

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

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

Meristic features

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

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

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

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

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

Similar larvae

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

***Osmerus mordax* (Mitchill)**

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

Meristics features

- Eggs**
- Demersal, adhesive, in clusters.
 - Diameter: 0.6-1.2 mm.
- Larvae**
- Hatching occurs at about 5-6 mm; preanal myomeres 38-43.
 - Adipose fin present.
 - Fins well developed at about 15 mm.
 - Air bladder obvious in sizes greater than 15 mm.
 - Pigmentation: up to 15 mm, may have ventral pair of spots anterior to pectoral fins.

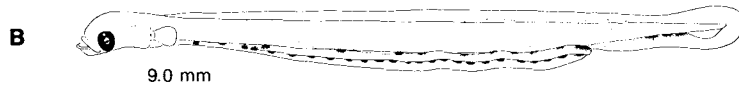
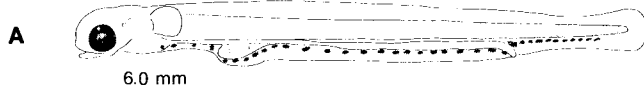
Myomeres: 62-64
 Vert : 62-64
 D : 10-11
 A : 15-17
 Plv : 8
 P : 11-12

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

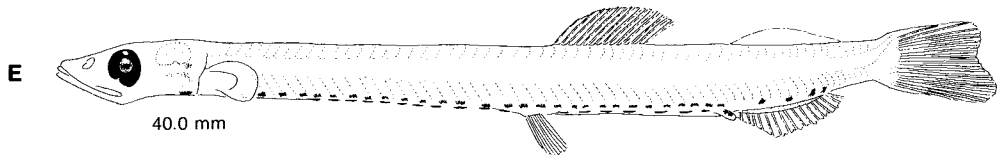
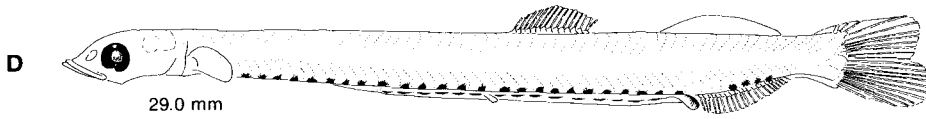
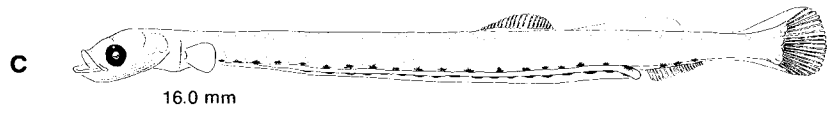
Ref. — Rice 1878; McKenzie 1964; Serebryakov MS 1980; H. Powles 1982 (pers. comm.).

Mallotus villosus

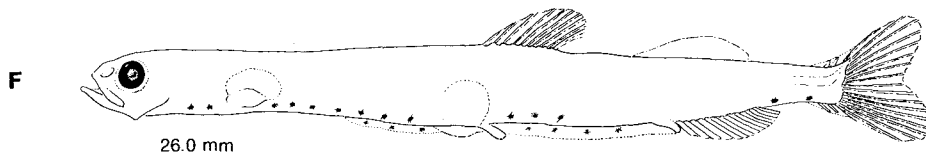
OSMERIDAE



One or more pairs of elongate spots laterally on isthmus



Osmerus mordax



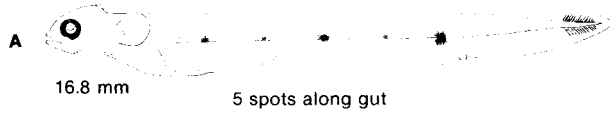
ARGENTINIDAE***Argentina silus* Ascanius**

(North Atlantic)

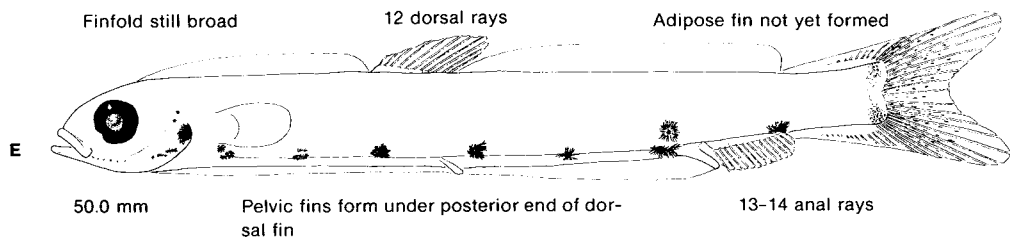
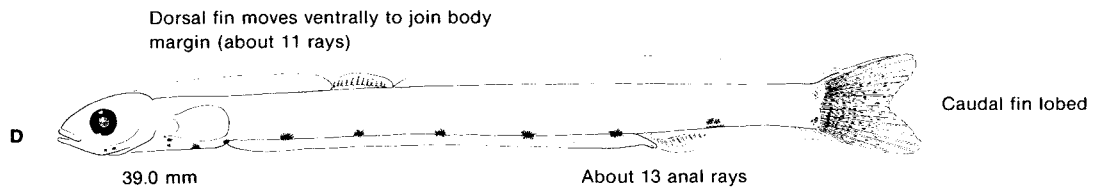
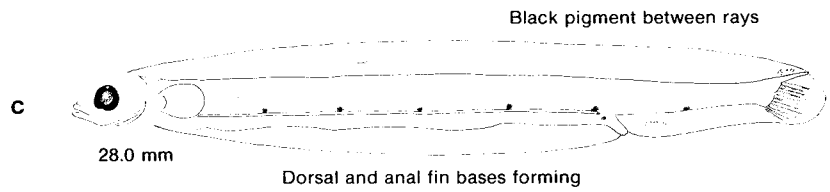
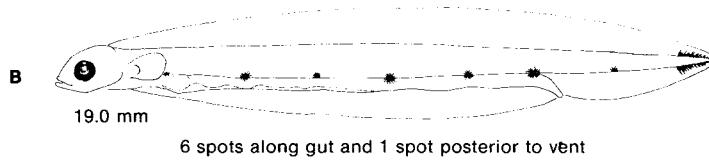
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|-------------|--|--------------------------|
| Eggs | <ul style="list-style-type: none"> — Pelagical, spherical. — Diameter: 3.0–3.5 mm. — Shell: smooth. — Yolk: segmented. — Oil globules: 1. — O.G. diameter: 0.95–1.16 mm. — Perivitelline space: narrow.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

Argentina silus

ARGENTINIDAE



Spots dorsal and ventral to notochord tip



ARGENTINIDAE ***Microstoma microstoma* (Risso)**

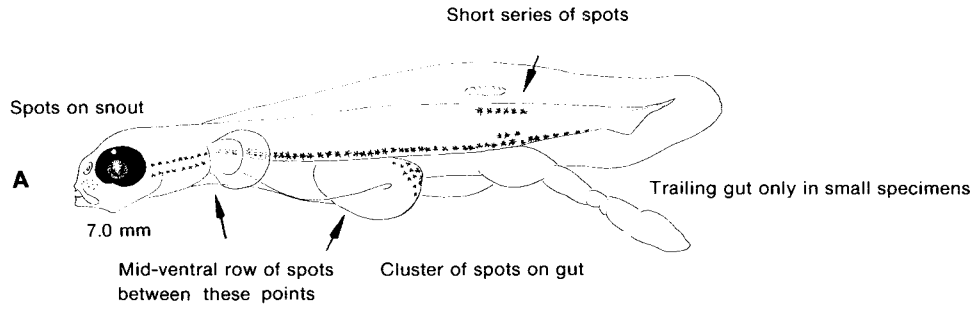
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| Eggs | <ul style="list-style-type: none"> — Pelagic, spherical and transparent. — Diameter: 1.60–1.72 mm. — Shell: sculptured with internally-directed projections. — Yolk: segmented. — Oil globules: 1. — O. G. diameter: 0.48–0.52 mm. — Perivitelline space: narrow. | Meristic features |
| | | <ul style="list-style-type: none"> Myomeres: 45–46 Vert : 29–30+15–17 D : 11–12 A : 8–9 Piv : 9–11 P : 8 |
| Larvae | <ul style="list-style-type: none"> — Fairly slender with swollen trailing gut. — No adipose fin. — Low number of branchiostegal rays (3–4). — Flexion occurs at about 7–11 mm, and transformation at about 17–20 mm. — Dorsal and anal fins form distally in finfold. — Pectoral and pelvic fins form late. — Pigmentation: (see illustrations opposite). | |

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

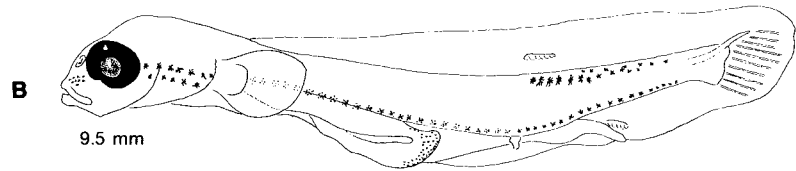
Ref. — Sanzo 1931a.

Microstoma microstoma

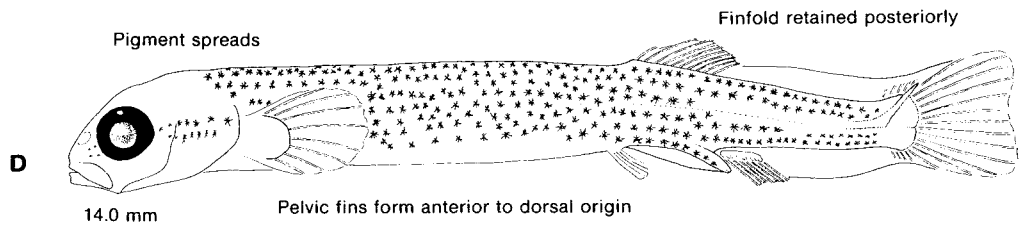
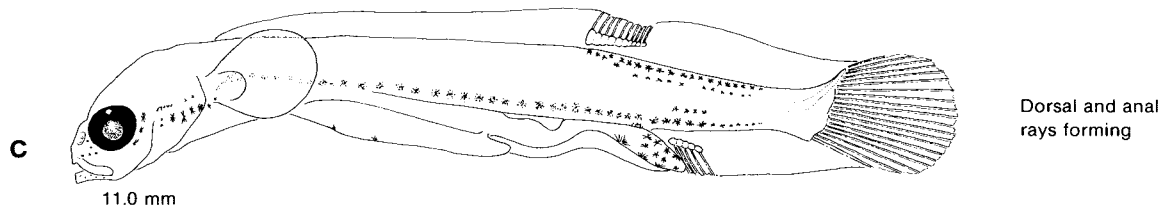
ARGENTINIDAE



Conspicuous row of spots from eye along ventral edge



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



A-D (Mediterranean material)

ARGENTINIDAE *Nansenia groenlandica* (Reinhardt)

Eggs — Undescribed.

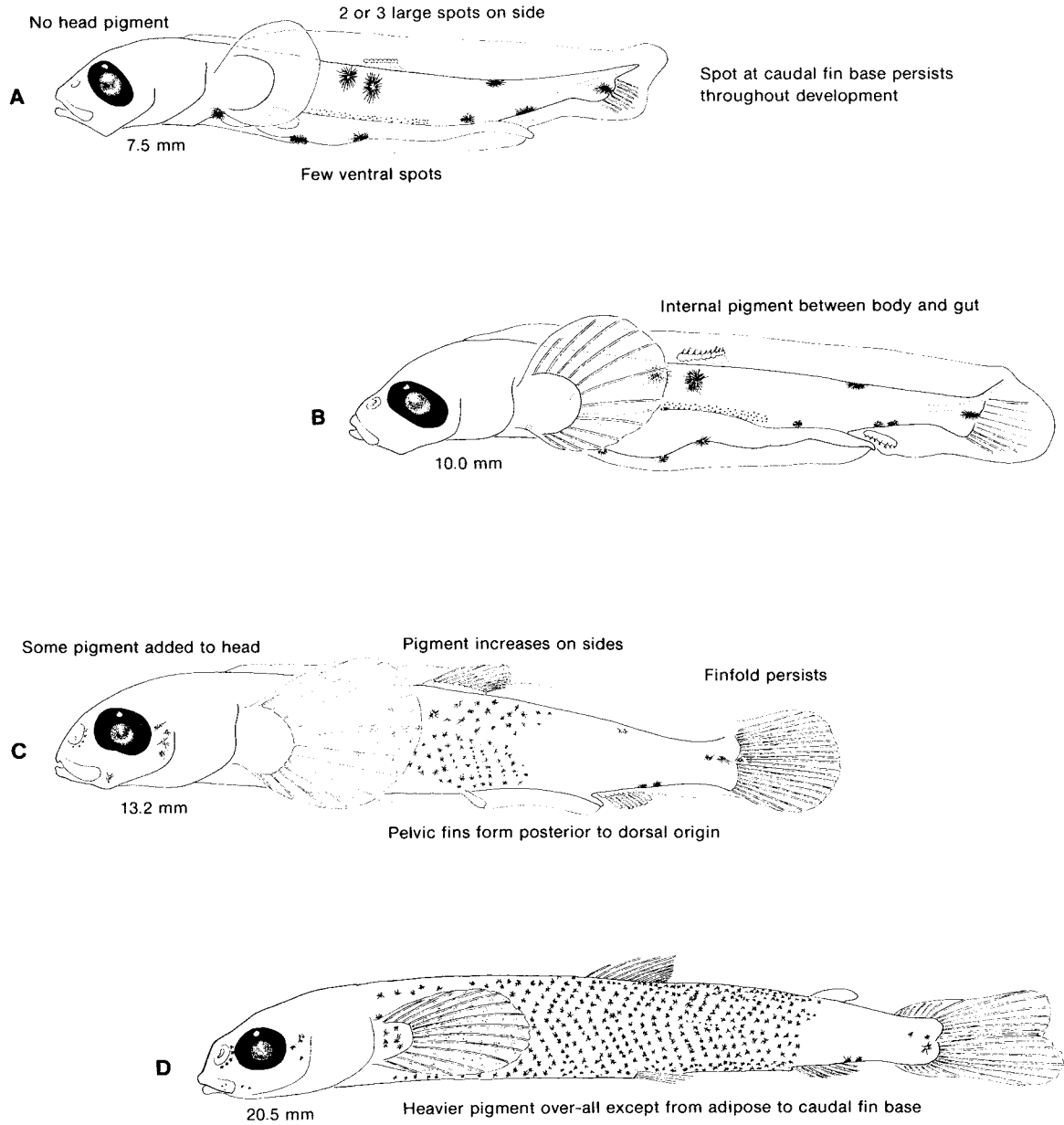
- Larvae** — Fairly slender, with long thick gut.
— Low number of branchiostegal rays (3–4).
— Adipose fin forms before transformation.
— Flexion complete at about 10–13 mm; and transformation occurs at >20 mm.
— Dorsal and anal fins form distally in finfold.
— Pelvic fin forms late.
— Dorsal fin origin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

Meristic features

Myomeres: 43–44
Vert : 43–44
D : 10–11
A : 9–11
Piv : 9–11
P : 14–15

Nansenia groenlandica

ARGENTINIDAE



A-D (eastern North Atlantic material).

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

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

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

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

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

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

"*Bathylagus benedicti*" (Fig. D)

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

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

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

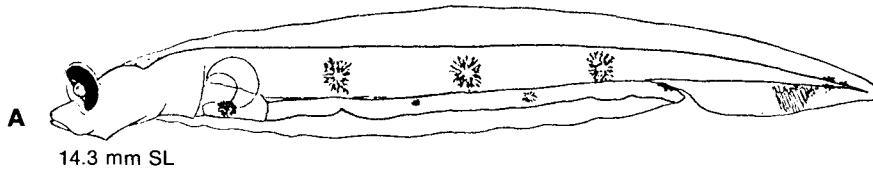
Note: Beebe (1933) referred this species to *B. glacialis*.

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

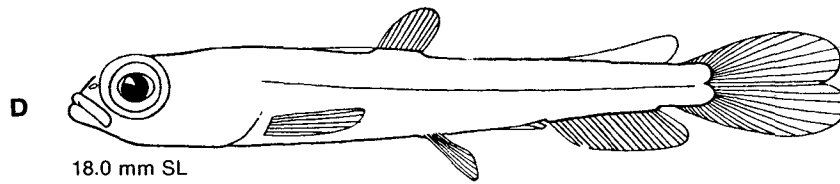
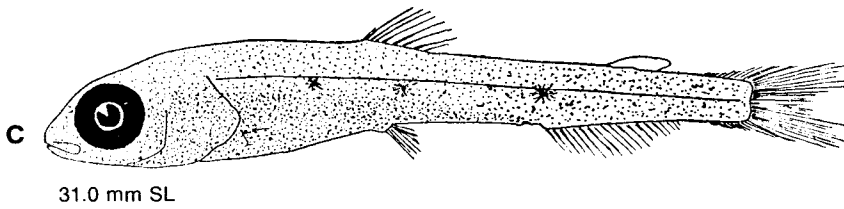
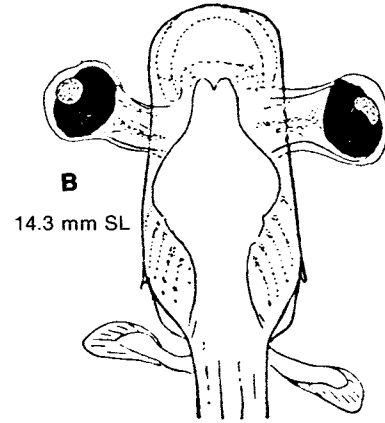
Ref. — Cohen 1964.

Bathylagus (euryops)

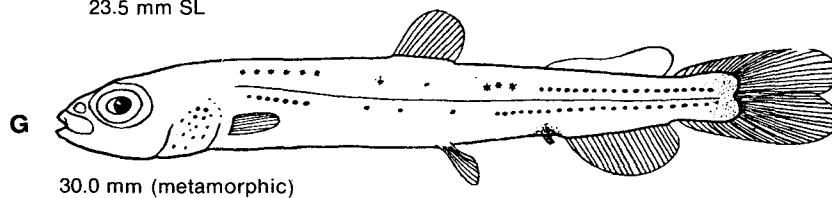
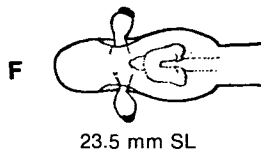
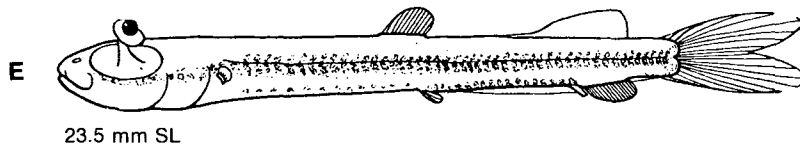
BATHYLAGIDAE



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



***Bathylagus compsus* Cohen**



GONOSTOMATIDAE Family Characters

(including STERNOPTYCHIDAE)

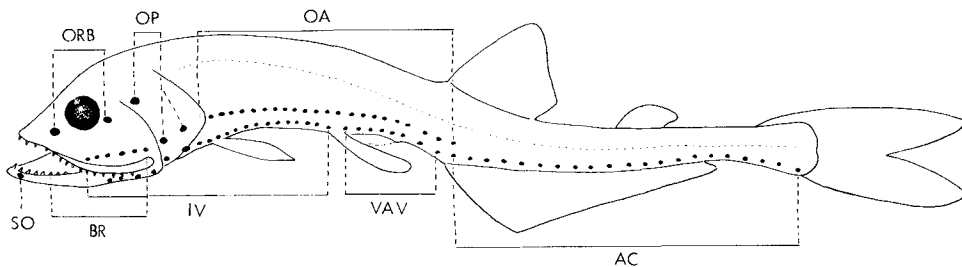
General: Larval descriptions available for 12 of 16 genera in the western North Atlantic; very abundant in oceanic collections; *Cyclothone* (adults) may be most abundant genus; *Vinciguerria* and *Maurolicus* larvae very abundant.

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

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

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

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



Family Characters GONOSTOMATIDAE

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

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

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

² Trailing gut present.

³ Very long gut; anus shifts anteriorly before metamorphosis.

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

⁵ OA photophores lacking.

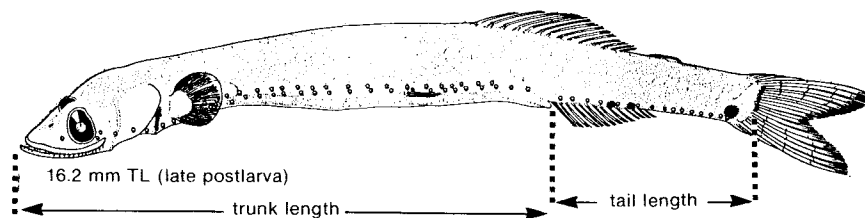
⁶ The very similar and common *Sternoptyx* sp. is characterized by a much shorter gut before transformation, normal eyes after transformation (telescopic in *Argyropelecus*), and transformation occurring at smaller sizes.

GONOSTOMATIDAE *Vinciguerria* (3 species)

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

Distinguishing characters:

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

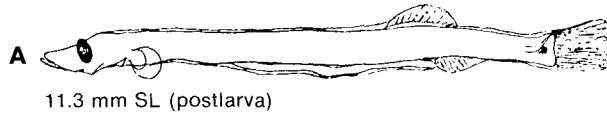


Vinciguerria nimbaria (Indian Ocean specimen, Silas and George, 1969)

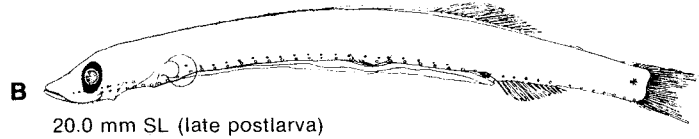
Fig. — A-B, D-H, Jespersen and Täning 1926; C, Ahistrom and Counts 1958.

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

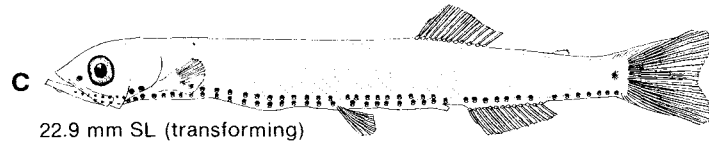
***Vinciguerria poweriae* GONOSTOMATIDAE**



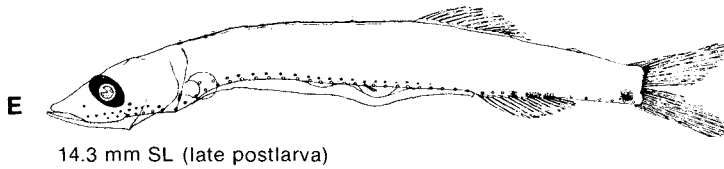
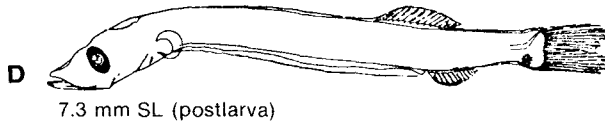
Small round organ sometimes visible in body above anal papilla



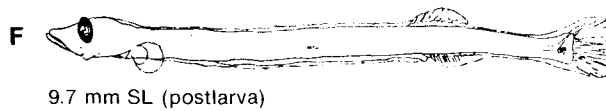
Generic features: gape does not extend as far back as in engraulids; spots larger than in clupeids or engraulids; oval eye



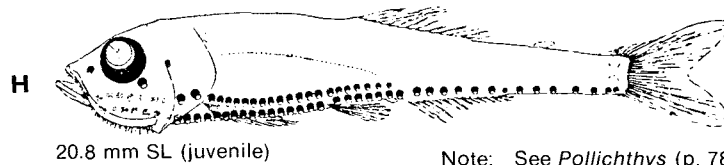
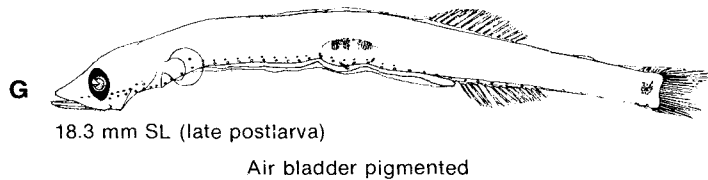
Vinciguerria nimbaria



Vinciguerria attenuata



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



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

GONOSTOMATIDAE *Cyclothone braueri* Jespersen and Tåning

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

***Ichthyococcus ovatus* (Cocco)**

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

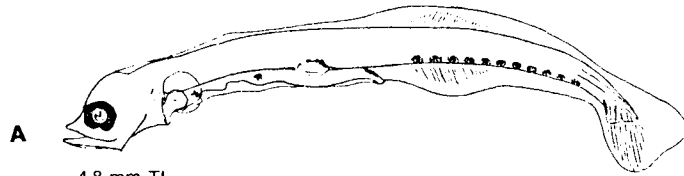
General note: In the two species above and *Pollichthys maui* (p. 78–79), photophores are separate, and most ventral photophores form simultaneously during late larval stage.

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

Ref. — Sanzo 1913, 1930; Ahlstrom 1974.

Cyclothone braueri

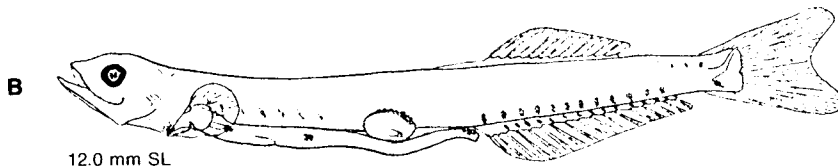
GONOSTOMATIDAE



4.8 mm TL

Anal origin under dorsal; dorsal fin base relatively long

No adipose fin

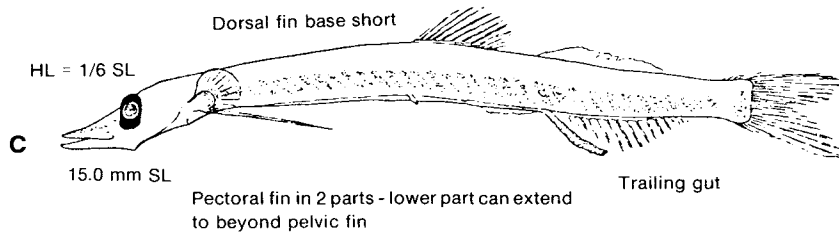


12.0 mm SL

Pelvic and anal fins separated by short gap

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

Ichthyococcus ovatus



HL = 1/6 SL

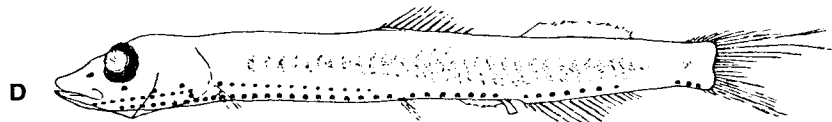
15.0 mm SL

Dorsal fin base short

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

Trailing gut

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



13.0 mm SL (transforming)

Pigment on snout and pectoral fin

Broad, lateral stripe of diffuse pigment

A-D (eastern Atlantic material)

GONOSTOMATIDAE *Pollichthys maui* (Poll)

Eggs — Undescribed.

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

Meristic features

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

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

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

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

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

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

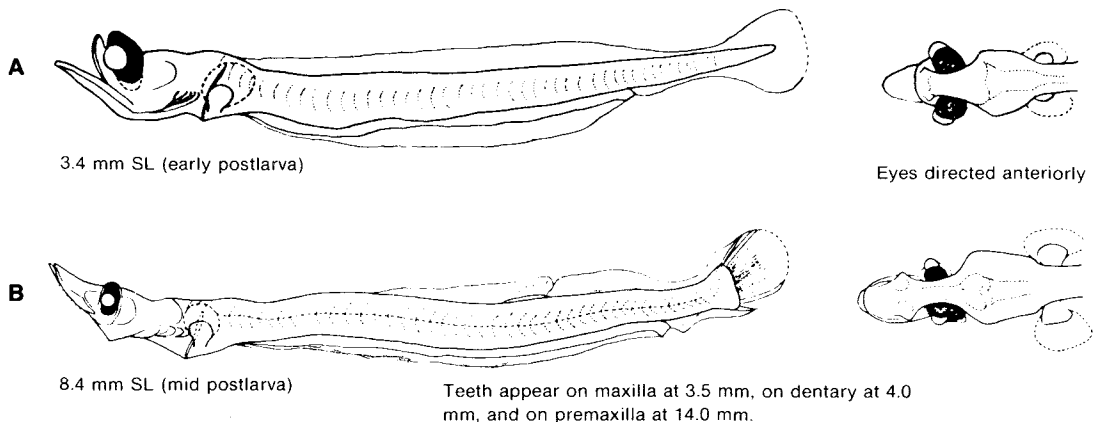
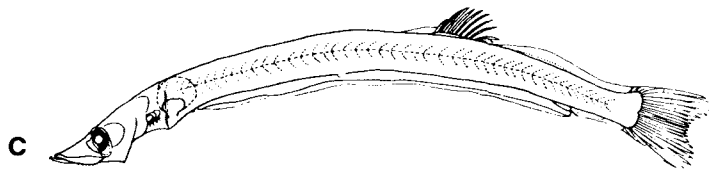


Fig. — **A-E, H,** Ozawa 1976; **F-G,** Grey 1964.

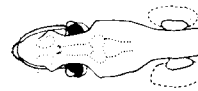
Ref. — Ahlstrom 1974.

Pollichthys maui

GONOSTOMATIDAE

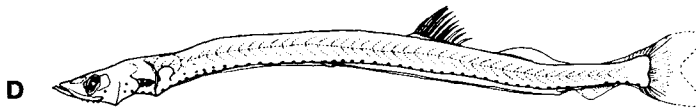


C
12.7 mm SL (mid postlarva)

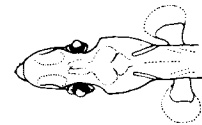


Pectorals fan-shaped

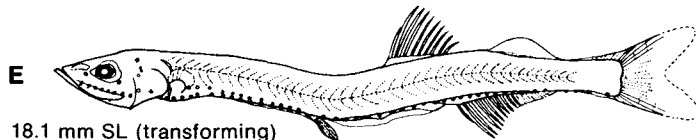
Pelvic bud at myomere 18-20, dorsal fin origin at myomere 26-29, and anus at myomere 39-43 (dorsal and anal shift anteriorly at transformation)



D
21.3 mm SL (late postlarva)



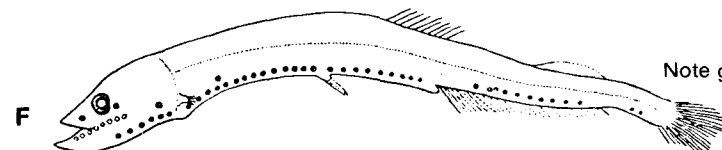
OA series late forming;
AC group incomplete initially (similar to *Gonostoma* and *Margrethia*)



E
18.1 mm SL (transforming)



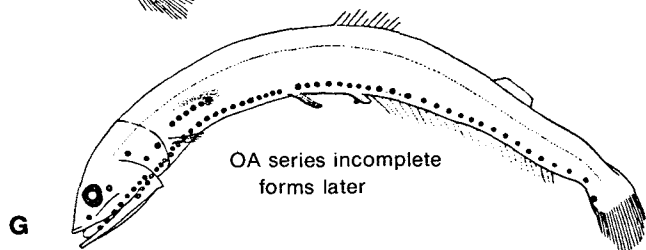
Sudden transition in body shape at transformation; anal fin origin moves from behind dorsal fin to under anterior dorsal fin



F
17.0 mm SL (transforming)

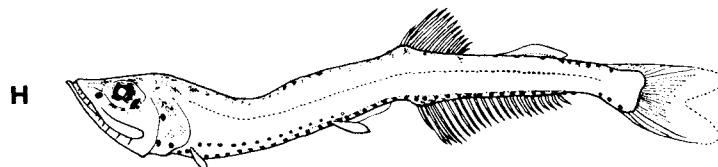
Note gap in developing AC photophores

Lacks body pigment



G
16.5 mm SL (transforming)

OA series incomplete forms later



H
18.1 mm SL (juvenile)



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

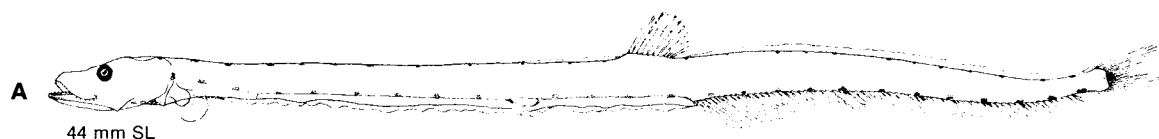
A-E, H (Pacific material)

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

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

Meristic features

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



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

Fig. — A, Jespersen and Tåning 1919.

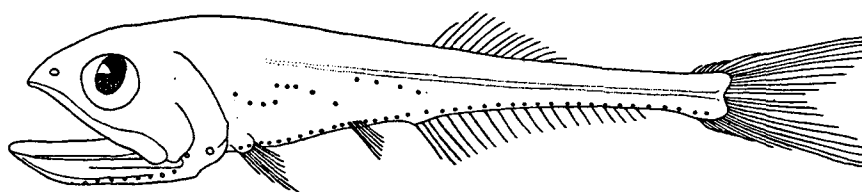
Ref. — Grey 1964.

Characteristics of Four Species GONOSTOMATIDAE

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

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

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



20 mm SL

Gonostoma bathyphilum
(Koefoed 1958)

GONOSTOMATIDAE ***Gonostoma atlanticum* Norman**

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

Meristic features

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

***Gonostoma elongatum* Günther**

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

Meristic features

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

***Bonapartia pedaliota* Goode and Bean**

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

Meristic features

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

***Margrethia obtusirostra* Jespersen and Tåning**

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

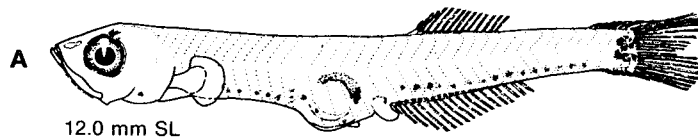
Meristic features

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

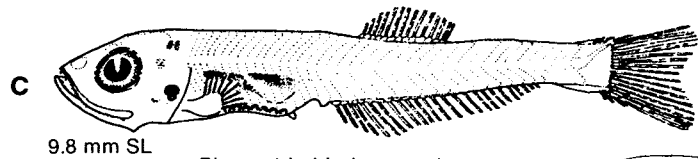
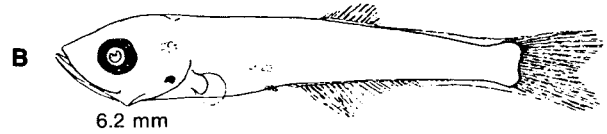
Fig. — **A, C**, Ahlstrom 1974; **B, D, F-I**, Jespersen and Tåning 1919; **E**, Badcock 1977 (redrawn). (Fig. **A**, and **C** reproduced through the courtesy of Springer-Verlag, New York, Inc.; Fig. **E** reproduced through the courtesy of Pergamon Press Inc., New York.)

Ref. — Grey 1964; Jahn and Backus 1976.

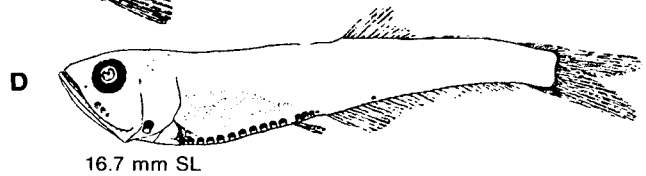
Gonostoma atlanticum GONOSTOMATIDAE



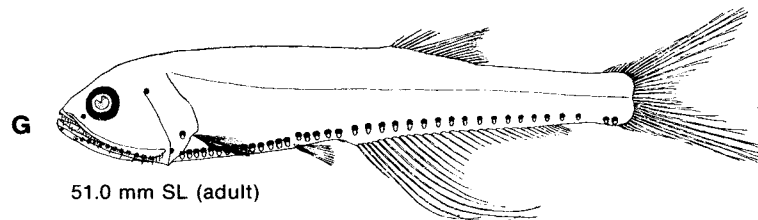
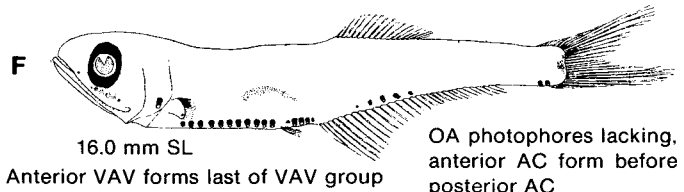
Gonostoma elongatum



Pigment behind eye and on gut above pelvic



Bonapartia pedaliota

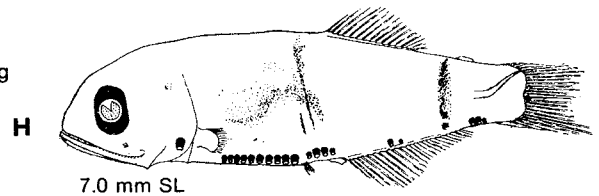


Posterior IV forms first, added to anteriorly (see E)

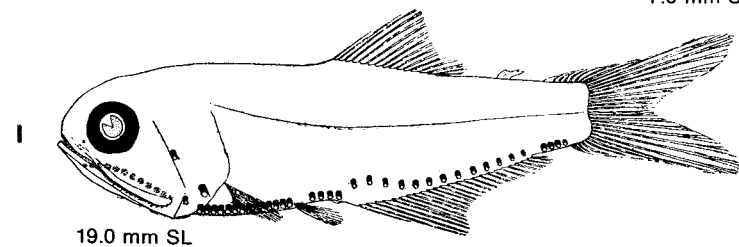
Margrethia obtusirostra

OA photophores lacking

Peritoneal pigment



Pigment bars not typical



GONOSTOMATIDAE *Maurolicus muelleri* (Gmelin)**Comment:** Widespread mesopelagic species.**Meristic features****Eggs** — Sculptured shell with points hexagonally arranged (also see Gonostomatidae introductory pages).

Myomeres: 33–35

Vert : 33–35

Larvae — Eye vertically elliptical, becoming rounded in late larvae.

D : 10–11

A : 19–22

— Adipose fin present.

Piv : 6–8

— Preanal length 52–69% SL, increasing from 59% SL at 10 mm to 65% SL at 30 mm.

P : 17–20

— Body depth increases from 11% SL at 3.9 mm to 25% SL at 20 mm.

— Head length increases from 22% SL at 3.9 mm to 29% SL at 20 mm.

— Flexion occurs at 4–6 mm SL.

— Transformation gradual; general adult form attained at 13–14 mm.

— Anal fin origin posterior to dorsal fin origin.

— Fin and vertebral formation (Japanese material): sizes at beginning of ossification and completion of fin rays and vertebrae:

Principal caudal rays	6.0 mm	6.5 mm
Anal rays	6.5	9.8
Dorsal rays	8.7	10.3
Pelvic rays	9.0	11.3
Pectoral rays	9.2	13.0
Vertebrae	7.2	9.3

— Photophores gradually acquired; sizes at formation and completion as follows:

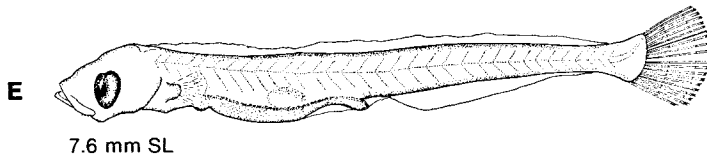
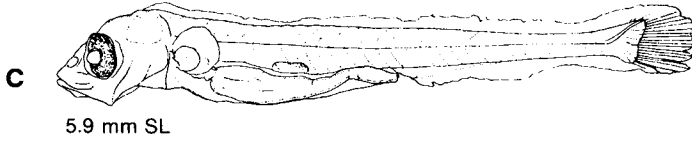
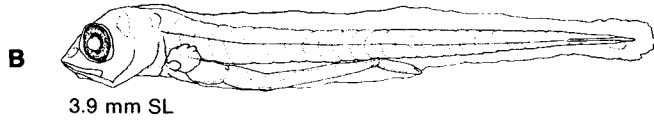
BR, post. IV	7–8 mm	14 mm
OP, ORB	10–12	13
mid. AC	10–12	21
VAV, OA	12–13	16–20

— Pigmentation: Atlantic specimens may have row of 7–10 spots along anal fin base at 6–10 mm SL (disappear later); few spots on nape and cluster on peduncle; black pigment spreads on dorsum from head to peduncle in specimens > 10 mm SL.

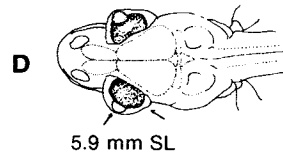
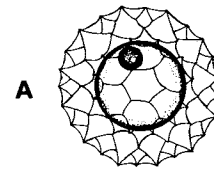
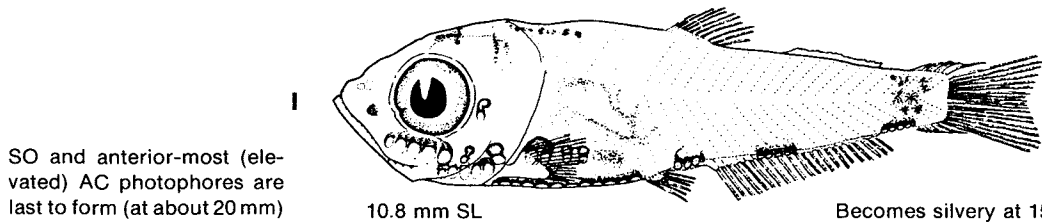
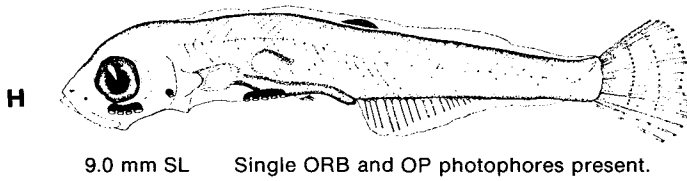
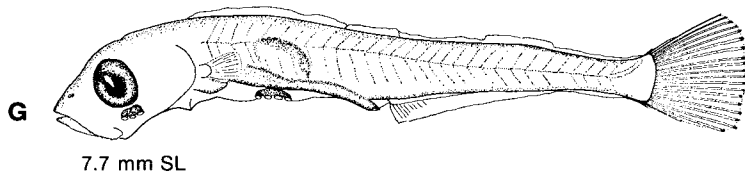
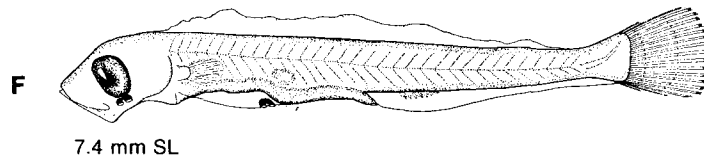
Note: Development of photophores varies between Atlantic, Mediterranean and Pacific specimens.**Fig.** — **A, E–H**, Robertson 1976; **B–D**, Okiyama 1971; **I**, Ahlstrom 1974. (Fig. I reproduced through the courtesy of Springer-Verlag, New York, Inc.)**Ref.** — Grey 1964; Jespersen and Taning 1926.

Maurolicus muelleri

GONOSTOMATIDAE



2 BR and 2 IV photophores form first



Atlantic specimens (6-10 mm) may have row of 7-10 spots along anal fin base and an accumulation at peduncle

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

GONOSTOMATIDAE *Valenciennellus tripunctulatus* (Esmark)

- Larvae** — Oval eye, short dorsal fin base.
 — Adipose fin present.
 — Anal fin origin slightly anterior to dorsal fin origin.
 — Photophore development (length range over which one or some photophores of group form): none up to 9 mm, BR about 8 mm, posterior IV at 9–11 mm, VAV at 10.5–12.0 mm, ORB at 11.5–12.0 mm, anterior IV at 11.0–14.5 mm, OA at 13.5–15.0 mm, OP at 14.5–15.0 mm, posterior AC at 15–16 mm.
 — Pigment aggregation over each photophore.

Meristic features

Myomeres:	32–33(–35?)
Vert :	32–33
D :	7–8
A :	23–25
Plv :	6–8
P :	12–13

Argyripnus atlanticus Maul

- Larvae** — Maxillary extends to posterior eye margin.
 — Adipose fin present.
 — Gap in developing anal fin (see Fig. D).
 — Anal fin origin under or slightly anterior to dorsal fin origin.
 — Preanal length about 43% SL, increases to about 50% SL in juveniles.
 — Head length 25–28% SL, eye diameter 11–13% SL.
 — BR, ORB, OP₂ and OP₃ photophores appear early (about 16 mm).
 — Pigment only around crown and some photophores (each photophore not accompanied by pigment as in *Valenciennellus tripunctulatus*).

Meristic features

Myomeres:	45–46
Vert :	45–46
D :	11–12
A :	13–15+9
Plv :	6–7
P :	17–19

STERNOPTYCHIDAE *Argyropelecus hemigymnus* Cocco

- Larvae** — Premetamorphic larvae range 4–9 mm.
 — During transformation, body (especially anterior part) shrinks 2–3 mm, gut shortens, head deepens, and eyes become telescopic.
 — Photophores develop after shrinkage stage (6–10 mm); in larger larvae, gap forms in anal rays (where photophores develop).
 — Photophore development sequence: lower OP, BR, posterior IV, anterior IV, posterior AC, anterior AC, OA, ORB and VAV.
 — Preanal myomeres 16–18 before and about 10 after transformation.

Meristic features

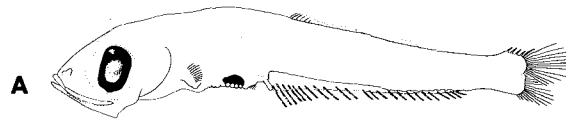
Myomeres:	37–38
Vert :	14–15+22–23
D :	8
A :	6+5
Plv :	6
P :	9–11

- Note:** (1) Striking change in body form of *A. hemigymnus* during transformation (see Badcock and Baird (1980) for description of rapid transformation in *Sternoptyx diaphana*).
 (2) Other genera and species are present in the western North Atlantic.

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

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

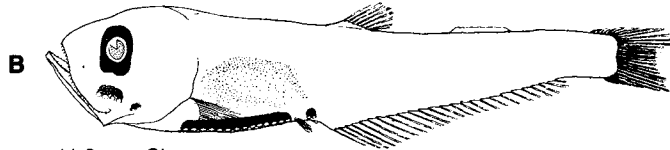
***Valenciennellus tripunctulatus* GONOSTOMATIDAE**



10.5 mm SL

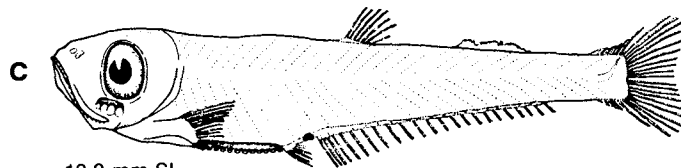
Peritoneal pigment

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



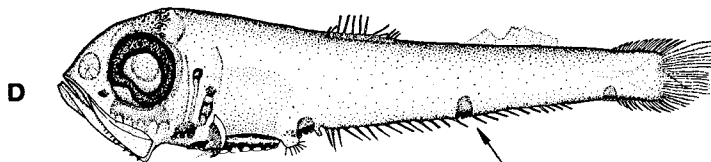
11.0 mm SL

Lateral pigment over abdomen at 10-12 mm



13.2 mm SL.

Argyripnus atlanticus

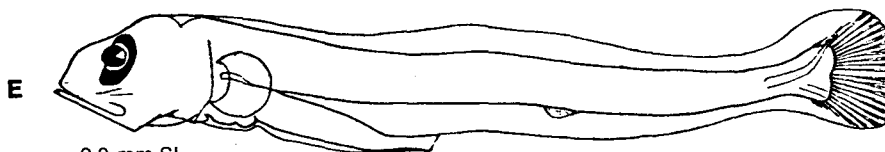


18.7 mm SL

OP₃ photophore enlarged and double

Gap in anal fin between ray 13 and 15 (under developing middle AC photophores)

***Argyropelecus hemigymnus* STERNOPTYCHIDAE**



9.0 mm SL

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

CHAULIODONTIDAE *Chauliodus sloani* Bloch and Schneider

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

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

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

STOMIATIDAE *Stomias ferox* Reinhardt

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

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

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

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

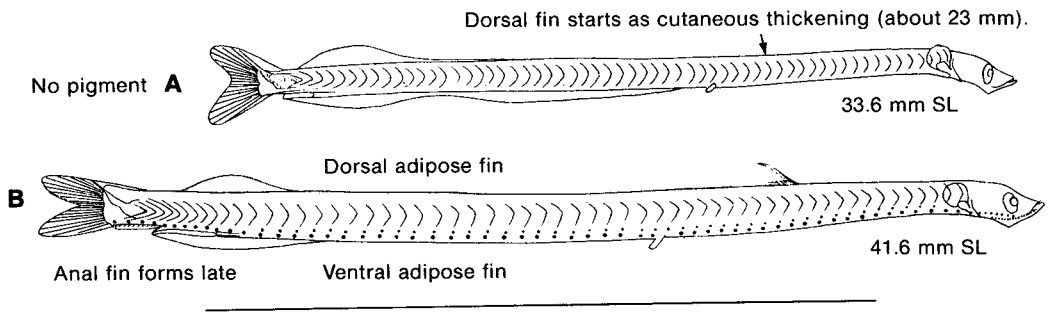
- Note:** (1) Vertebral counts in other Atlantic species are: 75–78 in *S. boa*, 66–71 in *S. affinis*, 64–68 in *S. brevibarbus*, 66–72 in *S. colubrinus*; myomere counts average 2 more.
- (2) Both *S. ferox* and *S. boa* (see illustrations opposite) have very light pigment, and lack widely-spaced dorsal spots as in *Eustomias* (p. 90).

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

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

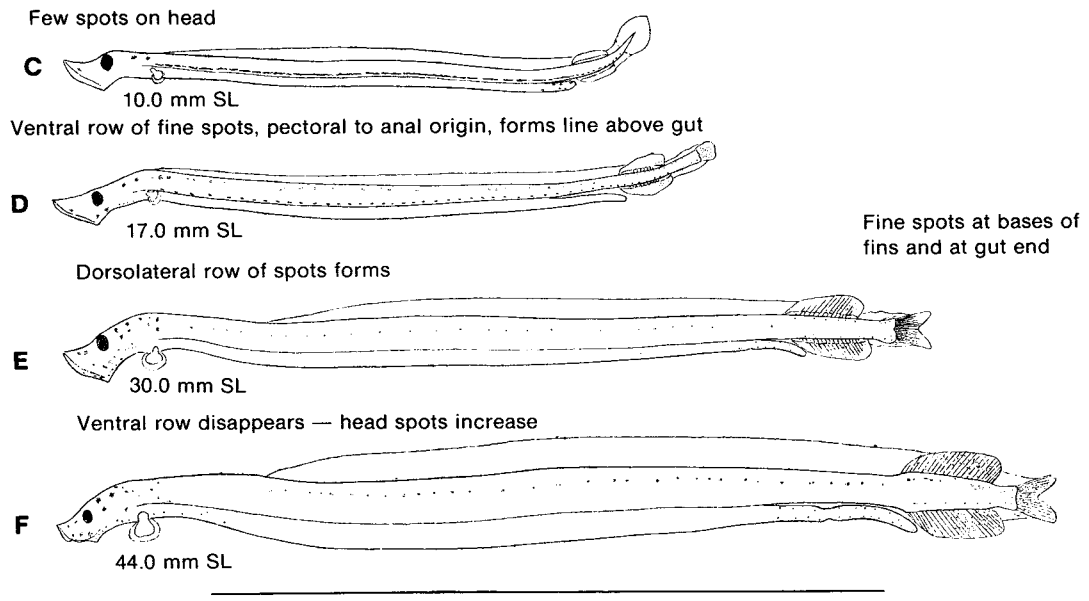
Chauliodus sloani

CHAULIODONTIDAE

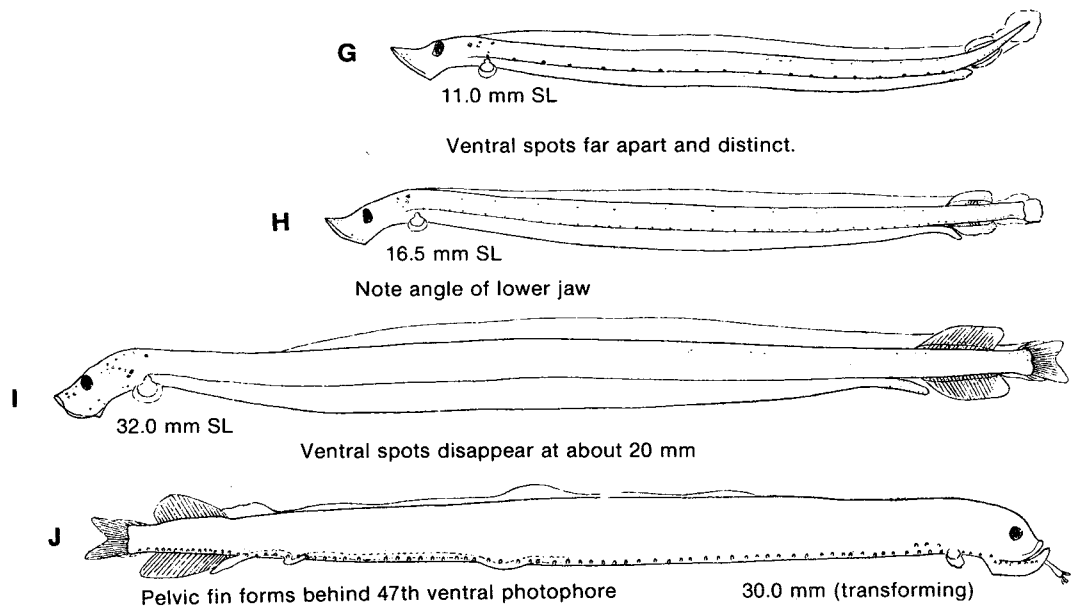


Stomias ferox

STOMIATIDAE



Stomias boa



G-J (eastern Atlantic material)

MELANOSTOMIATIDAE Five Genera

(=Melanostomiidae)

Morphological features

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

Meristic characters (Counts in bold type are diagnostic)

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

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

^b Range of counts within genera.

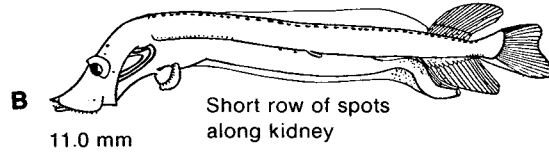
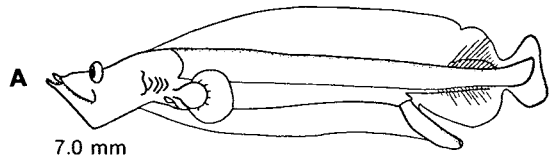
Other characters

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

Fig. — A-J, Beebe and Crane 1939.

Ref. — Sanzo 1914, 1918.

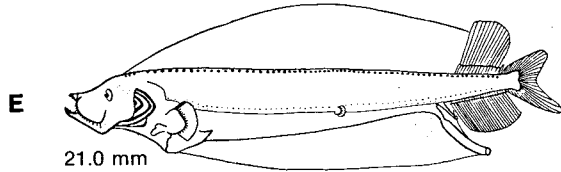
Bathophilus sp.



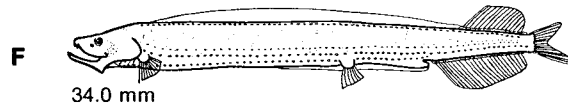
Parallel rows of spots along base of dorsal finfold

MELANOSTOMIATIDAE

Flagellostomias boureei

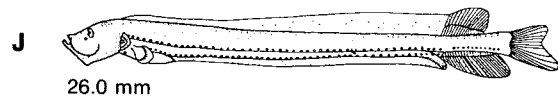
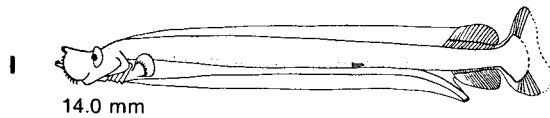


Dorsal spots (about 1 per myomere) to side of dorsal midline; ventral spots — same number but lighter

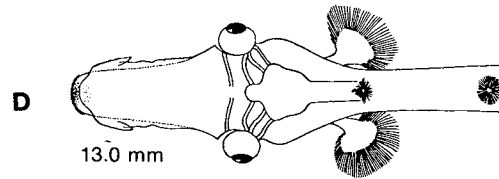
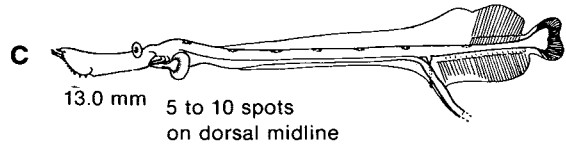


Short row of spots on each side of nape

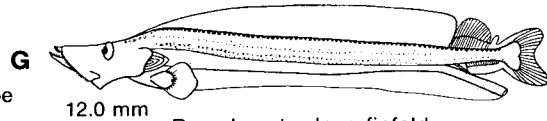
Photonectes parvimanus



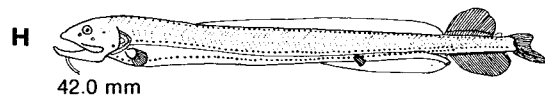
Eustomias sp.



Leptostomias gladiator



Dorsal spots along finfold and 3 lighter rows on sides



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

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

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

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

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

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

Idiacanthus fasciola

IDIACANTHIDAE

