Gadiformes – Bathygadidae and Macrouridae

Selected characters in bathygadid and macrourid genera occurring in the study area. # in column 2 refers to number of species reported from study area. Brstgl = Branchiostegal; Light organs 0 = none; B = bulbous; T = tubular; Pr = Present, Ab = Absent. Modified from Fahay and Markle, 1984.

Genus	#	Retia Mirabilia	Brstgl Rays	Precaudal Vertebrae	Pelvic Rays	1st Dorsal Fin Rays	Second Spinous Ray D_1	Light Organs O,B,T	Chin Barbel Pr – Ab	Distance Between D Fins
Bathygadus	1	2	7	12–14	7–11	8–13	Smooth	0	Pr/Ab	$<D_1$
Gadomus	2	4	7	11–13	8–9	11–14	Smooth	0	Pr/Ab	$<D_1$
Caelorinchus	4	4	6	11–12	7	9–14	Smooth	1B or 1T	Pr	$>D_1$[4]
Coryphaenoides	7	4(6)	6	11–16	7–11[1]	9–14	Serrate	0	Pr	Varies
Hymenocephalus	1	2	7	10–11	7–15	10–13	Smooth[3]	1T	Pr/Ab	$>D_1$
Macrourus	1	4	6	16–18	8–9	10–13	Serrate	0	Pr	$<D_1$
Malacocephalus	1	2	7	11–13	8–10	11–16	Smooth	1B	Pr	$\approx D_1$
Nezumia	6	2 (4)	7	13–14	6–17	10–15	Serrate	1B	Pr	$\approx$ or $>D_1$
Sphagebranchus	1	2	7	11–12	10–13[2]	12–13	Serrate	1B	Pr	$<D_1$
Trachonurus	1	2	7	12–13	7	7–11	Smooth	0 or 1B	Pr	$<D_1$
Trachyrincus	1	2	7	14	6–7	9–12	(Ray)	0	Pr	$<D_1$

[1] Rarely 6 or 12
[2] Rarely 8
[3] or weakly serrate
[4] usually $>D_1$, rarely = or $<D_1$

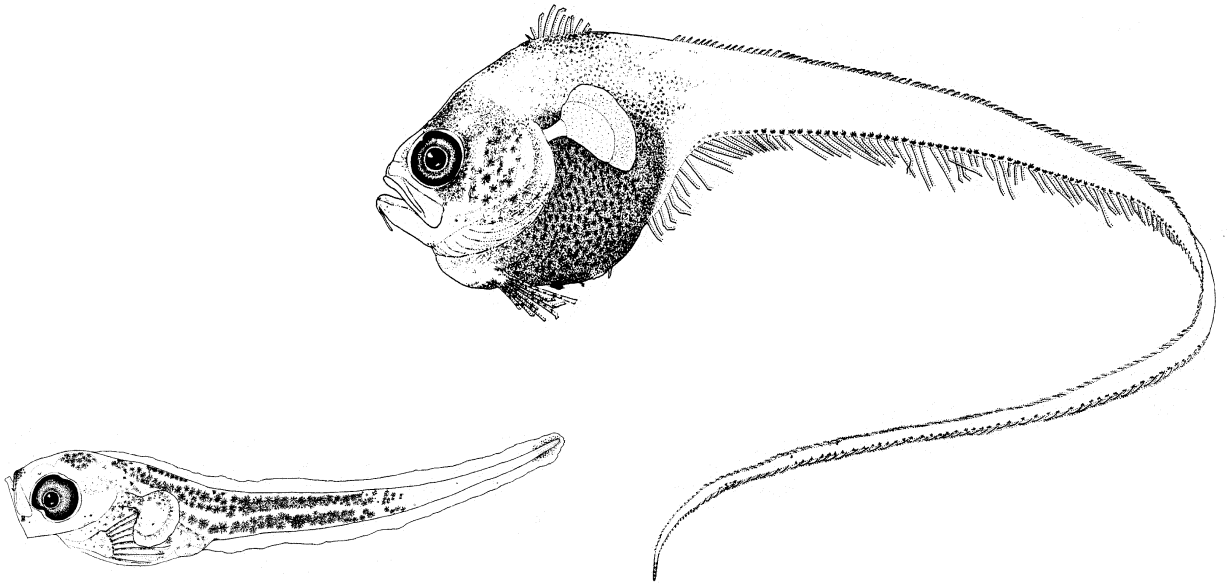
Selected ontogenetic characters in macrourid genera occurring in study area. Most observations based on one or a few species and may not pertain to all species within that genus. Development sizes refer to mmHL (Head Length). Modified from Fahay and Markle, 1984; Merrett, 1989. "–" indicates undescribed character.

	Preopercle Skin Tabs	Elongate Fin Rays	Swim Bladder Developed by:	Vertebrae Ossified by:	Light Organ Begins Development	Barbel Begins Development	Transformation Begins
Bathygadus	Pr	None	–	–	None	None	<8.5
Gadomus	Pr	None	–	–	None	–	<13.0
Caelorinchus	Ab	D_1, P_2	<3.0	4–5	None or 4.0	4.5–5.0	5.0–9.0
Coryphaenoides	Ab	D_1, P_2	2.0–2.5	2.5–5.5	None	3.5–6.7	9.0–16.0
Hymenocephalus	Ab	D_1, P_2, 'tail'	–	–	<9.5	–	7.0–9.5
Macrourus	Ab	None	3.0	3.0	None	<4.5	>10.9
Malacocephalus	Ab	D_1 , P_2	<8.0	<8.0	<8.0	<8.0	8.0–10.0
Nezumia	Ab	D_1, P_2	<8.5	<8.5	<8.5	<8.5	>8.5
Sphagebranchus	Ab	None	<9.0	<9.0	<9.0	<9.0	>9.0
Trachonurus	Ab	—	–	–	–	–	–
Trachyrincus	–	None	–	–	None	–	<14.0

Gadiformes – Bathygadidae and Macrouridae

The eggs of most macrourids are undescribed. Presumably, all are spawned near-bottom in deep water and are buoyant, but density changes during early development may impede a rise toward the surface, such that hatching probably occurs at great depths (Merrett, 1989; Merrett and Barnes, 1996). In those eggs that are known, the chorion ranges from smooth to highly ornamented (Merrett and Barnes, 1996). Among the taxa occurring in the study area, 4 species have smooth chorions, 4 have hexagonal honeycombed ornamentation, and 1 is described as having "partial ornamentation". Eggs are undescribed in the remaining species (see species accounts for egg characters).

Small macrourid larvae are rarely collected. In the few that have been collected, note early forming pelvic fin rays, pedunculate pectoral fin base, and attenuate body form (Fig. A).



A. 11.2 mmTL. Unidentified.
Huntsman Marine Laboratory, uncatalogued
Collected off Newfoundland.
Betsy Washington (Fahay and Markle, 1984)

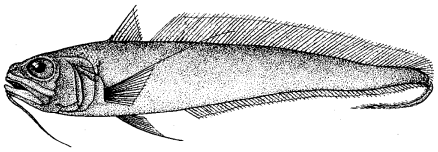
B. 60 mmTL. Unidentified (Macrourinae)
Huntsman Marine Laboratory, H6818
Collected 39°52.5'N, 58°54.0'W
Betsy Washington (Fahay and Markle, 1984)

This larva (Fig. B) has 7 branchiostegal rays, densely pigmented peritoneum, and extremely elongate body. Other characters, however, do not allow identification to a level lower than subfamily, pending future study.

Pigment in early stages is important and appears to occur in three basic "patterns" (*sensu* Merrett, 2003) or "types":

Type I: Conspicuous bars or patches; often in saddles on unpigmented background; peritoneum may be pigmented
Type II: Overall scattered, minute melanophores, often fade out toward tail tip
Type III: Most of head, gut and anterior tail darkly pigmented, usually with large melanophores, ending abruptly, leaving tail tip unpigmented; forms an abdominal "hoop" that is obviously darker than anterior head and remainder of tail; tail may or may not have few obvious spots. (see Fig. B above for example.)

Gadomus dispar (Vaillant, 1888)
Bathygadidae
Longbeard grenadier



Range: Western North Atlantic Ocean from Wilmington Canyon to Caribbean Sea

Habitat: Demersal at depths between 620 and 2,165 m

Spawning: Undescribed

Eggs: – Undescribed

Meristic Characters

Myomeres:	difficult to count
Vertebrae:	12–13 + ? = 80+ total
Dorsal fin rays:	12–13 + ?
Anal fin rays:	many
Pectoral fin rays:	18–20
Pelvic fin rays:	8
Caudal fin rays:	none

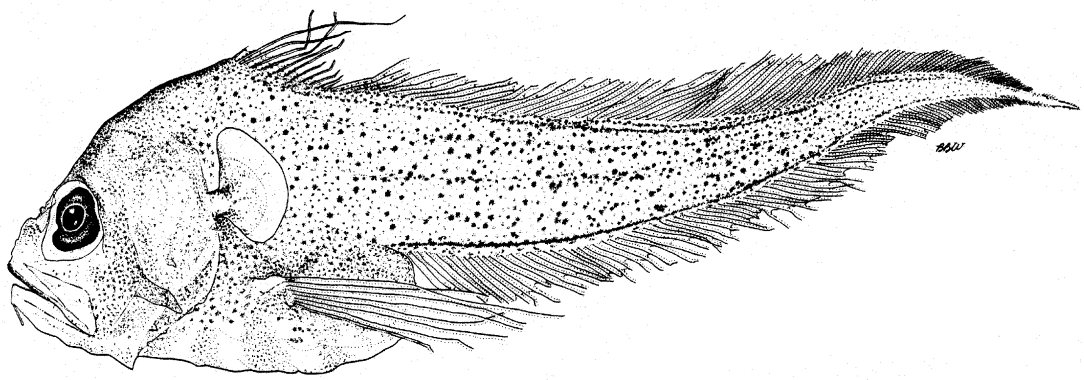
Larvae:
- Body elongate with bulky head and gut; tail tapers to finless tip
- HL to TL ratio: 1 to 5–6
- Pectoral fin bases pedunculate
- Branchiostegal rays: 7
- Gill rakers (total) on 1st arch: 20–21
- Precaudal vertebrae: 11–13
- Pelvic fin rays: 8; fins laterally placed, thoracic
- D_1 fin ray count: II,10–11; 2nd spinous fin ray of D_1 smooth
- Short (or no) interspace between dorsal fins
- Barbel present on tip of lower jaw
- Paired flaps on preopercle
- Light organ absent between the pelvic fin ray bases
- Anus located at anal fin origin
- 4 gas glands present in air bladder
- Pelvic fin rays moderately elongate
- Dorsal fin rays scarcely longer than anal fin rays
- Pigment pattern Type II; melanophores scattered over most of head and body, fading to lighter spots at tail tip; peritoneum slightly darker than remainder of body

Note:
1. *Gadomus longifilis* (Goode and Bean, 1886) is known from the eastern Atlantic Ocean and Caribbean Sea. A single adult specimen was recently collected west of Greenland (Jørgensen, 1996). It has 14–16 pectoral fin rays, 27–31 gill rakers on the 1st arch, and greatly elongate D_1, P_1, and P_2 fin rays.
2. The illustrated pelagic-juvenile in Fig. A (MCZ 58621) was collected at 25°48'N, 91°40'W and has not been identified to species
3. Also see comparative tables in Macrouridae Introduction

Figures: Adult: Geistdoerfer, 1986; **A**: Betsy Washington (Fahay and Markle, 1984)

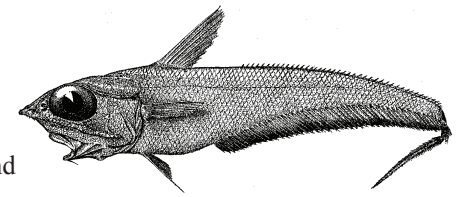
References: Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al*., 1990; Ambrose, 1996i; Iwamoto, 2002

***Gadomus* sp.**



A. 30+ mmTL

Caelorinchus coelorhynchus (Risso, 1810)
Macrouridae
Hollowsnout grenadier



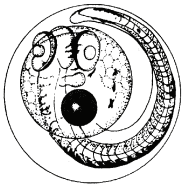
Range: Western North Atlantic Ocean from east of Scotian Shelf and Grand Bank to Brazil; also eastern Atlantic

Habitat: Benthopelagic, usually in depths of 200–500 m (maximum depth range 90–850 m)

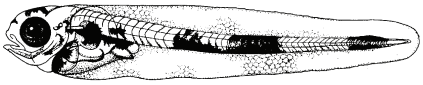
Meristic Characters

Myomeres:	difficult to count
Vertebrae:	11–12 + ?
Dorsal fin rays:	10–11 + ?
Anal fin rays:	many
Pectoral fin rays:	17–21
Pelvic fin rays:	7
Caudal fin rays:	none

Spawning: Undescribed



Eggs:
- 1.2 mm diameter
- Hexagonal honeycomb sculpting on chorion
- Single oil globule



Yolk-sac larva, 3.9 mmTL

Larvae:
- Body initially uniformly elongate, becomes more stocky anteriorly; tail tapers to finless tip
- Anus exits laterally on finfold in early larvae
- HL to TL ratio: 1 to 4+
- Pectoral fin bases very strongly pedunculate
- Branchiostegal rays: 6
- Gill rakers (total) on 1st arch: 7–12
- Precaudal vertebrae: 11–12
- Pelvic fin rays: 7; fins placed low on side of gut
- D1 fin ray count: II, 8–9; 2nd spinous fin ray of D_1 smooth
- Barbel present on tip of lower jaw
- Light organ present between the pelvic fin ray bases
- Anus located at anal fin origin
- 4 gas glands present in air bladder
- Elongate fin rays in D_1 and P_2 fins
- Anal fin rays longer than dorsal fin rays; anterior anal fin rays slightly elevated
- Moderately wide interspace between dorsal fins
- Pigment in early stages vaguely banded; later larvae have pigment pattern Type III (tentative; not well described); most of head, gut and anterior tail darkly pigmented; peritoneum very dark; tip of tail may be less pigmented

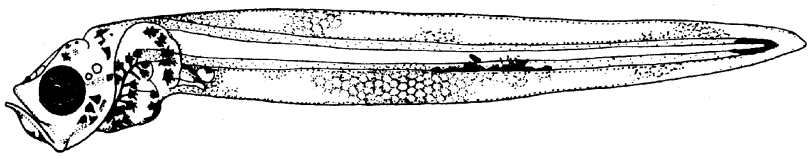
Note:
1. Eggs and larvae illustrated collected in eastern Atlantic
2. Also see comparative tables in Macrouridae Introduction
3. Both the genus and species names have been spelled in a variety of ways in recent literature; all pertain to the species described by Risso (1810):

Coelorhynchus coelorhynchus	Geistdoerfer, 1986
Caelorinchus	Eschmeyer, 1990
Caelorinchus caelorinchus	Merrett and Barnes, 1996
Coelorinchus coelorhincus	Cohen *et al*., 1999
Caelorinchus caelorincus	Klein-MacPhee, 2002d
Caelorinchus caelorincus	Iwamoto, 2002
Caelorinchus caelorhincus	Iwamoto, 2002
Caelorinchus coelorhinchus	Merrett, 2003
Caelorinchus coelorhynchus	Merrett, 2003

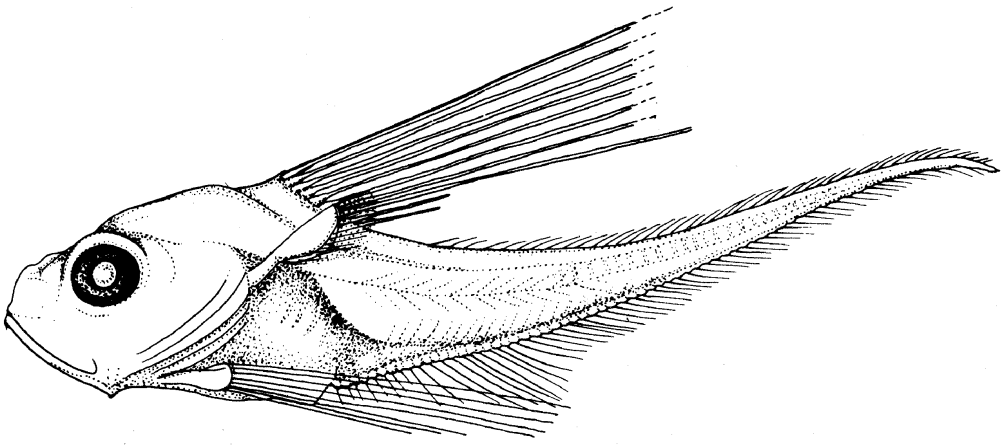
Figures: Adult: Geistdoerfer, 1986; Egg, yolk-sac larva, and **A**: Sanzo, 1933 (redrawn in Merrett, 1986); **B**: C. E. Darter (Merrett, 1986)

References: Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al*., 1990; Ambrose, 1996i; Iwamoto, 2002

Caelorinchus coelorhynchus

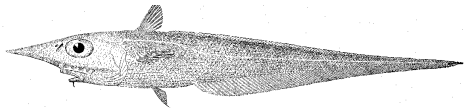


A. 4.6 mmTL



B. 5.0 mmHL

Caelorinchus occa (Goode and Bean, 1886)
Macrouridae
Spear-snouted grenadier



Range: Both sides of North Atlantic Ocean; in the western North Atlantic from Alvin, Welker and Norfolk canyons, Bermuda and Florida Straits to Suriname, including Gulf of Mexico and Caribbean Sea

Habitat: Benthopelagic in depths of 400–2,200 m

Spawning: Undescribed

Eggs: – Undescribed

Meristic Characters

Myomeres:	difficult to count
Vertebrae:	12–13 + ?
Dorsal fin rays:	9–11 + ?
Anal fin rays:	many
Pectoral fin rays:	17–20
Pelvic fin rays:	7
Caudal fin rays:	none

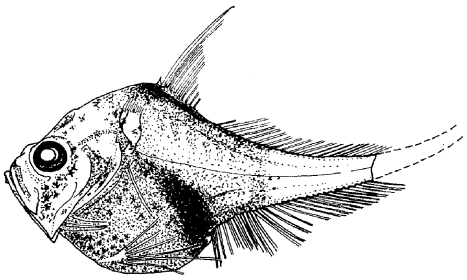
Larvae:
- Body very deep anteriorly in early larvae; tail tapers to finless tip
- HL to TL ratio: 1 to 4–6
- Pectoral and pelvic fin bases strongly pedunculate
- Branchiostegal rays: 6
- Gill rakers (total) on 1st arch: 7–9
- Precaudal vertebrae: 12–13
- Pelvic fin rays: 7
- D_1 fin ray count: I–II, 7–9; 2nd spinous fin ray of D_1 smooth
- Barbel present on tip of lower jaw; begins to form at about 4.5 mmHL
- Light organ absent between the pelvic fin ray bases
- Anus located at anal fin origin
- 4 gas glands present in air bladder
- Rays of D_1 slightly elongate
- Anal fin rays longer than dorsal fin rays
- Moderate space between dorsal fins
- Pigment pattern Type III; most of head, gut and anterior tail darkly pigmented, usually with large melanophores, ending abruptly, leaving posterior part of tail unpigmented; pigment forms an abdominal "hoop" that is obviously darker than anterior head and remainder of tail

Note:
1. Illustrated larvae collected in eastern Atlantic
2. Also see comparative tables in Macrouridae Introduction

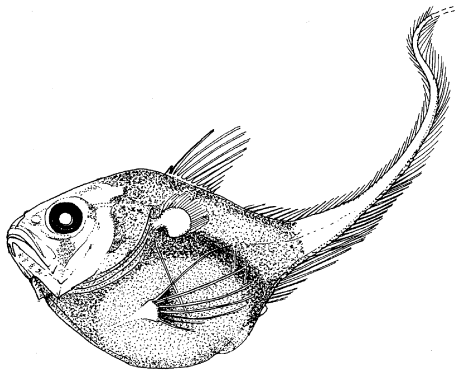
Figures: Adult: Goode and Bean, 1896; **A–E**: C. Darter (Merrett, 1989)

References: Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al*., 1990; Ambrose, 1996i; Iwamoto, 2002

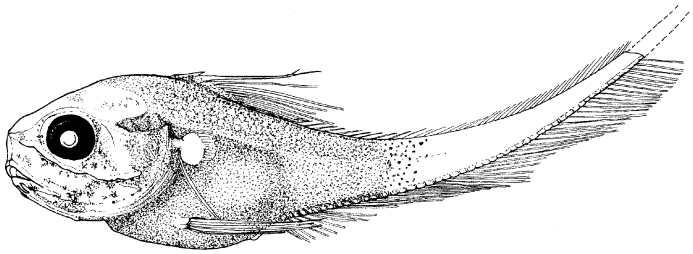
Caelorinchus occa



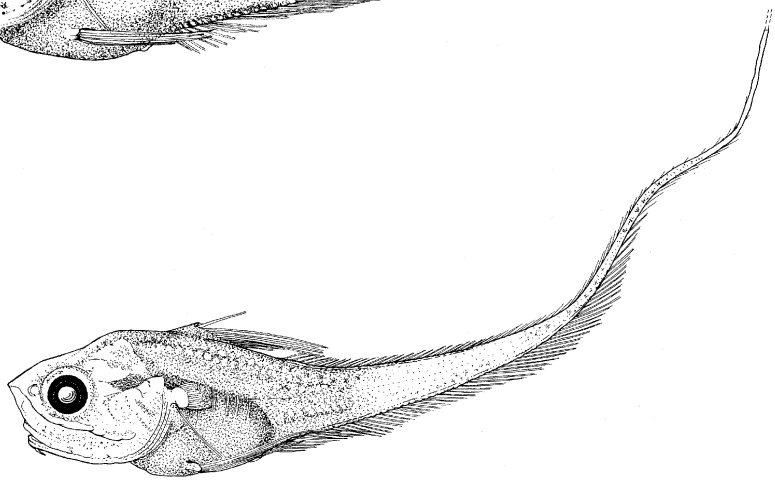
A. 3.0 mmHL



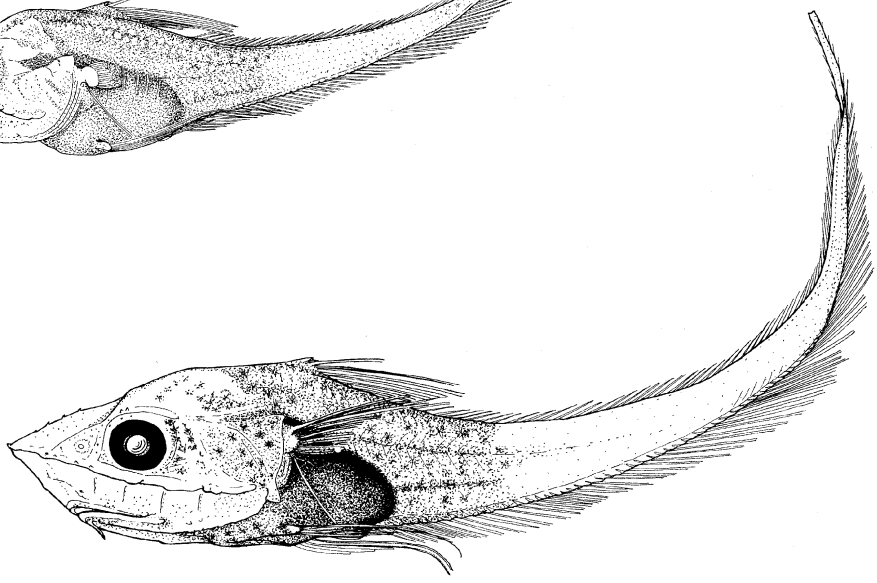
B. 4.5 mmHL



C. 6.0 mmHL

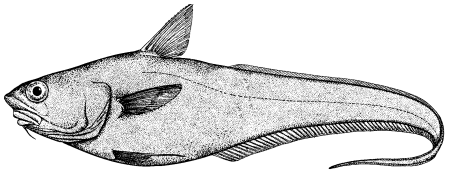


D. 7.0 mmHL



E. 9.0 mmHL

Coryphaenoides armatus (Hector, 1875)
Macrouridae
Abyssal grenadier



Range: Worldwide in subpolar to tropical waters; in the western North Atlantic Ocean from Newfoundland to Cape Hatteras

Habitat: Benthopelagic on deep continental slope and upper continental rise substrates in depths of 2,000–5,500 m

Spawning: Undescribed

Eggs: – Undescribed

Meristic Characters

Myomeres:	difficult to count
Vertebrae:	13–15 + ?
Dorsal fin rays:	10–12+ about 125
Anal fin rays:	~135
Pectoral fin rays:	19–21
Pelvic fin rays:	10–11
Caudal fin rays:	none

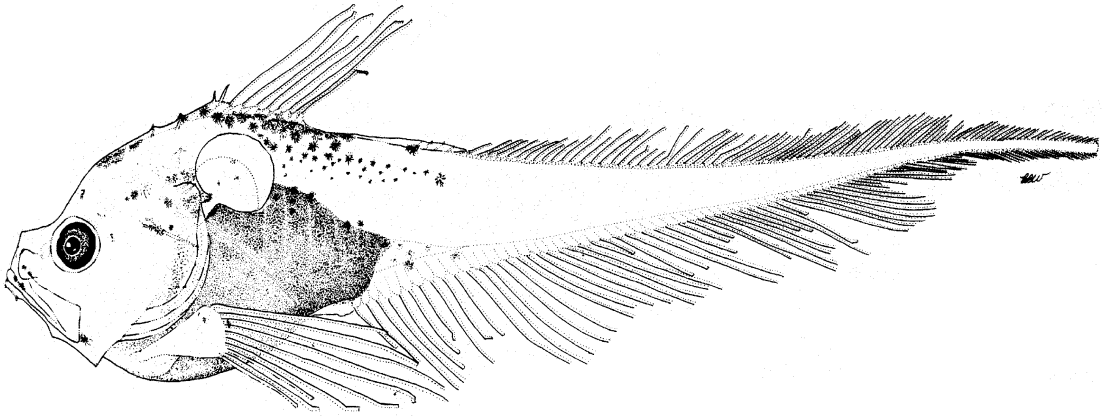
Larvae:
- Body deep anteriorly; tail tapers to finless tip
- HL to TL ratio: unknown
- Pectoral and pelvic fin bases strongly pedunculate
- Branchiostegal rays: 6
- Gill rakers (total) on 1st arch: 11–14
- Precaudal vertebrae: 13–15
- Pelvic fin rays: 10–11 (usually 10 in Atlantic)
- D_1 fin ray count: II, 8–10; 2nd spinous fin ray of D_1 serrate
- Small barbel present on tip of lower jaw
- Light organ absent between the pelvic fin ray bases
- Anus located at anal fin origin
- 5 gas glands present in air bladder
- D_1 and P_2 fin rays moderately elongate
- Anal fin rays longer than dorsal fin rays
- Wide space between dorsal fins
- Pigment pattern Type III; posterior part of head, gut, and anterior body with heavy, large melanophores, ending abruptly, leaving much of tail unpigmented; peritoneal pigment very dark

Note:
1. The illustrated larva (MCZ 58623) was collected at 34°27'N, 71°19'W
2. Also see comparative tables in Macrouridae Introduction

Figures: Adult: Cohen *et al*., 1990 (modified); **A**: Betsy Washington (Fahay and Markle, 1984)

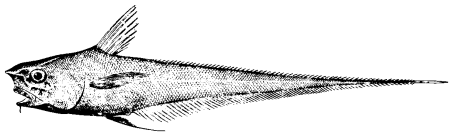
References: Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al*., 1990; Ambrose, 1996i; Iwamoto, 2002

Coryphaenoides armatus



A. 5.5 mmHL

Coryphaenoides carapinus Goode and Bean, 1883
Macrouridae
Carapine grenadier



Range: North Atlantic Ocean; in the western North Atlantic from Nova Scotia to Cape Hatteras; also along Mid-Atlantic Ridge

Habitat: Benthopelagic over continental slope and continental rise substrates in depths of 1,440–5,610 m

Spawning: Undescribed

Eggs: – Undescribed

Meristic Characters

Myomeres:	difficult to count
Vertebrae:	12–15 + ?
Dorsal fin rays:	10–11+100?
Anal fin rays:	117
Pectoral fin rays:	17–20
Pelvic fin rays:	9–11
Caudal fin rays:	none

Larvae:
- Body deep anteriorly, tail tapers to finless tip
- HL to TL ratio 1 to 5–6
- Pectoral and pelvic fin bases strongly pedunculate
- Branchiostegal rays: 6
- Gill rakers (total) on 1st arch: 8–11
- Precaudal vertebrae: 12–15
- Pelvic fin rays: 9–11
- D_1 fin ray count: 10–11; 2nd spinous fin ray of D_1 serrate
- Barbel present on tip of lower jaw
- Light organ absent between the pelvic fin bases
- Anus located at anal fin origin
- 6 gas glands present in air bladder
- Rays of D_1 and P_2 elongate
- Anal fin rays longer than dorsal fin rays
- Wide space between dorsal fins
- Pigment pattern Type III; most of head, gut, anterior tail darkly pigmented, usually with many large melanophores, ending abruptly, leaving posterior end of tail unpigmented; pigment forms an abdominal "hoop" that is obviously darker than anterior head and remainder of tail

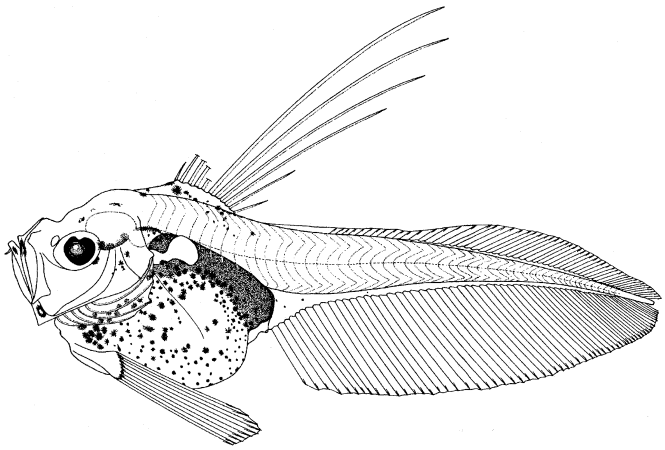
Note:
1. Also see comparative tables in Macrouridae Introduction
2. Collection details for illustrated larvae:

Fig. A: (MCZ 85685) 34°13'N, 71°25'W, Apr 13, 1977
Fig. B: (MCZ 58622) 40°04'N, 68°07'W, Jul 10, 1969
Fig. C: (MCZ 101078) 38°29'N, 72°02'W, Jul 22, 1993

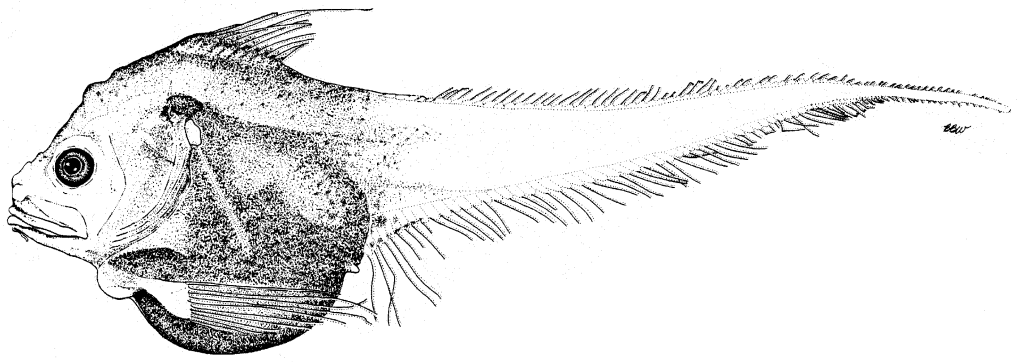
Figures: Adult: Geistdoerfer, 1986; **A, C**: Merrett, 2003; **B**: Betsy Washington (Fahay and Markle, 1984)

References: Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al*., 1990; Ambrose, 1996i; Iwamoto, 2002

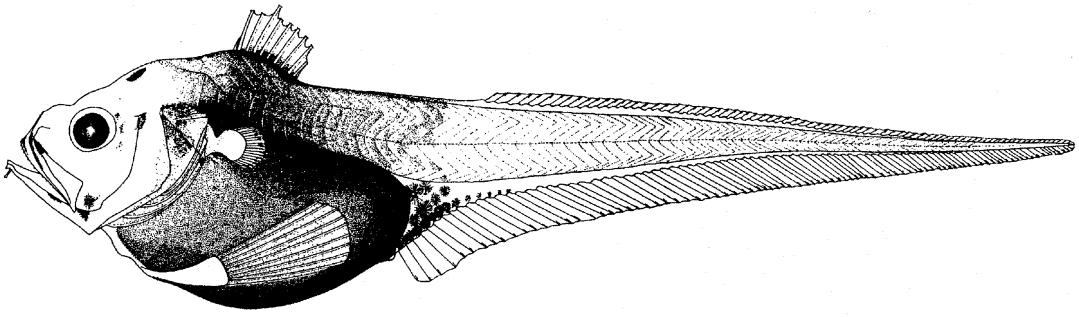
Coryphaenoides carapinus



A. 4.0 mmHL

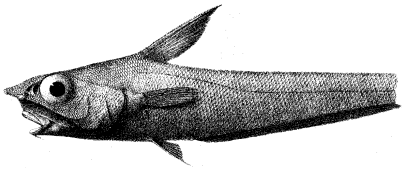


B. 7.5 mmHL



C. 8.0 mmHL

Coryphaenoides guentheri (Vaillant, 1888)
Macrouridae
Günther's grenadier



Meristic Characters

Myomeres:	difficult to count
Vertebrae:	11–14 + ?
Dorsal fin rays:	11–12 + ?
Anal fin rays:	many
Pectoral fin rays:	19–21
Pelvic fin rays:	7–8 (9)
Caudal fin rays:	none

Range: North Atlantic Ocean and Mediterranean Sea; in the western North Atlantic from Davis Strait to vicinity of Alvin and Block canyons

Habitat: Benthopelagic in depths of 831–2,830 m

Spawning: Undescribed

Eggs:
- Chorion smooth, unsculpted (based on observation of oocytes)
- Pores present, diameter 0.1–0.3 µm
- Otherwise undescribed

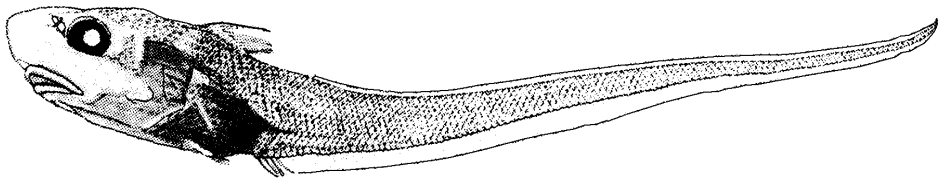
Larvae:
- Early larvae undescribed; characters of pelagic-juvenile follow:
- Body very elongate, only moderately deeper anteriorly; tail tapers to finless tip
- HL to TL ratio: 1 to 4–5
- Pectoral fin bases strongly pedunculate
- Branchiostegal rays: 6
- Gill rakers (total) on 2nd arch: 0+1+6
- Precaudal vertebrae: 11–14
- Pelvic fin rays: 7–8 (rarely 9)
- D_1 fin ray count: 11–12; 2nd spinous fin ray of D_1 serrate
- Barbel present on tip of lower jaw; forms at size <12.0 mmHL
- Light organ absent between the pelvic fin ray bases
- Anus located at anal fin origin
- 4 gas glands present in air bladder
- No elongate fin rays
- Anal fin rays longer than dorsal fin rays
- Wide space between dorsal fins
- Pigment pattern Type II; small melanophores scattered over head and body, decreasing near tail-tip; peritoneum densely pigmented

Note: 1. Also see comparative tables in Macrouridae Introduction

Figures: Adult: Geistdoerfer, 1986; **A**: C. E. Darter (Merrett, 1978) (modified)

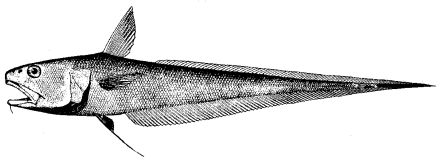
References: Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al*., 1990; Merrett and Barnes, 1996; Ambrose, 1996i; Iwamoto, 2002

Coryphaenoides guentheri



A. 12.0 mmHL

Coryphaenoides leptolepis (Günther, 1877)
Macrouridae
No common name



Meristic Characters

Myomeres:	difficult to count
Vertebrae:	12–13+ ?
Dorsal fin rays:	8–10 + ?
Anal fin rays:	many
Pectoral fin rays:	19–20
Pelvic fin rays:	9–10
Caudal fin rays:	none

Range: Western North Atlantic Ocean between 41° and 31°N and 78° and 65°W (northeast Georges Bank to Georgia); also off northeastern Brazil, Mid-Atlantic Ridge, off southern Portugal and northern Pacific Ocean

Habitat: Benthopelagic in depths of 610–4,000 m

Spawning: Undescribed

Eggs:
- Undescribed

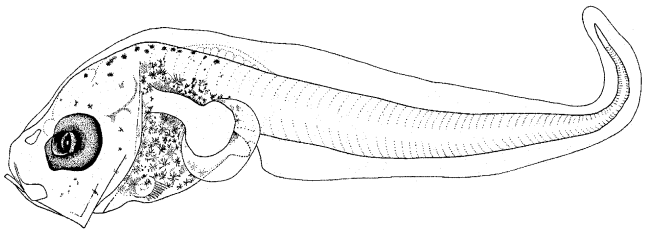
Larvae:
- Body deep anteriorly, tail tapers to finless tip
- HL to TL ratio: 1 to 5–6
- Pectoral and pelvic fin bases pedunculate
- Branchiostegal rays: 6
- Gill rakers (total) on 1st arch: 9–11
- Precaudal vertebrae: 12–13
- Pelvic fin rays: 9–10
- D_1 fin ray count: 8–10; second spinous dorsal fin ray serrated
- Fin rays (except pectoral) formed by 3.0–4.0 mmHL
- Barbel present on tip of lower jaw
- Light organ absent between the pelvic fin ray bases
- Anus at anal fin origin
- 6 gas glands present in air bladder
- Rays of first dorsal and pelvic fins somewhat elongate
- Anal fin rays longer than dorsal fin rays
- Wide space between dorsal fins
- Pigment pattern Type III; pigment includes a distinctive dorsal "oval" of melanophores from nape to origin of 2nd dorsal fin, separated from mass of spots over gut (including internal peritoneal pigment) by an unpigmented strip along lateral line; also a cluster of spots on dorsum of head, above the eye, and scattered spots on side of head; no pigment posterior to level of anal fin ray #10
- Transformation occurs at sizes of 6.2 to 13.6 mmHL, when pectoral fin loses pedunculate base

Note:
1. Also see comparative tables in Macrouridae Introduction
2. Illustrations based on specimens collected in the northeast Pacific Ocean

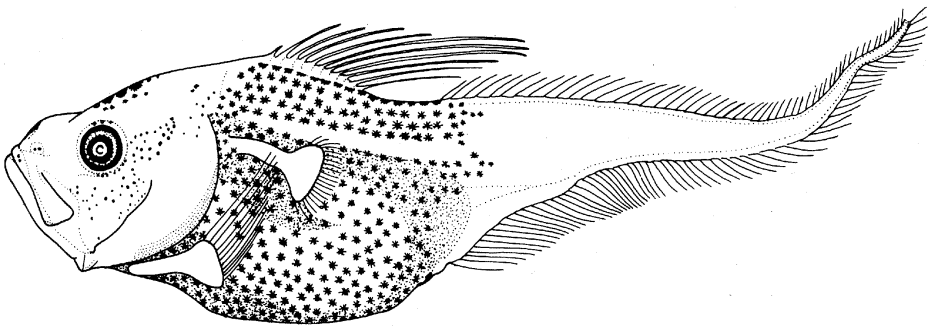
Figures: Adult: Geistdoerfer, 1986; **A**: Mary Vona (Ambrose, 1996i); **B–C**: Bruce Mundy (Stein, 1980)

References: Iwamoto and Stein, 1974; Fahay and Markle, 1984; Merrett 1978; 1986; 1989; 2003; Cohen *et al.*, 1990; Ambrose, 1996i; Iwamoto, 2002

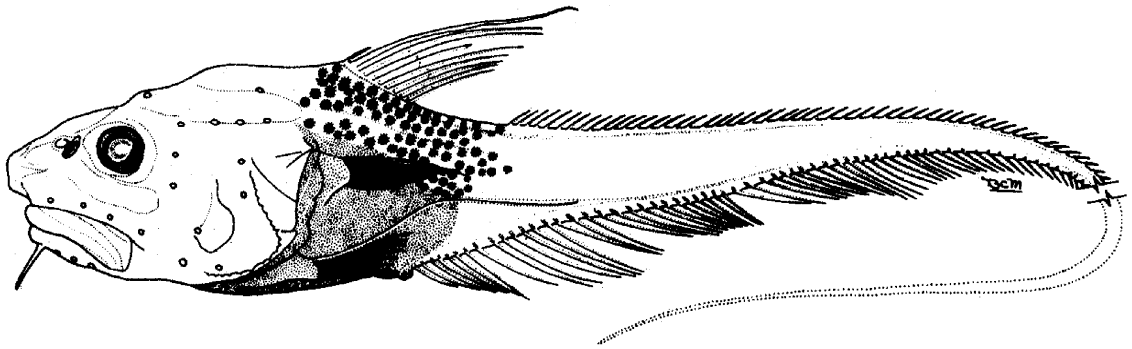
Coryphaenoides leptolepis



A. 1.2 mmHL

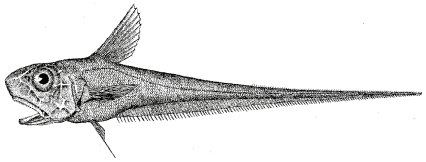


B. 6.2 mmHL



C. 15.2 mmHL

Coryphaenoides rupestris Gunnerus, 1877
Macrouridae
Roundnose grenadier



Range: Western North Atlantic Ocean from Davis Strait (Baffin Island) south to 37°N; isolated occurrence in the Bahamas; also eastern Atlantic and southeastern Greenland

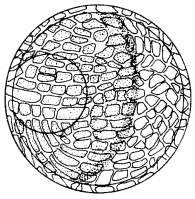
Habitat: Benthopelagic in depths of 400–1,500 m (maximum 2,200 m); sometimes in midwater, to 1,000 m off bottom

Spawning: Apparently spawns summer and fall in northeast Atlantic, especially near Iceland

Meristic Characters

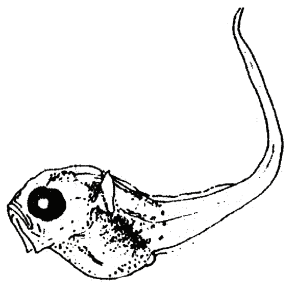
Myomeres:	difficult to count
Vertebrae:	11–13 + ?
Dorsal fin rays:	10–13 (1st)
Anal fin rays:	104–193
Pectoral fin rays:	16–19
Pelvic fin rays:	7–8
Caudal fin rays:	none

Eggs:
- Pelagic, spherical, 2.3–2.4 mm diameter
- Chorion with 'cellular' sculpting, or smooth, or "partially ornamented" (presumably capable of being either smooth or sculpted)
- Pores present, 0.2–0.3 µm in diameter
- Single oil globule, 0.80–1.20 mm



Gastrula stage egg

Larvae:
- Body moderately deep anteriorly, tapers to finless tip
- HL to TL ratio: 1 to 4–6
- Pectoral and pelvic fin bases pedunculate
- Branchiostegal rays: 6
- Gill rakers (total) on 1st arch: 18–20
- Precaudal vertebrae: 11–13
- Pelvic fin rays: 7–8
- D_1 fin ray count: 10–13: second spinous dorsal fin ray serrate
- Fin rays (except pectoral) formed by 12.0 mm HL
- Barbel present, short, at tip of lower jaw
- Light organ absent between the pelvic fin bases
- Anus at anal fin origin
- 4 gas glands present in air bladder
- No elongate fin rays
- Anal fin rays longer than dorsal fin rays
- Wide space between dorsal fins
- Pigment pattern in early larvae Type II, where minute melanophores are scattered over-all on body, fading out near tail-tip; later larvae closer to pigment pattern Type III, where pigment posterior to level of dorsal fin origin is weak or absent; in all stages, peritoneum densely pigmented



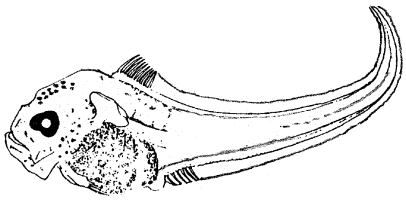
Yolk-sac larva

Note:
1. The 'cellular' sculpting of the chorion (Grigor'ev and Serebryakov, 1981) has been described as unlike the hexagonal pattern described in some other macrourid species. Other observations of eggs of laboratory-reared *Coryphaenoides rupestris* (Merrett, 1989; Merrett and Barnes, 1996), indicate a lack of chorion sculpting, suggesting some variation within and between species

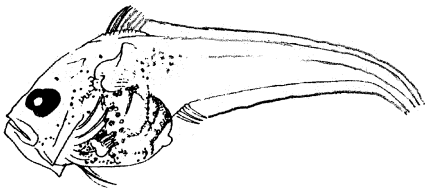
Figures: Adult: D. R. Harriott (Scott and Scott, 1988); Egg: Grigor'ev and Serebryakov, 1981; Yolk-sac larva and **A–G**: C. E. Darter (Merrett, 1978)

References: Grigor'ev and Serebryakov, 1981; Fahay and Markle, 1984; Merrett 1978; 1986; 1989; Merrett and Barnes, 1996

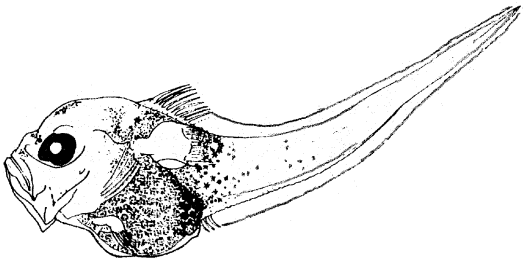
Coryphaenoides rupestris



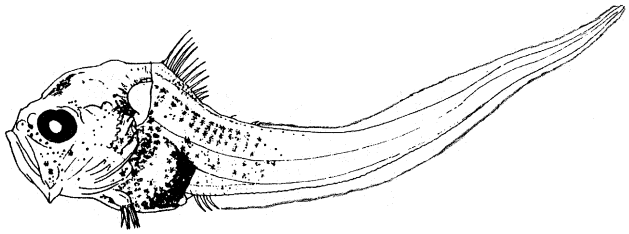
A. 2.5 mmHL



B. 3.1 mmHL

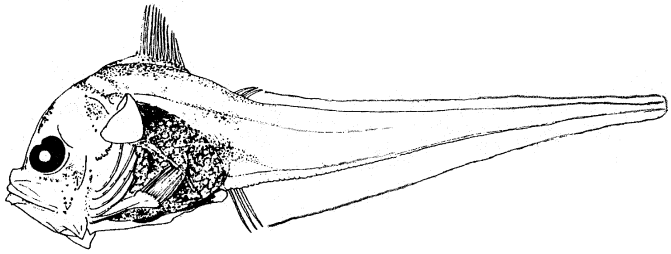


C. 3.3 mmHL

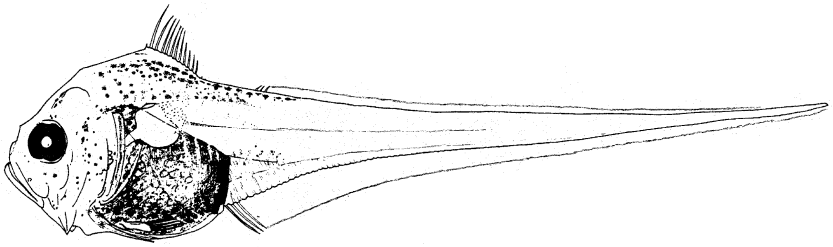


D. 4.0 mmHL

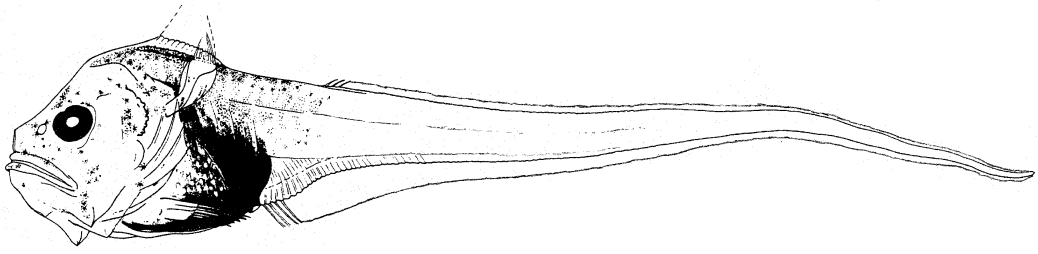
E. 5.0 mmHL



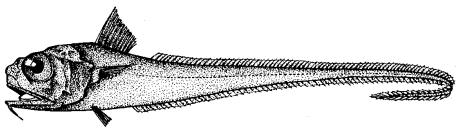
F. 5.1 mmHL



G. 6.9 mmHL



Hymenocephalus italicus Giglioli, 1884
Macrouridae
Glasshead grenadier



Range: Western North Atlantic Ocean from Norfolk and Hydrographer canyons, Florida, through the Gulf of Mexico and Caribbean Sea to Brazil; also eastern Atlantic

Habitat: Benthopelagic at depths of 100–800 m, mostly <500 m

Spawning: Seasonality and location undescribed

Meristic Characters

Myomeres:	difficult to count
Vertebrae:	10–11 (precaudal)
Dorsal fin rays:	11–14 (1st)
Anal fin rays:	many
Pectoral fin rays:	14–17
Pelvic fin rays:	10–11(12)
Caudal fin rays:	none

Eggs:
- Ripe, ovarian eggs 1.00–1.08 mm in diameter
- Chorion of ovarian eggs described as smooth, unsculpted
- Chorion of free eggs with hexagonal honeycombed ornamentation
- A large oil globule, 0.26–0.28 mm, and a smaller oil globule present
- Yolk: homogeneous

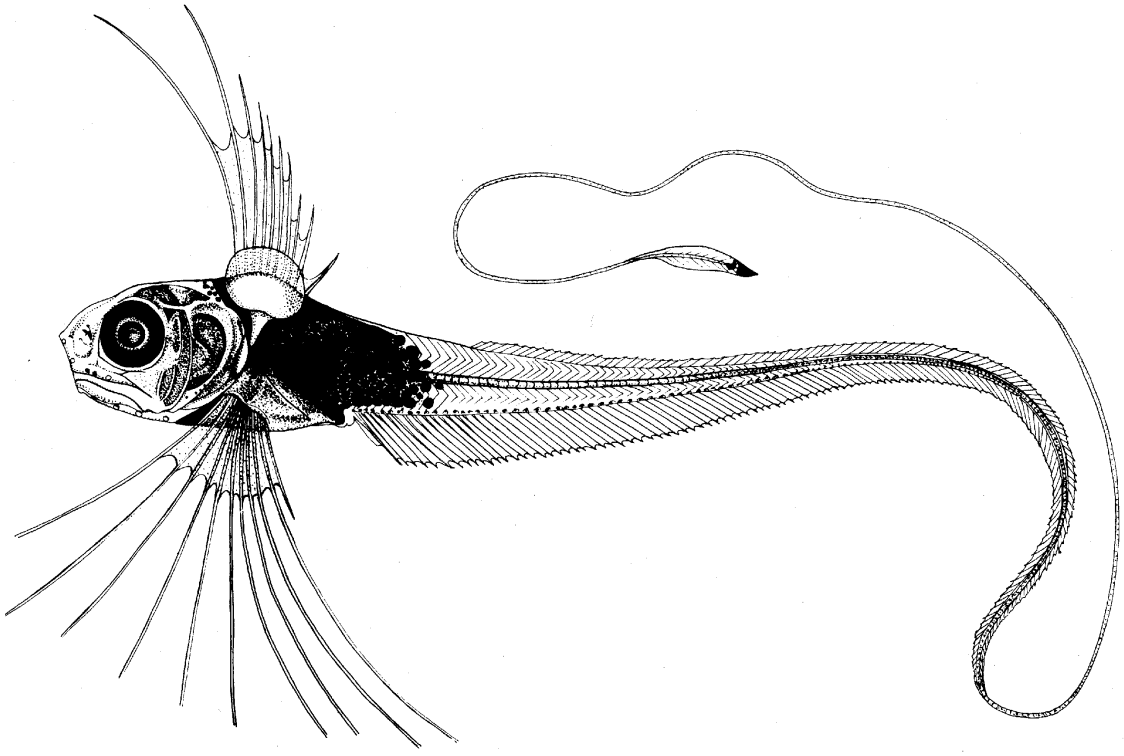
Larvae:
- Body moderately deep anteriorly, tapers to elongate, finless tip with fleshy tab at end
- HL to TL ratio: 1 to 6
- Pectoral and pelvic fin bases pedunculate
- Branchiostegal rays: 7
- Gill rakers (total) on 1st arch: 21–25
- Precaudal vertebrae: 10–11
- Pelvic fin rays: 10–11
- D_1 fin ray count: 11–14; second spinous dorsal fin ray smooth
- Dorsal, anal and pelvic fin rays formed <6.6 mmHL
- Very small chin barbel at tip of lower jaw (appears after transformation)
- Light organ forms between pelvic fin bases at <9.5 mmHL; anterior and posterior lenses separated by secondary duct
- Anus at anal fin origin
- 2 gas glands present in air bladder
- Elongate fin rays present in D_1, P_1, P_2 and tail filament
- Anal fin rays longer than dorsal fin rays
- Wide space between dorsal fins
- Pigment pattern Type III; melanophores dense on head, abdomen and anterior tail, ending abruptly; most of tail unpigmented
- Transformation occurs at sizes 7.0–9.5 mmHL

Note: 1. Compare egg characteristics with those described for other macrourids.

Figures: Adult: Geistdoerfer, 1986; **A**: Sanzo, 1933a (reversed)

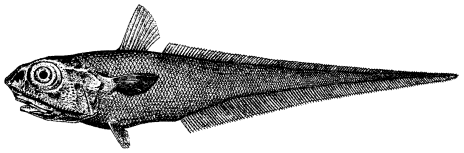
References: Sanzo, 1933a; Fahay and Markle, 1984; Merrett 1978; 1986; 1989; Endo *et al*., 1992; Merrett and Barnes, 1996; Moore *et al*., 2003

Hymenocephalus italicus



A. 102 mmTL

Macrourus berglax Lacépède, 1810
Macrouridae
Roughhead grenadier



Range: Western North Atlantic Ocean from Davis Strait and southern Greenland to Georges Bank and Norfolk Canyon; also eastern Atlantic from Greenland to Ireland, Norway and Barents Sea

Habitat: Benthopelagic in depths of 100–1,000 m (mostly 300–500 m); prefers bottom temperatures of 1°–4°C

Spawning: Late winter to early summer, possibly more protracted; serial spawner; up to 25,000 eggs in a 70-cm female; spawning aggregations observed at depths of 700–800 m (off Norway)

Meristic Characters

Myomeres:	difficult to count
Vertebrae:	16–18 (precaudal)
Dorsal fin rays:	11–13+124
Anal fin rays:	about 148
Pectoral fin rays:	16–19
Pelvic fin rays:	7–9
Caudal fin rays:	none

Eggs:
- Pelagic, spherical
- Diameter: 3.4 to 3.85 mm (ovarian) or 3.48–4.02 mm (planktonic)
- Chorion: "celled" structure, hexagonal honeycombed ornamentation based on ovarian eggs (Yanulov, 1962; Magnusson, 1978)
- Oil globule: single, >0.32 mm in diameter

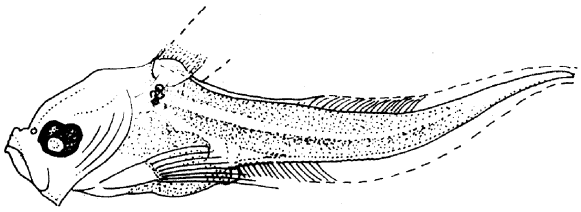
Larvae:
- Body moderately deep anteriorly, tapers to a finless tip
- HL to TL ratio: 1 to 5–7
- Pectoral and pelvic fin bases pedunculate
- Branchiostegal rays: 6
- Gill rakers (total) on 1st arch: 8–10
- Precaudal vertebrae: 16–18
- Pelvic fin rays: 7–9 (usually 8)
- D_1 fin ray count: 11–13; second spinous dorsal fin ray serrate
- Chin barbel very small, forms <4.5 mmHL
- Light organ absent between pelvic fin bases
- Dorsal, anal and pelvic fin rays formed by 3.0 mmHL
- 2nd dorsal fin origin anterior to anus (unusual for early stages of macrourids in study area)
- Anal fin rays longer than dorsal fin rays
- Narrow space between dorsal fins
- Anus at anal fin origin
- Pelvic fin rays elongate; D_1 fin rays moderately elongate
- 4 gas glands present in air bladder
- Pigment pattern Type II; minute melanophores occur over-all on body, tending to fade out near tail tip; linear clusters of several larger melanophores on upper sides, under anterior end of second dorsal fin; peritoneal pigment light
- Transformation occurs at sizes <11.0 mmHL

Note: 1. Illustrated larvae collected from Labrador Sea (Fig. A–C) and east of Greenland (Fig. D)

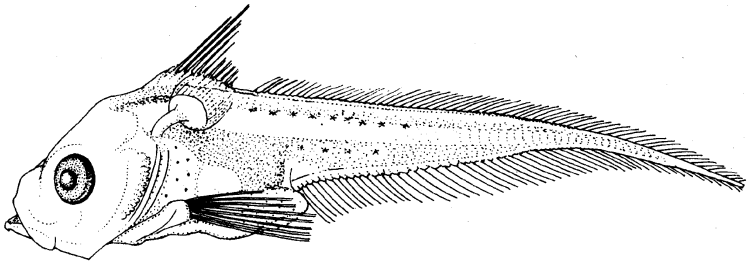
Figures: Adult: H. L. Todd; **A–D**: C. Darter (Merrett, 1986)

References: Grigor'ev, 1971; Magnusson, 1978; Savvatimsky, 1989; Fahay and Markle, 1984; Merrett 1978; 1986; 1989; 2003; Cohen *et al*., 1990

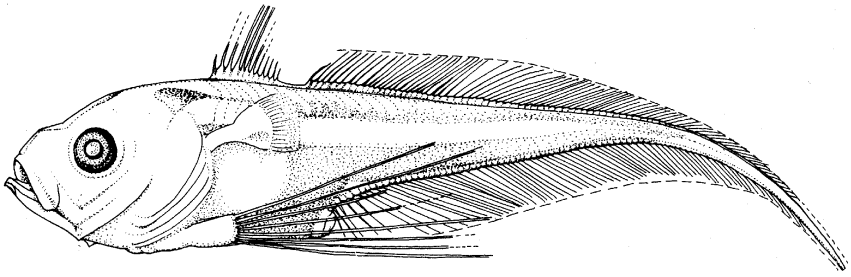
Macrourus berglax



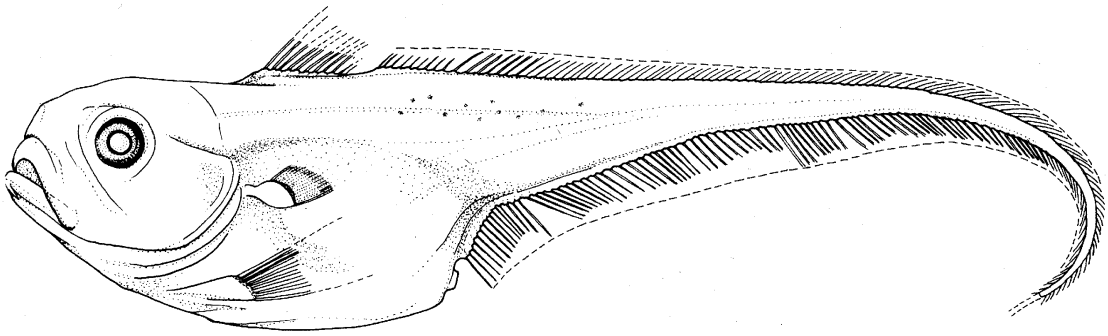
A. 3.0 mmHL



B. 4.5 mmHL

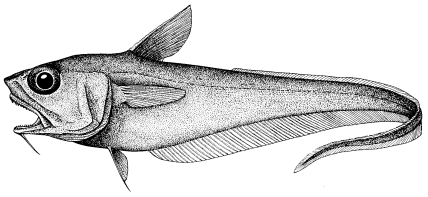


C. 6.5 mmHL



D. 10.9 mmHL

Malacocephalus occidentalis Goode and Bean, 1885
Macrouridae
Western softhead grenadier



Range: Western Atlantic Ocean from Newfoundland to Argentina, including Gulf of Mexico and Caribbean Sea

Habitat: Benthopelagic on continental slopes in depths of 200–600 m; most common between 300 and 500 m

Spawning: Undescribed

Eggs: – Undescribed

Meristic Characters

Myomeres:	difficult to count
Vertebrae:	11–13 (precaudal)
Dorsal fin rays:	13–15 (1st)
Anal fin rays:	many
Pectoral fin rays:	21–26
Pelvic fin rays:	(7) 8
Caudal fin rays:	none

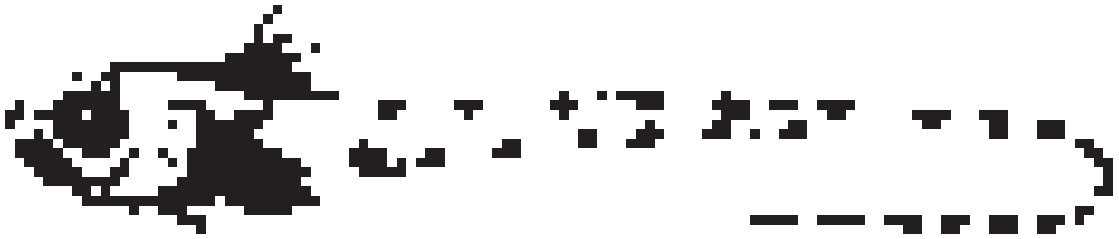
Larvae:
- Body very elongate, only slightly deeper anteriorly; tail tapers to finless tip
- HL to TL ratio: 1 to 8
- Pectoral and pelvic fin bases strongly pedunculate
- Branchiostegal rays: 7
- Gill rakers (total) on 1st arch: 11–13
- Precaudal vertebrae: 11–13
- Pelvic fin rays: 8 (rarely 7)
- D_1 fin ray count: 13–15; 2nd spinous fin ray of D_1 serrate
- Barbel present on tip of lower jaw
- Light organs 2, each associated with a separate lens
- Anus located between pelvic and anal fins
- 2 gas glands present in air bladder
- D_1 and P_2 fin rays elongate
- Anal fin rays longer than dorsal fin rays
- Moderate space between dorsal fins
- Pigment pattern Type I; melanophores arranged in prominent patches or large, saddle shaped spots; background of body pale or unpigmented; peritoneum heavily pigmented

Note:
1. Also see comparative tables in Macrouridae Introduction
2. Identification of specimen in Fig. A putative; may refer to larva of *M. okamurai*; see Merrett (2003); illustration based on MCZ 65171
3. *Malacocephalus laevis* occurs in tropical waters of Atlantic and Indian oceans, in the western Atlantic from Gulf of Mexico to northern South America; series included here for comparison to congeners and to demonstrate consistency in most developmental characters; differences include a smooth 2nd spinous ray of D_1

Figures: Adult: P. Lastrico (Cohen *et al*., 1990); **A**: Merrett, 2003; **B–D**: Merrett, 1989

References: Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al.*, 1990; Ambrose, 1996i; Iwamoto, 2002

Malacocephalus occidentalis

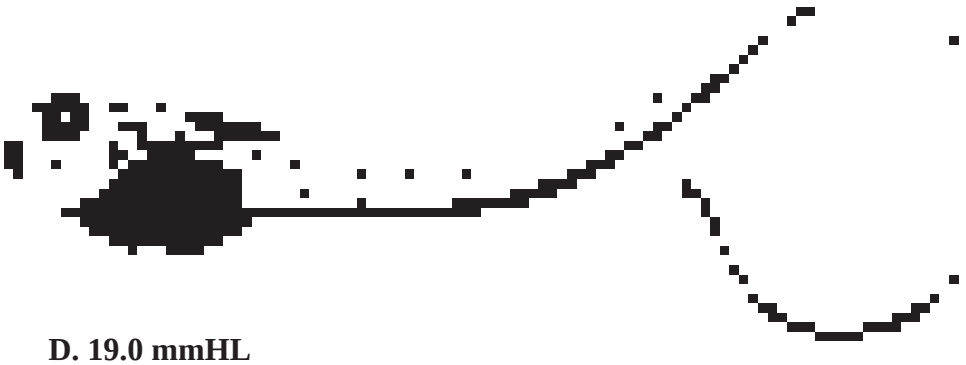


A. 14.0 mmHL

Malacocephalus laevis

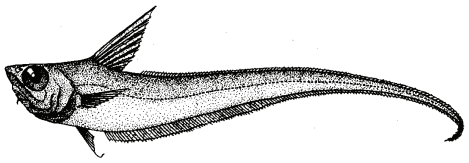
B. 8.0 mmHL

C. 10.0 mmHL



D. 19.0 mmHL

Nezumia aequalis (Günther, 1878)
Macrouridae
Common Atlantic grenadier



Range: Widespread on both sides of the Atlantic Ocean; in the western North Atlantic from Labrador Sea, entire North American coast, through Gulf of Mexico, West Indies and Caribbean Sea to Brazil

Habitat: Benthopelagic at depths of 200–1,000 m, maximum 2,320 m

Spawning: Undescribed

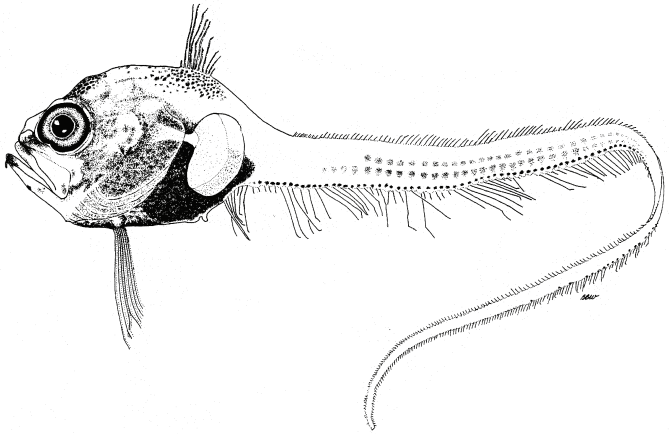
Meristic Characters

Myomeres:	difficult to count
Vertebrae:	13–14 (precaudal)
Dorsal fin rays:	11–14 (1st)
Anal fin rays:	many
Pectoral fin rays:	(15)19–21(23)
Pelvic fin rays:	(7)8–9
Caudal fin rays:	none

Eggs:
- Chorion of ovarian eggs smooth, unsculpted
- Pores present, <0.1–0.3 µm in diameter
- Otherwise undescribed

Larvae:
- Body elongate, much deeper anteriorly
- HL to TL ratio: 1 to 7 or more
- Pectoral and pelvic fin bases pedunculate
- Branchiostegal rays: 7
- Gill rakers (total) on 1st arch: 8–12
- Precaudal vertebrae: 13–14; pelvic fin rays: 8–9 (rarely 7)
- D_1 fin ray count: 11–14; second spinous fin ray serrate
- Barbel present on tip of lower jaw; barbel forms <8.5 mmHL
- Light organ present, begins formation <8.5 mmHL
- Anus located between pelvic and anal fin origins
- 2 gas glands present in air bladder
- Pelvic fin rays very elongate; dorsal rays moderately so
- Dorsal, anal and pelvic fin rays developed by 8.5 mmHL
- Anal fin rays longer than dorsal fin rays; wide space between dorsal fins
- Pigment pattern Type II; fine melanophores scattered over body, fading out near tail-tip; peritoneum darkly pigmented; 2 rows of spots along midlateral region in some
- Transformation occurs at sizes >8.5 mmHL

Note: 1. The "*Khronius*" larvae (Fig. A and B) illustrated by Schmidt (1895) and Costa (1869), respectively, were referred to *Nezumia aequalis* by Marshall (1973). The 92-mm larva was also illustrated in Ehrenbaum (1909).

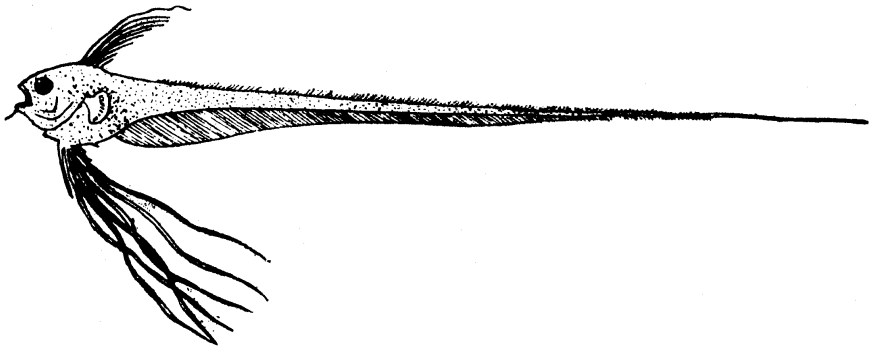


D. 3.0 mmHL
***Nezumia* sp.**

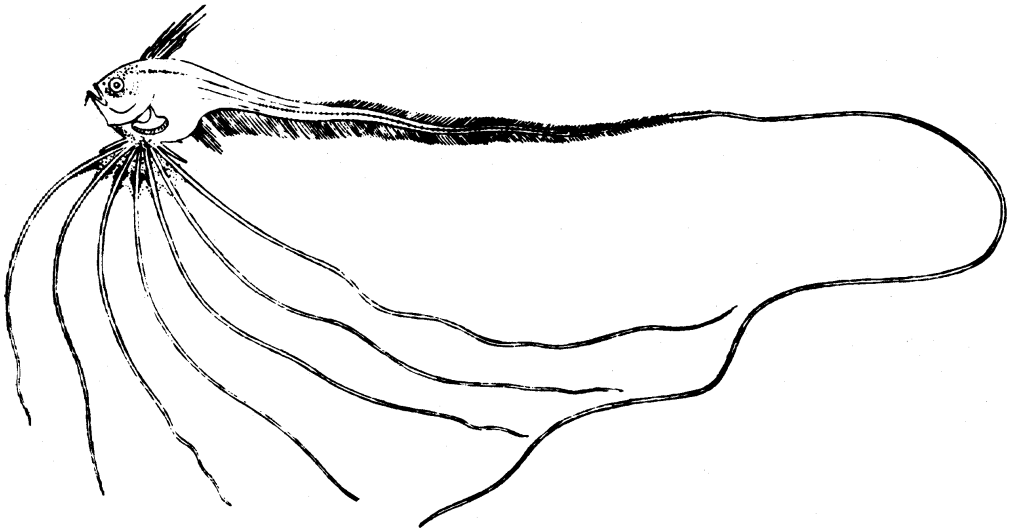
Figures: Adult: Geistdoerfer, 1986; **A**: Schmidt, 1895; **B**: Costa, 1869; **C**: C. Darter (Merrett, 1989); **D**: Betsy Washington (Fahay and Markle, 1984)

References: Sanzo, 1933a; Marshall, 1973; Fahay and Markle, 1984; Merrett 1978; 1986; 1989; 2003; Merrett and Barnes, 1996

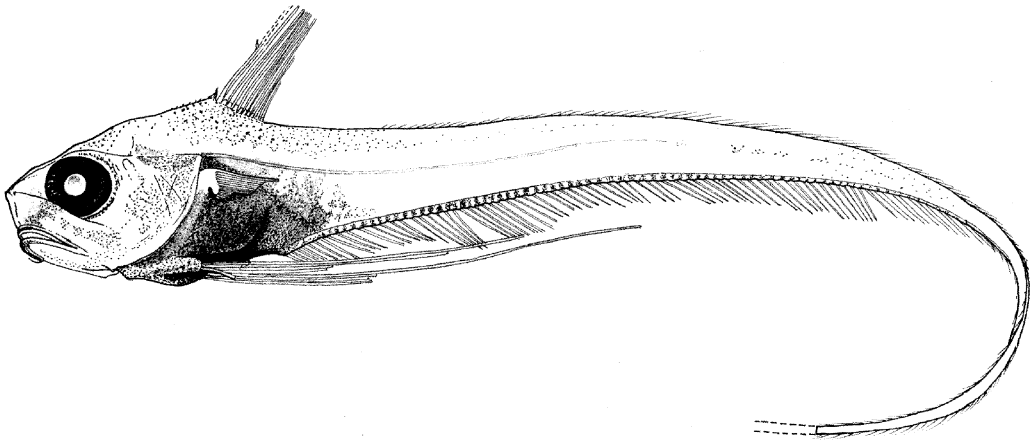
Nezumia aequalis



A. 92 mmTL

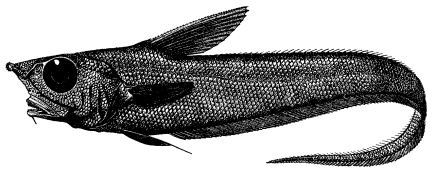


B. 120 mmTL



C. 8.5 mmHL

Nezumia cyrano Marshall and Iwamoto, 1973
Macrouridae
No common name



Meristic Characters

Myomeres:	difficult to count
Vertebrae:	13–14 (precaudal)
Dorsal fin rays:	11–13 (1st)
Anal fin rays:	many
Pectoral fin rays:	18–22
Pelvic fin rays:	8–10
Caudal fin rays:	none

Range: Western North Atlantic Ocean from Hudson Canyon to Suriname, including Gulf of Mexico and Caribbean Sea

Habitat: Benthopelagic in depths of 640–1324 m

Spawning: Undescribed

Eggs: – Undescribed

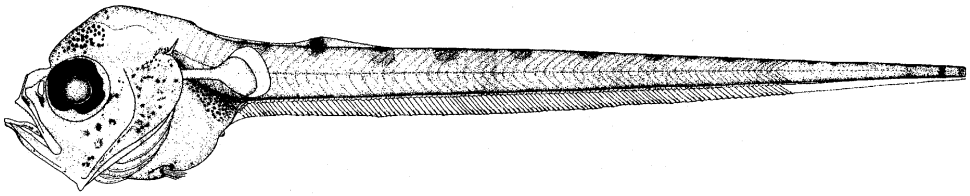
Larvae:
- Body very elongate, deeper anteriorly; tail tapers to finless tip
- HL to TL ratio: 1 to 6–10
- Pectoral and pelvic fin bases strongly pedunculate
- Branchiostegal rays: 7
- Gill rakers (total) on 1st arch: 6–10
- Precaudal vertebrae: 13–14
- Pelvic fin rays: 8–10
- D_1 fin ray count: 11–13; 2nd spinous fin ray of D_1 serrate (at least at tip)
- Barbel present on tip of lower jaw
- Light organ present between the pelvic fin ray bases
- Anus located between pelvic and anal fins
- 2 gas glands present in air bladder
- D_1 fin rays moderately elongate
- Anal fin rays longer than dorsal fin rays
- Wide space between dorsal fins
- Pigment pattern Type III; most of head, gut and anterior tail dark, often with rows of larger spots; pigment ends abruptly, leaving tail tip mostly pale; anterior portion of head less pigmented than abdominal "hoop" (darkly pigmented area under D_1 and over gut); note trace of Type I pattern in early larva

Note:
1. Also see comparative tables in Macrouridae Introduction
2. Illustration in Fig. A based on MCZ 85682

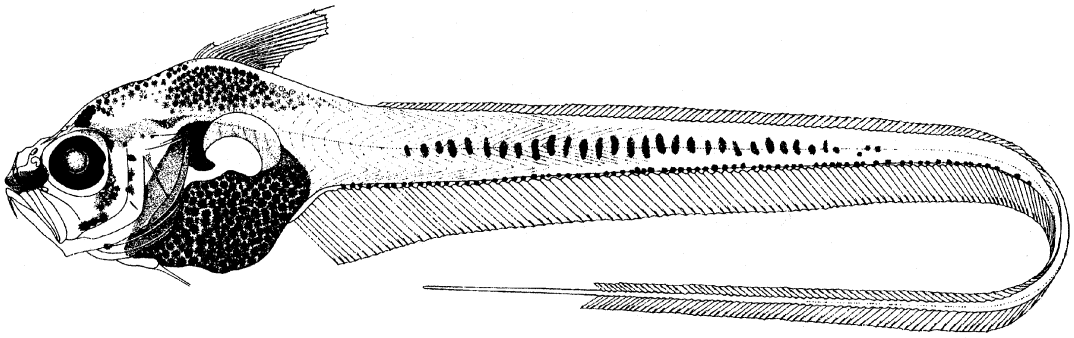
Figures: Adult: N. Strekalovsky (Marshall and Iwamoto, 1973); **A–B** Merrett, 2003

References: Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al*., 1990; Ambrose, 1996i; Iwamoto, 2002

Nezumia cyrano

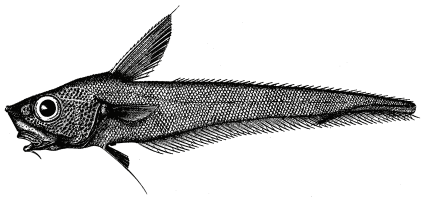


A. 1.7 mmHL



B. 6.8 mmHL

Nezumia sclerorhynchus (Valenciennes, 1838)
Macrouridae
Roughtip grenadier



Range: Both sides of North Atlantic Ocean and Mediterranean Sea; in the western North Atlantic from Georges Bank and Bear Seamount to Straits of Florida and Windward Islands

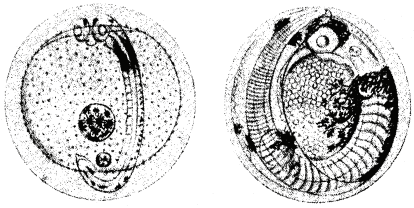
Habitat: Benthopelagic in depths of 130–1,097 m; mostly 450–730 m

Spawning: Undescribed

Meristic Characters

Myomeres:	difficult to count
Vertebrae:	13–14 (precaudal)
Dorsal fin rays:	11–12
Anal fin rays:	many
Pectoral fin rays:	17–21
Pelvic fin rays:	7–10
Caudal fin rays:	none

Eggs:
- Buoyant, spherical, transparent
- Diameter: 1.6 mm
- Chorion: smooth, unsculptured (with protrusions inward)
- Chorion also described as having possible hexagonal, honeycombed ornamentation
- Oil globule: 1 (or more?) 0.32 mm in diameter
- Yolk: homogeneous
- Perivitelline space: wide



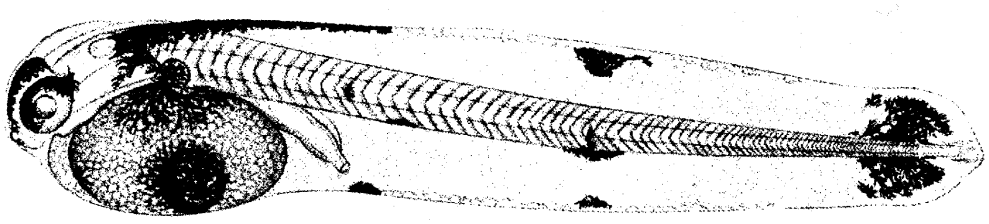
Larvae:
- Undescribed beyond yolk-sac stage; characters below based on adult characters or those common to all macrourids
- Anus opens laterally on finfold
- Pectoral fin bases strongly pedunculate
- Branchiostegal rays: 7
- Gill rakers (total) on 1st arch: 9–11
- Precaudal vertebrae: 13–14
- Pelvic fin rays: 7–10 (usually 9)
- D_1 fin ray count: 11–12; 2nd spinous fin ray of D_1 serrate
- Barbel present on tip of lower jaw
- Light organ present between the pelvic fin ray bases
- Anus located between pelvic and anal fins
- 2 gas glands present in air bladder
- Wide space between dorsal fins
- Pigment pattern in yolk sac larvae includes a dark patch on dorsum over gut, a band composed of 3 parts at level of mid-tail, and a prominent blotch at tip of notochord, spreading onto finfold; top of head well-pigmented

Note: 1. Also see comparative tables in Macrouridae Introduction

Figures: Adult: Mildred Carrington (Marshall and Iwamoto, 1973); eggs and **A**: Sanzo, 1933a

References: Sanzo, 1933a; Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al*., 1990; Ambrose, 1996i; Iwamoto, 2002

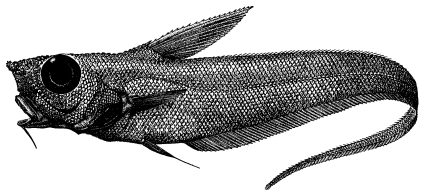
Nezumia sclerorhynchus



A. 4.3 mmTL

Larvae older than yolk-sac stage undescribed

Nezumia suilla Marshall and Iwamoto, 1973
Macrouridae
No common name



Range: Western North Atlantic Ocean from Bear Seamount to Cuba and Suriname, including Gulf of Mexico and Caribbean Sea

Habitat: Benthopelagic in depths of 900–1,500 m

Spawning: Undescribed

Eggs: – Undescribed

Meristic Characters

Myomeres:	difficult to count
Vertebrae:	13–14 (precaudal)
Dorsal fin rays:	11–13
Anal fin rays:	many
Pectoral fin rays:	19–22
Pelvic fin rays:	7
Caudal fin rays:	none

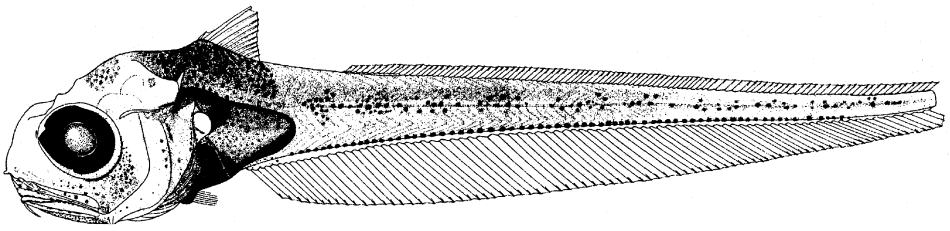
Larvae:
- Body very elongate, anterior part only slightly deeper; tail tapers to finless tip
- HL to TL ratio: 1 to 8 or more
- Pectoral fin bases moderately pedunculate
- Branchiostegal rays: 7
- Gill rakers (total) on 1st arch: 7–9
- Precaudal vertebrae: 13–14
- Pelvic fin rays: 7
- D_1 fin ray count: 11–13; 2nd spinous fin ray of D_1 serrate
- Barbel present on tip of lower jaw
- Light organ present between the pelvic fin ray bases
- Anus located between pelvic and anal fins
- 2 gas glands present in air bladder
- D_1 fin rays moderately elongate
- Anal fin rays longer than dorsal fin rays
- Wide space between dorsal fins
- Pigment pattern Type III; posterior part of head, gut and anterior body densely pigmented, with row of scattered melanophores extending length of tail to tail tip; anterior head relatively unpigmented

Note:
1. Also see comparative tables in Macrouridae Introduction
2. Illustrations based on (Fig. A): MCZ 85705; (Fig. B): USNM 289478

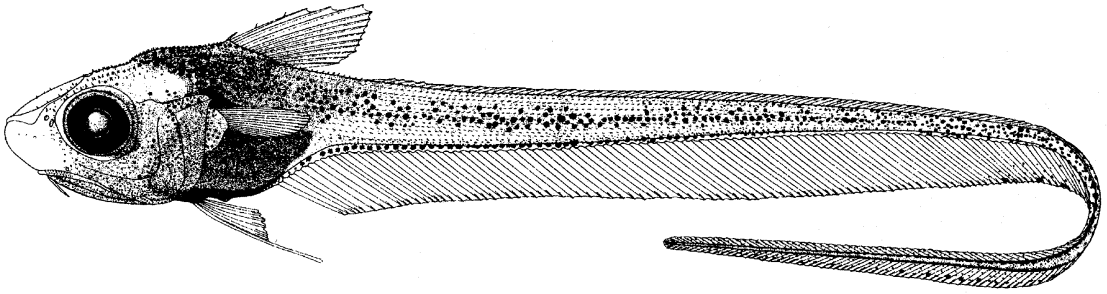
Figures: Adult: N. Strekalovsky (Marshall and Iwamoto, 1973); **A–B**: Merrett, 2003

References: Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al.*, 1990; Ambrose, 1996i; Iwamoto, 2002

Nezumia suilla

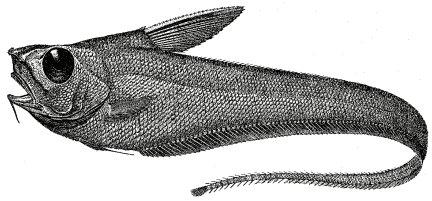


A. 8.0 mmHL



B. 9.0 mmHL

Sphagemacrurus grenadae (Parr, 1946)
Macrouridae
Pugnose grenadier



Range: Western North Atlantic Ocean from Bear Seamount and Hudson Canyon to northern South America, including Gulf of Mexico and Caribbean Sea

Habitat: Benthopelagic in depths of 1,000–1,960 m

Spawning: Undescribed

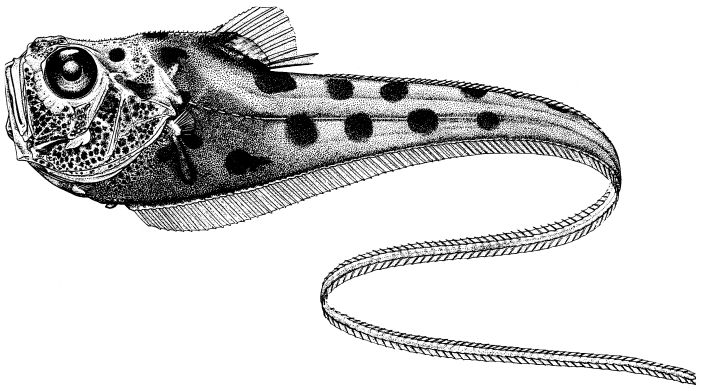
Eggs: – Undescribed

Meristic Characters

Myomeres:	difficult to count
Vertebrae:	11–12 (precaudal)
Dorsal fin rays:	12–13 (1st)
Anal fin rays:	many
Pectoral fin rays:	18–22
Pelvic fin rays:	11–12
Caudal fin rays:	none

Larvae:
- Body very elongate, anterior part slightly deeper; tail tapers to finless tip
- HL to TL ratio: 1 to 7–8
- Pectoral fin bases strongly pedunculate
- Branchiostegal rays: 7
- Gill rakers (total) on 1st arch: 9–10
- D_1 fin ray count: 12–13; 2nd spinous fin ray of D_1 serrate
- Barbel present on tip of lower jaw
- Light organ present between the pelvic fin ray bases
- Anus located between pelvic and anal fins
- 2 gas glands present in air bladder
- Pelvic fin rays elongate
- Anal fin rays longer than dorsal fin rays
- Narrow space between dorsal fins
- Pigment pattern Type II; much of head, gut and tail densely pigmented with fine spots, pigment fading out to almost none near tail tip; young stages have series of melanophores laterally on mid-tail; anterior head remains more lightly pigmented than remainder of head; large spots on cheek below eye

Note:
1. Also see comparative tables in Macrouridae Introduction
2. Illustrations based on (Fig. A): MCZ 86053; (Fig. B): USNM 290724
3. A juvenile (Fig. C) ascribed to "*Sphagemacrurus*? sp." (Backus *et al.*, 1965, fig. 3) has been identified as a young example of *Mesobius berryi* (Merrett, 2003). This species occurs in the equatorial and western South Atlantic, and Indo-Pacific oceans.

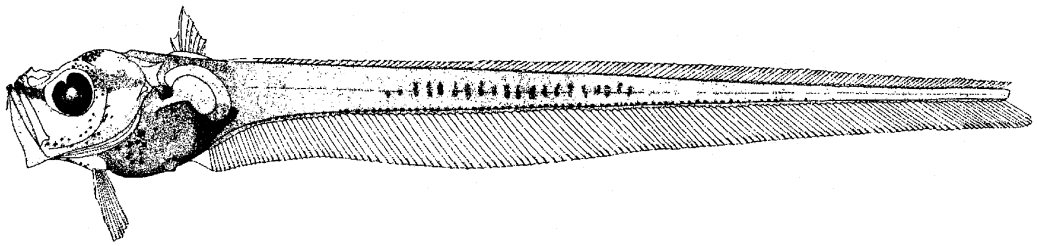


C. 153 mmSL

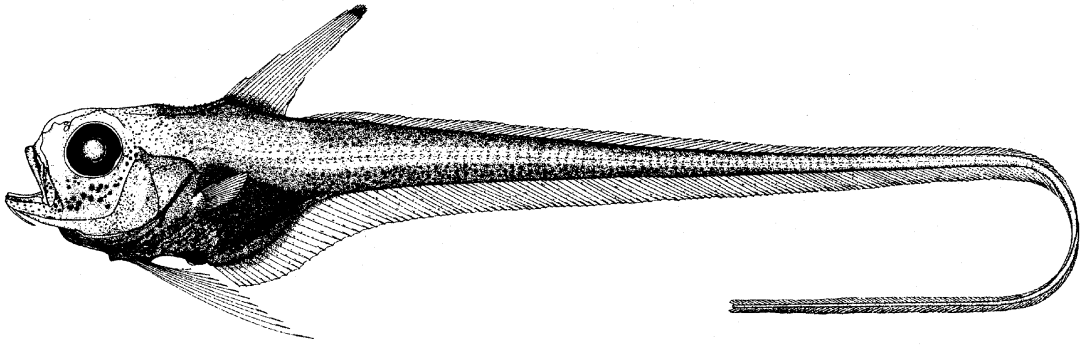
Figures: Adult: N. Strekalovsky (Marshall, 1973); **A–B**: Merrett, 2003; **C**: N. Strekalovsky (Backus *et al*., 1965)

References: Fahay and Markle, 1984; Merrett, 1978; 1986; 1989; 2003; Cohen *et al*., 1990; Ambrose, 1996i; Iwamoto, 2002

Sphagemacrurus grenadae



A. 4.5 mmHL



B. 8.8 mmHL