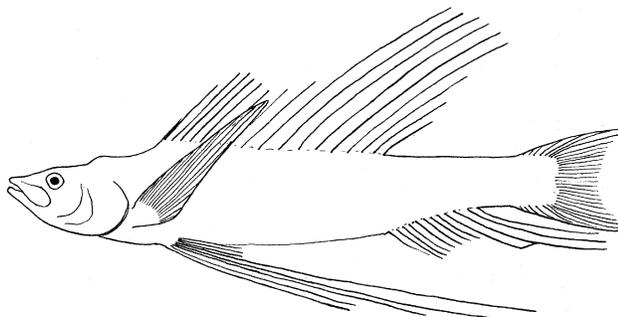
2. "*Macristium*" larvae (including *Macristium chavesi*) pertain to this genus

Juveniles:

Meristic Characters

Myomeres:	about 60–63
Vertebrae:	60–63
Dorsal fin rays:	16–18
Anal fin rays:	11–13
Pectoral fin rays:	15–16
Pelvic fin rays:	8
Caudal fin rays:	10+9 (PrC)

D. 110 mmSL
Bathysaurus ferox

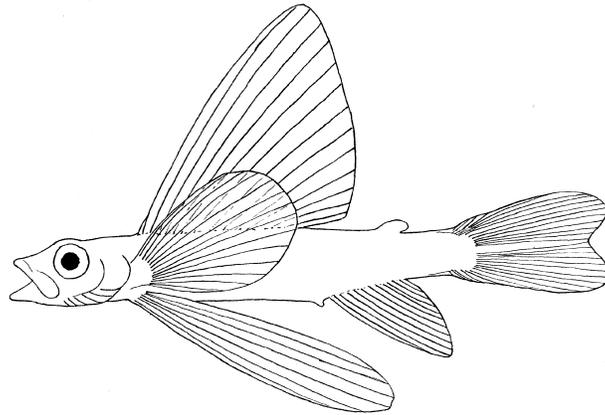


E. 188.5 mmSL
Bathysaurus mollis

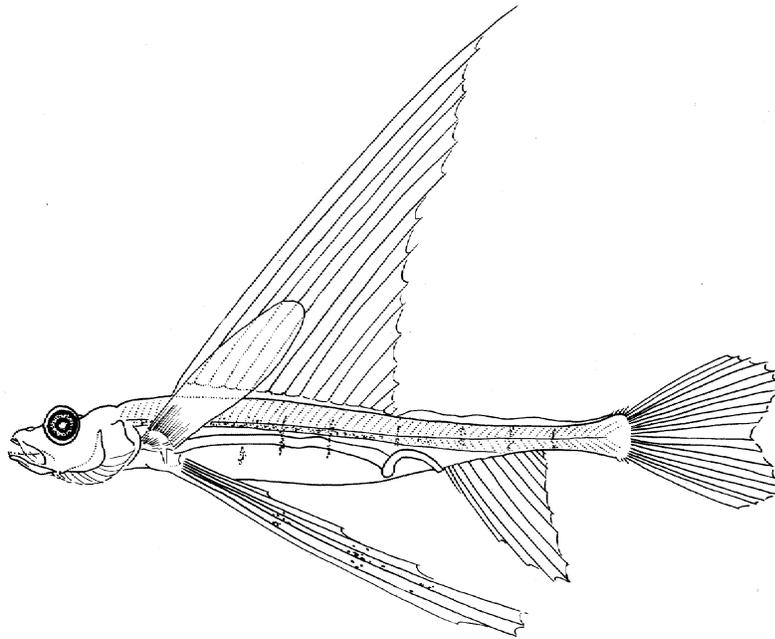
Figures: Adult and **E:** Margeret G. Bradbury (Mead, 1966a); **A, D:** Rosen, 1971; **B:** Marshall, 1961; **C:** R. K. Johnson, 1974c

References: Rosen, 1971; R.K. Johnson, 1974c; Sulak, 1984b; Okiyama, 1984a; 1984b

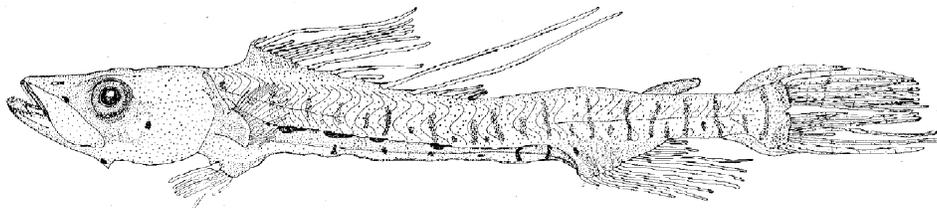
Bathysaurus ferox and *B. mollis*



A. 20.0 mmSL *Bathysaurus* sp.



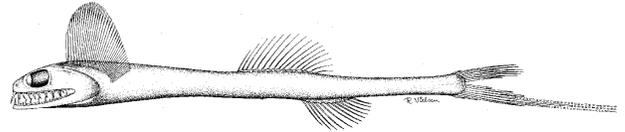
B. 33.0 mmSL *Bathysaurus ferox*



C. 37.6 mmSL *Bathysaurus mollis*

Gigantura indica* Brauer, 1901*Giganturidae**

No common name



Range: Atlantic, Pacific and Indian oceans, mostly between 30°N and 30°S; generally distributed in central and tropical water masses; larvae and juveniles have been collected as far north as continental slope off Georges Bank

Habitat: Meso- to bathypelagic, in depths of 500–2,000 m; larvae may occur in shallower depths

Spawning: Undescribed

Eggs: – Undescribed

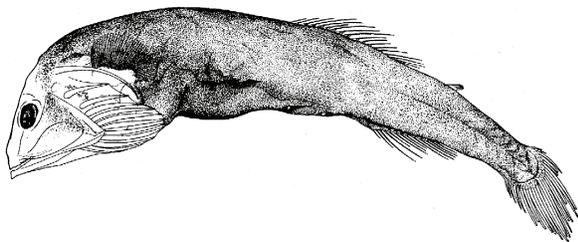
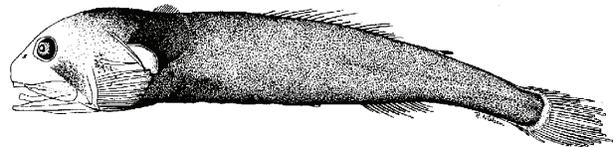
Meristic Characters

Myomeres:	about 30
Vertebrae:	16+14=30
Dorsal fin rays:	16–19
Anal fin rays:	11–14
Pectoral fin rays:	36–42
Pelvic fin rays:	none
Caudal fin rays:	3–5+10+6–7+3–5

Comparison of Larvae and Adults:

	Larvae	Juveniles and Adults
Snout	Pointed	Round
Skin	Transparent, with few, scattered spots	Densely pigmented, black with bright silvery layer
Eyes	Round, lateral, mobile, placed high	Tubular, directed backward, immobile, placed close to upper jaws
Jaw Teeth	Non-depressible	Posteriorly hinged
Basihyal Teeth	2–4	Absent
Premaxillary	Short, not reaching anterior eye	Long, reaching well behind eye
Maxillary	Not excluded from gape by premaxillary	Excluded from gape by premaxillary
Branchiostegal Rays	10, large, flattened	Absent
Pelvic Fins	Pedunculate with 5 rays	Absent
Adipose Fins	Present	Absent
Pectoral Fin Base	Vertical; behind gill opening	Nearly horizontal; above gill opening
Procurrent Caudal Fin Rays	(3)–4–(5)	(0)–1–(2–3)
Body Shape	Short, deep, rotund	Elongate, shallow, slender

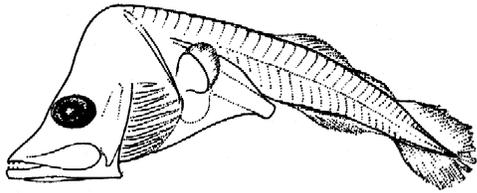
Note: 1. *Rosaura rotunda* (Tucker, 1954) pertains to a larva of the Giganturidae

Transforming Larvae:**G. Mid-Transformation 46 mm****H. Late Transformation 38 mm**

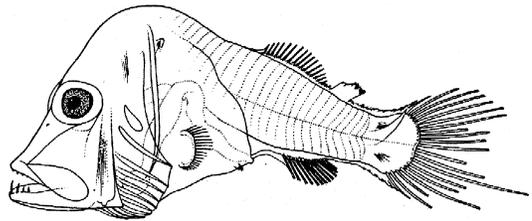
Figures: Adult and A–H: R. Nielsen (Johnson and Bertelsen, 1991)

References: Berry and Perkins, 1966; Jackson, 2002; R. K. Johnson, 1986b

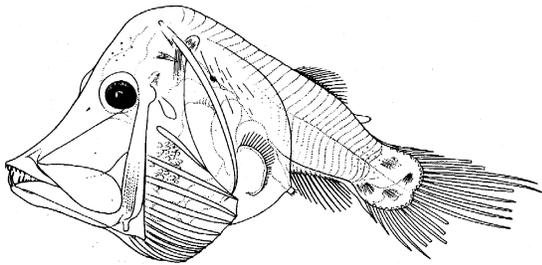
Gigantura indica



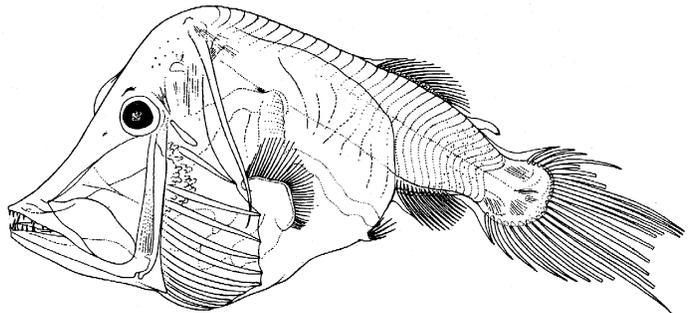
A. 3.6 mm



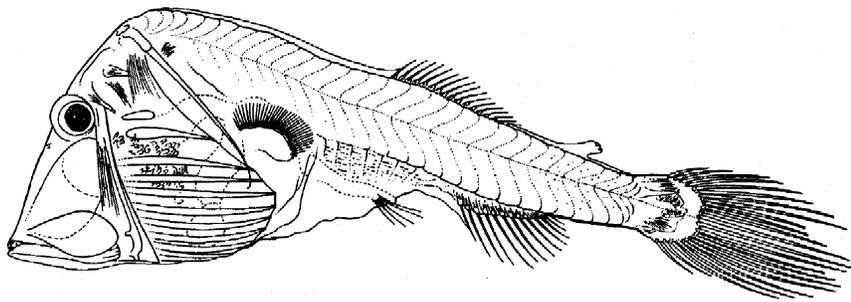
B. 4.5 mm



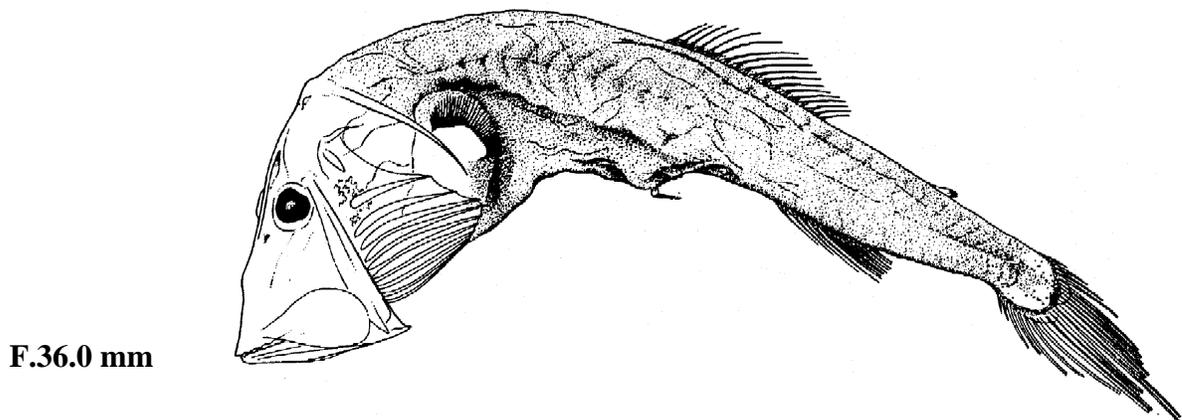
C. 7.8 mm



D. 15.0 mm



E. 28.0 mm



F. 36.0 mm