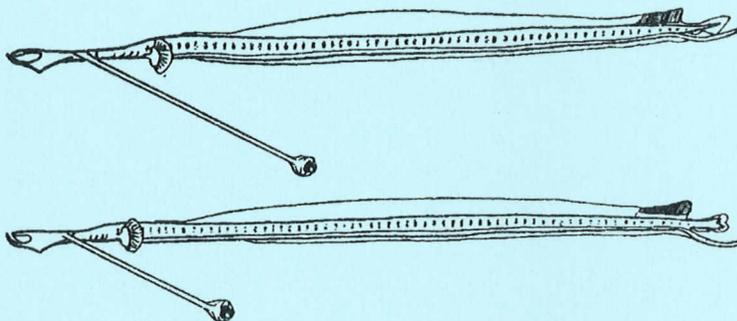




PRELIMINARY GUIDE TO THE IDENTIFICATION OF THE EARLY LIFE HISTORY STAGES OF
STOMIIFORM FISHES OF THE WESTERN CENTRAL ATLANTIC

BY

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ORDER STOMIIFORMES

W. J. Richards

This order contains the largest number of vertebrate animals on earth although they are small to medium sized fishes found in all oceans from the surface (as young) to meso- and bathypelagic zones. Based on larval abundances, the species of the genera *Vinciguerria* and *Cyclothone* are the most abundant by numbers of any vertebrate. The order contains about 51 genera and about 321 species, but family names are in a state of flux because of the lack of a satisfactory classification (Nelson 1994). Until the situation is satisfactorily resolved, herein I consider those familial taxa which best recognizes differences for use in identifying young stages. The primitive stomiiformes comprise the abundant taxa (Families Gonostomatidae, Sternoptychidae, Phosichthyidae) while the advanced groups (Chauliodontidae, Stomiidae, Astronesthidae, Melanostomiidae, Malacosteidae, and Idiacanthidae) comprise species that are rare in collections. This rarity is in part responsible for our limited knowledge of the order. Ahlstrom, Richards & Weitzman (1984) reviewed the primitive families and provided much information of ELH stages and Kawaguchi & Moser (1984) did likewise for the advanced groups. Traditionally, the order was classified with two primitive families (Gonostomatidae and Sternoptychidae) and five advanced (those listed above). The primitive genera were rearranged into three families and Fink (1984, 1985) combined the 26 genera of the advanced group into one family – Stomiidae, which is a sound systematic conclusion. His characters included presence of a single infraorbital bone, lack of gill rakers in adults, presence of a mental barbel associated with the hyoid apparatus, a portion of the adductor mandibulae muscle inserting on the postorbital photophore, and a divided geniohyoideus muscle. Subsequent to Fink (1984, 1985), Harold & Weitzman (1996) discussed the changes in classifications and conclude that, though still incomplete, the Phosichthyidae and the advanced stomiiform genera are not diagnosable. Until this is resolved I follow Moser & Watson (1996) who, in turn, followed Eschmeyer (1990) in continuing to retain the advanced genera in six families as this aids in ELH identification.

Eggs are poorly known for most species except for the very unusual shaped shell of *Maurollicus* with its sharp protuberances (Table Stomiiformes 1). Other primitive stomiiform eggs closely resemble clupeiform eggs with a wide perivitelline space, segmented yolk, one oil globule, and planktonic habitat. Advanced stomiiform eggs are usually large with a wide perivitelline space, segmented yolk, and lack oil globules. Larvae of most primitive stomiiforms are known, but advanced stomiiform larvae are not well known, especially at the species level. The arrangements of photophores and meristic characters are critical tools for ELH stomiiform identification.. A synopsis of photophore definitions is given in Table Stomiiformes 2 and meristic characters are given in Table Stomiiformes 3. Tables Stomiiformes 4 & 5 provide helpful identification information for the order. Figure Stomiiformes 1 illustrates photophore patterns of typical stomiiforms. An important reference is Table 46 in Kawaguchi & Moser (1984) that summarizes characters for advanced stomiiforms.

The families included are:

Primitive stomiiforms – Gonostomatidae, Sternoptychidae, and Phosichthyidae

Advanced stomiiforms – Chauliodontidae, Stomiidae, Astronesthidae, Melanostomiidae, Malacosteidae, and Idiacanthidae

Figure Stomiiformes 1. Generalized photophore patterns and their codes for lightfishes (top – after Fahay 1983); hatchetfishes (middle – after Badcock & Baird 1980 as modified by Moser & Watson 1996); and stomioids (bottom – Morrow 1964a). The definitions and codes are given in Table Stomiiformes 1.

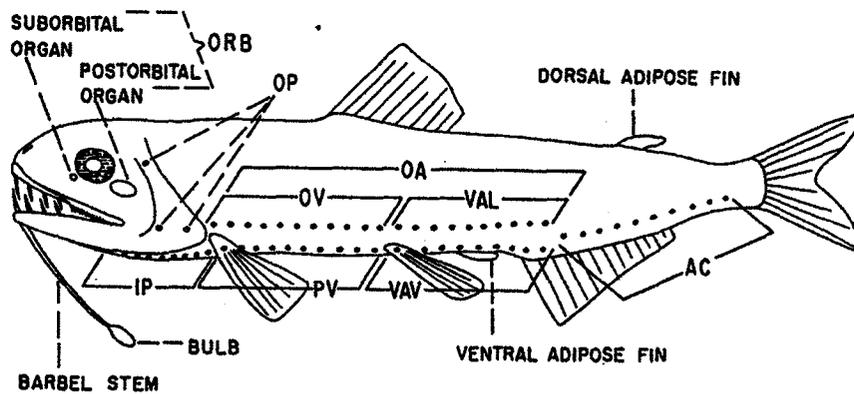
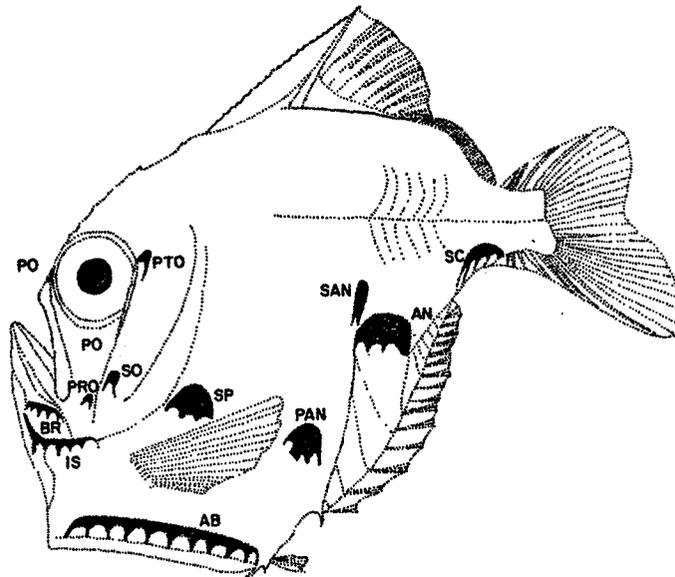
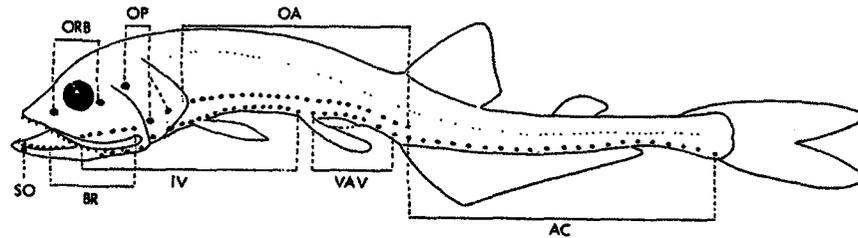


Table Stomiiformes 1. Summary of diagnostic characters of eggs of certain stomiiform fishes (after Ahlstrom et al. 1984)

Species	Egg diameter	Oil globule	Diameter	Yolk	Special features	Illustrated	Source
<i>Argyropelecus hemigymnus</i>	0.92-1.04	1	0.26-0.28	segmented	large oil globule	Yes	Sanzo 1931
<i>Ichthyococcus ovatus</i>	0.80	1	0.24	segmented	large oil globule	Yes	Sanzo 1931
<i>Maurolicus muelleri</i>	1.63 1.32-1.58	1	0.25 0.26-0.28	segmented segmented	hexagonal pattern on shell	Yes Yes	Mito 1961a Sanzo 1931
<i>Vinciguerrria poweriae</i>	0.75-0.85	1	0.17-0.19	segmented	no thin inner shell membrane	Yes	Ahlstrom & Counts 1958
<i>nimbaria</i>	0.64-0.72	none		irregularly segmented	thin inner shell membrane	No	Ahlstrom & Counts 1958
<i>attenuata</i>	0.84-0.92	1	0.18-0.195	segmented	no thin inner shell membrane	No	Sanzo 1931

Table Stomiiformes 2. Photophore nomenclature definitions and codes for the families of stomiiform fishes following Ahlstrom et al. (1984). For the deep bodied sternoptychids, Harold (1994) modified the terminology of earlier works (Baird 1971) and both codes are given.

Deep bodied sternoptychids (Genera <i>Argyropelecus</i> , <i>Sternoptyx</i> , & <i>Polyipnus</i>)			Other stomiiforms	
Harold's Code	Baird's Code	Description	Code	Description
OP (in part)	SO	Subopercle photophore which is equivalent to posteriormost photophore in opercular series in other stomiiforms.	SO	Symphseal photophores (organs) located at tip of lower jaw.
ORB	PO	Photophore located anterior to orbit.	Orb	Photophores associated with the eye located anterior & posterior of orbit.
OP (in part)	PTO	Photophore located posterior to orbit & may be equivalent to upper photophore of opercular series of other stomiiforms.	Op	Photophores located on opercle series, generally 3 coded as 1(1+1).
OP (in part)	PRO	Preopercular photophore, used for PO photophore dorsal to ventral limb of preopercle.	Br(BRP)	Photophores located on the branchiostegal membranes.
OP		(=PRO+PTO+SO)	Is(I)	Photophores located on the isthmus.
BR	Br	Same as stomiiform definition.	IP	Photophores of the ventral series found from isthmus to base of pectoral fin.
IP	Is	Same as stomiiform definition.	PV	Photophores of the ventral series found from pectoral fin base to pelvic (ventral) fin base.
PV	AB	Photophores of ventral series located abdominally between pectoral fin base & pelvic & equivalent to PV in other stomiiforms, plus a few posterior photophores of the IP series.	VAV	Photophores of the ventral series found from the pelvic (ventral) fin base to anal fin base.
VAV	PAN	Photophores found anterior to anal fin & may be equivalent to VAV or VA in other stomiiforms.	AC	Photophores of the ventral series found from anal fin base to caudal fin base of the ventral series.
ACB	AN	Photophores found above anal fin.	IC	Summary of photophores of the ventral series from isthmus to caudal fin base (IP+PV+VAV+AC)
ACC	SC	Photophores found on lower (sub) caudal peduncle. Together AN group may be equivalent to AC in other stomiiforms.	IV	Summary of photophores of the ventral from isthmus to pelvic (ventral) fin base (IP+PV).
OVB	SAB	Photophores located above (supra) the abdominal series & may be equivalent to VA series in other stomiiforms.	VA(VALA)	Photophores of the lateral series from pelvic (ventral) fin base to anal fin base.
OVA	SP	Photophores located above (supra) the pectoral fin & may be equivalent to OV in other stomiiforms.	OAA	Summary of photophores of OV + VA series.
L	L	Photophore located laterally above PAN (found only in <i>Polyipnus</i>).	OA(OAB)	Summary of lateral photophores from the opercle to anal fin base (OV+VA).
ACA	SAN	Photophores located above (supra) to anal photophores & equivalent to part of AC series in other stomiiforms.	OAC(OC)	Entire lateral series on body sides just dorsal to ventral series & extending from opercular border, or just medial to it, over anal fin to caudal fin base.
AC		Subdivided into ACA+ACB+ACC		
OV		Subdivided into OVA & OVB		

Table Stomiiformes 3. Meristic characters of the nine families of stomiiform fishes. (*) advanced stomiiforms lack gill rakers as adults. (**) indicates count based on one genus.

Family	Fin Rays				Gill rakers	Vertebrae	Branchiostegals
	Dorsal	Anal	Pectoral	Pelvic			
Gonostomatidae	9-20	16-61	8-16	6-8	10-27	29-99	10-16
Sternoptychidae	7-16	11-25	10-19	6-7	7-25(28)	29-48	8-10
Phosichthyidae	10-16(17)	12-33	7-11	6-8	15-22	38-54	11-17
Chauliodontidae	5-7	10-13	11-14	6-8	0*	51-62	12-21
Stomiidae	13-21	13-23	6-7(9)	4-5	0*	64-83	17-19
Astronesthidae	9-18	10-28	6-9	6-8	0*	45-55**	14-25
Melanostomiidae	11-29	13-46	0-37	4-26	0*	38-83	8-22
Malacosteidae	14-28	17-32	0-17	5-6	0*	44-58	9-15
Idiacanthidae	54-74	38-49	0	6	0*	ca. 78	17

Table Stomiiformes 4. Position of the dorsal and anal fin and condition of the adipose fin in certain stomiiform fishes modified after Ahlstrom et al. 1984

Dorsal Fin Position			
Taxa	Adult	Larvae	Adipose fin
<i>Argyripnus</i>	Anal origin opposite dorsal origin	Anal origin opposite dorsal origin	Present
<i>Argyropelecus</i>	Anal origin opposite last dorsal ray	Anal origin behind dorsal fin	Present or Absent
Astronesthidae spp	Anal origin just under or behind dorsal base	Anal origin behind dorsal base => dorsal fin base	Present
<i>Bathophilus</i>	Anal origin opposite dorsal origin	Same as adult	Absent
<i>Bonapartia</i>	Anal origin well in advance of dorsal by 9 rays	Same as adult	Absent
<i>Chauliodus</i>	Dorsal origin far in advance of anal origin	Same as adult	Present
<i>Cyclothone</i>	Anal origin opposite dorsal fin or slightly behind	Same as adult	Absent
<i>Eustomias</i>	Anal origin in advance of dorsal origin	Same as adult	Absent
<i>Gonostoma</i>	Anal origin opposite dorsal fin	Same as adult	Absent
<i>Ichthyococcus</i>	Anal origin behind dorsal fin by a space=1/2 dorsal base	Anal origin behind dorsal fin	Present
<i>Idiacanthus</i>	Anal origin beneath middle of dorsal fin	Same as adult	Absent
Malacosteidae spp	Anal origin usually opposite dorsal origin	Same as adult	Absent
<i>Manducus</i>	Anal origin beneath 3rd from last or last dorsal fin ray	Anal origin behind last dorsal fin ray	Absent
<i>Margrethia</i>	Anal origin beneath 5th dorsal fin ray	Same as adult	Present
<i>Maurolicus</i>	Anal origin beneath last dorsal fin ray	Anal origin beneath middle of dorsal fin, advances to adult condition as juveniles	Present
Melanostomiidae spp	Anal origin usually opposite dorsal origin	Same as adult	Absent
<i>Pollichthys</i>	Anal origin beneath 3rd dorsal fin ray	Anal origin advances forward beneath dorsal fin	Present
<i>Polyipnus</i>	Anal origin usually beneath middle of dorsal fin	Same as adult	Present or absent
<i>Polymetme</i>	Anal origin beneath end of dorsal fin	Unknown	Present
<i>Sigmops</i>	Anal origin 3-4 rays in advance of dorsal fin	Same as adult	Present
<i>Sonoda</i>	Anal origin in advance of dorsal. Dorsal origin above 5th anal ray	Unknown	Absent
<i>Sternoptyx</i>	Anal origin opposite dorsal origin	Anal origin behind dorsal fin	Present
<i>Stomias</i>	Anal origin opposite or slightly in advance of dorsal origin	Same as adult	Absent
<i>Triplophos</i>	Anal origin beneath end of dorsal fin	Unknown	Absent
<i>Valenciennellus</i>	Anal origin 1 or 2 rays in advance of dorsal origin	Same as adult	Present
<i>Vinciguerria</i>	Anal origin beneath middle of dorsal fin	Same as adult	Present
<i>Woodsia</i>	Anal origin behind middle of dorsal fin by distance about = dorsal base	Same as adult	Present
<i>Yarella</i>	Anal origin beneath middle of dorsal fin	Same as adult	Absent

Table Stomiiformes 5. Photophore distribution in certain primitive stomiiform genera. Refer to Table Stomiiformes 2 for definitions of codes.

Genera	No. of										Grouped as Glands
	Rows	SO	ORB	OP	BR	IS	IV	VAV	AC		
<i>Argyripnus</i>	2	No	1	3	6	Yes	(6)+(10)	(18-28)	(5)+(17)	Yes	
<i>Argyrolepecus</i>	2	No	2	2	6	Yes	(18)	(4)	(6)+0+(4)	Yes	
<i>Bonapartia</i>	1	Yes	1	3	11-13	No	14-16	5-6	16-18+2-3	No	
<i>Cyclothone</i>	2	No	1	2	8-11	No	12-14	4-5	12-16	No	
<i>Diplophos</i>	3+	Yes	1	3	7-12+0-3	Yes	33-49	13-17	46+2-3	No	
<i>Gonostoma</i>	2	Yes	1	2	9	No	11-13	3-5	19	No	
<i>Ichthyococcus</i>	2	No	2	3	11-12	Yes	25-28	9-14	12-13	No	
<i>Manducus</i>	2+	Yes	1	3	8-13	Yes	30-33	12-14	28-30	No	
<i>Margrethia</i>	1	No	1	3	9-12	No	13-15	4	13-14+3-4	No	
<i>Mauroliticus</i>	2	Yes	1	3	(6)	Yes	(6)+(12)=18	(6)	1+(15-16)+ (7-9)=23-26	Yes	
<i>Pollichthys</i>	2	Yes	2	3	8	Yes	21-23	7-9	18-21	No	
<i>Polyipnus</i>	2	No	2	2	6	Yes	(16)	(5)	(8-10 or 11-13)+ 1+(2)+(4)=15-20	Yes	
<i>Polymetme</i>	2	Yes	1	3	9-10	Yes	9+1+11=19-21	7-8	24-25	No	
<i>Sigmops</i>	2	Yes	1	3	9	Yes	15-16	4-5	20-23	No	
<i>Sonoda</i>	2	No	1	3	(6-7)	Yes	(6)+(10)=16	(7-8)	(6)+(5)+(5)=16 (16-21)+(19-24)=36-43	Yes	
<i>Sternoptyx</i>	2	No	2	2	3	Yes	(15)	(3)	(3)+1+(4)	Yes	
<i>Triplophos</i>	2+3 or 4	Yes	1	3	8-11	Yes	24-25	5-7	37-39	No	
<i>Valenciennellus</i>	2	No	1	3	6	Yes	(3)+(4)+(16)	(5)	(3)+(2-3)+(2-3)+ (2-4)+(4)=13-17	Yes	
<i>Vinciguerria</i>	2	Yes or no	2	3	7-9	Yes	21-24	7-11	12-14	No	
<i>Woodsia</i>	2	Yes	2	3	14	Yes	8+3+14=25	11-12	12	No	
<i>Yarella</i>	2+ sev	Yes	1	3	11-13	Yes	9+3-4+11-12=24-25	12	24-28	No	

GONOSTOMATIDAE: Bristlemouths

W. J. Richards

Sixteen species in eight genera of gonostomatids are found in our area and the members of the genus *Cyclothone* are found in most offshore plankton collections. Of the eight genera, larval stages are known for all but the monotypic *Triplophos* and most species are known except for two of the eight species of *Cyclothone*. The composition of the gonostomatids has undergone several changes in the past 20 years and relationships are still not resolved. Recently molecular data have been utilized and the relationships are clearer within the family (Miya & Nishida 2000). The family is cosmopolitan and all genera are represented in our area: *Diplophos taenia*, *Manducus maderensis*, *Triplophos hemingi*, *Bonapartia pedaliota* (Eschmeyer 1998 suggests that the replacement name *Zaphotias* Goode & Bean in Jordan & Evermann 1898 should be used), *Margrethia obtusirostre*, *Gonostoma atlanticum*, *Sigmops bathyphilum* & *S. atlanticum* (removed from *Gonostoma* and placed in *Sigmops* Gill by Miya & Nishida 2000), and *Cyclothone* with eight species – *acclinidens*, *alba*, *braueri*, *microdon*, *obscura*, *pallida*, *parapallida*, and *pseudopallida*.

Adult bristlemouths are small (usually >20 cm), bioluminescent, compressed, and elongate fishes inhabiting epi- meso- & bathypelagic depths. The genus *Cyclothone* is one of the most abundant vertebrates on the planet. They are closely related to phosichthids and sternoptychids and some larvae are very difficult to differentiate among the three families. All have 4 bony pectoral fin radials except *Cyclothone* with 1; adipose fin present or absent, and may be divided into two subfamilies following Nelson (1994), the Diplophinae which includes *Diplophos*, *Manducus*, and *Triplophos* that are characterized by absent adipose fin, 34-69 anal fin rays, and 60-99 vertebrae, and the Gonostomatinae which includes *Bonapartia*, *Margrethia*, *Gonostoma*, *Sigmops*, and *Cyclothone* characterized by adipose present or absent, 16-32 anal fin rays, and 29-39 vertebrae.

A lot of literature exists on the ELH of the family and was reviewed by Watson (1996a) who points out, that despite the preponderance, larval identities are poorly known and little literature exists on eggs (see Table Stomiiformes 1). ELH stages of *Triplophos* have remained unidentified. Watson (1996a) provides thorough descriptions of the larval stages of *Diplophos taenia*, *Cyclothone acclinidens*, *C. pseudopallida*, *Gonostoma atlanticum*, and *Sigmops elongatum*; Smith et al. (1991) described *Manducus maderensis*; Ahlstrom, Richards, & Weitzman (1984) briefly described *Bonapartia pedaliota*, *Sigmops bathyphilum*, and *Margrethia obtusirostre*; Ozawa & Oda (1986) described *C. alba* and *C. pallida*; Jespersen & Tåning (1926) described *C. braueri*, and Mukhacheva (1954) described *C. microdon*. However, many of these descriptions are based on small sample sizes and, in the case of *Cyclothone*, the taxonomy has been confused and material is usually heavily damaged. Small specimens and damaged specimens are very difficult to identify as key characters are often missing. Meristics are very valuable especially number of vertebrae (myomeres) and position and number of dorsal and anal fin rays. Pigmentation is diagnostic as is the developmental pattern of the photophores. Photophores for all are individual and separate (not grouped together), but develop in two patterns – simultaneously and initiated as a “white” photophore stage in *Cyclothone*, *Diplophos*, and *Manducus* (and presumably *Triplophos* & found in all phosichthids, too) and, the remaining genera with gradual and protracted photophore metamorphosis that first appear pigmented and do not have the white stage. Sternoptychids have coalesced photophores that develop gradually.

In identifying small and damaged larvae it is advised that all three families be carefully reviewed and considered together until identifications and series of specimens are gathered. Tables Stomiiformes 3, 4, & 5 provide some characters that are useful in identifying genera of the primitive stomiiform families. Data for identifying the ELH stages of gonostomatids are provided in Tables Gonostomatidae 1, 2, & 3 and the individual species accounts for all except species with unknown ELH stages. The following artificial key will help in identifying larval gonostomatids.

Key to Larvae of the Family Gonostomatidae

- 1a. Myomeres 60-99, anal rays 34-69 Diplophinae 2
- 1b. Myomeres 29-39, anal rays 16-32 Gonostomatinae 4
- 2a. Myomeres 89-99, body very elongate with pigment blotches on dorsal & ventral edge of body & tail..... *Diplophos taenia*
- 2b. Myomeres 60-63 larvae moderately elongate 3
- 3a. Myomeres 63, anal rays 34-41, pigment spots on each side of dorsum, on ventral margin of tail, and over caudal base, gut with pronounced annular mucosal folds..... *Manducus maderensis*
- 3b. Myomeres ca. 60, anal rays 57-63, larvae unknown*Triplophos hemingi*
- 4a. Anal fin origin opposite dorsal fin origin, row of pigment spots on ventral margin of tail, pigment over gas bladder..... 5
- 4b. Anal origin well in advance of or well behind dorsal fin origin, no pigment along ventral edge of tail..... 6
- 5a. Pigment on caudal peduncle restricted to dark line along edge of parhupural bone *Cyclothone* spp.
- 5b. Pigment scattered over caudal peduncle at caudal fin base, OP1 forms early*Gonsotoma atlanticum*
- 6a. Anal origin well in advance of dorsal fin origin, myomeres 37-39, tail pigment if present confined to dorsal edge of caudal peduncle 7
- 6b. Anal origin beneath 5th dorsal ray, myomeres 34, distinct vertical streak of pigment around caudal peduncle on most specimens *Margrethia obtusirostre*
- 7a. Deep pigment spot behind eyes, pigment lacking or confined to dorsal edge of caudal peduncle..... 8
- 7b. No deep pigment spot behind eyes, pigment spot on caudal.....*Bonapartia pedaliota*
- 8a. Pigment lacking on caudal peduncle*Sigmops elongatum*
- 8b. Pigment on dorsal edge of caudal peduncle*Sigmops bathyphilum*

Table Gonostomatidae 1. Meristic characters of adult gonostomatids. Data from Grey 1964, Badcock 1982, Ahlstrom et al. 1984, Smith et al. 1991, & Watson 1996.

Taxon	Dorsal Fin rays	Anal Fin rays	Pectoral Fin rays	Pelvic Fin rays	Gill Rakers	Branchi- ostegals	Verte- brae	Source
<i>Diplophos taenia</i>	12-13	59-72	8-10	7-8	3+7-8=10-11	12-14	37-41+52-59=89-99	Grey 1964, Watson 1996
<i>Manducus maderensis</i>	10-13	34-41	10-11	8	3-5+8-9=12-14	11-13	63	Grey 1964, Smith et al. 1991
<i>Tripolphos hemingi</i>	10-11	57-63	9-10	6-7	9+14-16=23-25	11-14	ca. 60	
<i>Bonapartia pedaliota</i>	17-20	29-31	14-16	7-8	5-6+11-12=16-18	13-16	37	Ahlstrom et al 1984
<i>Margrethia obtusirostre</i>	15-16	21-26	13-15	8	5+10-11=15-16	13	34	Ahlstrom et al 1984
<i>Sigmops bathyphilum</i>	13(12-14)	22-24	10-11	7-8	9-11+15-17=24-27	12-13	37	Grey 1964
<i>elongatum</i>	12-14	29-32	10-12	8	7-9+11-12=19-20(18)	12-13	39	Grey 1964
<i>Gonostoma atlanticum</i>	16-18	28-30	10	6-7	6+11=17	11	38	Grey 1964
<i>Cyclothone acclindens</i>	12-15	16-21	9-13	6-7	4-10+1-2+7-18=14-27	10-14	29-33	Grey 1964
<i>alba</i>	14-15(13)	19(18-20)	9-10(8)	6(7)	7(6-9)+12-14(15-17)=23-25	14(13-15)	31(30-32)	Badcock 1982, Watson 1996
<i>braueri</i>					4+1+9=14			Grey 1964
<i>microdon</i>					5-6+2+9-10=15-17(18)			Grey 1964
<i>obscura</i>					6-8+13-14=19-22			Grey 1964
<i>pallida</i>	14(12-15)	18(16-19)			23-29			Badcock 1982
					9(8-10)+10(9-11)+4(5)=23-24(22-25)		31-32(33)	Grey 1964
<i>parapallida</i>	14(13-15)	18-19	9(10-11)		8-9+9(10)+4(5)=21-22(23)		32(31-33)	Badcock 1982
<i>pseudopallida</i>	13-14(12-15)	19-20(17-21)	9-10	6-7	4-7+11-14=18-20	14	33(29-34)	Watson 1996

Table Gonostomatidae 2. Sequence of photophore formation in Gonostomatidae. (d=damaged, obscured).

Species	size	SO	ORB	OP	BR	IP	IV	PV	VAV	AC	OA	IC	Source
<i>Diplophos</i>													
<i>taenia</i>	adult	1	1	3	12		47		16-17	46+2-3	71-73	111-113	Grey 1964
	31.5	1	1	1	11		ca.45		17	46+2	68	ca.110	Grey 1964
<i>Triplophos</i>													
<i>hemingi</i>	adult	1	1	3	8-11		12-13+4+8		7	37-39	50-55	68-70	
<i>Manducus</i>													
<i>maderensis</i>	adult	1	3	3	8-9	13-14	30-33	17-18	12-13	28-30	45-48		Grey 1964
	15	0	0	0	0	0		0	0	0	0		Smith et al. 1991
	18	1	2	3	9	12		17	12	27	ca.44		Smith et al. 1991
	18.5	0	2	3	9	7		21	13	26	41		Smith et al. 1991
	18.5	1	2	3	9	13		18	ca. 11	29	46		Smith et al. 1991
	22.0	1	d	3	11	2		18	10	24	0		Smith et al. 1991
	22.0	1	3	3	11	7		20	13	35	ca.30		Smith et al. 1991
	23.0	1	3	3	13	10		21	15	35	52		Smith et al. 1991
<i>Bonapartia</i>													
<i>pedaliota</i>	adult	1	1	3	11-13	0		14-15	5-(6)	16-18+2-3	0		Grey 1964
	9.5	0	0	1	2	0		3	0	0	0		Grey 1964
	11.5	0	0	1	3	0		5	2	0	0		Ahlstrom et al. 1984
	12.0	0	0	1	4	0		5	2	0	0		Grey 1964
	14.0	0	1	1	5	0		10	4	3+1	0		Grey 1964
	15.0	0	1	1	5	0		9	3	1+1	0		Ahlstrom et al. 1984
	16.0	0	1	1	6	0		11	5	5+2	0		Jespersen & Taning, 1919
	23.0	0	1	3	11	0		14	5	14+2	0		Grey 1964
<i>Margrethia</i>													
<i>obtusirostre</i>	adult	0	1	3	9-12	0		13-15	4	13-14+3-4	0		Grey 1964
	5.8	0	0	1	0	0		2	0	0	0		Ahlstrom 1974
	6.4	0	0	1	0	0		6	2	1+2	0		Ahlstrom 1974
	8.0	0	0	1	2	0		10	4	1+2	0		Ahlstrom 1974
	11.3	0	d	2	6	0		14	4	5+3	0		Ahlstrom 1974
	15.0	0	1	3	9	0		14	4	11+4	0		Ahlstrom 1974
<i>Cyclothone</i>													
spp.	adult	0	0-1	2	8-11	0	12-14		4-5	12-16	6-10	29-34	Grey 1964
<i>obscura</i>	adult	0	0	0	0	0	0	0	0	0	0	0	Grey 1964

Table Gonostomatidae 2 (continued).

Species	size	SO	ORB	OP	BR	IP	IV	PV	VAV	AC	OA	IC	Source
<i>Sigmops</i>													
<i>elongatum</i>	adult	1	1	3	9	0		15	(4)-5	21-23		13-15	Grey 1964
	6.0	0	0	1	0	0		0	0	0		0	Ahlstrom 1974
	7.5	0	0	1	0	0		5	0	0		0	Ahlstrom 1974
	7.9	0	0	1	0	0		4	0	0		0	Ahlstrom et al. 1984
	10.2	0	0	1	2/1	0		10	2	0		0	Ahlstrom 1974
	13.0	0	0	1	2	0		11	3	0		0	Ahlstrom 1974
	14.0	0	1	1	2	0		11	2/3	1+		0	Grey 1964
	16.7	0	1	1	3	0		11	4	1+		0	Jespersen & Taning, 1919
	22.5	1	1	3	9	0		15	5	22		13	Grey 1964
<i>Sigmops</i>													
<i>bathophilum</i>	adult	0	1	2	9	0		11-12	4-5	20-21		14	Grey 1964
	11.0	0	0	1	0	0		5	0	0		0	Ahlstrom 1974
	14.8	0	1	1	4	0		10	2	0		0	Ahlstrom 1974
<i>Gonostoma</i>													
<i>atlanticum</i>	adult	1	1	2	9	0		15-16	5	19		13	Grey 1964
	12.0	0	0	1	0	0		0	0	0		0	Ahlstrom 1974
	13.0	0	0	1	0	0		1	0	0		0	Ahlstrom 1974
	14.5	0	0	1	0	0		2	0	0		0	Ahlstrom 1974
	17.8	0	1	1	4	0		13	3	1		0	Ahlstrom et al. 1984
	18.8	0	1	2	9	0		16	5	19		0	Ahlstrom 1974
	23.8	0	1	3	9	0		16	5	19		13	Ahlstrom et al. 1984

Table Gonostomatidae 3. Characters used for identifying *Cyclothone* species (modified from Badcock 1982).

Species	Nature of Gill Filaments	Pigmentation				No. of Gill Rakers		No. of Pyloric Caecae
		Gill Filaments	Branchiostegals	Meninges	Snout	First Arch	Hypobranchial	
<i>acclindens</i>	not fused	transparent	discrete	diffuse	conspicuous	23-25	5(6)	3
<i>alba</i>	fused basally	transparent	discrete	V-shape	absent	14	3	4
<i>braueri</i>	fused basally	transparent	discrete	V-shape	nares only	15-17(18)	3	3
<i>microdon</i>	fused basally	pigmented	discrete	diffuse	conspicuous	19-22	4-5	3
<i>obscura</i>	not fused	transparent	diffuse	diffuse	conspicuous	23-29	5(6)	3
<i>pallida</i>	not fused	transparent	diffuse	diffuse	conspicuous	23-24(22-25)	4-5	4
<i>parapallida</i>	not fused	transparent	diffuse	diffuse	absent	21-22(23)	4(5)	4
<i>pseudopallida</i>	fused basally	transparent	diffuse	V-shape	conspicuous	18-20	4	4

Species	Position of Anus	Photophore Features				Maxillary Teeth	Posterior series
		No. VAV anterior to genital pore	VAV Spacing	No. AC between last anal & 1st procurrent ray	Supracaudal Gland	Forward Curvation	Caudad Form
<i>acclindens</i>	closer to pelvic than anal	2-3	even	2	well developed	sharply	uniform enlargement
<i>alba</i>	just behind pelvics	1	even	0-1	inconspicuous	slightly	long teeth separated with short teeth
<i>braueri</i>	just behind pelvics	2	1st 2 close	1	inconspicuous	slightly	long teeth separated with short teeth
<i>microdon</i>	closer to pelvic than anal	3(4)	even	1	distinct	slightly	long teeth separated with short teeth
<i>obscura</i>	midway between pelvic & anal	absent	absent	absent	absent	slightly	long teeth separated with short teeth
<i>pallida</i>	closer to pelvic than anal	2(3)	even	2-3	distinct	slightly	long teeth separated with short teeth
<i>parapallida</i>	closer to pelvic than anal	2	even	2-3	less distinct	slightly	long teeth separated with short teeth
<i>pseudopallida</i>	just behind pelvics	2	1st 2 close	1(2)	weakly developed	slightly	long teeth separated with short teeth

MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	37
Number of Fin Rays:	
Dorsal	17-20
Anal	29-31
Pectoral	14-16
Pelvic	7-8
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Total	
Gillrakers on First Arch	
Upper	5-6
Lower	11-12
Total	16-18
Branchiostegals	13-16

LIFE HISTORY

Range: Throughout area and eastern Atlantic.
 Habitat: Meso- & bathypelagic
 ELH Pattern: Oviparous, planktonic eggs & larvae
 Spawning: Larvae rarely collected

LITERATURE

Grey 1964, Ahlstrom, Richards, & Weitzman 1984

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Length at Flexion:

Length at Transformation:

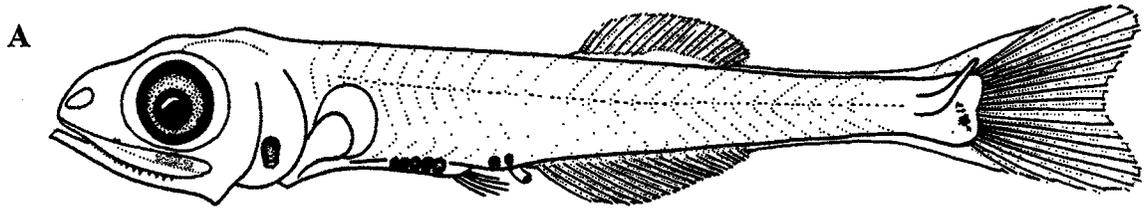
Sequence of Fin Development: C, A, D, P₁ & P₂

Pigmentation: larvae with little pigment confined to caudal peduncle

Diagnostic Characters: Larvae rarely collected but pigment pattern unique coupled with meristics. Caution – larvae resemble some sternoptychids because of little pigmentation.

ILLUSTRATIONS

Ahlstrom, Richards, & Weitzman 1984: A) 11.5 mm SL



11.5 mm SL

MERISTICS

Vertebrae:	
Precaudal	13-14
Caudal	17-19
Total	31(30-32)
Number of Fin Rays:	
Dorsal	14-15(13)
Anal	19(18-20)
Pectoral	9-10(8)
Pelvic	6(7)
Caudal	
Dorsal Secondary	6-7
Principal	10+9
Ventral Secondary	5-6
Gillrakers on First Arch	
Upper	7(6-9)
Lower	12-14(15-17)
Total	23-25
Branchiostegals	14(13-15)

LIFE HISTORY

Range: Cosmopolitan, in tropical waters in the Atlantic.
 Habitat: Epi- & mesopelagic, at ca. 50=1900 m depth
 ELH Pattern: Oviparous; planktonic eggs & larvae
 Spawning: No information

LITERATURE

Badcock 1982, Watson 1996a

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Length at Flexion: ca. 5-6 mm

Length at Transformation: ca. 13-14 mm to ca. 22 mm

Sequence of Fin Development: C₁, A, D & C₂, P₂, P₁

Pigmentation: *Preflexion-postflexion* – pairs along sides of gut; over gas bladder; 4-9 on myosepta over gut after ca. 4 mm; 9-13 (usually 10-11) on ventral margin of tail from postanal myomere 1-3 (usually 2), gradually becoming internal; double row on A ray bases; 1 under notochord tip/along parhypural; 0-1 at center of hypural margin; 0-1 over notochord tip; series over notochord beginning at myomere 28-30 at 6.5-7 mm, extending to myomere 12-15 by ca. 10 mm. *Transformation* – between neural & haemal spines; on hypurals; on hindbrain; on margins of branchiostegal membranes; on D & A bases; external midlaterally beginning at ca. 15 mm.

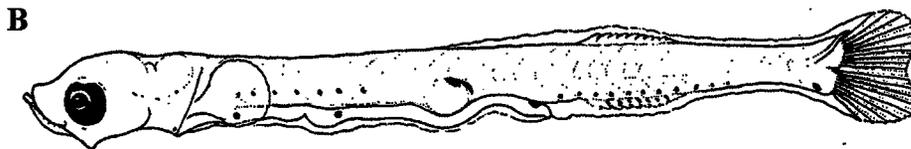
Diagnostic Characters: Myoseptal pigment above gut; pigment over notochord beginning after 6.5 mm, spreading forward to 2-3 melanophores past D origin by transformation; pigment ventrally on tail beginning at postanal myomere 0-2 (usually 1); 8 ceratobranchial gill rakers (by ca. 11 mm); 12-16 preanal myomeres (usually 15-16 before, 12-13 during transformation), 31-33 (usually 31-32) total myomeres.

ILLUSTRATIONS

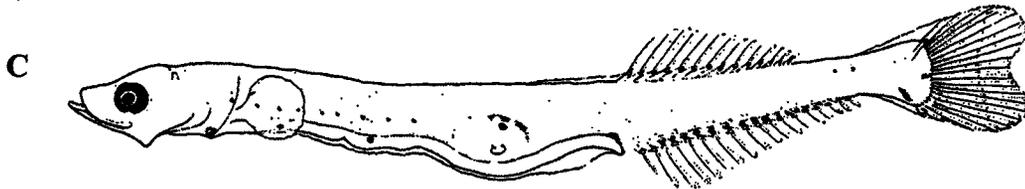
Watson 1996a: A-E) Pacific specimens 5.8 mm NL preflexion, 5.8 mm SL flexion, 10 mm SL postflexion, 13.7 mm SL postflexion, & 21.1 mm SL juvenile



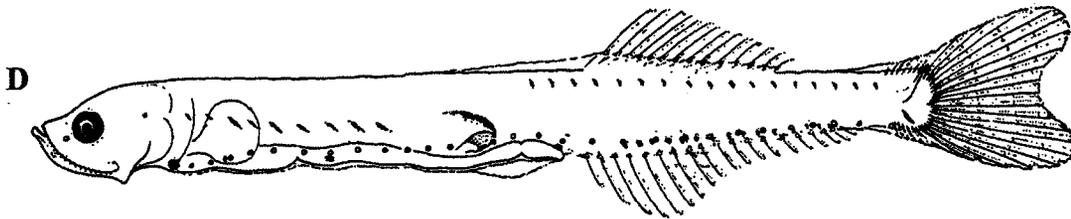
5.8 mm NL



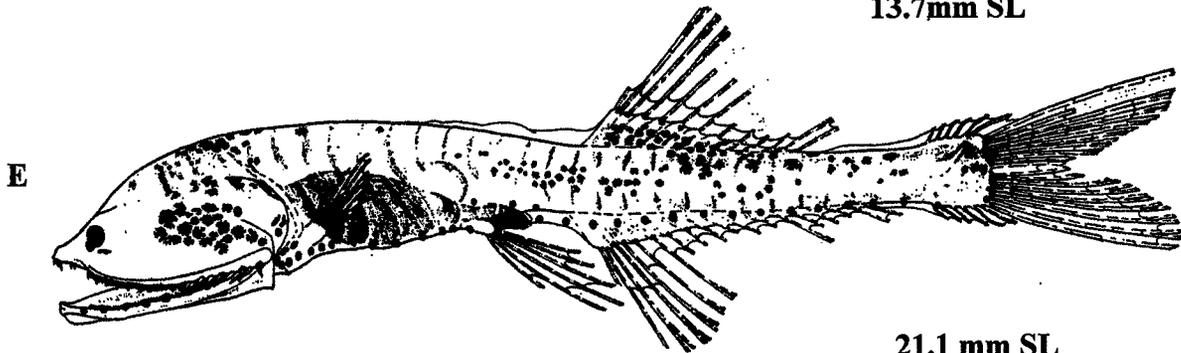
5.8 mm SL



10.0 mm SL



13.7mm SL



21.1 mm SL

MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	
Number of Fin Rays:	
Dorsal	
Anal	
Pectoral	
Pelvic	
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Total	
Gillrakers on First Arch	
Upper	4
Lower	10
Total	14
Hypobranchial Only	3
Branchiostegals	

LIFE HISTORY

Range: Presumed to enter our area.

Habitat: Mesopelagic

ELH Pattern: Oviparous with planktonic eggs & larvae

LITERATURE

Badcock 1982, Grey 1964; Ozawa & Oda 1986

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Length at Flexion: ca. 3.8 mm

Length at Transformation: >12 mm

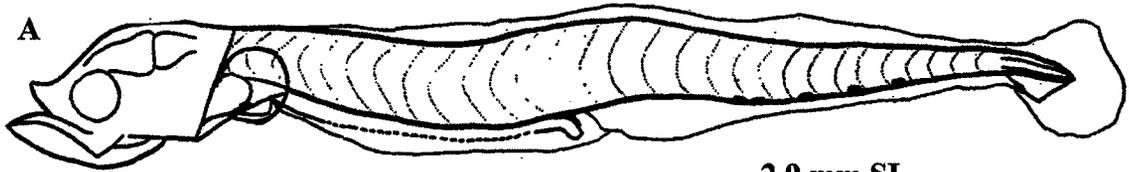
Sequence of Fin Development: C, A & D, P₁, P₂

Pigmentation: *Flexion* – ca. 5 pairs on ventral tail margin, streak on parhypural; few over gas bladder, & over hindgut. *Postflexion* – 5 increasing to 8 pairs on ventral tail margin above A fin base, on parhypural; 1 on dorsal margin of caudal peduncle increasing to 4 at 8.6 mm; 5 below dorsal fin; few laterally on gut, scattered over gas bladder, & on hindgut; ca. 6 internal streaks on ventral trunk myosepta; on cleithral symphysis.

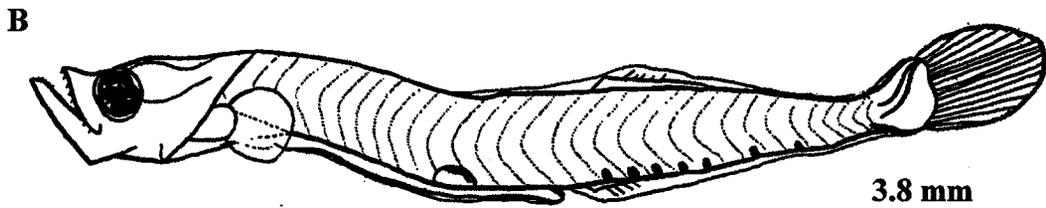
Diagnostic Characters: few gill rakers fused ventrally, pigment pattern including discrete pigmentation absent on snout, V-shaped on meninges with prominent streaks of brown present basal to BR photophores, along medial free edge, and over the branchiostegal rays (pattern shared with *C. braueri* & *C. pseudopallida*).

ILLUSTRATIONS

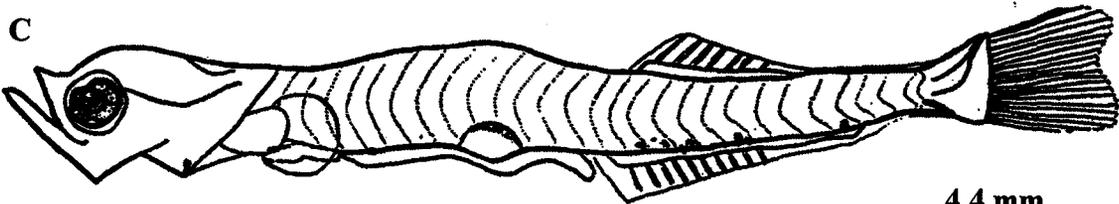
Ozawa & Oda 1986: A-F) Pacific specimens – 2.9, 3.8, 4.4, 7.1, 8.6 & 9.7 mm.



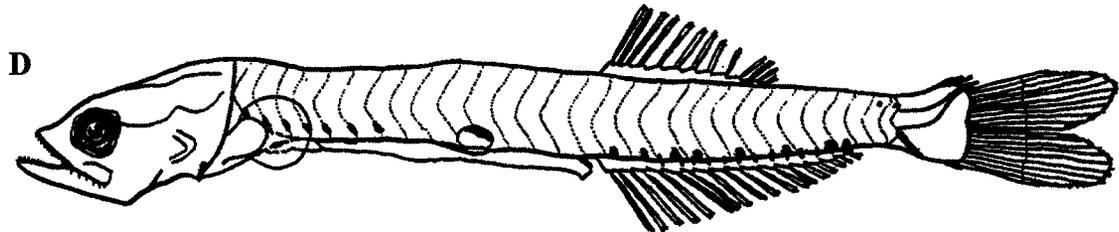
2.9 mm SL



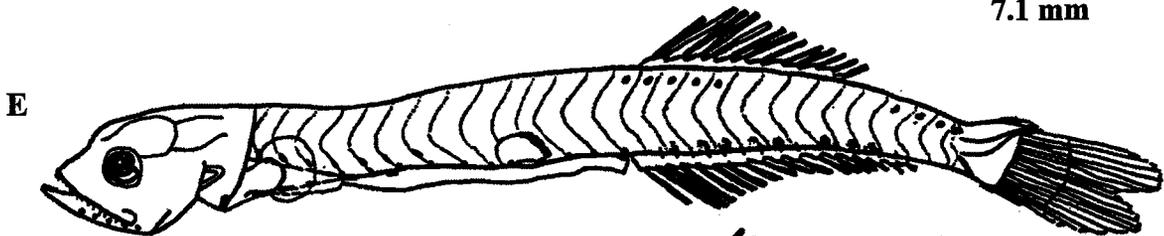
3.8 mm



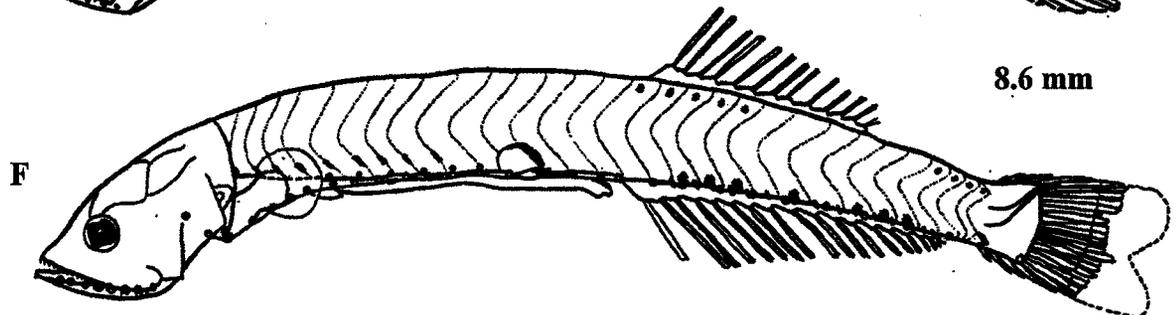
4.4 mm



7.1 mm



8.6 mm



9.7 mm

MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	
Number of Fin Rays:	
Dorsal	
Anal	
Pectoral	
Pelvic	
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Total	
Gillrakers on First Arch	
Upper	5-6
Lower	2+9-10
Total	15-17(18)
Hypobranchial Only	3
Branchiostegals	

LIFE HISTORY

Range: North Atlantic, Mediterranean, & South Atlantic. Anti-tropical and may just enter northern edge of our area.

Habitat: Mesopelagic

ELH Pattern: Oviparous with planktonic eggs & larvae

Spawning:

 Season:

LITERATURE

Jespersen & Tåning 1926, Grey 1964, Badcock 1982, Miya & Nishida 1996; Sanzo 1931

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Length at Flexion: ca. 4.8 mm

Length at Transformation: >12 mm

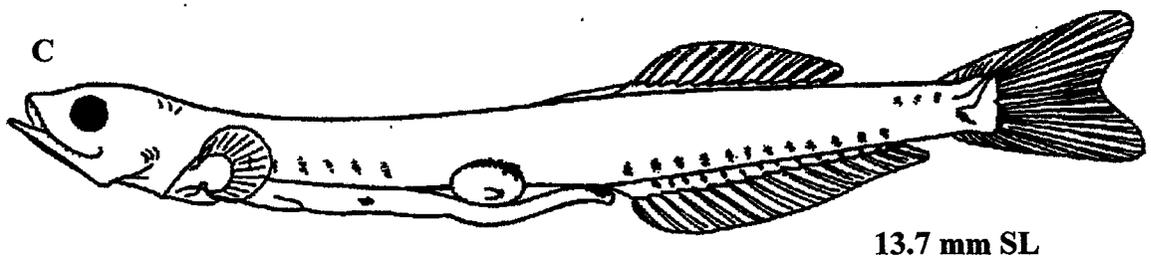
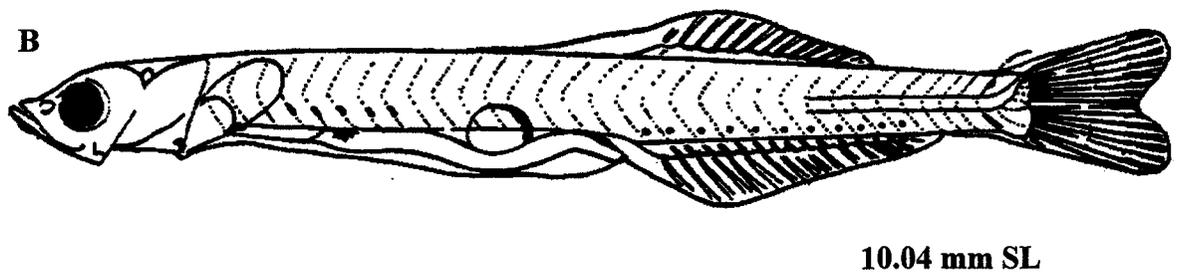
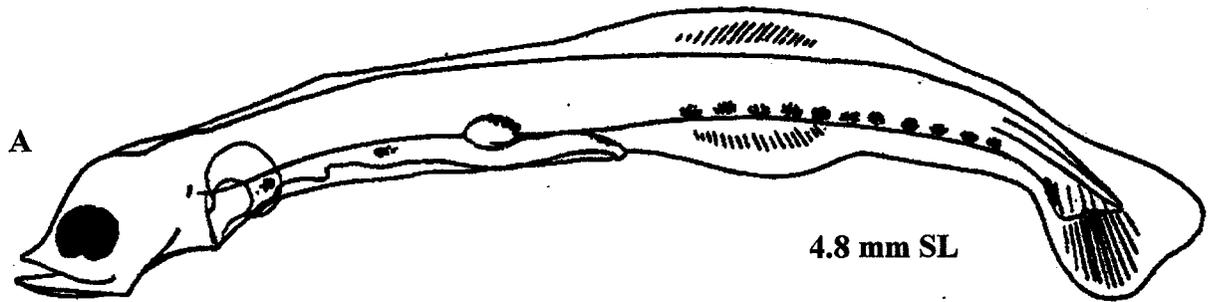
Sequence of Fin Development: C, A & D, P₁, P₂

Pigmentation: *Flexion* – 11 pairs on ventral tail margin, streak on parhypural; laterally 2 on gut, few over gas bladder, & over hindgut; internal on hindbrain. *Postflexion* – 12 pairs on ventral tail margin above A fin base, on parhypural; 3 on dorsal margin of caudal peduncle; 2 laterally on gut, scattered over gas bladder, & on hindgut; ca. 6 internal streaks on ventral trunk myosepta; on cleithral symphysis; dorsally on hindbrain.

Diagnostic Characters: few gill rakers fused ventrally, pigment pattern including discrete pigmentation with prominent streaks of brown present basal to BR photophores, along medial free edge, and over the branchiostegal rays (pattern shared with *C. alba* & *C. pseudopallida*).

ILLUSTRATIONS

Sanzo 1931: A-C) 4.8 mm SL, 10.04 mm SL, 13.7 mm SL



MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	
Number of Fin Rays:	
Dorsal	
Anal	
Pectoral	
Pelvic	
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Total	
Gillrakers on First Arch	
Upper	6-8
Lower	13-14
Total	19-22
Hypobranchial only	4-5
Branchiostegals	

LIFE HISTORY

Range: Cosmopolitan.
 Habitat: Mesopelagic
 ELH Pattern: Oviparous with planktonic eggs & larvae
 Spawning:
 Season: unknown

LITERATURE

Grey 1964, Badcock 1982, Mukhacheva 1954

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Length at Flexion:

Length at Transformation:

Sequence of Fin Development:

Pigmentation: based on 1 postflexion specimen, 8 mm, from North Pacific – 12 pairs on ventral tail margin over A base, melanophores on A bases, streak on parhypural, 4 on dorsal caudal peduncle, 3 on foregut, over gas bladder, at clethral symphysis & over hindgut. Internal on ventral trunk myosepta.

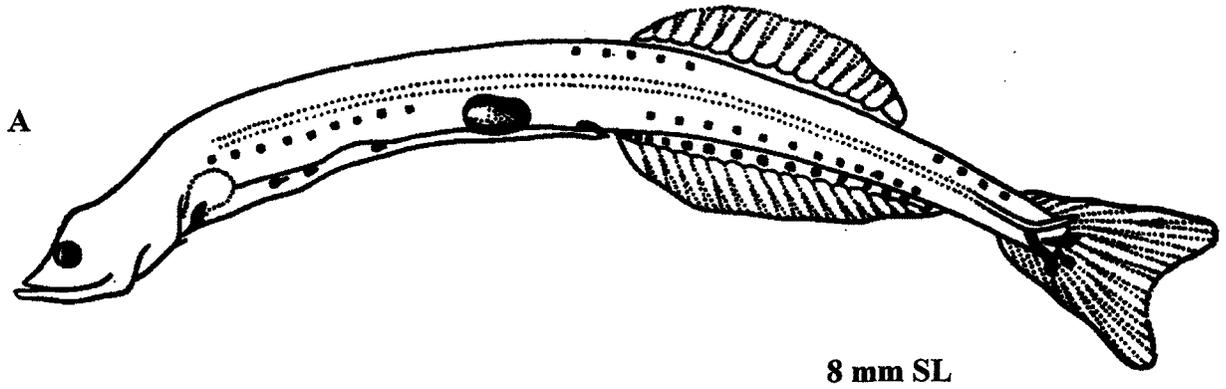
Diagnostic Characters:

JUVENILES:

Diagnostic Characters: Fused gill filament bases are diffuely pigmented & not transparent as all other *Cyclothone*.

ILLUSTRATIONS

Mukhacheva 1954: A) 8 mm SL



MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	31-32(33)
Number of Fin Rays:	
Dorsal 14(12-15)	
Anal	18(16-19)
Pectoral	
Pelvic	
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Total	
Gillrakers on First Arch	
Upper	9(8-10)
Lower	10(9-11)
Total	23-24(22-25)
Hypobranchial Only	4(5)
Branchiostegals	

LIFE HISTORY

Range: Presumed to enter our area.
 Habitat: Mesopelagic
 ELH Pattern: Oviparous with planktonic eggs & larvae

LITERATURE

Badcock 1982, Grey 1964; Ozawa & Oda 1986

EARLY LIFE HISTORY DESCRIPTION

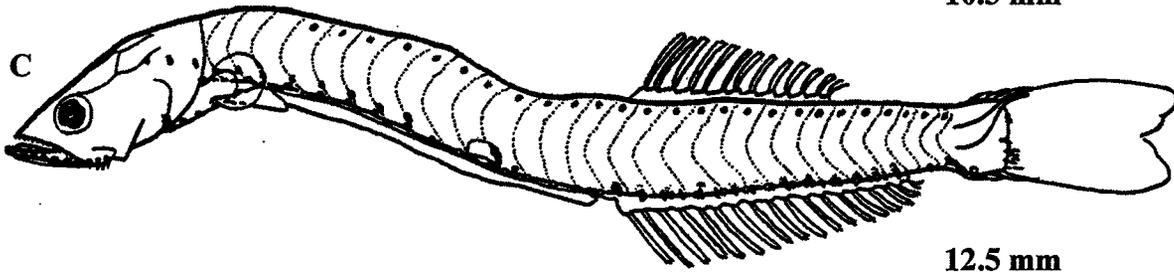
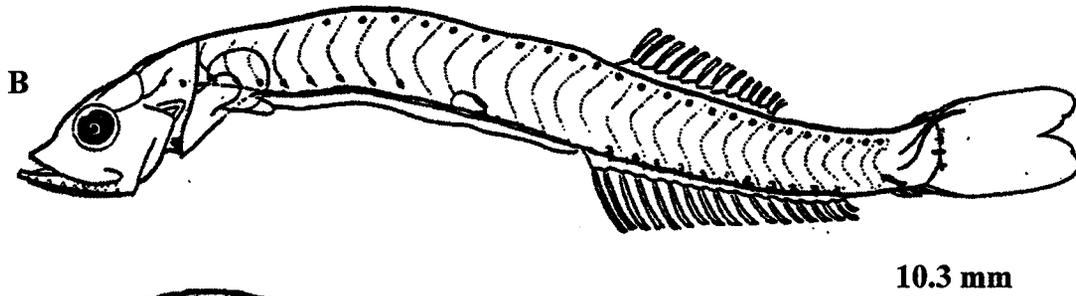
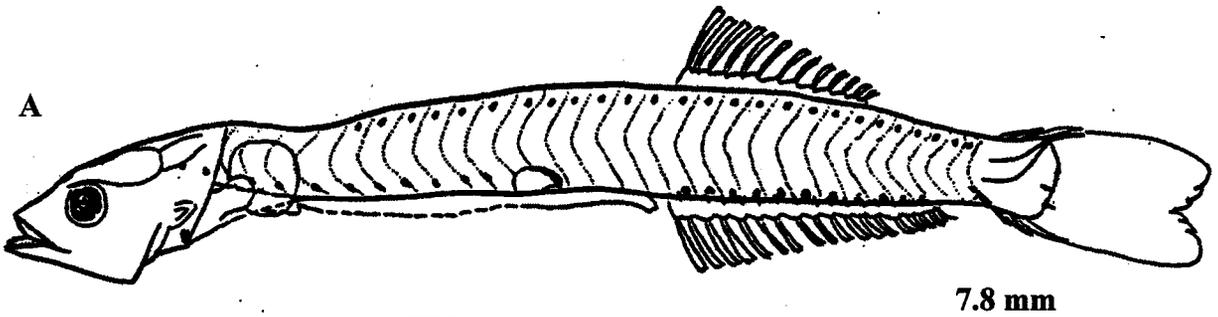
EGGS: Unknown

LARVAE:

Length at Flexion: unknown
 Length at Transformation: >12.5 mm
 Sequence of Fin Development: C, A & D, P₁, P₂
 Pigmentation: *Postflexion* – ca.12 pairs on ventral tail margin above A fin base, on parhypural; 1 pair on most dorsal myomeres; on all ventral myosepta in advance of gas bladder extending anteriorly under opercle; scattered over gas bladder, on cleithral symphysis.
 Diagnostic Characters: gill rakers not fused ventrally, pigment pattern including discrete pigmentation conspicuous on snout, diffuse on meninges & branchiostegals.

ILLUSTRATIONS

Ozawa & Oda 1986: A-C) Pacific specimens – 7.8, 10.3 & 12.5 mm.



MERISTICS

Vertebrae:	
Precaudal	13(12-14)
Caudal	20(17-21)
Total	33(29-34)
Number of Fin Rays:	
Dorsal	13+14(12-15)
Anal	19-20(17-21)
Pectoral	9(10)
Pelvic	6(7)
Caudal	
Dorsal Secondary	6-7
Principal	10+9
Ventral Secondary	7(6)
Gillrakers on First Arch	
Upper	4(5-7)
Lower	11-14
Total	23-25
Branchiostegals	14

LIFE HISTORY

Range: Cosmopolitan, subtropical-tropical.
 Habitat: Meso- & bathypelagic at ca. 300-1400 m depth
 ELH Pattern: Oviparous, planktonic eggs & larvae
 Spawning: Off Guyana.

LITERATURE

Grey 1064, Badcock 1982, Miya 1994, Watson 1996a

EARLY LIFE HISTORY DESCRIPTION**EGGS:**

Diameter: 0.48-0.58 mm

LARVAE:

Length at Flexion: ca. 5-6 mm

Length at Transformation: ca. 16.5-22 mm

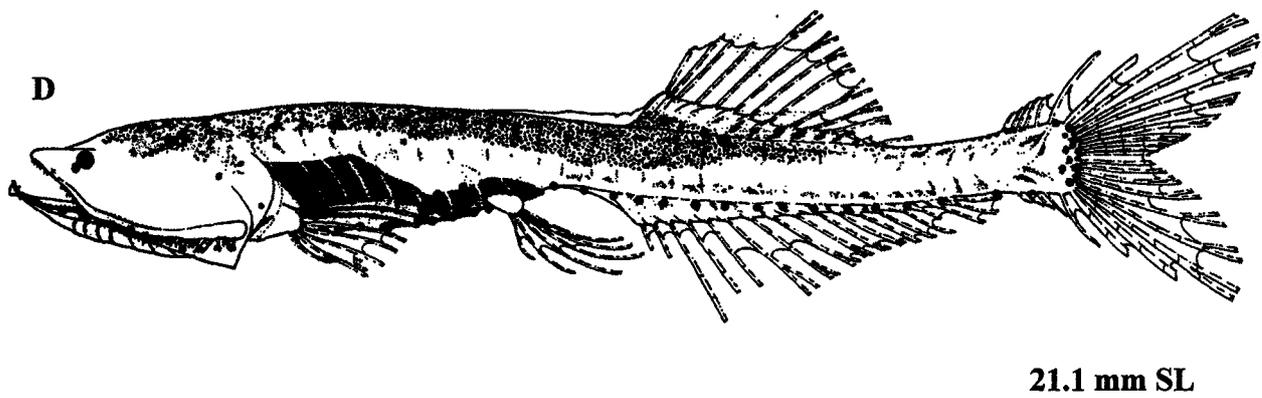
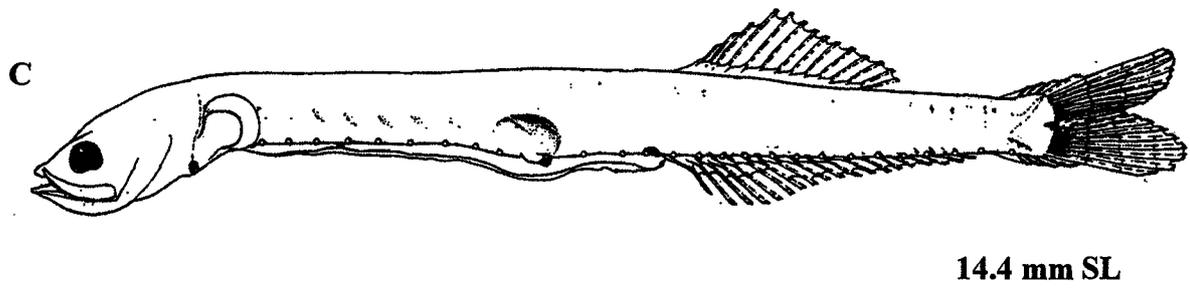
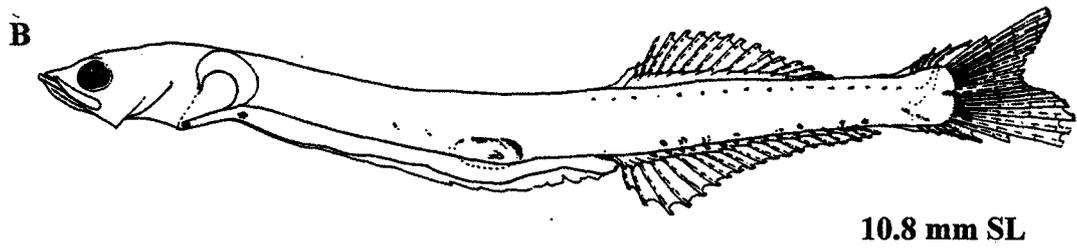
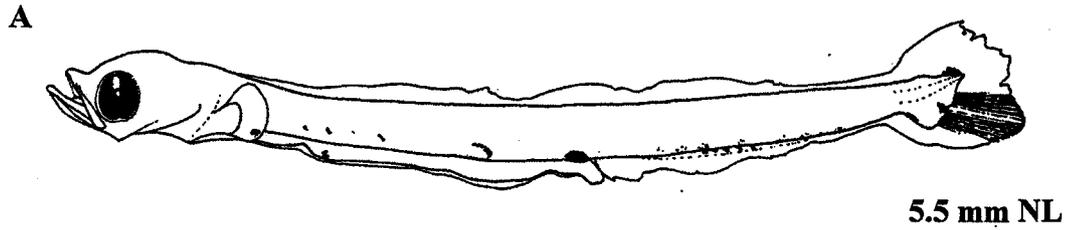
Sequence of Fin Development: C₁, D & A & C₂, P₂, P₁

Pigmentation: *Flexion-transformation* – 1-2 pairs along sides of gut anteriorly; pair at cleithral symphysis; over gas bladder; over end of hindgut; 7-12 on myosepta above gut anteriorly, increasing to 10-12; 9-11 internally, ventrally along tail; externally on A ray bases; on parhypural; 1 at center of hypural margin; on lower C rays; on upper C rays after ca. 12 mm; over notochord tip in flexion larvae; over notochord beginning posteriorly, extending anteriorly to 8-11 melanophores past D origin by ca. 16.5 mm; on head in transforming specimens.

Diagnostic Characters: pigmentation & meristic characters.

ILLUSTRATIONS

Watson 1996a: A-D) 5.5 mm NL, 10.8 mm SL, 14.4 mm SL, & 21 mm SL



MERISTICS

Vertebrae:	
Precaudal	37-41
Caudal	52-59
Total	89-99
Number of Fin Rays:	
Dorsal	12-13
Anal	59-72
Pectoral	8-10
Pelvic	8
Caudal	
Upper Procurrent	3-6
Principal	10+9
Lower Procurrent	3-4
Gillrakers on First Arch	
Upper	3
Lower	7-8
Total	10-11
Branchiostegals	12-1

LIFE HISTORY

Range: Cosmopolitan, through our area.

Habitat: Epi- & mesopelagic in upper 100 m at night & at ca. 450-610 m depth during the day.

ELH Pattern: Oviparous, planktonic eggs & larvae

Spawning:

 Season: unknown, rarely taken.

LITERATURE

Ahlstrom, Richards, & Weitzman 1984; Grey 1964; Ozawa et al. 1990; Rudometkina 1981; Watson 1996a

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Hatching length: ca. 3.5-5 mm

Length at Flexion: ca. 19-19.5 through ca. 27.5-28 mm

Length at Transformation: ca. 43 through 30 mm (larvae shrink during transformation)

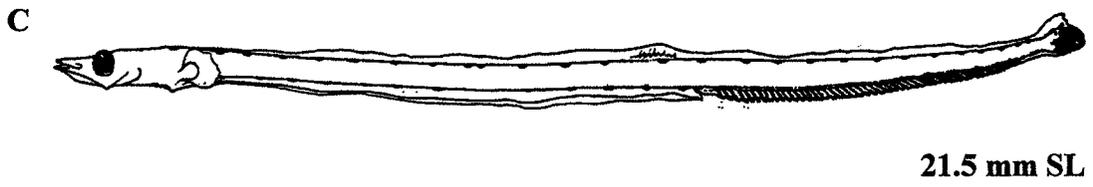
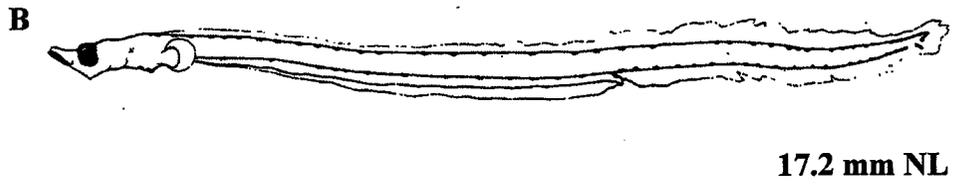
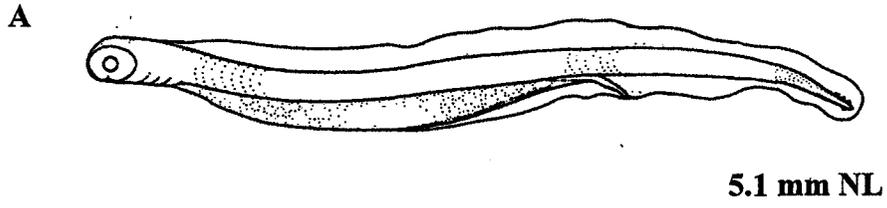
Sequence of Fin Development: C₁, A, D, C₂, P₂, P₁

Pigmentation: *Yolk-sac* – apparently limited to end of notochord. *Preflexion-postflexion* – Initially nearly continuous double rows on dorsal & ventral margins of tail, condensing into ca. 20-40 dorsal & 9-22 ventral (tail) melanophores or pigment patches; 11-20 pairs over gut; 1-4 on isthmus after ca. 8 mm; ventrolaterally on hindbrain at ca. 17-20 mm; on mandible by ca. 39 mm; decreasing on notochord tip after ca. 19 mm. *Transformation* – increasing on entire dorsal surface & along lateral midline.

Diagnostic Characters: Very elongate & slender; large size at flexion & transformation stages; dorsal & ventral series of melanophores or pigment patches, usually 25-35 dorsal, 14-17 ventral (on tail), during most of larval development; 43-50 (usually 47) preanal myomeres, 89-99 (usually 91-95) total myomeres.

ILLUSTRATIONS

Ahlstrom, Richards, & Weitzman 1984: C) 21.5 mm SL
Watson 1996a: A-B, D) 5.1 mm NL, 17.2 mm NL, and 43.0 mm SL



MERISTICS

Vertebrae:	
Precaudal	18
Caudal	20
Total	38
Number of Fin Rays:	
Dorsal	16-18
Anal	28-30
Pectoral	10
Pelvic	6-7
Caudal	
Principal	10+9
Procurent:	
Upper 7-8	
Lower 6-7	
Gillrakers on First Arch	
Upper	6-7
Lower	11-12
Branchiostegals	11-12

LIFE HISTORY

Range: Worldwide, offshore throughout our area
Habitat: Meso- & bathypelagic, at ca. 100-2500 m depth; primarily 150-300 m at night & 490-560 during the day
ELH Pattern: Oviparous, planktonic eggs & larvae found in mixed surface layer
Spawning:
 Season: larvae found in all months
 Area: offshore throughout area

LITERATURE

Grey 1964, Ahlstrom, Richards, & Weitzman 1984, Watson 1996a

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

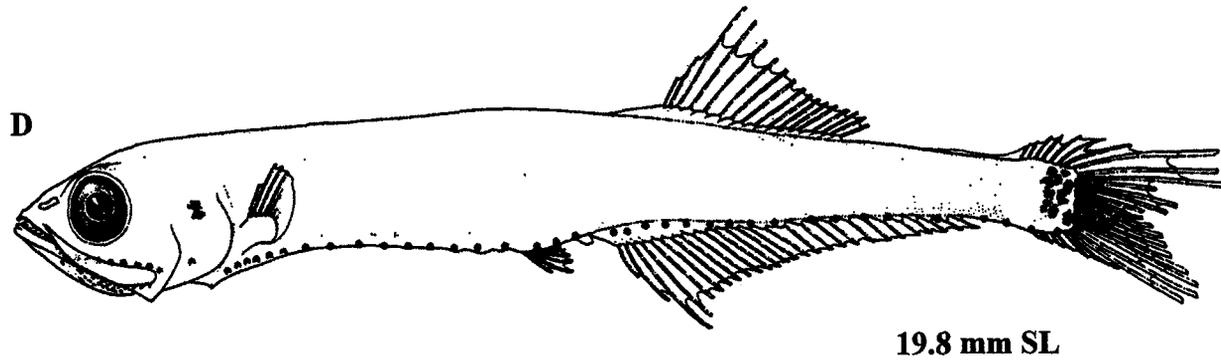
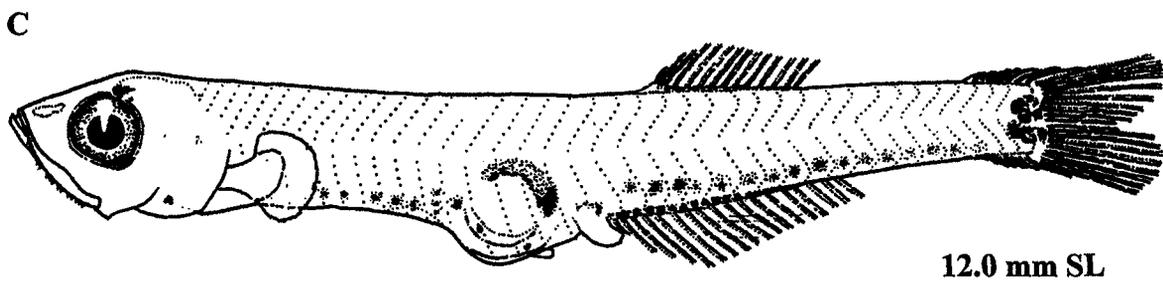
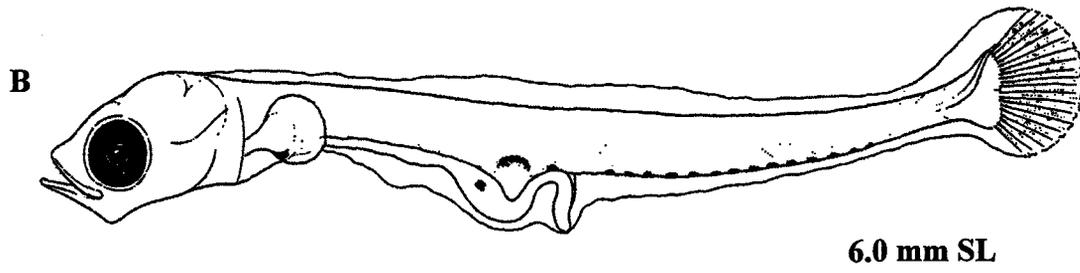
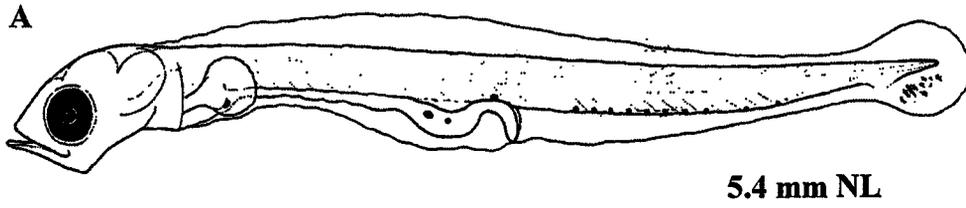
Hatching length: <3.5 mm
Length at Flexion: ca. 4.5-6 mm
Length at Transformation: >14.8 mm, <17.6 to ca. 21 mm
Sequence of Fin Development: C, A, D, P₁, P₂
Pigmentation: *Preflexion-flexion* – 5-13 melano-phores along ventral tail margin, over gas bladder after ca. 4 mm, pair on gut just posterior of P₁, present or absent on hindgut loop. *Postflexion-transformation* – 17-18 in ventral tail series, double row along anal fin base, row alongside of gut from P₁ to hindgut, all increasing during transformation, few on caudal peduncle near hypural edges but forming distinct patches, pair anteriorly on midbrain ba ca. 6-7 mm; on hindbrain (deep behind eye) by ca. 11.5 mm; pigment increases on head

Diagnostic Characters: 17-19 preanal myomeres, 37-40 (usually 38) total myomeres, hindgut loop below prominent gas bladder, preanal length ca. 55-60% SL, oval eye, pigment on ventral margin of tail, dorsally on gas bladder & laterally on gut; no internal parhypural pigment but pigment over hypurals, deep hindbrain spot.

Distinguish from *Cyclothone* spp. which also has ventral tail pigment and prominent gas bladder by absence of parhypural pigment and hindbrain spot.

ILLUSTRATIONS

Ahlstrom, Richards & Weitzman 1984: C) 12 mm SL
Watson 1996a: A-B,D) 5.4 mm NL, 6.0 mm SL, 19.8 mm SL



MERISTICS

Vertebrae:	
Total	63
Number of Fin Rays:	
Dorsal	10-13
Anal	34-41
Pectoral	10-11
Pelvic	8
Caudal	
Principal	10+9
Gillrakers on First Arch	
Upper	3-5
Lower	8-9
Total	12-14
Branchiostegals	11-13

LIFE HISTORY

Range: Endemic in the Atlantic Ocean.

Habitat: Meso-pelagic (ca. 450-600 m) with diel migration into upper 0-100 m at night by 20-100 mm & to 150 m by adults.

ELH Pattern: Oviparous, planktonic eggs & larvae

Spawning: Unknown

LITERATURE

Grey 1964, Smith et al. 1991

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Length at Flexion: Unknown

Length at Transformation: 15-18 mm SL

Sequence of Fin Development: C, D, A, P₁ & P₂

Pigmentation: *Flexion – transformation* dorso-lateral row of melanophores & scattered melanophores over brain, internal streak before & after eye, gut & pectoral fin base. Small row along anal base & mandible. Scattered over caudal base.

Diagnostic Characters: pigmentation, pronounced annular mucosal folds along gut, fewer than 42 anal rays. Photophores absent.

Distinguish from other elongate gonostomatids by mucosal folds of gut, dorsolateral row of melanophores, <42 anal rays.

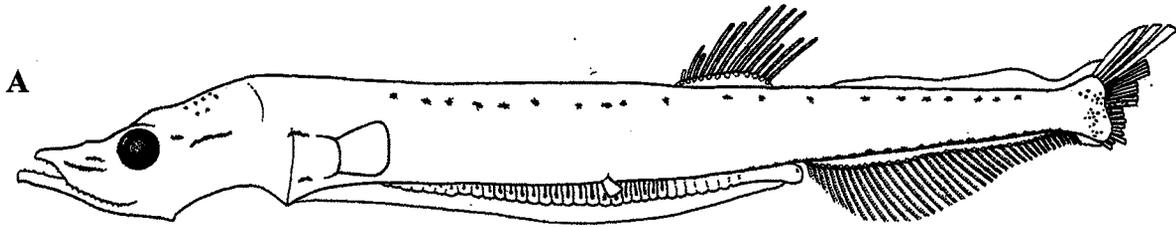
JUVENILES:

Pigmentation: Larval melanophores retained with adult pigmentation appearing around larval melanophores.

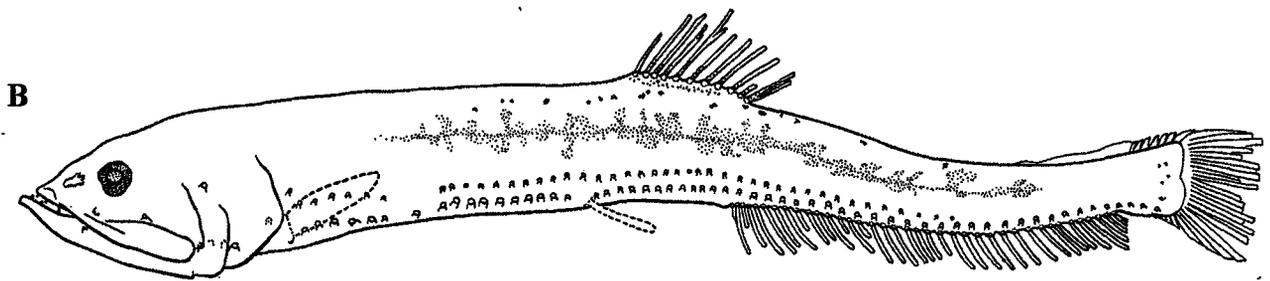
Diagnostic Characters: photophores appear at 18 mm SL. Distinguish from other elongate gonostomatids by meristics and photophore pattern.

ILLUSTRATIONS

From Smith et al. 1991: A-B) 10 mm SL - 18 mm SL



10 mm SL



18 mm SL

MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	34
Number of Fin Rays:	
Dorsal	15-16
Anal	21-26
Pectoral	13-15
Pelvic	8
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Total	
Gillrakers on First Arch	
Upper	5
Lower	10-11
Total	15-16
Branchiostegals	13

LIFE HISTORY

Range: Throughout area.

Habitat: Meso- & bathypelagic

ELH Pattern: Oviparous, planktonic eggs & larvae

Spawning:

 Season: Unknown

LITERATURE

Grey 1964, Ahlstrom, Richards, & Weitzman 1984

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Sequence of Fin Development: C, A, D, P₁ & P₂

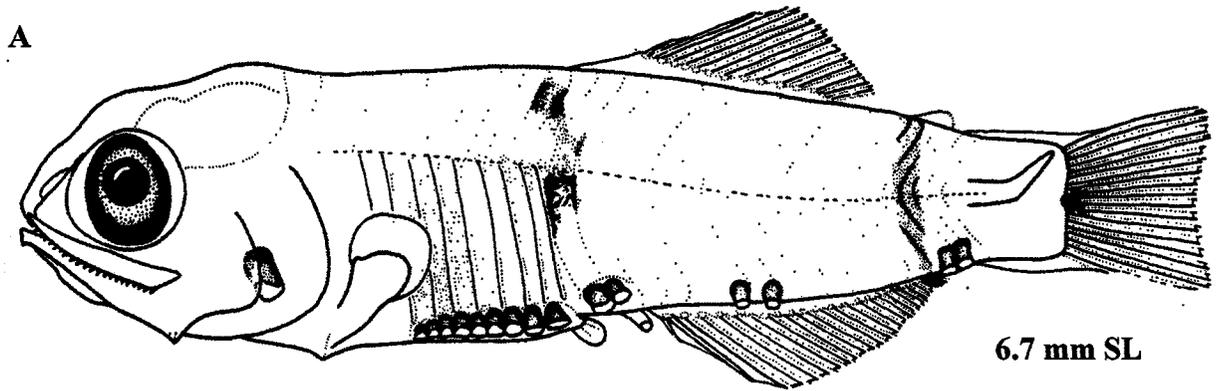
Pigmentation: most larvae with pigmented ring around caudal peduncle at adipose fin to end of anal fin.

Larger larvae with pigment on trunk below dorsal fin origin and spot on caudal base.

Diagnostic Characters: pigmentation & meristics plus larger larvae deep-bodied and not slender as other genera.

ILLUSTRATIONS

Ahlstrom, Richards, & Weitzman 1984: A) 6.7 mm SL



MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	37
Number of Fin Rays:	
Dorsal	13(12-14)
Anal	22-24
Pectoral	10-11
Pelvic	7-8
Caudal	
Principal	10+9
Gillrakers on First Arch	
Upper	9-11
Lower	15-17
Total	24-27
Branchiostegals	12-13

LIFE HISTORY

Range: Atlantic Ocean, offshore throughout our area

Habitat: Meso- & bathypelagic, occurring more frequently at depths >2000m

ELH Pattern: Oviparous, planktonic eggs & larvae found in mixed surface layer; protandric hemaphroditism.

Spawning:

 Season: Poorly known, larvae caught infrequently

LITERATURE

Grey 1964, Ahlstrom, Richards & Weitzman 1984, Miya & Nishida 2000

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE: Poorly known, rare

Length at Flexion: <11.0 mm

Length at Transformation: >14.8 mm

Sequence of Fin Development: C, A, D, P₁ & P₂

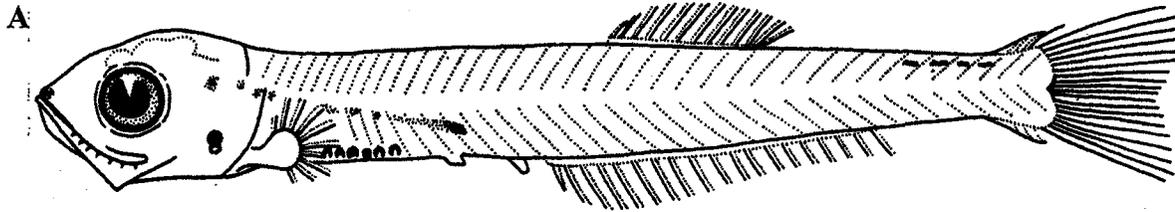
Pigmentation: *Flexion-transformation* – deep pigment spot behind eyes, pigment present on dorsal edge of caudal peduncle. Pigment over gut & gas bladder appears as a dark streak

Diagnostic Characters: Pigment on dorsal edge of caudal peduncle is unique for genus in our area.

Distinguish by caudal peduncle pigmentation.

ILLUSTRATIONS

Ahlstrom, Richards & Weitzman 1984 Fig. 101 (top):
A) 11.0 mm SL



11.0 mm SL

MERISTICS

Vertebrae:	
Precaudal	15
Caudal	24
Total	39
Number of Fin Rays:	
Dorsal	12-14
Anal	29-32
Pectoral	10-12
Pelvic	8
Caudal	
Principal	10+9
Procurent:	
Upper 10-13	
Lower 8-10	
Gillrakers on First Arch	
Upper	7-9
Lower	11-12
Branchiostegals	12-13

LIFE HISTORY

Range: Worldwide, offshore throughout our area
Habitat: Meso- & bathypelagic, at ca. 60-265 m depth at night & >500 during the day
ELH Pattern: Oviparous, planktonic eggs & larvae found in mixed surface layer, protandric hermaphroditism.
Spawning:
 Season: larvae found in all months
 Area: offshore throughout area

LITERATURE

Grey 1964; Ahlstrom, Richards & Weitzman 1984;
Watson 1996a, Miya & Nishida 2000

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Hatching length: <3.9 mm

Length at Flexion: ca. 4.7-5.3 mm

Length at Transformation: >14.8 mm, <17.6 to ca. 21 mm

Sequence of Fin Development: C, A, D, P₁, P₂

Pigmentation: *Preflexion-flexion* – None initially; over gas bladder by ca. 4.7 mm; ventrolaterally on hindbrain at ca. 5.2 mm. *Postflexion* – dorsally on most of gut by ca. 10.2 mm; surrounding stomach, beginning at ca. 11 mm; dorsolaterally on hindbrain, beginning between 8-11 mm. *Transformation* – increasing on gut region and hindbrain; extending onto midbrain by ca. 18.9 mm.

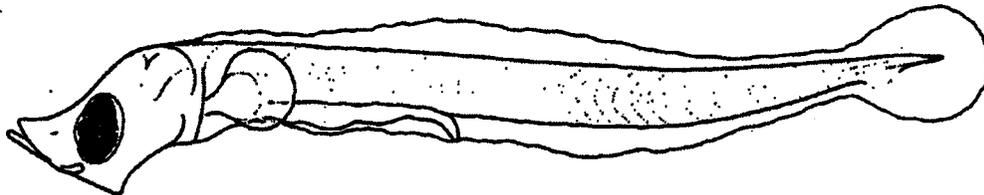
Diagnostic Characters: 15-18 preanal myomeres (usually 16 through flexion stage, 18 thereafter), 39 total myomeres; usually 0-1 myomeres between anus and anal fin origin; preanal length usually 45-50% SL through transformation stage; moderately narrow eye; little pigment through postflexion stage; dorsolateral pigmentation on hindbrain by 8-11 mm. Very difficult to distinguish from other larvae with little pigmentation especially the sternoptychid *Valenciennellus*.

ILLUSTRATIONS

Watson 1996a: A-B) 4.6 & 4.7 mm NL

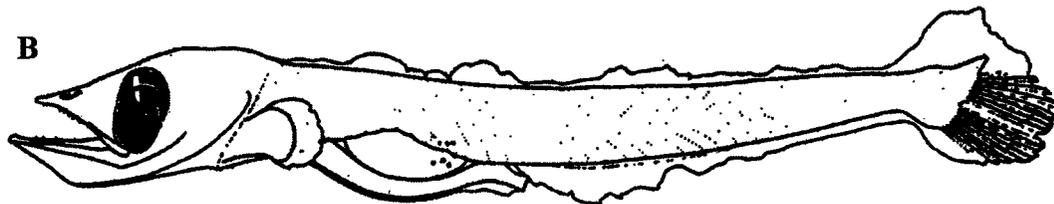
Ahlstrom, Richards & Weitzman 1984: C) 9.8 mm SL

A



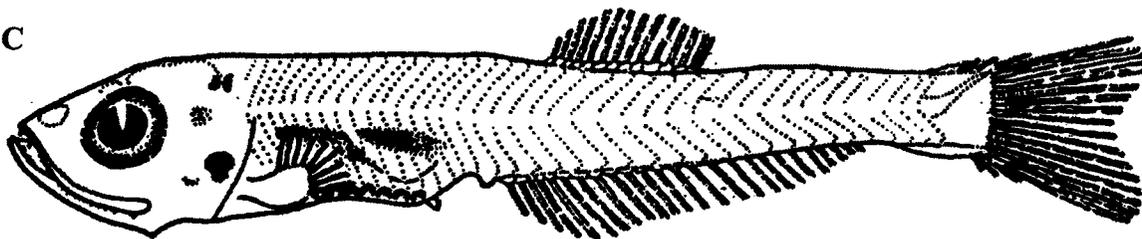
4.6 mm NL

B



4.7 mm NL

C



9.8 mm SL

STERNOPTYCHIDAE: Marine Hatchetfishes & Relatives

W. J. Richards

Sixteen species in seven genera of sternoptychids are found in our area. One of these, Maurolicine species Alpha, appears to be an undescribed species as only two larval specimens are known – one from the Pacific and one from the Atlantic. The marine hatchetfishes (Subfamily Sternoptychinae) of the genera *Argyropelecus* (5 species), *Polyipnus* (3 species), and *Sternoptyx* (2 species) are well known as adults, but the larvae and eggs are poorly known because these species are found below 200 m where ichthyoplankton nets are seldom fished. Howell & Krueger (1987) provide extensive depth data from Bermuda for several species of *Sternoptyx* & *Argyropelecus* plus *Valenciennellus* & *Maurolicus*. The remaining larvae (Subfamily Maurolicinae) comprise the monotypic genera *Maurolicus* and *Valenciennellus* that are often quite commonly found in ichthyoplankton collections, but the monotypic *Argyripnus* is rare as this species is presumed to be benthic. The ELH stages of *Sonoda* (two species) are unknown. The main character of the family is the grouping of some photophores coalesced in gland-like clusters and presence of a pseudobranch.

The marine hatchetfish have unusual shapes as adults with very deep, strongly compressed bodies, near vertical mouths, eyes sometimes telescopic, abdominal keel-like structure, blade-like structure in advance of the dorsal fin (comprised of specialized dorsal pterygiophores), and vertically oriented pelvic fin spines. This results in the hatchet-like shape from which the common name is derived. The larvae of these genera have the same shape with very short, deep bodies and long tails giving an even more hatchet-like shape. The remaining species (Subfamily Maurolicinae) have elongate bodies, never extremely compressed, and the larvae do not have unusual shapes either except for the enigmatic Alpha with its extremely long body and gut and unusual myomere count. Counts and photophore development characters are given in Tables Sternoptychidae 1-3. Pigment is limited in all the known species thus identification depends on photophore patterns (some coalesced plus gradual development) and fin ray counts and fin position. Some of this information is given in Tables Stomiiformes 1-5. The following key must be used with care as several taxa have unknown larval stages. Also refer to the Gonostomatidae account as some early stages of *Sigmops elongatum* resemble *Maurolicus* & *Valenciennellus* prior to photophore formation.

Preliminary Key to Sternoptychid Larval Stages

- 1a. Body hatchet-like with short, deep trunk and long slender tail 2
- 1b. Body not hatchet-like, head and trunk only slightly deeper than tail 4
- 2a. Intense dark pigment over forebrain, less than 30 myomeres, 6 branchiostegal rays *Sternoptyx*
- 2b. No forebrain pigment, 32-40 myomeres, 10 branchiostegal rays..... 3
- 3a. Myomeres 32-33, tail at anus almost as deep as head tapering to slim caudal peduncle, 12-16 dorsal rays..... *Polyipnus*
- 3b. Myomeres 34-39, tail at anus very narrow continuing slim to caudal peduncle, dorsal rays 8-9 *Argyropelecus*
- 4a. Myomeres 32-33 *Valenciennellus & Maurolicus*
(refer to species accounts & Table Sternoptychidae 2 for photophore development for separation)
- 4b. Myomeres 40-48 *Argyripnus & Sonoda* (larvae unknown) & Type A (species unknown)

Table Sternoptychidae 1. Meristic characters of the Family Sternoptychidae Data from Ahlstrom et al. 1984, Baird 1971; Grey 1964; & Harold 1994.

Species	Fin Rays					Vertebrae	Branchi- ostegals	Source
	Dorsal	Anal	Pectoral	Pelvic	Gill Rakers			
<i>Maurolicus muelleri</i>	10-11	19-23	17-19	7(6?)	4-7+17-19=22-25(28)	33	9-10	Grey 1964
<i>Valenciennellus tripunctulatus</i>	7	24-25	13	6	2+12=14	32-33	10	Grey 1964
<i>Argyripnus atlanticus</i>	11-12	13-15+9=22-25	17-19	6-7	17-18(19)+6-7=24-25(26)	46	8	Grey 1964
<i>Sonoda megalophthalma</i>	8-9	8-9+14-16=22-25	13-15	6	15-18+3=18-21	40	8	Grey 1964
<i>paucilampa</i>	9	10+14=24	15	6	16+5=21		9-10	Grey 1964
Maurolicine Type A						48		Ahlstrom
<i>Argyropelcus aculeatus</i>	9	12	10-11		15-17	34-36		Baird 1971
<i>affinis</i>	9	12-13	11(10)		18-22	38-39(40)		Baird 1971
<i>gigas</i>	9(10)	12-13	10-11		18-21	38-39		Baird 1971
<i>hemigygnus</i>	8	11	10-11		19-23(18-24)	37-38(36)		Baird 1971
<i>sladeni</i>	9	12	10-11		17-21	35-37		Baird 1971
<i>Polyipnus asteroides</i>	12-16	16-17	14-15	7	7-8+13-16=20-24	32-33	10	Harold 1994
<i>clarus</i>	15-16	16-17	13-15	7	5-7+13-15=19-21	32-33		Harold 1994
<i>laternatus</i>	12-15	15-18	12-14	6-7	4-6+11-14=16-19	32-33(34)		Harold 1994
<i>Sternoptyx pseudobscura</i>	10-11	14-16	10-11		7-9	29		Baird 1971
<i>diaphana</i>	9-11	14-16	10-11		7-8(9)	29(30)		Baird 1971

Table Sternoptychidae 2. Photophore development & distribution in the sternoptychid larval genera *Argyripnus*, *Maurolicus*, *Valenciennellus*, *Sonoda* and Maurolicine type A

Species	Size	ORB	OP	SO	BR	IP	PV	VAV	AC	OA	Source
<i>Argyripnus</i>											
<i>atlanticus</i>	adult	1	3	0	(6)	(6)	(10)	(26)	(5)+(17)	(3)+4	Badcock & Merrett 1972
	18.7	1	2	0	(6)	(3)	(10)	(3)	(4)+(4)	0	Badcock & Merrett 1972
	16.8	1	2	0	(6)	(3)	(10)	(2)	(4)+(3)	0	Badcock & Merrett 1972
<i>Maurolicus</i>											
<i>muelleri</i>	adult	1	3	1	(6)	(6)	(12)	(6)	3/(4)=(8)	(2)+7	Ahlstrom et al. 1984
	13.5	1	3	0	(6)	(6)	(12)	(6)	0+(9)+(7)	(2)+6	Ahlstrom et al. 1984
	10.8	1	3	0	(6)	(5)	(12)	(4)	0+(5)+(6)	(2)+2	Ahlstrom et al. 1984
	9.7	1	3	0	(5)	(5)	(11)	(3)	0+(4)+(6)	(2)+1	Ahlstrom et al. 1984
	9.0	1	2	0	(5)	(3)	(11)	(2)	0+(3)+(3)	1	Ahlstrom et al. 1984
	8.6	1	2	0	(5)	(3)	(12)	(2)	0+(3)+(3)	0	Ahlstrom et al. 1984
	7.5	1	1	0	(4)	1	(9)	0	0+(2)+0	0	Ahlstrom et al. 1984
	6.9	1	1	0	(4)	0	(8)	0	0	0	Ahlstrom et al. 1984
	6.7	0	1	0	(3)	0	(5)	0	0	0	Ahlstrom et al. 1984
	6.5	0	0	0	(2)	0	(4)	0	0	0	Ahlstrom et al. 1984
	6.2	0	0	0	(2)	0	(2)	0	0	0	Ahlstrom et al. 1984
	5.5	0	0	0	(1/2)	0	0	0	0	0	Ahlstrom et al. 1984
<i>Sonoda</i>											
<i>megaophthalma</i>	adult	1	3	0	(6), rarely (7)	(6)	(10)	(7-8)	(16-21)+(19-24)	(2)+4-5	Grey 1964
<i>paucilampa</i>	adult	1	3	0	(6)	(6)	(10)	(8)	(6)+(5)+(5)	(2)+?	Grey 1964

Table Sternoptychidae 2. (continued)

Species	Size	ORB	OP	SO	BR	IP	PV	VAV	AC	OA	Source
<i>Valenciennellus</i>											
<i>tripunctulatus</i>	adult	1	3	0	(6)	(3)+(4)	(16-17)	(4-5)	(3)+(3)+(3)+(2)+(4)	(2)+3	Ahlstrom et al. 1984
	17.0	1	2	0	(4-5)	(3)+(4)	(15)	(5)	(3)+(3)+0+(3)+(4)	(2)	Ahlstrom et al. 1984
	14.0	1	0	0	(5)	(4)	(15)	(5)	0	0	Ahlstrom et al. 1984
	13.2	0	0	0	(4)	0	(14)	(3)	0	0	Ahlstrom et al. 1984
	13.0	1	0	0	(5)	(2)	(15)	(2)	0	0	Ahlstrom et al. 1984
	12.4	1	0	0	(5)	0	(15)	(2)	0	0	Ahlstrom et al. 1984
	12.0	0	0	0	(4)	0	(13)	(2)	0	0	Ahlstrom et al. 1984
	11.0	0	0	0	(4)	0	(10)	0	0	0	Ahlstrom et al. 1984
	9.5	0	0	0	(4)	0	(6)	0	0	0	Ahlstrom et al. 1984
	8.6	0	0	0	(3)	0	(3)	0	0	0	Ahlstrom et al. 1984
	7.8	0	0	0	0	0	0	0	0	0	Ahlstrom et al. 1984
Maurolicine type A	7.5	0	0	0	0	0	0	0	0	0	Ahlstrom et al. 1984

Table Sternoptychidae 3. Sequence of photophore formation in *Argyropelecus*, *Polyipnus*, and *Sternoptyx*. *P. polli* is from the eastern Atlantic and is included as an example for the genus.

Species	Size	PO =ORB	PTO =OP-2	BR	IS I=IP	PRO+SO OP-1+OP-3	SP =OV-A	AB =PV	SAB =OV-B	PAN =VAV	AN =AC-B	SAN =AC-A	SC =AC-C	Source
														Ahlstrom et al. 1984 Harold 1994
<i>Argyropelecus</i> spp.	adult	1	1	6	6	1+1	2	12	6	4	6	0	4	Baird 1971
	adult	1	1	6	6	1+1	2	12	6	4	6	0	4	Ahlstrom et al. 1984
	10.0	1	1	6	6	1+1	2	12	5	4	5	0	4	Ahlstrom et al. 1984
	7.4	1	1	6	6	1+1	2	12	4	4	4	0	3	Ahlstrom et al. 1984
	7.0	1	0	6	6	1+1	2	10	0	0	3	0	4	Ahlstrom et al. 1984
	7.0	1	0	6	6	1+1	2	12	0	0	3	0	3	Ahlstrom et al. 1984
	9.5	0	0	6	6	0+1	0	8	0	0	3	0	0	Ahlstrom et al. 1984
	9.5	0	0	6	6	0+1	0	6	0	0	1	0	0	Ahlstrom et al. 1984
	4.5	0	0	0	0	0+0	0	0	0	0	0	0	0	Ahlstrom et al. 1984
<i>aculeatus</i>	adult	1	1	6	6	1+1	2	12	6	4	6	0	4	Baird 1971
	28.4	1	1	6	6	1+1	2	12	6	4	6	0	4	Original
	17.6	1	1	6	6	1+1	2	12	6	4	6	0	4	Original
	12.7	1	1	6	6	1+1	2	12	6	4	5	0	4	Original
	11.9	1	1	6	6	1+1	2	12	6	4	5	0	4	Original
	11.1	1	1	6	6	1+1	2	12	6	4	4	0	4	Original
	10.8	1	1	6	6	1+1	2	12	5	4	5	0	4	Original
	10.0	1	1	6	6	1+1	2	12	6	3	4	0	4	Original
	9.9	1	1	6	6	1+1	2	12	0	3	4	0	4	Original
<i>affinis</i>	adult	1	1	6	6	1+1	2	12	6	4	6	0	4	Baird 1971
	16.0	1	1	6	6	1+1	2	12	6	4	6	0	4	Watson 1996
	11.5	1	0	6	6	1+1	2	12	1	1	5	0	4	Watson 1996
	11.0	1	0	6	6	1+1	1	9	0	0	2	0	2	Watson 1996
	10.4	0	0	0	0	0+0	0	0	0	0	0	0	0	Watson 1996

Table Sternoptychidae 3. (continued)

Species	Size	PO	PTO	BR	IS	PRO+SO	SP	AB	SAB	PAN	AN	SAN	SC	Source
														Ahlstrom et al. 1984
		=ORB	=OP-2		I=IP	OP-1+OP-3	=OV-A	=PV	=OV-B	=VAV	=AC-B	=AC-A	=AC-C	Harold 1994
<i>gigas</i>	adult	1	1	6	6	1+1	2	12	6	4	6	0	4	Baird 1971
<i>hemigygnus</i>	adult	1	1	6	6	1+1	2	12	6	4	6	0	4	Ahlstrom et al. 1984
	11.20	1	1	6	6	1+1	2	12	2	3	4	0	4	Ahlstrom et al. 1984
	7.84	1	0	6	6	1+1	2	12	0	0	3	0	4	Ahlstrom et al. 1984
	9.92	0	0	4	6	0+1	0	9	0	0	2	0	3	Ahlstrom et al. 1984
	10.92	0	0	6	6	0+1	0	7	0	0	1	0	2	Ahlstrom et al. 1984
<i>sladeni</i>	adult	1	1	6	6	1+1	2	12	6	4	6	0	4	Baird 1971
	13.8	1	1	6	6	1+1	2	12	6	4	6	0	4	Watson 1996
	8.2	1	0	6	6	0+1	2	10	0	0	3	0	2	Watson 1996
	10.0	0	0	6	6	0+1	0	6	0	0	0	0	0	Watson 1996
	9.4	0	0	0	0	0	0	0	0	0	0	0	0	Watson 1996
<i>Polyipmus</i>	adult	1	1	6	6	1+1	3	10	3	5	6-14	3	4	Baird 1971
<i>asteroides</i>									1+1+1		8-10	1+(2)	(4)	Harold 1994
<i>clarus</i>									1+1+1		8-10	1+(2),	(4)	Harold 1994
												rare 1+1+1		
<i>laternatus</i>									1+1+1		11-13			Harold 1994
<i>polli</i>	adult	1	1	6	6	1+1	3	10	1+1+1	5	7-8	1+(2)	(4)	Harold 1994
	23.5	1	1	6	6	1+1	3	10	3	5	7	3	(4)	Ahlstrom et al. 1984
	18.4	1	1	6	6	1+1	3	10	3	5	6	3	(4)	Ahlstrom et al. 1984
	17.0	1	1	6	6	1+1	3	10	3	5	4	2	(4)	Ahlstrom et al. 1984
	15.3	1	1	6	6	1+1	3	10	3	5	4	1	(4)	Ahlstrom et al. 1984
	13.5	1	1	6	6	1+1	3	10	3	5	4	0	(4)	Ahlstrom et al. 1984
	9.6	1	1	6	6	1+1	2	10	1	3	2	0	2	Ahlstrom et al. 1984
	9.0	1	1	6	6	1+1	2	10	0	3	2	0	2	Ahlstrom et al. 1984
	7.5	1	1	6	6	1+1	2	10	0	3	0	0	0	Ahlstrom et al. 1984
	6.0	1	1	6	6	1+1	2	10	0	1	0	0	0	Ahlstrom et al. 1984
	5.5	1	1	6	4	1+1	2	8	0	0	0	0	0	Ahlstrom et al. 1984
	4.8	1	0	4	2	1+1	0	3	0	0	0	0	0	Ahlstrom et al. 1984
	4.3	0	0	2	0	0+1	0	1	0	0	0	0	0	Ahlstrom et al. 1984

Table Sternoptychidae 3. (continued)

Species	Size	PO =ORB	PTO =OP-2	BR	IS I=IP	PRO+SO OP-1+OP-3	SP =OV-A	AB =PV	SAB =OV-B	PAN =VAV	AN =AC-B	SAN =AC-A	SC =AC-C	Source	
														Ahlstrom et al. 1984 Harold 1994	
<i>Sternoptyx</i> spp	adult	1	1	3	5	1+1	3	10	0	3	3	1	4	Baird 1971	
	11.2	0	1	3	5	1+1	3	10	0	1	3	0	2	Watson 1996	
	7.6	0	1	2	5	0+1	3	10	0	1	3	0	1	Ahlstrom et al. 1984	
	8.8	0	1	3	4	0+1	2	7	0	0	0	0	0	Watson 1996	
	8.1	0	1	2	4	0+1	2	7	0	0	0	0	0	Ahlstrom et al. 1984	
	7.8	0	1	2	3	0+1	0	4	0	0	0	0	0	Ahlstrom et al. 1984	
	7.5	0	0	0	0	0+1	0	0	0	0	0	0	0	Ahlstrom et al. 1984	
	6.6	Pigment	1	2	4	0+1	Pigment?	5	0	2	0	0	0	0	Original
	6.4	0	0	0	0	0+1	0	0	0	0	0	0	0	0	Watson 1996
	5.2	0	0	0	0	0+0	0	0	0	0	0	0	0	0	Watson 1996
4.8	0	0	0	0	0+1	0	0	0	0	0	0	0	0	Ahlstrom et al. 1984	
<i>diaphana</i>	adult	1	1	3	5	1+1	3	10	0	3	3	1	4	Baird 1971	
<i>pseudobscura</i>	adult	1	1	3	5	1+1	3	10	0	3	3	1	4	Baird 1971	

MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	46
Number of Fin Spines and Rays:	
Dorsal Spines	0
Dorsal Rays	11-12
Anal	13-15+9=22-25
Pectoral	17-19
Pelvic	6-7
Caudal:	
Principal	10+9
Gillrakers on First Arch	
Upper	6-7
Lower	17-18(19)
Total	24-25(26)
Branchiostegals	8

LIFE HISTORY

Range: Rare, N of Bahamas, W of Puerto Rico, w. Caribbean
 Habitat: Unknown, possibly benthic
 ELH Pattern: Presumed oviparous with planktonic eggs & larvae
 Spawning Season: Unknown

LITERATURE

Grey 1964; Badcock & Merrett 1972; Ahlstrom, Richards, & Weitzman 1984

EARLY LIFE HISTORY DESCRIPTION

EGGS: unknown

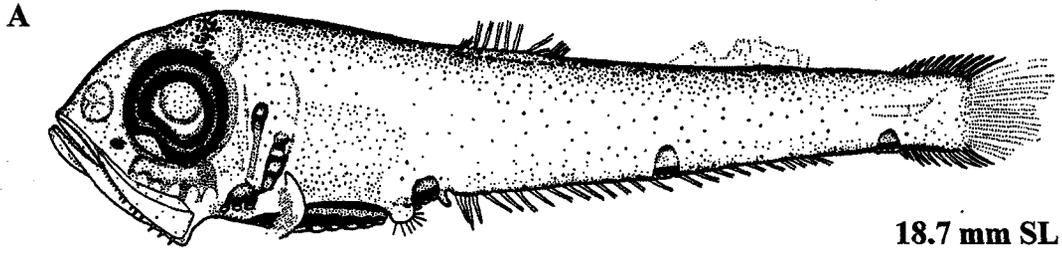
LARVAE: unknown

JUVENILES:

Diagnostic Characters: Meristics and photophores

ILLUSTRATIONS

Badcock & Merrett 1972: A) 18.7 mm



MERISTICS

Vertebrae:	
Total	34-36
Number of Fin Spines and Rays:	
Dorsal Spines	0
Dorsal Rays	9
Anal	12
Pectoral	10-11
Pelvic	6
Caudal	
Principal	10+9
Gillrakers on First Arch	
Total	15-17
Branchiostegals	10

LIFE HISTORY

Range: Throughout area,
Habitat: Epi- & mesopelagic, 80-200 m at night, 200-550 m depth by day.
ELH Pattern: Oviparous, planktonic eggs & larvae.
Spawning Season: Possibly year-round, larvae abundant in spring

LITERATURE

Ahlstrom, Richards, & Weitzman 1984; Baird 1971;
Howell & Krueger 1987

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Pigmentation: *Transformation* - Over gas bladder, around stomach, over brain, at dorsum on each side of cleithrum, below eye as scattered melanophores which increase over trunk, associated with photophore groups. Spot appears above AC-C group which enlarges forming a dense spot around caudal peduncle.

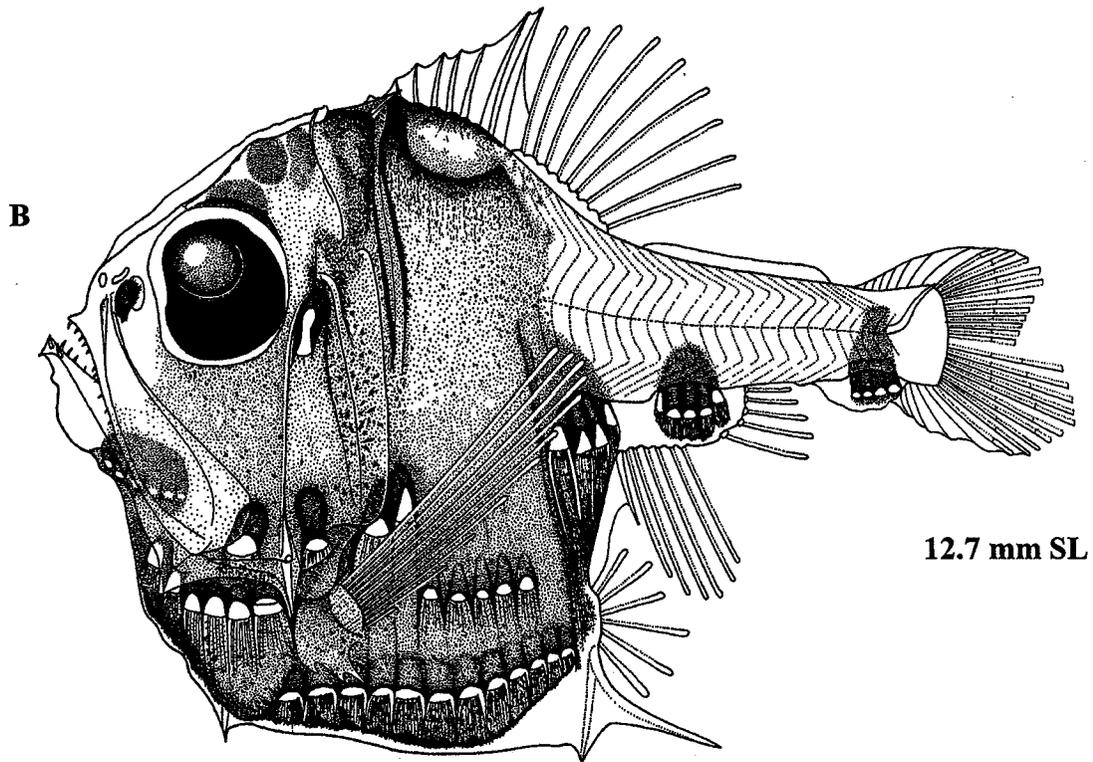
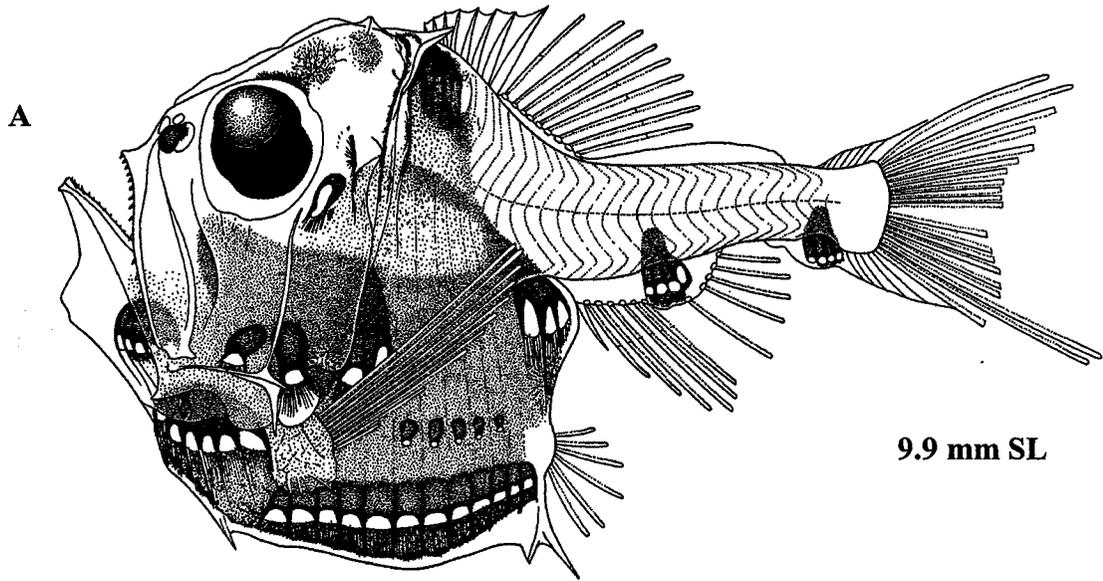
Diagnostic Characters: Photophores and shape of posterior postabdominal spine directed posteriorly.

JUVENILES:

Diagnostic Characters: Photophores and posteriorly directed posterior postabdominal spine.

ILLUSTRATIONS

Original: A-B) 9.9 mm SL LH3 St. 7504; 12.7 mm SL LH3 St. 75A3



MERISTICS

Vertebrae:	
Total	38-39(40)
Number of Fin Spines and Rays:	
Dorsal Spines	0
Dorsal Rays	9
Anal	12
Pectoral	11(10)
Pelvic	6
Caudal	
Principal	10+9
Gillrakers on First Arch	
Total	18-22
Branchiostegals	10

LIFE HISTORY

Range: Throughout area
Habitat: Epi- & mesopelagic, 170-400 m at night, 350-600 m depth by day.
ELH Pattern: Oviparous, planktonic eggs & larvae.
Spawning Season: Possibly year-round, larvae abundant in spring

LITERATURE

Ahlstrom, Richards & Weitzman 1984; Baird 1971, Watson 1996b

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

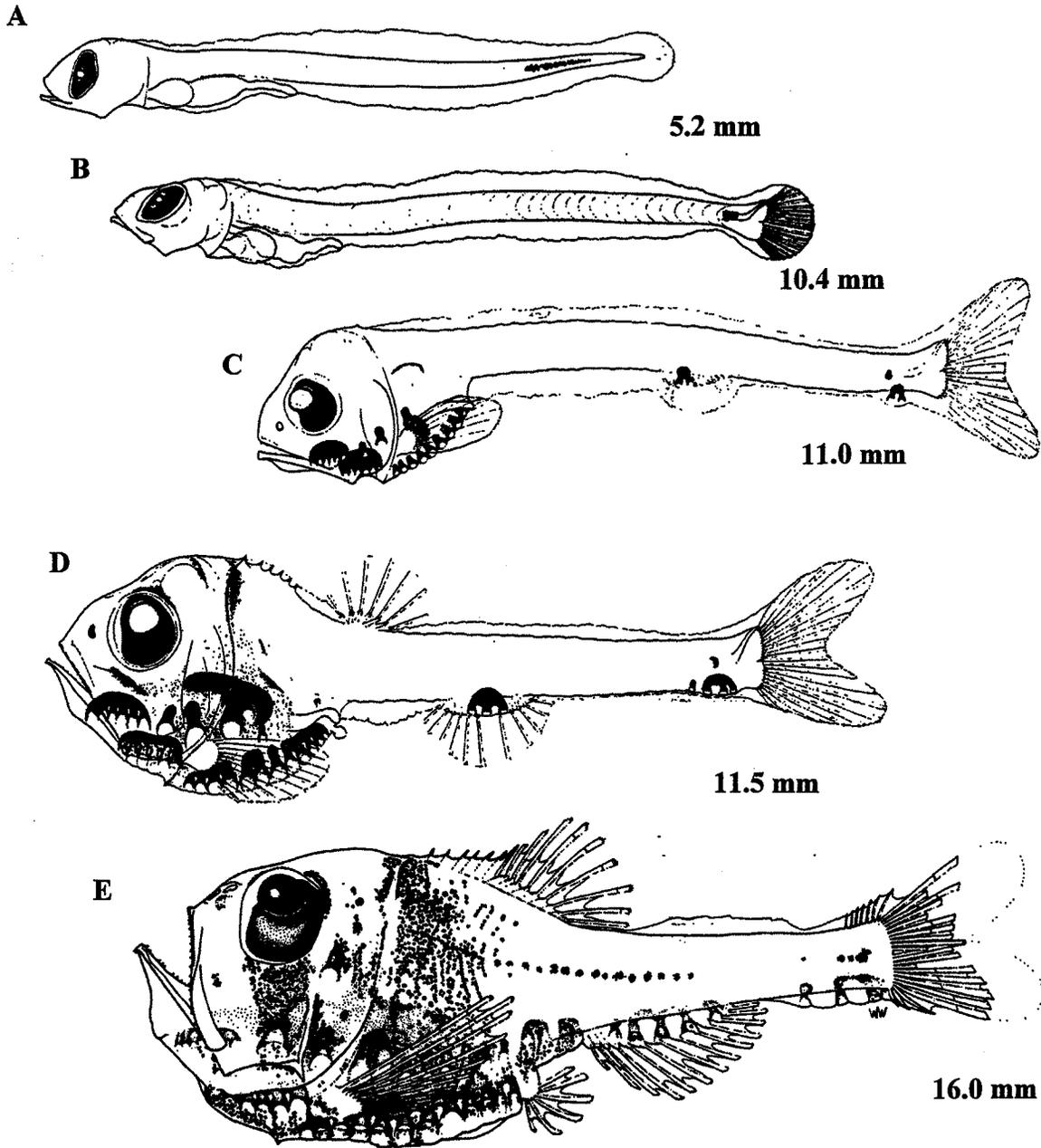
Hatching length: <7 mm
Flexion length: ca. 7-8 mm through ca. 9-11 mm
Transformation length: ca. 10.5-11.5 mm through ca. 14.5-15.0 mm (larvae shrink in length during early part of transformation)
Pigmentation: *Preflexion-postflexion*-Internally on notochord at last myomere, extending as far forward as last 5-10 myomeres in some. *Transformation*-Over gas bladder, around stomach, on frontals between eyes; subsequently increasingly over fore- & midbrain, on opercular area, on gut; lateral midline series begins at ca. 13-16 mm; internal caudal peduncle pigment condenses to one blotch.
Diagnostic Characters: Internal pigment at last 1-10 myomeres; short preanal length; 10-15 preanal myomeres (usually 12-13), 38-39 total myomeres; photophores in AN & SC groups widely spaced.

JUVENILES:

Diagnostic Characters: Photophores and low dorsal blade.

ILLUSTRATIONS

Watson 1996b: A-E) Pacific series 5.2, 10.4, 11.0, 11.5, & 16.0 mm



MERISTICS

Vertebrae:	
Precaudal	11
Caudal	25-27
Total	37-38(36)
Number of Fin Spines and Rays:	
Dorsal Spines	0
Dorsal Rays	8
Anal Spines	0
Anal	11
Pectoral	10-11
Pelvic	6
Caudal:	
Dorsal Secondary	9-10
Principal	10+9
Ventral Secondary	5
Gillrakers on First Arch	
Upper	
Lower	
Total	19-23(18-24)
Branchiostegals	10

LIFE HISTORY

Range: Throughout area, oceanic
Habitat: Epi- & mesopelagic, principally at ca. 200-1000 m depth
ELH Pattern: Oviparous, planktonic eggs & larvae
Spawning season: Possibly year-round

LITERATURE

Sanzo 1931; Ahlstrom, Richards, & Weitzman 1984;
Howell & Krueger 1987; Watson 1996b

EARLY LIFE HISTORY DESCRIPTION**EGGS:**

Diameter: 0.92-1.04 mm
No. of Oil Globules: 1
Oil Globule Diameter: 0.26-0.28 mm
Yolk: Segmented
Shell: Smooth, clear
Hatch Size: 2.5 mm
Incubation: Unknown
Pigmentation: None
Diagnostic Characters: Segmented yolk; secondary membrane inside chorion

LARVAE:

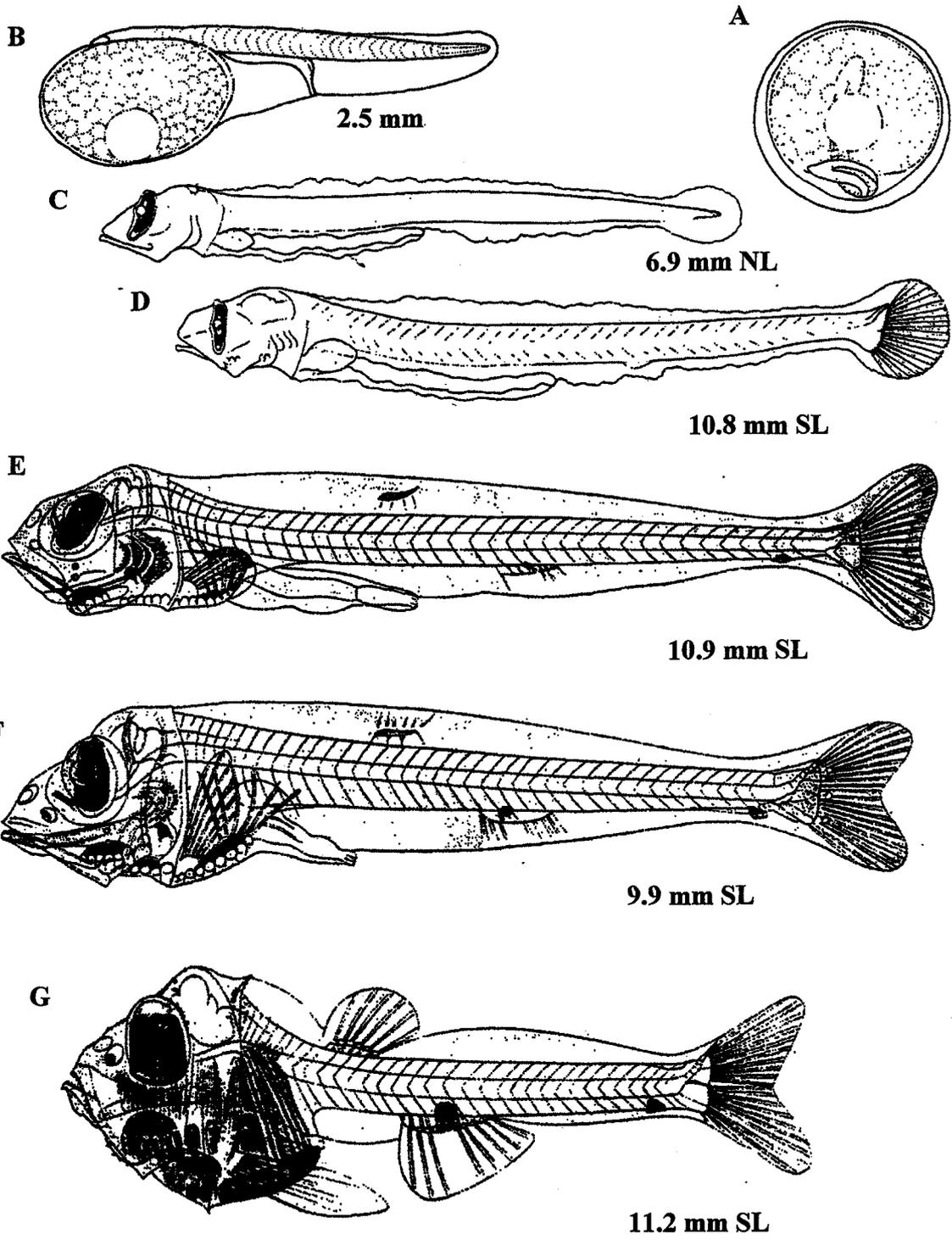
Length at Flexion: 10.8 mm
Length at Transformation: 7.8-12.0 mm
Sequence of Fin Development: C₁, P₁, A & C₂, D, P₂
Pigmentation: Confined to eye and photophores through postflexion; transformation has black pigment associated with photophores plus pigment on gut at 10.2 mm, on frontal region adjacent to eye, along lower posttemporal/upper supracleithrum region, on opercle below eye, over gas bladder by ca. 9 mm, subsequently increases on head & gut area.
Diagnostic Characters: Photophore sequence, lack of pigment especially none on anterior midbrain; conical choroid tissue below eyes; long preanal length before transformation; 14-18 preanal myomeres before transformation, 11-14 subsequently, 37-38 total myomeres.

JUVENILES:

Diagnostic Characters: Photophore sequence; anterior half heavily pigmented & discontinuous stripe along lateral midline.

ILLUSTRATIONS

Watson 1996b: A-D) egg, 2.5 mm (redrawn from Sanzo 1931), 6.9mm NL & 10.8 mm SL
Sanzo 1931: E-G) 10.9 mm SL, 9.9 mm SL, & 11.2 mm SL (all redrawn)



MERISTICS

Vertebrae:	
Precaudal	11-12
Caudal	24-26
Total	35-37
Number of Fin Spines and Rays:	
Dorsal Spines	0
Dorsal Rays	9
Anal	12
Pectoral	10-11
Pelvic	6
Caudal:	
Dorsal Secondary	10-11
Principal	10+9
Ventral Secondary	6-7
Gillrakers on First Arch.	
Upper	7-8
Lower	10-11
Total	17-21
Branchiostegals	10

LIFE HISTORY

Range: Throughout area, abundant Venezuelan Caribbean coast, Gulf of Mexico and Straits of Florida
Habitat: Epi- & mesopelagic, primarily at 100-600 m depth
ELH Pattern: Oviparous, planktonic eggs & larvae
Spawning Season: Possibly year-round

LITERATURE

Ahlstrom, Richards, & Weitzman 1984; Baird 1971;
Watson 1996b

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Length at Flexion: ca. 7.5 mm through ca. 8.5-9.4 mm
Length at Transformation: ca. 8.2-10.0 mm through ca. 13.0 mm

Sequence of Fin Development: C₁, P₁, A & C₂, D & P₂
Pigmentation: *Preflexion-postflexion*—None.

Transformation - None before SC photophores form; by ca. 9.2-9.5 mm (white SC photophores present at this size) on frontal region adjacent to eye, anteriorly on each side of midbrain, along lower posttemporal/upper supracleithrum region, over gas bladder, around stomach; subsequently increases over gut area, laterally above gut, on opercular area, & over brain.

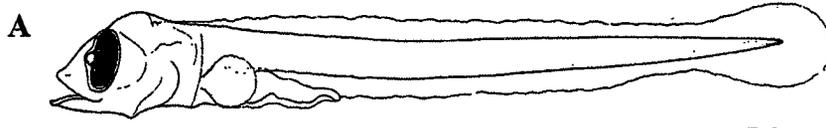
Diagnostic Characters: No internal pigment in tail; pair of large melanophores anteriorly over midbrain in transformation stage; narrow choroid tissue mass below eye; short preanal length; 11-12 preanal myomeres (usually 12), 35-37 total myomeres.

JUVENILES:

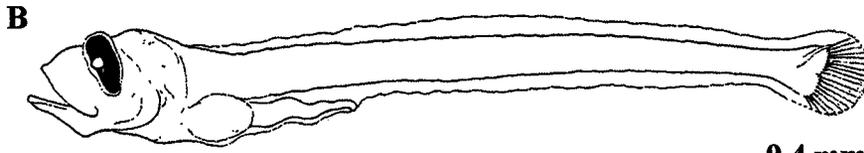
Diagnostic Characters: Postabdominal spines of nearly equal length; dark well-developed pigment spots form along posterior midline.

ILLUSTRATIONS

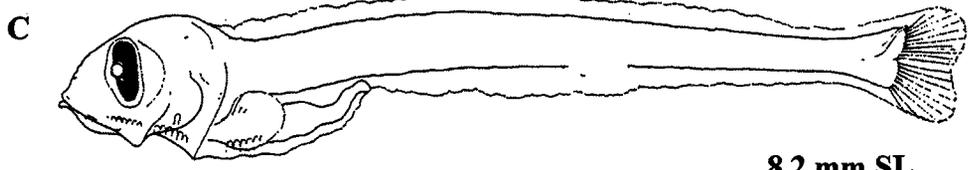
Watson 1996b: A-E) 5.2 mm NL, 9.4 mm Sl, 10.0 mm Sl, 8.2 mmSL, & 13.8 mm SL



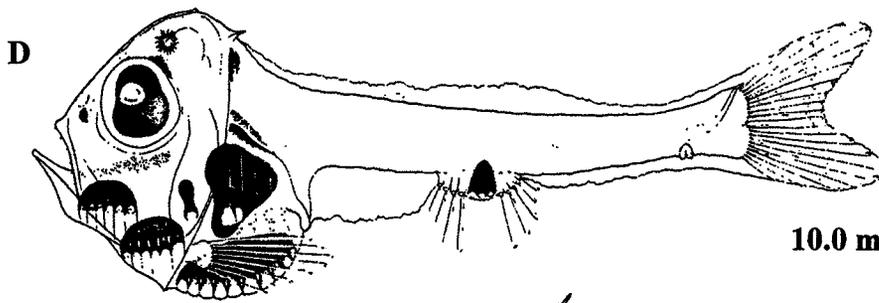
5.2 mm NL



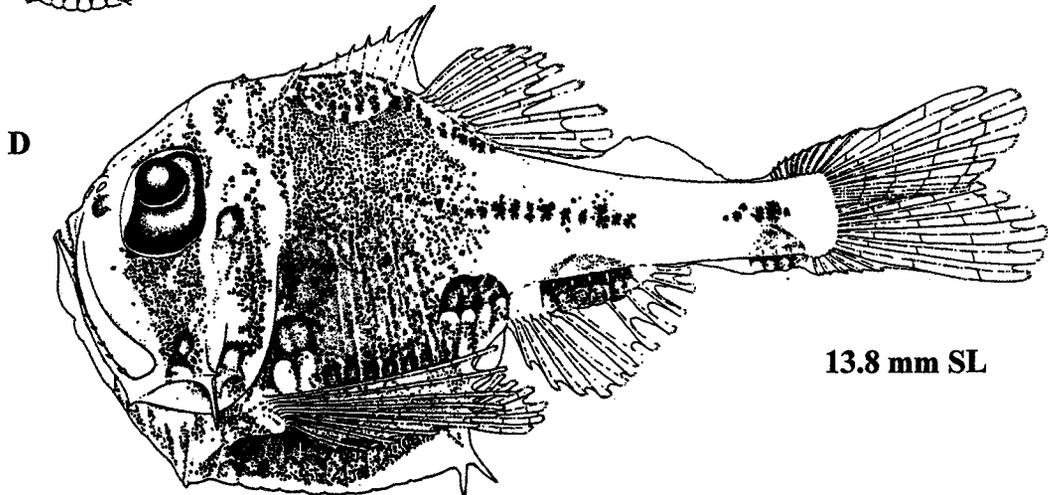
9.4 mm SL



8.2 mm SL



10.0 mm SL



13.8 mm SL

MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	33
Number of Fin Spines and Rays:	
Dorsal Spines	0
Dorsal Rays	10-11
Anal	19-23
Pectoral	17-19
Pelvic	7(6?)
Caudal:	
Principal	10+9
Gillrakers on First Arch	
Upper	4-7
Lower	17-19
Total	22-25(28)
Branchiostegals	9-10

LIFE HISTORY

Range: Throughout area, locally abundant near continental shelf margin

Habitat: Epi- & mesopelagic from 100-500 m depth

ELH Pattern: Oviparous, planktonic eggs & larvae

Spawning Season:

LITERATURE

Ahlstrom, Richards, & Weitzman 1984; Grey 1964;
Howell & Krueger 1987; Robertson 1976

EARLY LIFE HISTORY DESCRIPTION**EGGS:**

Diameter: 1.3-2.0 mm

No. of Oil Globules: One

Oil Globule Diameter: 0.87-1.2 mm

Yolk: Segmented

Shell: Sculptured into hexagonally shaped points

Diagnostic Characters: Unique shell shape

LARVAE:

Length at Flexion: ca. 6.0 mm

Length at Transformation: ca. 10.8-11.7 mm

Sequence of Fin Development: C, P₁, A, D & P₂

Pigmentation: *Preflexion-postflexion* – none except at early appearance of BR at 5.5 mm followed by PV at 6.2 mm; *Late postflexion* – gas bladder & OP at 8.0 mm. *Transformation* – pigment associated with photophores & on midbrain, over gut & on caudal peduncle followed by pigment on dorsum from anterior to posterior.

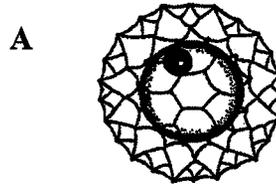
Diagnostic Characters: Early appearance of photophores; gut < 50 % SL; lack of pigment except over gas bladder.

JUVENILES:

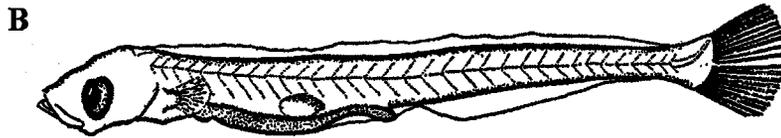
Diagnostic Characters: Photophores, meristics, and pigmentation

ILLUSTRATIONS

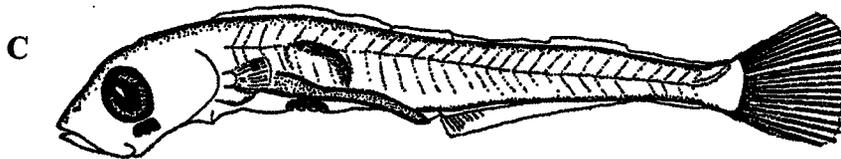
Robertson 1976: A-D) egg, 7.7 mm SL larva, 7.9 mm SL larva, & 12.1 mm SL larva. Ahlstrom, Richards, & Weitzman 1984: E) 10.8 mm SL transition stage.



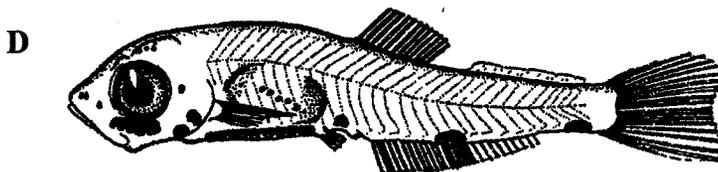
0.5 mm



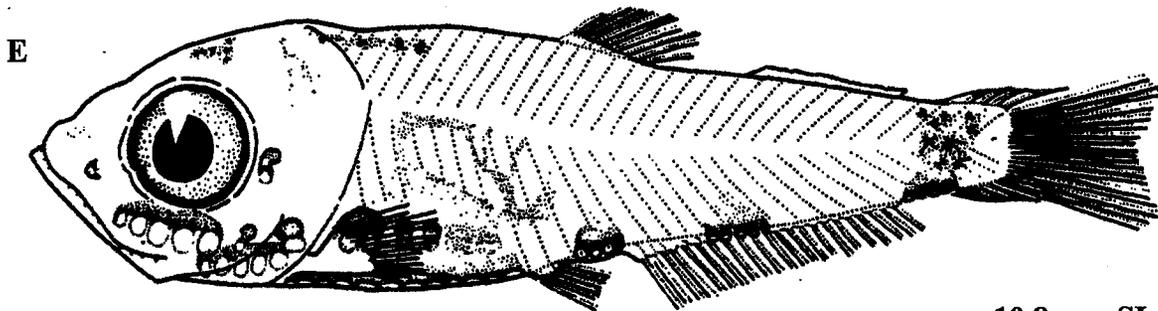
7.7 mm SL



7.9 mm SL

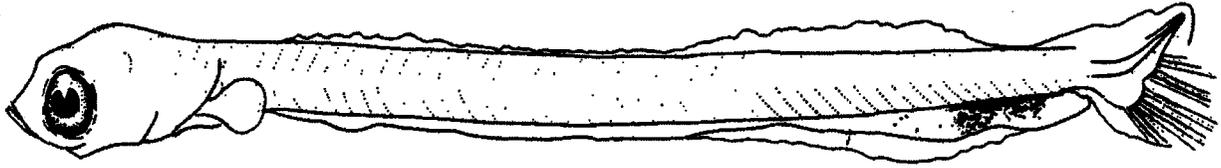


12.1 mm SL



10.8 mm SL

A



7.5 mm SL

MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	32-33(34)
Number of Fin Spines and Rays:	
Dorsal	12-16
Anal	15-18
Pectoral	12-15
Pelvic	6-7
Caudal	
Principal	10+9
Gillrakers on First Arch	
Upper	4-8
Lower	11-16
Total	16-24
Branchiostegals	10

LIFE HISTORY

Range: Throughout area
 Habitat: 300-600 m
 ELH Pattern: Oviparous, pelagic eggs & larvae

LITERATURE

Harold 1994

EARLY LIFE HISTORY DESCRIPTION

EGGS: unknown

LARVAE: unknown

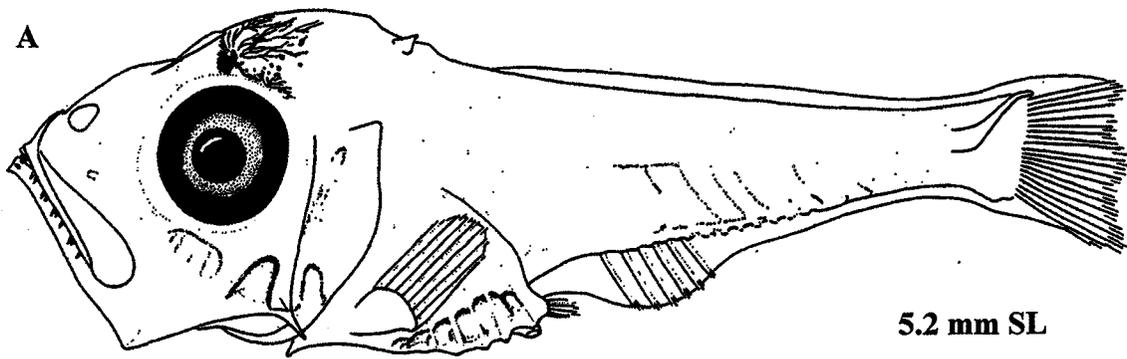
JUVENILES:

Diagnostic Characters:

Distinguish species as follows: *P. laternatus* separated from others by ventral preopercular spine prominent, tapered, ACB photophores 9-13 without conspicuous step between photophores #3 & #4 (specimens > 25 mm), posttemporal spine long and needle-like. *P. clarus* & *P. asteroides* with ventral preopercular spine reduced & imbedded within ventral lamella of preopercle ACB photophores 7-10 with a conspicuous step between photophores #3 & #4, posttemporal spine short & stout, expanded basally. *P. asteroides* distinguished from *P. clarus* by deeper body, higher gill raker counts, basally expanded and shorter anal-fin pterygiophore spines, and darker pigmentation.

ILLUSTRATIONS

Ahlstrom, Richards, & Weitzman 1984: A) an illustration of *P. polli* 5.2 mm SL as an example of the genus.



MERISTICS

Vertebrae:	
Total	29-30
Number of Fin Spines and Rays:	
Dorsal	9-11
Anal	14-16
Pectoral	10-11
Pelvic	6-7
Caudal	
Principal	9+10
Gill rakers 7-9	

LIFE HISTORY

Range: *S. pseudobscura* – Staats of Florida, Gulf & Caribbean, eastern Atlantic & South Atlantic in 500 – 1500 m.

S. diaphana – Cosmopolitan in 400-1200 m.

Habitat: Meso- & bathypelagic

ELH Pattern: Oviparous, pelagic eggs & larvae

Spawning:

 Season: larvae rarely collected, no seasonality detected

LITERATURE

Baird 1971; Watson 1996b

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Hatching length: <3 mm

Flexion length: ca. 6-7 mm

Length at Transformation: ca. 7-11 mm

Fin development sequence: C₁, P₁, C₂, A, D, P₂

Pigmentation: *Preflexion to postflexion* – initially none; develops on head and gut region; in Atlantic specimens forebrain pigment appears early (ca. 4 mm); pigment develops in relation to photophores. *Transformation* - increases on head, jaws, over gut, & dorsum.

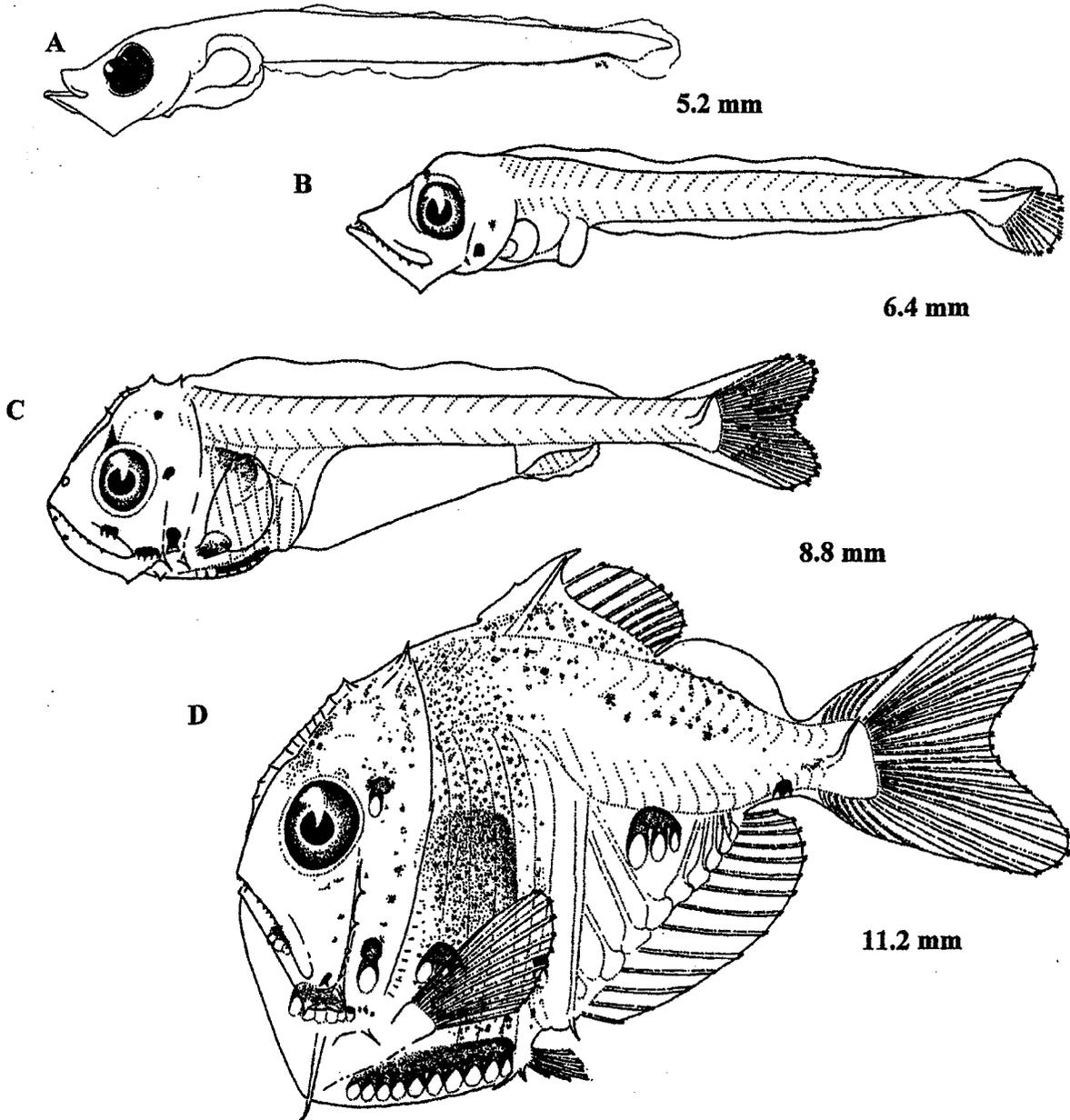
Diagnostic Characters: Species not separable; meristics, long tail, short gut, little pigment except forebrain.

JUVENILES:

Diagnostic Characters: *S. pseudobscura* differs from *S. diaphana* by larger mouth (lower jaw length > 5 mm vs <5 mm in SL <25 mm SL). Supra-anal photophore high near mid-line in *S. pseudobscura*, just above anal photophores in *S. diaphana*.

ILLUSTRATIONS

Watson 1996b: A-D) Pacific series 5.2-11.2 mm



STERNOPTYCHIDAE*Valenciennellus tripunctulatus* (Esmark)1871**MERISTICS**

Vertebrae:	
Precaudal	
Caudal	
Total	32-33
Number of Fin Rays:	
Dorsal	7
Anal	24-25
Pectoral	13
Pelvic	6
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Total	
Gillrakers on First Arch	
Upper	2
Lower	12
Total	14
Branchiostegals	10

LIFE HISTORY

Range: Throughout area

Habitat: Meso- & bathypelagic from 300-700 m depth.

ELH Pattern: Oviparous, planktonic eggs & larvae

LITERATURE

Grey 1964, Ahlstrom, Richards, & Weitzman 1984;
 Howell & Krueger 1987; Watson 1996b

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:Sequence of Fin Development: C, A, D, P₁ & P₂

Pigmentation: larvae with no pigment on body.

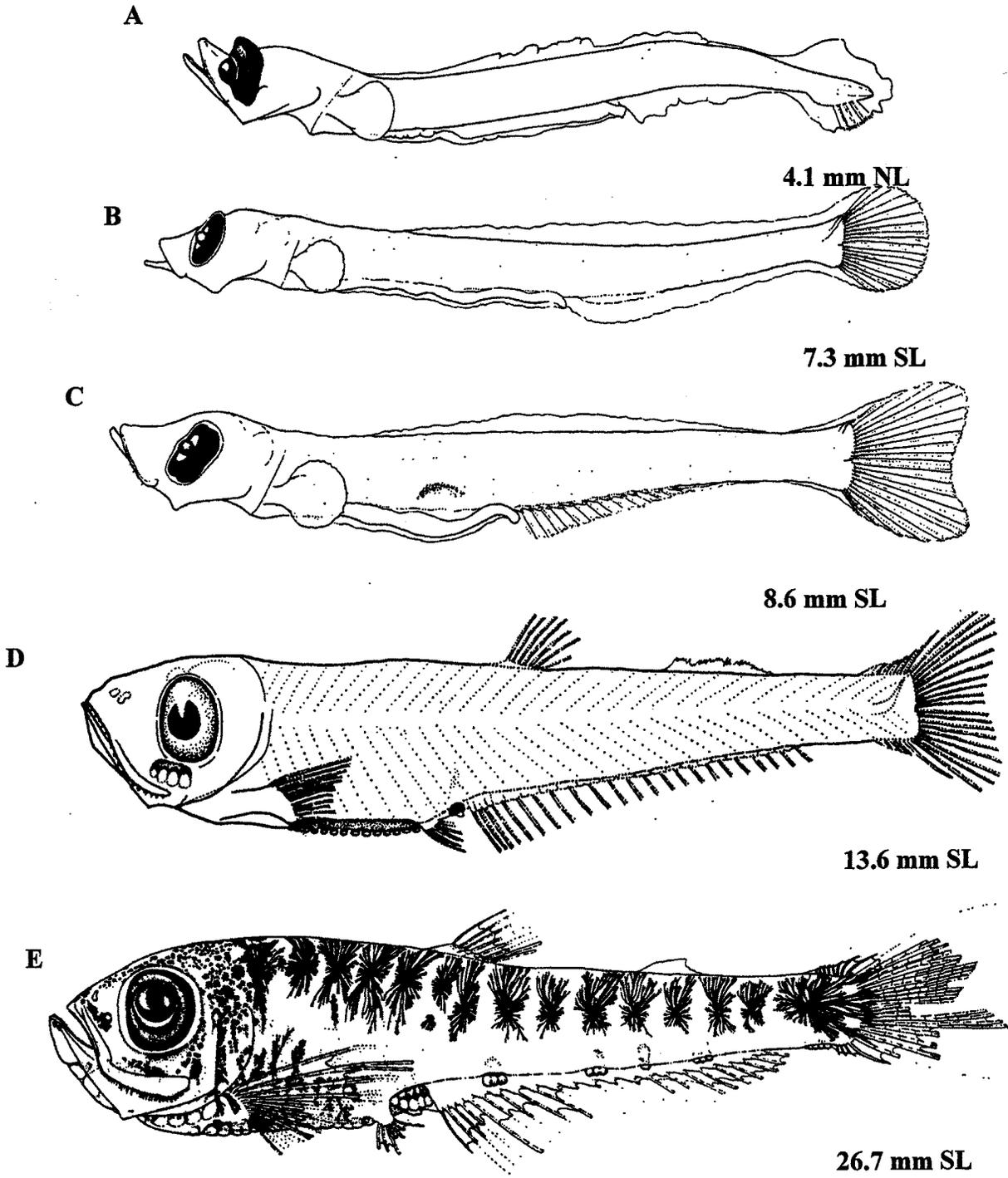
Transformation stage specimens show some pigment internally around gut and swim bladder.

Pigmentation limited to eye and photophores.

Diagnostic Characters: lack of pigmentation, meristics & photophore developmental pattern. Anal fin originates in advance of dorsal fin.

ILLUSTRATIONS

Ahlstrom, Richards, & Weitzman 1984: D) 13.6 mm SL; Watson 1996b: A-C, E) 4.1 mm NL, 7.3 mm SL, 8.6 mm SL, & 26.7 mm SL



Phosichthyidae: Lightfishes

W. J. Richards

This family is represented by 6 genera in our area with *Vinciguerria* with its 3 species (*attenuata*, *poweria*, and *nimbaria*) being the most abundant and common (*Vinciguerria* together with *Cyclothone* are the most abundant vertebrates on earth). The other members of this family are rarely encountered in ichthyoplankton collections and the early life stages of one of them, *Polymetme thaeocoryla*, are unknown. The other family members are monotypic and include *Pollichthys maui*, *Ichthyococcus ovatus*, *Woodsia nonsuchae*, and *Yarella blackfordi*. Adults are small (usually <10 cm), compressed, slender (except *I. ovatus*), and bioluminescent and are meso- and bathypelagic although adults of *P. thaeocoryla* are benthic on the continental slope.

Phosichthyids are oviparous, with planktonic eggs (described for several *Vinciguerria* species by Ahlstrom & Counts 1958 and Sanzo 1931, and *I. ovatus* by Sanzo 1931) and larvae are described for all (see Ahlstrom, Richards, & Weitzman 1984) except *P. thaeocoryla*. Eggs are small and spherical with clear shells (with double membrane in some species), segmented yolks, and with or without oil globules. Newly hatched embryos have unpigmented eyes, unfunctional mouth, and a large yolk sac. All larvae are slender and elongate with BD \leq 10% and long preanal length \geq 66% SL (Watson 1996c). The gut may trail especially in *I. ovatus*, eyes are usually oval at least during preflexion stage becoming round during postflexion and transformation. Trunk pigment is absent (*P. maui*) to quite heavy (*Y. blackfordi*). The unique feature of these larvae is the white photophore stage where photophores appear without pigment then develop pigment, nearly simultaneously. The white photophore stage is of quite short duration and rarely are specimens found in this stage. The larval phosichthyids are very similar to gonostomatid and sternoptychid larvae and great care is needed to identify them. Meristic characters (fin ray and myomere counts), morphometrics (preanal length and eye shape), and pigmentation are sufficient to identify the larval stages. The meristic characters are given in Table Phosichthyidae 1 and photophore counts in Table Phosichthyidae 2. Species accounts and illustrations are provided for all except *P. thaeocoryla* and this species is very similar to *P. maui*. I recommend that future workers consider the possibility that they are conspecific with *P. maui* representing the ELH stages as the adult *P. thaeocoryla* is, at times, quite abundant on the slope, but its ELH stages have not been captured. A comparison of meristics is given in Table Phosichthyidae 3 and the counts are very close (only myomeres and anal rays show distinct separation possibly due to small sample sizes) and the differences in number of photophores (ORB, OA, & IC differ slightly & could be due to loss through development). This is just speculation at this time.

Key to Larval Phosichthyids (excluding unknown *Polymetme*)

- 1a. Larvae lacking pigment on trunk and tail, gut very long \geq 60% SL.....*P. maui*
- 1b. Larval pigment on tail, usually on trunk..... 2
- 2a. Larval pigment confined to tail and occasionally on swimbladder or cleithrum..... *Vinciguerria* 3
- 2b. Larval pigment on trunk (distinctly on ventral trunk myomeres) and tail..... 5
- 3a. Pigment on tail above anal fin, on ventral margin of caudal peduncle, base of caudal rays, and on cleithrum..... *V. nimbaria*
- 3b. Pigment on absent from anal fin, caudal ray base, and cleithrum; pigment present medially on caudal peduncle..... 4
- 4a. Pigment present on swimbladder..... *V. attenuata*
- 4b. Pigment absent on swimbladder, (Caution: round oval gland at anal papilla may appear as pigmented spot)..... *V. poweriae*
- 5a. Heavily pigmented on dorsal and anal fin rays, chevron-like pigment on caudal peduncle and on parhypural, 54 myomeres.....*Y. blackfordi*
- 5b. Pigment absent from dorsal and anal fin-rays, no strong chevron-like pigment on tail, \leq 45 myomeres..... 6
- 6a. Pigment on snout and opercle, ventrally on myomeres, on trailing gut if present, and over upper and lower hypurals, pectoral fin with elongate lower rays (sometimes lost or difficult to observe), 38 myomeres.....*I. ovatus*
- 6b. Pigment on snout as faint streak, along lower edge of myomeres and not extending up myomeres, along ventral caudal peduncle base on lower hypurals and lower caudal rays, 42-45 myomeres..... *W. nonsuchae*

Table Phosichthyidae 1. Meristic characters of adult phosichthids

Taxon	Dorsal Fin rays	Anal Fin rays	Pectoral Fin rays	Pelvic Fin rays	Gill Rakers	Branchi- ostegals	Verte- brae	Source
<i>Ichthyococcus</i>								
<i>ovatus</i>	11-12	15-17	8	7	5+17=21-22	12	38	Grey 1964; Mukhacheva 1980
<i>Pollichthys</i>								
<i>mauli</i>	10-12	25-26	8	6-7	5+11-12=16-17	11-12	40	Grey 1964
<i>Polymetme</i>								
<i>thaeocoryla</i>	12-13	31-32(30-34)	10(9)	7	5(6)+11(10-12)=16	12-13	44-45	Parin & Borodulina 1990
<i>Vinciguerria</i>								
<i>nimbaria</i>	13-14	13-15	9-10	7	5-6+14-15(13)=19-21(18)	11	40-42	Grey 1964
<i>poweriae</i>	13-15	12-14	9-10	7	3-4+11-12=15	11	38-39	Grey 1964
<i>attenuata</i>	13-15	14-16	9-10	7	5-6+13-14=18-19	11	40-41	Grey 1964
<i>Woodsia</i>								
<i>nonsuchae</i>	11-12	14	9-10	7-8	3-5+13=16-18	17	42-45	Grey 1964
<i>Yarella</i>								
<i>blackfordi</i>	14-16(17)	29-31(28)	8-10	6-7	6-7+12-14=18-20	14-16	54	Grey 1964

Table Phosichthyidae 2. Sequence of photophore formation in Phosichthyidae. Photophores form simultaneously or nearly so at transformation.

Species	size	SO	ORB	OP	BR	IP	IV	PV	VAV	AC	OA	IC	Source
<i>Ichthyococcus</i>													
<i>ovatus</i>	adult	0	2	3	11		24-25		10	12-14	24-25	46-49	Grey 1964; Mukhacheva 1980
<i>Pollichthys</i>													
<i>mauli</i>	adult	1	2	3	8		21-23		7-9	18-21	19-21	47-50	Grey 1964
<i>Polymetme</i>													
<i>thaeocoryla</i>	adult	1	1	3	9	10	9+1+11=21	11	8	24-25	17	53-54	Parin & Borodulina 1990
<i>Vinciguerrria</i>													
<i>nimbaria</i>	adult	1	2	3	8		23-24		9-11	12-14	23-25	44-49	Grey 1964
	trans										20-22		Grey 1964
<i>poweriae</i>	adult	0	2	3			23		8-10	13-14	22-24	45-46	Grey 1964
	trans										20-22		Grey 1964
<i>attenuata</i>	adult	0	2	3	8		23		7-9	12-14	21-23	42-46	Grey 1964
	trans										17-19		Grey 1964
<i>Woodsii</i>													
<i>nonsuchae</i>	adult	1	2	3	14	8	8+3+14=25	17	11-12	12	29-31	48-49	Grey 1964
<i>Yarella</i>													
<i>blackfordi</i>	adult	1	1	3	12-13	9	9+3-4+11-12=24-25	14-15	12	24-27(28)	52-53	61-63	Grey 1964

Table Phosichthyidae 3. Comparison of western Atlantic *Pollichthys* & *Polymetme*. Data from Grey 1964 & Parin & Borodulina 1990.

Character	<i>Polymetme</i>	<i>Pollichthys</i>
Br rays	12-13	11-12
Gill rakers	5(6)+11(10-12)=16	5+11-12=16-17
Dorsal rays	12-13	10-12
Anal rays	31-32(30-34)	25-26
Pelvic rays	7	6-7
Pectoral rays	10(9)	8
Vertebrae	44-45	ca. 40
Photophores		
BR	9	8
IV	9+1+11=21 (10th Elevated)	=21-23 (8th or 9th Elevated)
VAV	8	7-9
AC	24-25 (1st 1 or 2 Slightly Elevated, 17-19 Above Anal Fin)	18-21
IC	53-54	47-50
OA	17	19-21
ORB	1	2
OP	3	3
SO	Present	Present

MERISTICS

Vertebrae:		
Precaudal	24	Caudal
14		
Total	38	
Number of Fin Rays:		
Dorsal	11-12	
Anal	15-17	
Pectoral	8	
Pelvic	7	
Caudal		
Principal	10+9	
Gillrakers on First Arch		
Upper	5	
Lower	17	
Total	21-22	
Branchiostegals	11-12	

LIFE HISTORY

Range: Throughout area
 Habitat: Larvae epi-pelagic, adults meso- & bathypelagic
 ELH Pattern: Oviparous, planktonic eggs & larvae
 Spawning:
 Season: Year around

LITERATURE

Ahlstrom, Richards, & Weitzman 1984; Grey 1964;
 Mukhacheva 1980; Sanzo 1931; Watson 1996c

EARLY LIFE HISTORY DESCRIPTION**EGGS:**

See Sanzo

LARVAE:

Fin Development Sequence: C₁, D, A & C₂, P₂, P₁

Pigmentation: *Flexion & postflexion larvae:*

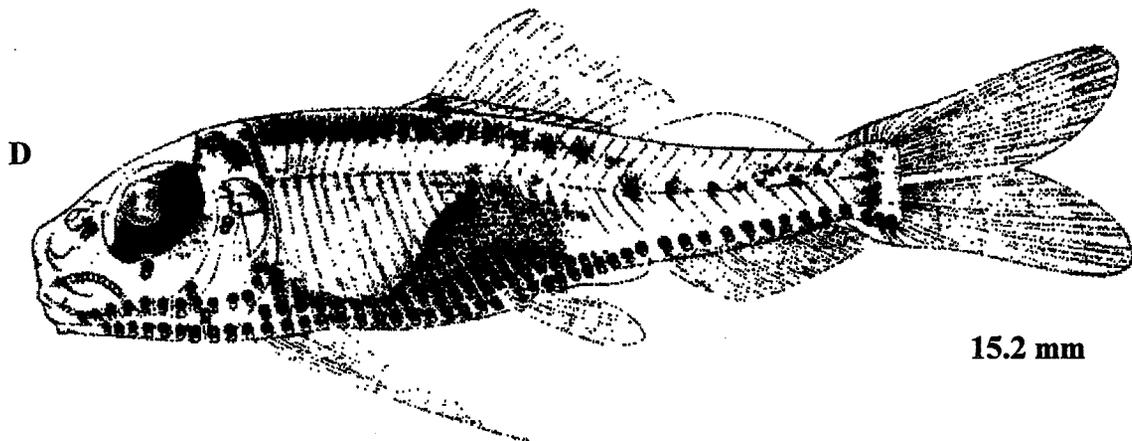
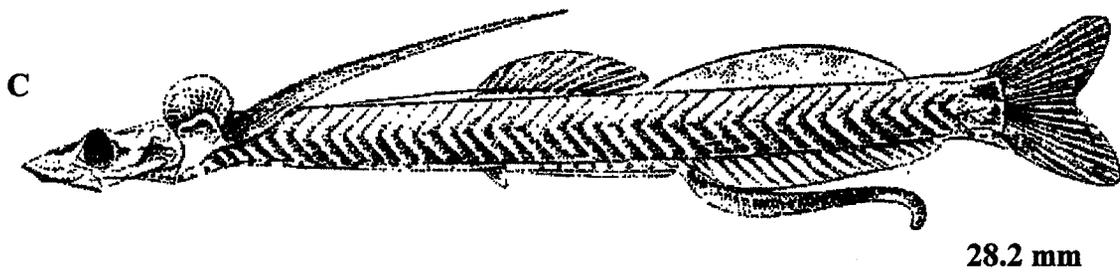
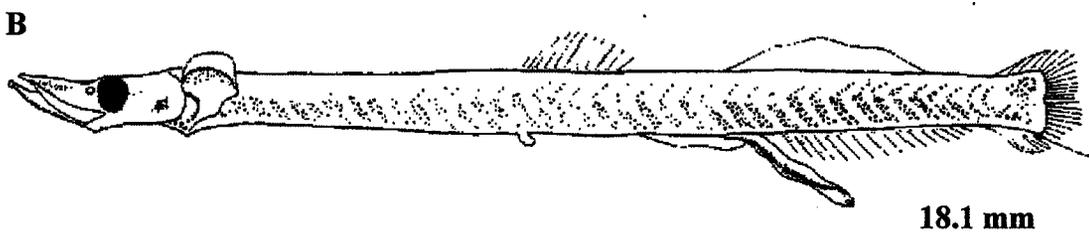
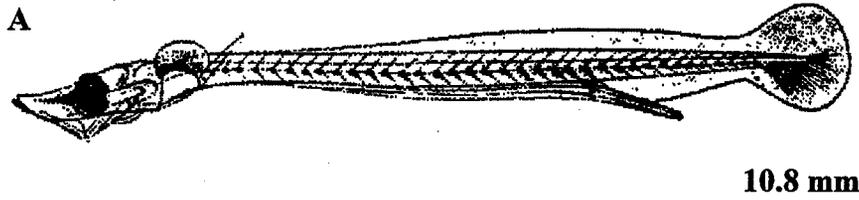
Melanophores on myomeres, streak on snout, extending on opercle, pigment over heart, on trailing gut, and on caudal peduncle. *Transformation stage:* Pigment as in postflexion with greater amounts on caudal peduncle.

Diagnostic Characters: *Preflexion & postflexion:*

Pigmentation pattern is unique, late developing anal fin; slender body; lower pectoral ray elongate; meristics. *Transformation stage:* Slender body & pigmentation; trailing gut; elongate lower pectoral ray.

ILLUSTRATIONS

Ahlstrom, Richards, & Weitzman 1984: B) 18.1 mm;
 Sanzo 1931: A,C,D) 10.8 mm, 28.2 mm, & 15.2 mm
 (shrinkage at transformation).



MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	40
Number of Fin Rays:	
Dorsal	10-12
Anal	25-26
Pectoral	8
Pelvic	6-7
Caudal	
Principal	10+9
Gillrakers on First Arch	
Upper	5
Lower	11-12
Total	16-17
Branchiostegals	11-12

LIFE HISTORY

Range: Throughout area
 Habitat: Meso- & bathypelagic
 ELH Pattern: Oviparous, planktonic eggs & larvae
 Spawning:
 Season: Year around

LITERATURE

Ahlstrom, Richards, & Weitzman 1984; Grey 1964;
 Ozawa 1976

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Fin Development Sequence: C₁, D, C₂, A, P₂, P₁

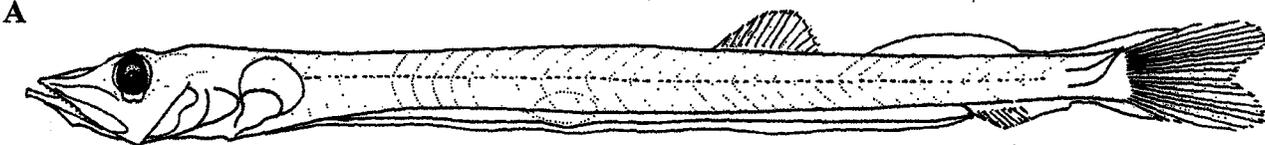
Pigmentation: Only eyes pigmented.

Diagnostic: Eyes elongated with ventral choroid tissue.

Very long gut, anal fin posteriorly placed, widely separated from dorsal fin. Adipose fin present.

ILLUSTRATIONS

Ahlstrom, Richards, & Weitzman 1984: A) 14.5 mm



14.5 mm

MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	40-41
Number of Fin Rays:	
Dorsal	13-15
Anal	14-16
Pectoral	9-10
Pelvic	7
Caudal	
Principal	10+9
Gillrakers on First Arch	
Upper	5-6
Lower	13-14
Total	18-19
Branchiostegals	11

LIFE HISTORY

Range: Throughout area
 Habitat: Meso- & bathypelagic
 ELH Pattern: Oviparous, planktonic eggs & larvae
 Spawning:
 Season: Year around

LITERATURE

Ahlstrom, Richards, & Weitzman 1984; Gorbunova
 1981; Grey 1964; Sanzo 1931

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Fin Development Sequence: C₁, D, C₂, A, P₂, P₁

Pigmentation: *Flexion & postflexion larvae:*

Melanophores confined to medial spot on caudal peduncle plus melanophores over the swimbladder.

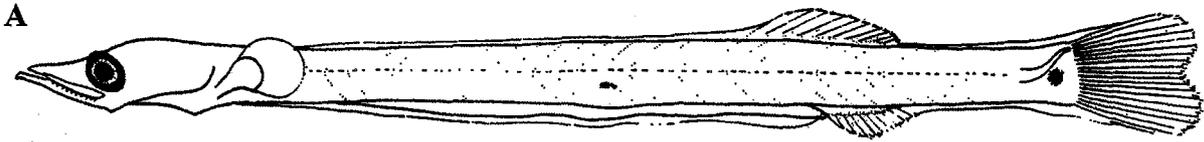
Transformation stage: caudal melanophore medial, white photophores appear and acquire pigment.

Diagnostic: Preflexion & postflexion: Pigmentation, no inner organ visible above anal papilla, anal origin below vertical from middle of dorsal fin. Tail about 2.75 times in trunk, a little more than 2 in oldest stages.

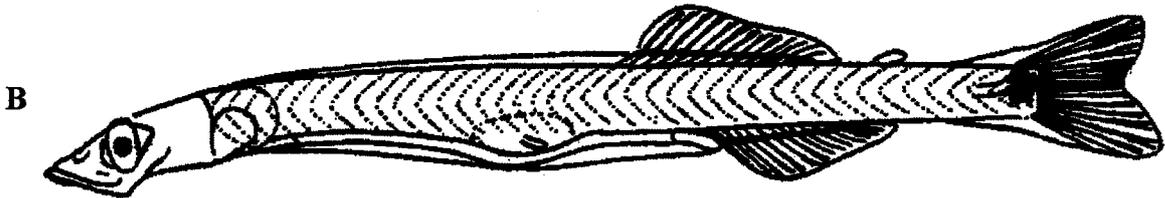
Transformation stage: SO photophore absent, OA 17-19 with last above 3rd-5th VAV; tail about 1.75 times in trunk; anal origin below middle of dorsal fin. Medial spot on caudal peduncle.

ILLUSTRATIONS

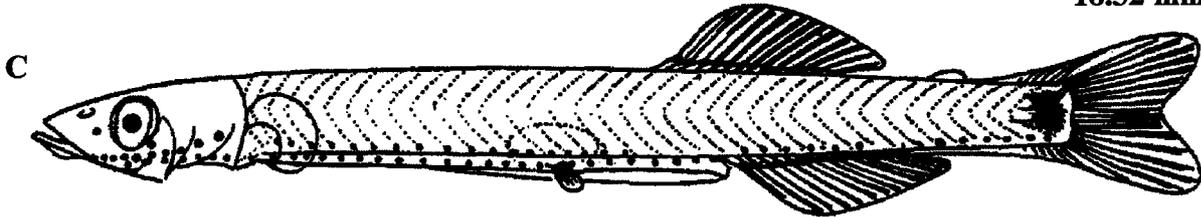
Ahlstrom, Richards, & Weitzman 1984: A) 9.7 mm SL.
 Sanzo 1931: B-C) 18.32 mm & 24 mm



9.7 mm SL



18.32 mm



24.0 mm

MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	40-42
Number of Fin Rays:	
Dorsal	13-14
Anal	13-15
Pectoral	9-10
Pelvic	7
Caudal	
Principal	10+9
Gillrakers on First Arch	
Upper	5-6
Lower	14-15(13)
Total	19-21(18)
Branchiostegals	11

LIFE HISTORY

Range: Throughout area
 Habitat: Meso- & bathypelagic
 ELH Pattern: Oviparous, planktonic eggs & larvae
 Spawning:
 Season: Year around

LITERATURE

Ahlstrom & Counts 1958; Ahlstrom, Richards, & Weitzman 1984; Gorbunova 1981; Grey 1964

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown, apparently indistinguishable from *V. lucetia*

LARVAE:

Fin Development Sequence: C₁, D, C₂, A, P₂, P₁

Pigmentation: *Flexion & postflexion larvae:*

Melanophores confined to ventral edge of caudal peduncle; 2 or more pigment spots above anal fin; 2-3 vertical dashes of pigment at caudal base; narrow line of pigment at juncture of isthmus and body.

Transformation stage: caudal melanophore ventral, white photophores appear and acquire pigment.

Pigment developing & increasing dorsally & dorsolaterally, spreading ventrad & caudad.

Diagnostic: Preflexion & postflexion: Pigmentation, anal origin below last 4th or 5th dorsal fin rays. Tail a little more than 3 times in trunk, about 2.75 in oldest stages.

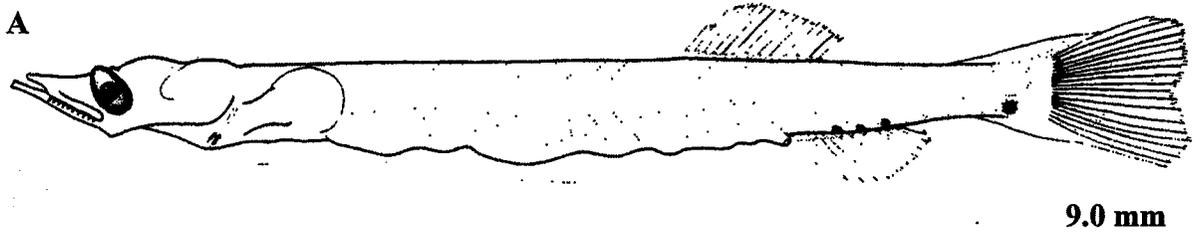
Transformation stage: SO photophore present, OA 20-22 with last above 6th-8th VAV; VAV 9-11; tail about 2-2.5 times in trunk; anal origin behind a vertical from middle of dorsal fin. Ventral spot on caudal peduncle.

ILLUSTRATIONS

Ahlstrom, Richards, & Weitzman 1984: A) 9.0 mm (modified from *V. lucetia* illustration)

PHOISICHTHYIDAE

***Vinciguerria nimbaria* Jordan & Williams**



MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	38-39
Number of Fin Rays:	
Dorsal	13-15
Anal	12-14
Pectoral	9-10
Pelvic	7
Caudal	
Principal	10+9
Gillrakers on First Arch	
Upper	3-4
Lower	11-12
Total	15
Branchiostegals	11

LIFE HISTORY

Range: Throughout area
 Habitat: Meso- & bathypelagic
 ELH Pattern: Oviparous, planktonic eggs & larvae
 Spawning:
 Season: Year around

LITERATURE

Ahlstrom & Counts 1958; Ahlstrom, Richards, & Weitzman 1984; Gorbunova 1981; Grey 1964; Sanzo 1931; Watson 1996c

EARLY LIFE HISTORY DESCRIPTION

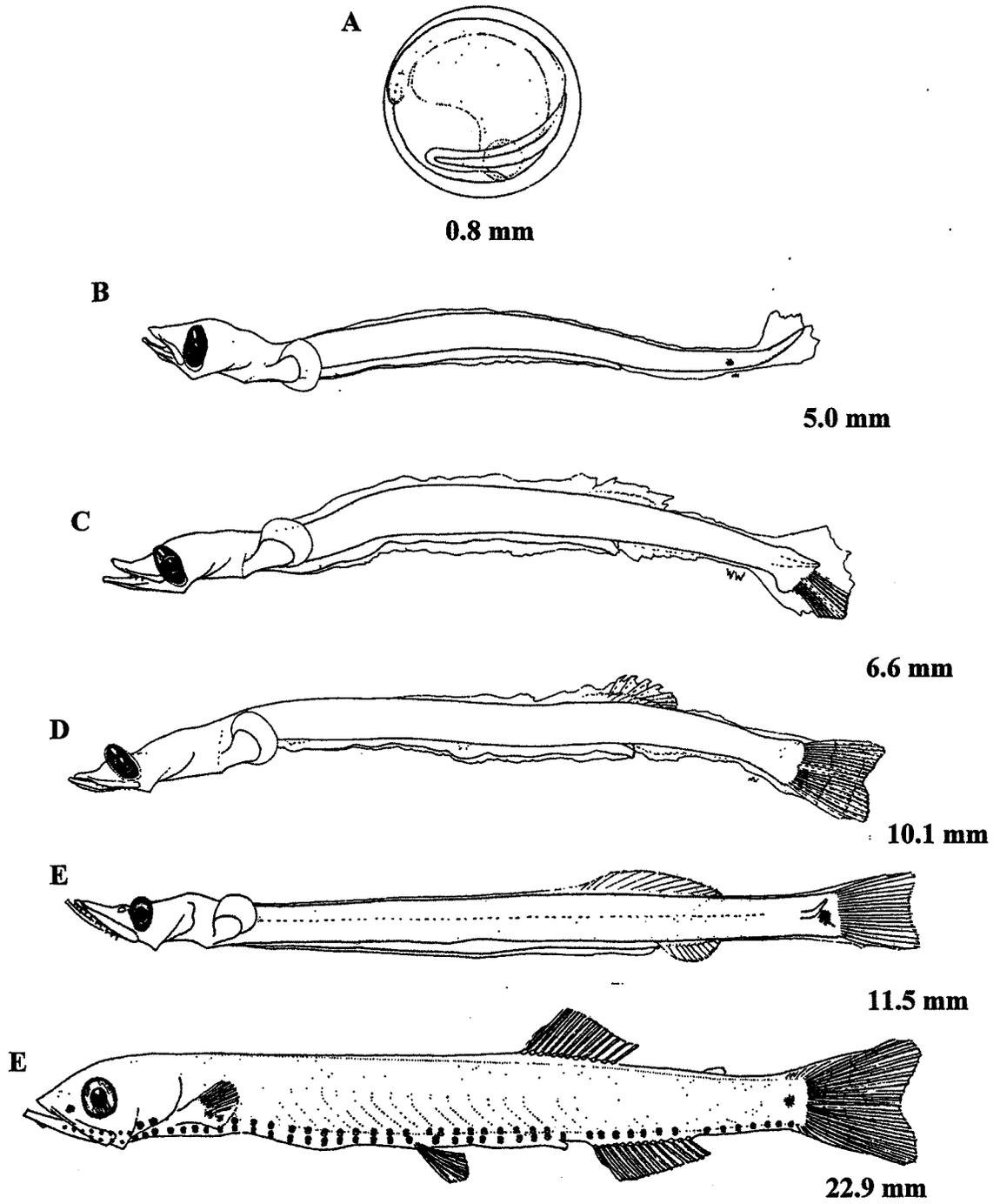
EGGS: Unknown
 Diameter: 0.75-0.85 mm
 No. of oil globules: 1
 Oil globule diameter: 0.17-0.19 mm
 Yolk: segmented
 Pigment: none
 Diagnostic characters: segmented yolk, no thin inner shell membrane, single oil globule

LARVAE:

Fin Development Sequence: C₁, D, C₂, A, P₂, P₁
 Pigmentation: *Flexion & postflexion larvae:*
 Melanophores confined to medial spot on caudal peduncle usually on both sides, one side only in Pacific specimens. Small oval organ above anal papilla may appear pigmented. *Transformation stage:* caudal melanophore medial, white photophores appear and acquire pigment. Pigment developing & increasing dorsally & dorsolaterally, spreading ventrad & caudad.
Diagnostic: Preflexion & postflexion: Pigmentation, small oval inner organ visible above anal papilla, anal origin below last 4th or 5th dorsal fin rays. Tail a little more than 3 times in trunk, a little more than 2 in oldest stages.
Transformation stage: SO photophore absent, OA 20-22 with last above 6th-8th VAV; tail about 1.75 times in trunk; anal origin behind a vertical from middle of dorsal fin. Medial spot on caudal peduncle.

ILLUSTRATIONS

Ahlstrom, Richards, & Weitzman 1984: E) 11.5 mm;
 Watson 1996c: A-D, F) Pacific specimens - egg, 5.0 mm, 6.6 mm, 10.1 mm, 22.5 mm



MERISTICS

Vertebrae:	
Precaudal	23
Caudal	19-20
Total	42-45
Number of Fin Rays:	
Dorsal	11-12
Anal	14
Pectoral	9-10
Pelvic	7-8
Caudal	
Principal	10+9
Procurent upper 4	
Procurent lower 4	
Gillrakers on First Arch	
Upper	3-5
Lower	13
Total	16-18
Branchiostegals	17

LIFE HISTORY

Range: Throughout area
 Habitat: Meso- & bathypelagic
 ELH Pattern: Oviparous, planktonic eggs & larvae
 Spawning:
 Season: Unknown

LITERATURE

Ahlstrom, Richards, & Weitzman 1984; Grey 1964;
 Watson 1996c

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

LARVAE:

Hatch size: <2.8 mm

Length at Flexion: ca. 6 mm, through ca. 7.5-8 mm

Length at Transformation: Begins >14.1 mm, <20.3 mm

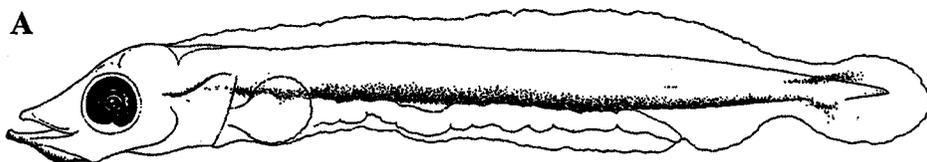
Fin Development Sequence: C₁, D & A, P₂ & C₂, P₁

Pigmentation: *Preflexion* – Series along ventral margin of gular membrane; series along ventral margin of isthmus & gut; heavy along dorsal margin of gut, continuing along ventral margin of tail; internal series along dorsal margin of notochord; arounds notochord tip & on caudal finfold. *Postflexion* – Disappears on dorsal part of C by ca. 10 mm; few on A base, present or not on A rays; series along midline of roof of mouth by ca. 11mm.

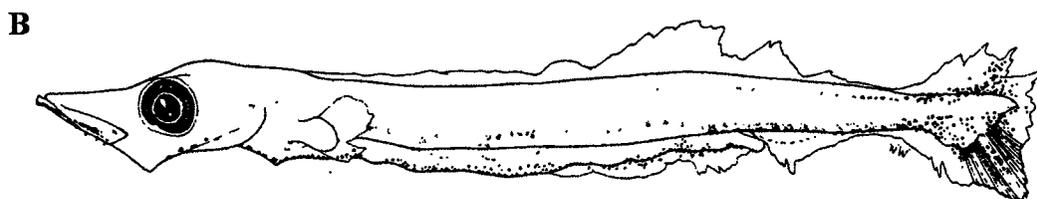
Diagnostic Moderately heavy pigment, mainly on lower half of body; 29-31 preanal myomeres (usually 29), 41-44 total myomeres (usually 42); preanal length ca. 70-80% SL; gut trails slightly, if at all; middle C rays elongate; D insertion 4-5 myomeres (usually 5) ahead of A origin.

ILLUSTRATIONS

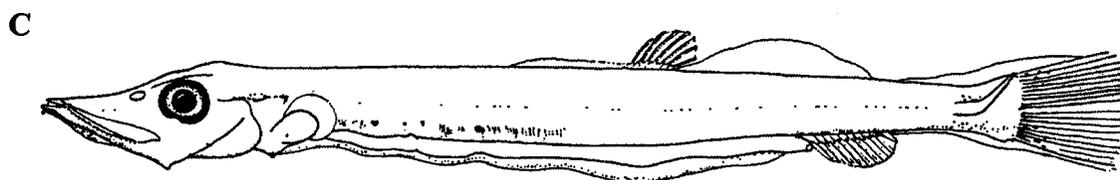
Watson 1996c: A-D) Pacific specimens - 5.4 mm, 5.7 mm, 11.5 mm, 20.3 mm



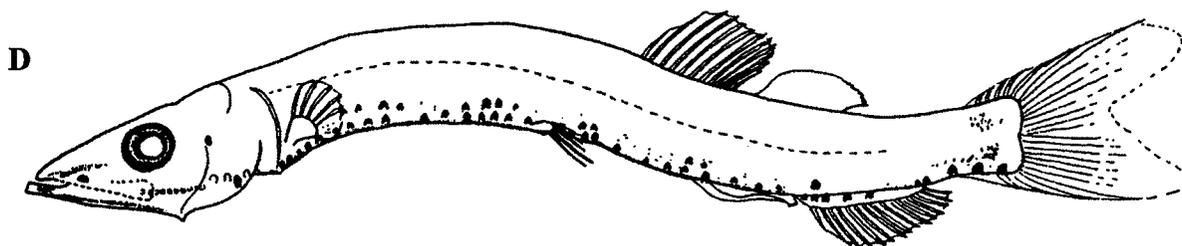
5.4 mm



5.7 mm



11.5 mm



20.3 mm

MERISTICS

Vertebrae:	
Precaudal	
Caudal	
Total	54
Number of Fin Rays:	
Dorsal	14-16(17)
Anal	29-31(28)
Pectoral	8-10
Pelvic	6-7
Caudal	
Principal	10+9
Gillrakers on First Arch	
Upper	6-7
Lower	12-14
Total	18-20
Branchiostegals	14-16

LIFE HISTORY

Range: Throughout area
 Habitat: Meso- & bathypelagic
 ELH Pattern: Oviparous, planktonic eggs & larvae
 Spawning:
 Season: Unknown

LITERATURE

Grey 1964; Ahlstrom, Richards, & Weitzman 1984

EARLY LIFE HISTORY DESCRIPTION

EGGS: Unknown

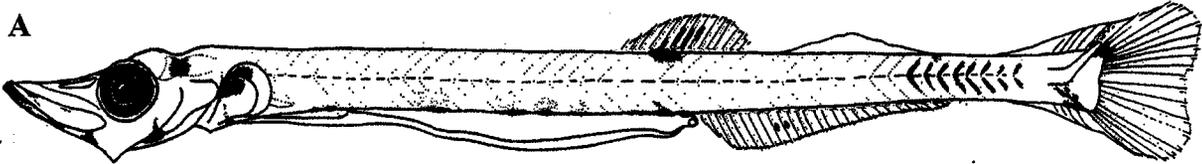
LARVAE:

Pigmentation: Melanophores forming distinct chevrons on caudal peduncle, dark spots on head, above gut, base of dorsal fin, lower hypurals, & medial fins.

Diagnostic Characters: pigmentation, photo-phore pattern, & meristics. Adipose fin absent.

ILLUSTRATIONS

Ahlstrom, Richards, & Weitzman 1984: A) 23.5 mm



23.5 mm

STOMIOIDEA: Advanced Stomiiforms

W. J. Richards

As stated in the Stomiiformes chapter we use the advanced stomiiform families for convenience as Fink (1985) has demonstrated monophyly of this group and did not propose a formal classification. I follow Moser (1996) in using Weitzman's (19774) superfamily Stomioidea as a convenient way of describing the ELH stages of these rare and interesting advanced stomiiforms to aid in identification. Kawaguchi & Moser (1984) reviewed the group and provided extensive information on the superfamily. Even though some data are used redundantly it is necessary to help in separating the various taxa to have the information presented in more than one venue. The families have different and unusual features including the presence of scales only in chauliodontids and stomiids; centra of one or more vertebrae unossified which allows the head to be thrown back and mouth to open widely in astronesthids and the melanostomiid genera *Chirostomias* and *Trigonolampa*; varying positions of the dorsal fin (chauliodontids has a short dorsal fin advanced near the head and the anal fin on the caudal peduncle, astronesthids have the dorsal fin midway on the trunk ending well before anal fin origin and the anal fin on the end of the body, while the remaining families have both the dorsal and anal fins posteriorly placed).

Stomioid larvae are very unique but unfortunately are very rare in collections. This rarity precludes identification below the family level in many instances because meristic characters greatly overlap and development of size series is difficult. Within many of the taxa the nature of the chin barbel is the criteria for specific identification and most larvae & juveniles do not have the barbel developed. These larvae have an elongated gut and body with the gut often trailing the body. The gut is voluminous in many but lacks mucosal striations. The dorsal and anal fins form on the body and not in the finfold as in some salmoniforms and their placement is diagnostic (see above). Pelvic and pectoral fins generally form late and the pectoral fin is often low on the body with a ventral orientation. The heads are often broad with a 'duck bill-like' appearance and the teeth are large and fang-like as development proceeds. Finfolds are large and voluminous. Eyes may be round or elongate and also stalked slightly or greatly as in *Idiacanthus*. Species accounts are few because of the difficulty of identifying to that level, but a number of illustrations are provided for each family. Because of their rarity, ELH stages should be deposited in major museums. Meristic characters are given in Table Stomioidea 1 and photophore counts in Table Stomioidea 2.

Table Stomioidea 1. Meristic characters and genera of the advanced stomiiforms (Superfamily Stomioidea). Data from Clarke (1998), Gibbs (1964 a & b), Gibbs et al. (1983), Morrow (1964 a, b, & c), Morrow & Gibbs (1964), Parin & Borodulina (1997, 1998).

Family & Genera	Fin Rays				Vertebrae	Branchiostegals	Species in Area
	Dorsal	Anal	Pectoral	Pelvic			
Stomiidae							
<i>Macrostomias</i>	13-14	16(15-18)	6-7	4-5	164-	18-19	1
<i>Stomias</i>	16-21	13-23	6-9	4-5	64-83	17-18	3
Chauliodontidae							
<i>Chauliodus</i>	5-7	10-13	11-14	6-8	51-62	12-21	2
Astronesthidae							
<i>Astronesthes</i>	11-20	11-19	6-9	6-8	31-37+13-18=45-55	14-20	ca. 10
<i>Borostomias</i>	10-14	10-18	7-9	7	53-55	16-23	7
<i>Heterophotus</i>	11-13	12-17	7	7	66	23-25	1
<i>Neonesthes</i>	9-12	25-28	7-8	6-8	53	18-21	1
<i>Rhadinesthes</i>	11-13	18-21	6-8	7	67		1
Melanostomiidae							
<i>Bathophilus</i>	13-17	13-18	2-37	4-26	38-45	8-14	13
<i>Chirostomias</i>	18-20	22-26	6	7	54-55	19-22	1
<i>Echiostoma</i>	11-16	13-19	4	8	57-59	13-15	1
<i>Eustomias</i>	20-29	32-46	0-13	7-8	56-71		ca. 33
<i>Flagellostomias</i>	14-17	21-26	9-11	7	ca.65	15-17	1
<i>Grammatostomias</i>	18-21	20-24	4-11	7-8	50-56	10-11	3
<i>Leptostomias</i>	14-22	23-29	5-11	7-8	75-83	16-19	6
<i>Melanostomias</i>	13-17	16-20	5	7	ca. 50-55		7
<i>Pachystomias</i>	21-24	25-27	5-6	7-9	48	ca. 9	1
<i>Photonectes</i>	15-22	18-24	0-3	6-7	49-64	11-15	12
<i>Thysanactis</i>	17-18	21-25	11	7	61		1
<i>Trigonolampa</i>	18-20	18-19	5	7	61-62	14-15	1
<i>Bathysphaera</i>	sighted from bathysphere, no collections made						1
Idiacanthidae							
<i>Idiacanthus</i>	54-74	38-49	0	6	ca.78	17	1
Malacosteidae							
<i>Aristostomias</i>	18-26	24-32	6-17	6	44-52	ca.15	6
<i>Malacosteus</i>	14-20	17-23	3-5	6	49		1
<i>Photostomias</i>	22-28	25-32	0	5-6	52-58	9-12	2

Table Stomioidea 2. Photophore counts in stomioid genera (Superfamily Stomioidea). (* IV = IP+PV count). Data from Clarke (1998), Gibbs (1964 a & b), Gibbs et al. (1983), Morrow (1964 a,b, & c), Morrow & Gibbs (1964), Parin & Borodulina (1997, 1998).

Family & Genera	Photophore Groups					
	IP	PV	VAV	AC	OV	VAL
Stomiidae						
<i>Macrostomias</i>	11	85-86	58-59	19-20	83-85	58-61
<i>Stomias</i>	10-13	35-51	6-13	15-19	32-50	6-14
Chauliodontidae						
<i>Chauliodus</i>	9-11	18-21	23-28	8-13	17-21	22-28
Astronesthidae						
<i>Astronesthes</i>	5-12	6-20	7-27	7-13	5-19	7-26
<i>Borostomias</i>	9-13	20-31	15-25	9-15	21-29	16-25
<i>Heterophotus</i>	10-11	32-35	13-16	12-15	33-36	16-20
<i>Neonesthes</i>	9-12	14-17	16-21	13-18	13-15	13-20
<i>Rhadinesthes</i>	6(?) -10	25-26	20-23	ca.16	22-24	20(?) -27
Melanostomiidae						
<i>Bathophilus</i>	4-6	12-18	11-17	5-9	10-16	8-17
<i>Chirostomias</i>	9	25-27	16-20	9-10	23-25	16-20
<i>Echiostoma</i>	8+2	25-28	14-18	12-13	24-27	13-17
<i>Eustomias</i>	7-8	24-36	11-20	15-25	24-37	12-21
<i>Flagellostomias</i>	9-10	32-34	14-15	16-18	31-32	14-15
<i>Grammatostomias</i>	7	15-18	20-22	11-13	15-18	19-22
<i>Leptostomias</i>	10-11	40-47	20-23	11-14	40-46	20-24
<i>Melanostomias</i>	8+2-3	23-30	12-15	9-11	22-28	11-15
<i>Pachystomias</i>	8-9	14-16	13-14	8-9	17-18	14-15
<i>Photonectes</i>	8-11	19-35	11-18	9-15	18-34	11-15
<i>Thysanactis</i>	20	31-32	14-16	11-12	30-32	14-16
<i>Trigonolampa</i>	11	23-24	22	10-11	22-24	23-24
<i>Bathysphaera</i>	Sighted from bathysphere, no specimens collected					
Idiacanthidae						
<i>Idiacanthus</i>	31-36*		16-18	13-18	22-25	31-35
Malacosteidae						
<i>Aristostomias</i>	5+3	14-18	13-18	9-12	14-19	15-18
<i>Malacosteus</i>	no countable photophores on body					
<i>Photostomias</i>	5+2	12-16	21-25	9-15	11-17	20-23

STOMIIDAE: Scaly Dragonfishes

W. J. Richards

Four species of stomiids occur in our area, three in the genus *Stomias*, and one in *Macrostomias* (Morrow 1964b). As adults the genera are separated by barbel length (equal or shorter than head length in *Stomias*, vs. 6-11 times head length in *Macrostomias*) and the barbel terminates in a bulb with filaments, number and nature of pelvic rays (5 with connected membranes vs. 4-5 isolated), and number of large photophores in the ventral series (100 or less vs. 170 or more). As with the other stomioids the teeth are large and fang-like, photophores consist of postorbital gland below the eye, small organs scattered over the head and body, two rows on side of body with upper row extending from gill opening to anal fin origin and a lower row from the isthmus to caudal base, and small organs on the branchiostegals. As with the chauliodontids, the body is covered with scales (5-6 rows of hexagonal scales), but the dorsal fin is placed posteriorly opposite the anal fin. They are small to moderate-size (to ca. 40 cm SL), slender, compressed fishes. Coloration is iridescent black or dark green with a gelatinous membrane over the scales. They are common midwater predators of all oceans, usually found at meso- to bathypelagic depths with young occurring in near surface waters at night.

Moser (1996c) summarized the ELH stages as follows: *Stomias* is oviparous with round pelagic eggs ranging in diameter from 0.88 to 1.5 mm, depending on the species; single oil globule, segmented yolk, and a distinct inner membrane. Larvae hatch at 3-4 mm and have an elongate yolk sac, larvae are slender, round in cross section with a long gut that is slightly shorter in relative length than that of *Chauliodus*. The head is relatively small, with a moderately long snout and slightly ovoid eyes; small median finfold; dorsal and anal fins develop in early postflexion larvae, but pelvic fins do not appear until late postflexion stage. Only *S. boa* has been described from Atlantic waters (Sanzo, 1931) and it has a distinct row of ventral pigment above the gut, intermittent pigment on dorsum, anal fin and lower caudal fin, and below the heart in 10.44 mm larvae. This pigment extends to the dorsal fin, fore and hind gut, upper caudal rays, and head in larger larvae and photophores in the white stage appear at ca. 30 mm. At transformation when the barbel appears the juveniles are shorter than the larvae. *S. affinis* has been described from Pacific waters by Ozawa (1988a). Illustrations are provided of *S. boa* (Fig. Stomiidae 1), but not species accounts as the described larvae were not from the area. Meristic data are given in Table Stomiidae 1 and photophore data in Table Stomiidae 2.

Figure Stomiidae 1. Redrawn series of *S. boa* from Sanzo 1931 (A-E: 10.44, 15.6, 30.4, 41.5 larvae and 32.3 mm transition stage).

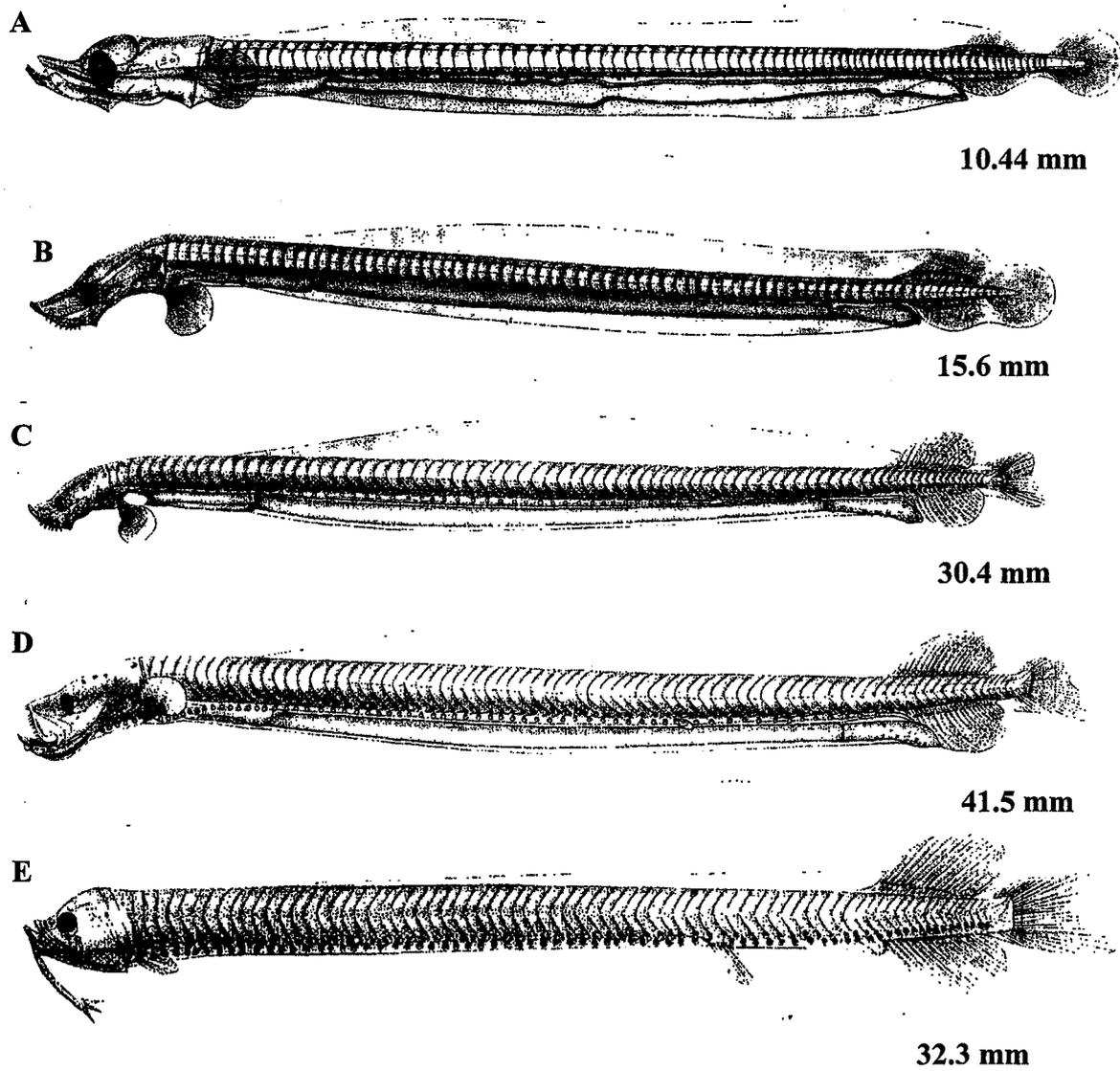


Table Stomiidae 1. Meristic characters of the species of the Family Stomiidae. Data from Morrow (1964b) & Shcherbachev & Novikova (1976).

Species	Fin Rays					Branchiostegals
	Dorsal	Anal	Pectoral	Pelvic	Vertebrae	
<i>Stomias</i>						
<i>affinis</i>	17-20(16-21)	13-23(25)	6-7		66-71	17-18
<i>boa</i>	17-21	19-23	6-7	5	77-83	17-18
<i>brevibarbata</i>	16(18-20)	19(20-23)	7(7-9)	5	64-68	17
<i>Macrostomias</i>						
<i>longibarbatus</i>	13-14	16(15-18)	6-7	4-5	164-	18-19

Table Stomiidae 2. Photophore counts of the species of the Family Stomiidae. Data from Morrow (1964b) & Shcherbachev & Novikova (1976).

Species	Photophore Groups					
	IP	PV	VAV	AC	OV	VAL
<i>Stomias</i>						
<i>affinis</i>	9-12	42-46	5-8(9)	14-18	40-46	7-9(4,6)
<i>boa</i>	10-13	46-51	10-13(14)	15-20	45-50(51)	11-14
<i>brevibarbata</i>	9-12	32-35	12-16	14-15	32-35	11-17
<i>Macrostomias</i>						
<i>longibarbatus</i>	11-12(13)	85-86	58-67(70-73)	19-22	77-85(86)	58-68(56-70)

CHAULIODONTIDAE: Viperfishes

W. J. Richards

Chauliodontidae comprises eight species in the genus *Chauliodus* of which two species occur in our area – *C. sloani* and *C. danae*. They are small to medium size (< 30 cm), slender, compressed fishes, with 5 rows of large deciduous scales embedded in shallow pockets with an hexagonal pigment pattern. In life they are iridescent blue or gray over a black background and preserved are very black with some hints of silvery iridescence. The mouth is large with long fang-like teeth on the premaxillaries and dentaries. The dorsal fin is unique among these advanced stomiiforms as it is placed far forward, just behind the head and well in advance of the pelvic fins. In addition, the first dorsal ray is usually produced with a long filament terminating in a small flap. Both dorsal and anal adipose fins present, the latter in advance of the anal fin. Pelvic fins lie before middle of body and the gut is very long (ca. 90% of SL). Atlantic species have reduced or absent mental barbel. Two rows of large photophores present on side of trunk with wavy or irregular row of smaller organs between them and a row on midventral line between the lower rows. Photophores present on branchiostegals membranes between rays; postorbital photophore present and preorbital photophore embedded in skin. Small photophores on each scale.

Chauliodontids are oviparous and have large (2.2-3.6 mm) round planktonic eggs with segmented yolk and no oil globule. The larvae of *C. sloani* have been well described (Sanzo, 1931) and the Pacific species *C. macouni* has been thoroughly described by Moser (1996). The larvae are very elongate and attain a size of ca. 45 mm at transformation when there is a reduction in size. The larvae have a round cross section and appear flaccid and pigmentless (except eyes and few melanophores above anal fin in *C. danae*) before transformation.

Meristic characters for the family in comparison with other stomiiforms are given in Table Stomiiformes 3, Tables Stomioidea 1 & 2, and for the species in Table Chauliodontidae 1. Fin placement features in comparison with other stomiiforms are given in Table Stomiiformes 4. Chauliodontids are unique stomiiforms in having the dorsal fin in such an advanced position. Larvae have little pigment and very long guts reaching to the posteriorly placed anal fin. The characteristic advanced dorsal fin appears at about 40 mm SL and can be easily overlooked. The two species may be separated as adults and late juveniles by the following characters from Morrow (1964):

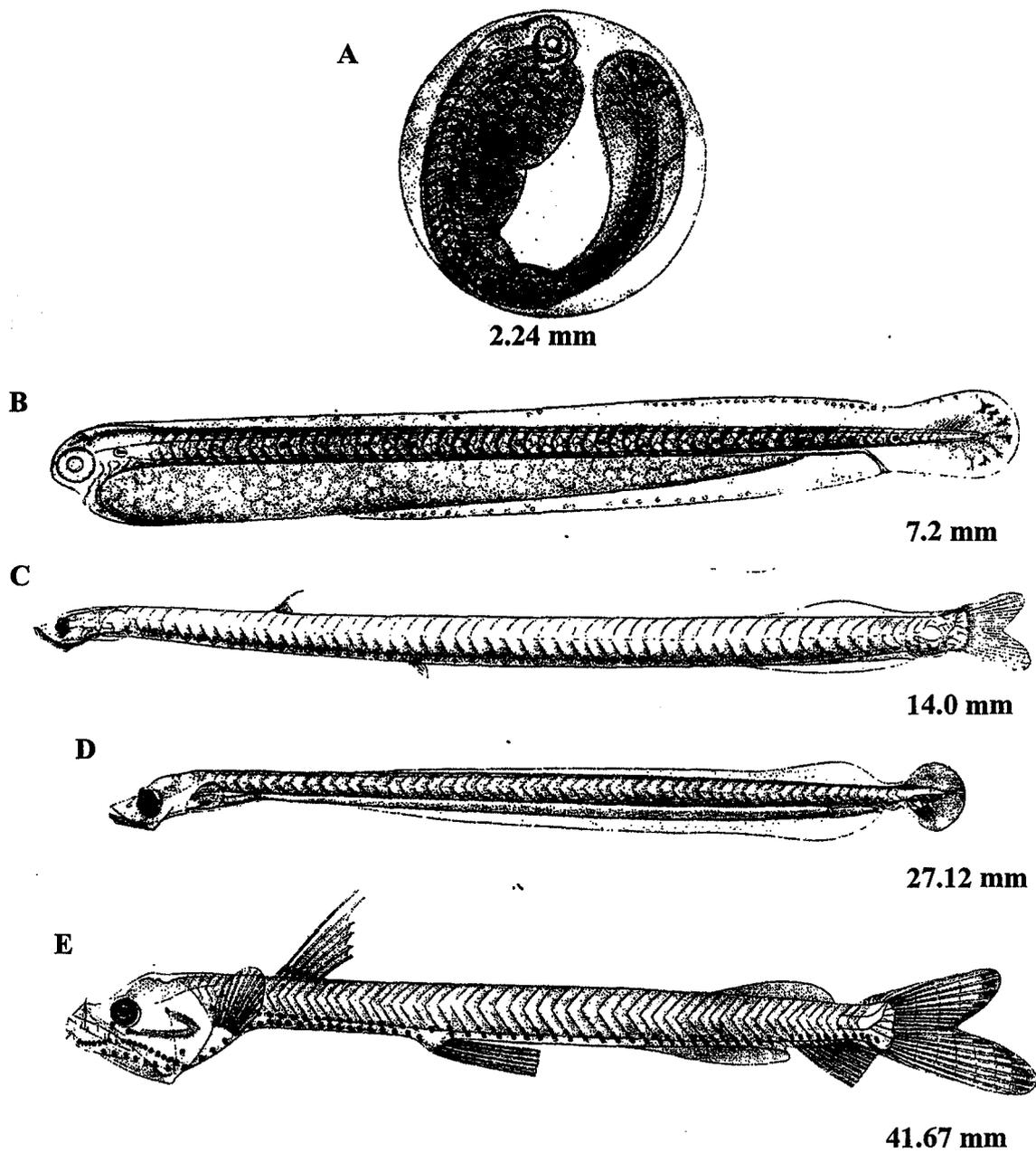
- C. danae* – posterior unpigmented organ of each series of small organs between ventral row absent, or much reduced; each series generally 1+2+0; chin barbel, when present, short, stiff, compressed, absent in most specimens longer than ca. 50 mm SL.
- C. sloani* – Posterior organ of each series nearly as large as central organs; each series generally 1+3+1 or 1+4+0; barbel tapered, slender, flexible, generally present in specimens up to about 100 mm SL.

The larvae are difficult to separate as meristic characters overlap, but *C. sloani* lacks body pigment (some pigment appears on caudal rays whereas *C. danae* develops pigment over the anal fin base). Very small larvae can only be separated if extremes of meristics (myomeres and branchiostegals) are countable. The eggs of *C. danae* are unknown whereas the eggs of *C. sloani* are very large (2.24 mm in diameter). Only illustrations are given for *C. sloani* (Fig. Chauliodontidae 1) as the described larvae were not from the area.

Table Chauliodontidae 1. Meristic characters of the species of the Family Chauliodontidae. Data from Morrow (1964).

Species	Fin Rays				Vertebrae	Branchiostegals
	Dorsal	Anal	Pectoral	Pelvic		
<i>Chauliodus</i>						
<i>danae</i>	5-6	10-12	12-14	6-7	51-58	12-18
<i>sloani</i>	5-7	10-13	11-14	6-8	54-62	14-21

Figure Chauliodontidae 1. Series of *Chauliodus sloani* redrawn from Sanzo 1931 (A-E) including an egg (2.24 mm diameter), 7.2 , 14.0, 27.12 mm larvae, and 41.67 mm transition juvenile.



ASTRONESTHIDAE: Snaggletooths

W. J. Richards

The family Astronesthidae includes 5 genera and about 22 species in our area. They are midwater predators and the adult of one species, *Astronesthes niger*, comes to the mixed surface layer at night and is often taken in plankton nets, the only advanced stomiiform to do so. The genus *Astronesthes* has received a lot of taxonomic attention and several new species have been described as recently as 1998 (see Parin & Borodulina 1998). Their larvae, like the other advanced stomiiforms, are rare in ichthyoplankton collections. According to Moser (1996d) they are small to moderate in size (up to 40 cm) and have moderately compressed, elongate, scaleless bodies that are usually black, some with silvery sides. The mouth is large, usually with fang-like teeth. The fin placement is diagnostic for the family as the dorsal fin originates slightly behind the mid-point of the body, but well in advance of the anal fin origin. An adipose fin is present in all genera except *Rhadinesthes* and some have an anal adipose fin, too. The head and body are covered with many small photophores and the body has two distinct ventral rows. The chin barbel is variable in length and has a terminal bulb in some species. Tables Astronesthidae 1 & 2 provide meristic and photophore data for adults.

Kawaguchi & Moser (1984) and Moser (1996d) have reviewed the ELH information which is quite scant as few ELH specimens have been collected. They point out that they are probably oviparous though no eggs have been identified from plankton net collections. Kawaguchi & Moser (1984) show that the larvae are highly diverse and can be grouped into two morphs: 1) laterally compressed body with elongate, sometimes trailing gut and 2) body rounded in cross-section with trailing gut deflected from the body posterior or anterior to midbody. They add that some type 2 species have dorsal and anal fins on cartilaginous pedestals and have large median finfolds. One species has an ornamented trailing gut with leaf-like appendages and another has a keel-like preanal finfold. Pigmentation patterns are also diverse ranging from few to no melanophores to heavy pigmentation on the finfolds and myosepta, or punctate melanophores along the body. The eyes are generally ovoid and not stalked, but the chief character is the placement of the dorsal fin in advance of the anal fin. Larval identifications will remain tenuous until complete series are collected or until biochemical identification means are developed. Table 46 in Kawaguchi & Moser (1984) should be consulted. I have provided illustrations of several types (Fig. 90 from Kawaguchi & Moser 1984) as examples in Figure Astronesthidae 1: A) Type I, 23.7 mm; B) Type II; C) Type IV, 33.0 mm D) Type V, 22.0 mm; E) Type VII, 28 mm. Every effort should be taken to preserve ELH specimens for future study.

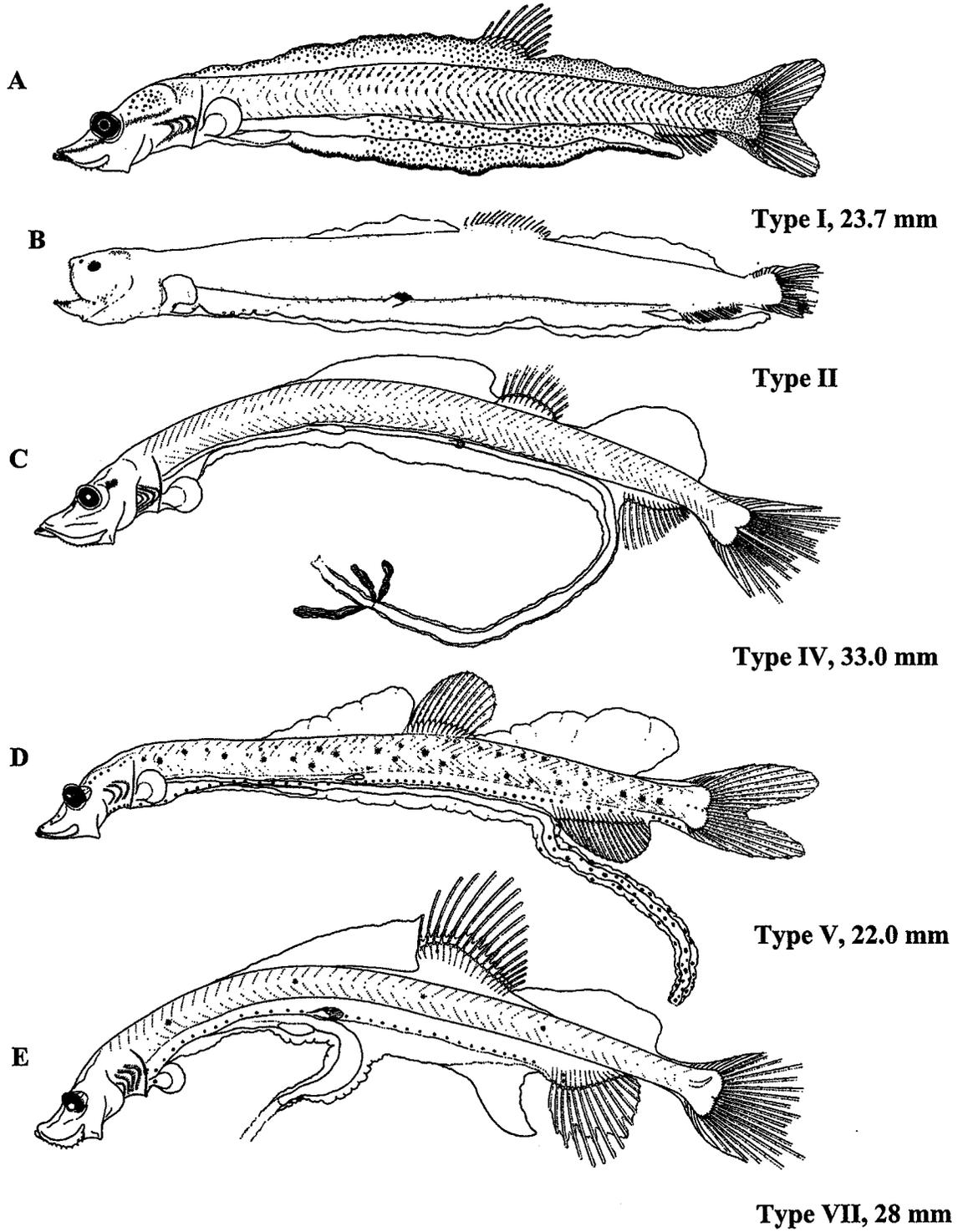
Table Astronesthidae 1. Meristic characters for the genera of astronesthid fishes. Data from Gibbs (1964), and Parin & Borodulina (1997, 1998).

Genera	Fin Rays				Vertebrae	Branchiostegals	Species in Area
	Dorsal	Anal	Pectoral	Pelvic			
<i>Astronesthes</i>	11-20	11-19	6-9	6-8	31-37+13-18=45-55	14-20	ca.10
<i>Borostomias</i>	10-14	10-18	7-9	7	53-55	16-23	7
<i>Heterophotus</i>	11-13	12-17	7	7	66	23-25	1
<i>Rhadinesthes</i>	11-13	18-21	6-8	7	67		1
<i>Neonesthes</i>	9-12	25-28	7-8	6-8		18-21	1

Table Astronesthidae 2. Photophore counts in astronesthid genera. Data from Gibbs (1964a), Parin & Borodulina (1997, 1998).

Genera	Photophore Groups					
	IP	PV	VAV	AC	IV	VAL
<i>Astronesthes</i>	5-12	6-20	7-27	7-13	5-19	7-26
<i>Borostomias</i>	9-13	20-31	15-25	9-15	21-29	16-25
<i>Heterophotus</i>	10-11	32-35	13-16	12-15	33-36	16-20
<i>Rhadinesthes</i>	6(?) -10	25-26	20-23	ca.16	22-24	20(?) -27
<i>Neonesthes</i>	9-12	14-17	16-21	13-18	13-15	13-20

Figure Astronesthidae 1. Examples of astronesthid larvae, see text for details.



MELANOSTOMIIDAE: Scaleless dragonfishes

W. J. Richards

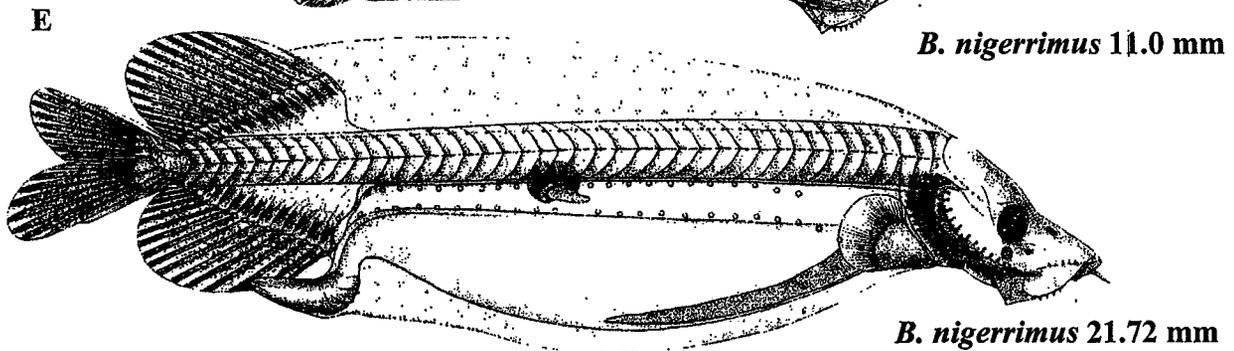
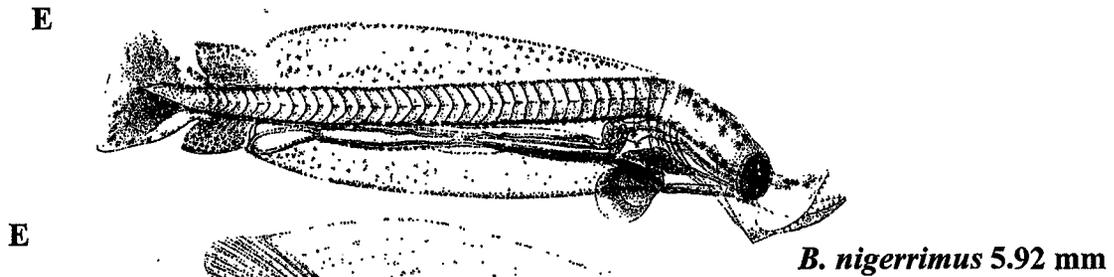
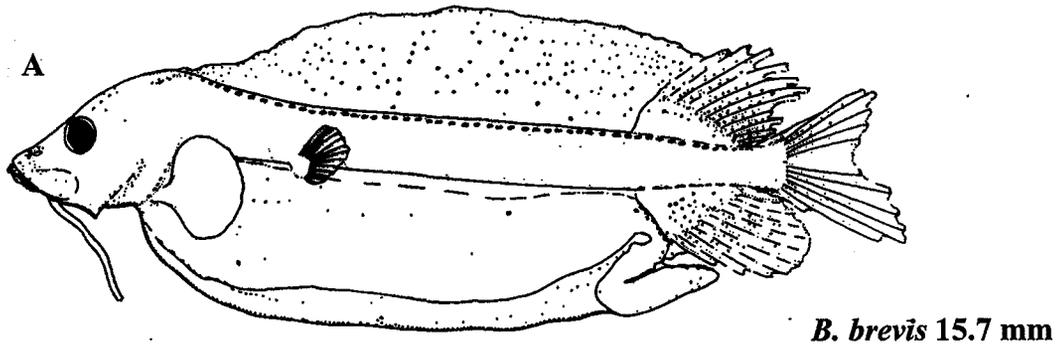
The family Melanostomiidae is the largest stomiiform family with 13 genera and about 80 species in our area. One monotypic genus, *Bathysphaera*, was described by Beebe (1932) from a bathysphere observation and its status remains unclear and is usually excluded from most accounts. The family was reviewed by Morrow & Gibbs (1964) and defined by them as follows: body long, slender & slightly compressed; skin naked with minute photophores scattered over the head & body, especially in vertical rows between myomeres; two rows of photophores along ventral body. The head is short and the jaws large with a chin barbel present. The dorsal and anal fins are placed far posteriorly on the caudal peduncle. The adults have been taken from near the surface down to 4500 m, but most are in the upper 1000 m. As with other Stomioidea, they are rarely taken especially the younger stages.

Kawaguchi & Moser (1984), Ozawa & Aono (1986), and Moser (1996e) have reviewed the early life history information which may be summarized as follows: melanostomiids are oviparous with pelagic eggs (only one non-Atlantic species has had eggs described), those eggs are large (1.38-1.55 mm) with segmented yolk, single oil globule, and large perivitelline space (Moser 1996e). Melanostomiid larvae are elongate and have a straight elongate gut with a pronounced muscular terminus, and as with adults the dorsal and anal fins are placed just in advance of the caudal fin. The larvae have round to laterally compressed bodies in cross-section, head and jaws relatively large, eyes small and elliptical, pigmentation variable, but with melanophores on the dorsal surface of each myomere and on the hypaxial myosepta. *Eustomias* has a trailing gut with large melanophores on the dorsal surface of each myomere. *Bathophilus* has myomeres on the ventral surface of each myomere. As with many other advanced stomiiforms, the rarity of larvae precludes precise identification even to the generic level. Beebe & Crane (1939) described and illustrated four species and additional forms of two genera. Kawaguchi & Moser (1984) summarized all the available information and added illustrations of several species. Ozawa & Aono (1986) and Ozawa (1988) added descriptions of North Pacific species, and Moser (1996e) provided details on California Current species. These publications should be consulted as genera and some species are common to our area as well as theirs. Meristics and photophore data are given in Tables Melanostomiidae 1 & 2.

To summarize, the following taxa have been illustrated and included herein: *Bathophilus nigerrimus* (after Sanzo 1931- note this was redrawn & incorrectly reversed by Kawaguchi & Moser 1984, thus the gut should exit from the right side of the specimen not the left), *B. brevis* (after Kawaguchi & Moser 1984), *Eustomias* sp. (original 24.9 mm Gulf of Mexico, ORII Cr. 166, Sta. 45418 R6B3), *Flagellostomias boureei* (after Kawaguchi & Moser 1984), *Leptostomias* sp. (original 12.6 mm Gulf of Mexico, ORII Cr. 166 Sta. 45476 R6B3), *Melanostomias* sp. (after Kawaguchi & Moser 1984), & *Photonectes* sp. (after Kawaguchi & Moser). Kawaguchi & Moser (1984) provide much information in their Table 46, p. 174-175 and illustrations of several genera. A few other illustrations appear in Beebe & Crane (1939) but are not reproduced because of high costs due to copyrights. These should be examined as they include pigment patterns (their Fig. 20) and larvae & transitional specimens of *Leptostomias gladiator* (Fig. 21), *Melanostomias spilorhynchus* (Fig. 30), *Photonectes parvimanus* (Fig. 42), *Flagellostomias boureei* (Fig. 47), *Grammatostomias dentatus* (Fig. 52), *G. flagellibarba* (Fig. 53), *Bathophilus* sp. (Fig. 57), *B. sp. near longipinnis* (Fig. 58), *B. brevis* (Fig. 59), *B. metallicus* (Fig. 61), *Eustomias* sp. (Fig. 66), & *Eustomias (Dinematochirus)* sp. (Fig. 68).

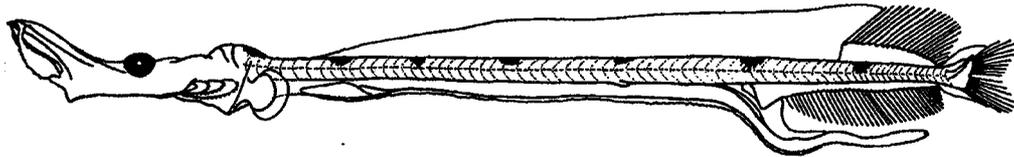
Summary of Generic Diagnostic Characters

Bathophilus –dorsal melanophores present (1 or >/myomere) with opposing series of melanophores along ventral myomer surface, pigment absent on epaxial & hypaxial myosepta, no trailing gut but gut large & voluminous with highly developed terminus, deep-bodied, finfolds large especially dorsal, and pigmented, head pigmented, eye size moderate, barbel forms in late postflexion larvae, transform at 25 mm or less. Examples shown: *B. brevis* 15.7 mm from Kawaguchi & Moser 1984 & *B. nigerrimus* series 5.92, 11.0, & 21.72 mm from Sanzo 1931.



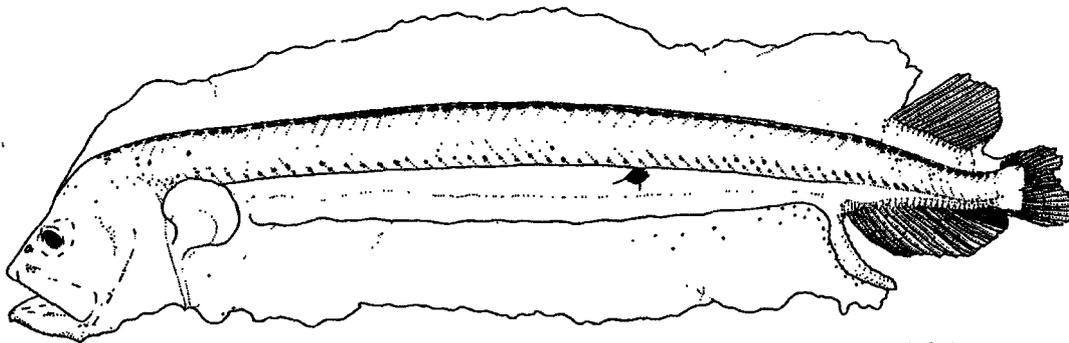
Echiostoma – dorsal melanophores present (1/myomere), pigment present on hypaxial myosepta (1-5 melanophores/myomere), pigment absent on epaxial myosepta, no trailing gut but gut voluminous & terminus developed on right side of anal fin & pigmented dorsally, top of head and isthmus pigmented, elongate, eyes elliptical to round, transform > 16 mm.

Eustomias – dorsal melanophores present (5-11 along midline), pigment absent on myosepta, trailing gut present, usually pigment at lower jaw symphysis, head elongate & flat with spatulate snout, eyes moderate in size, slightly elliptical to round, body slender & round, some larvae reach 45 mm. Example is 24.9 mm from the Gulf of Mexico.



24.9 mm

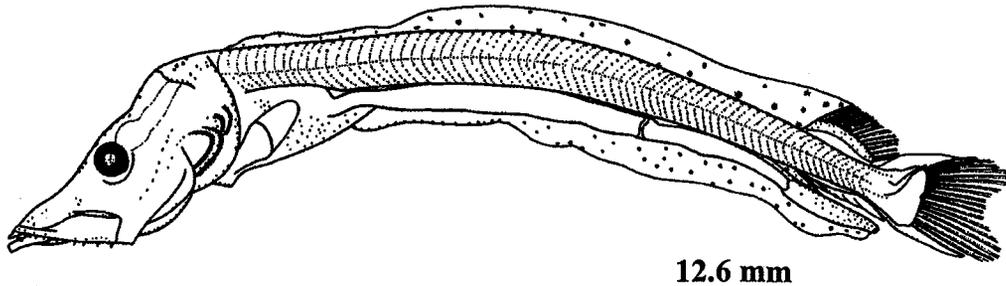
Flagellostomias – dorsal melanophores present (1 large/myomere), no epaxial myosepta melanophores, hypaxial melanophores present (1-3/myosepta), no trailing gut but relatively large diameter, head large, deep, with steeply sloping snout & large jaws, finfolds large accentuating body depth, few melanophores on median fin region & on dorsal & anal fins & on head, larvae may reach 30-40 mm. Example shown is *F. boureii* 36.4 mm after Kawaguchi & Moser 1984.



36.4 mm

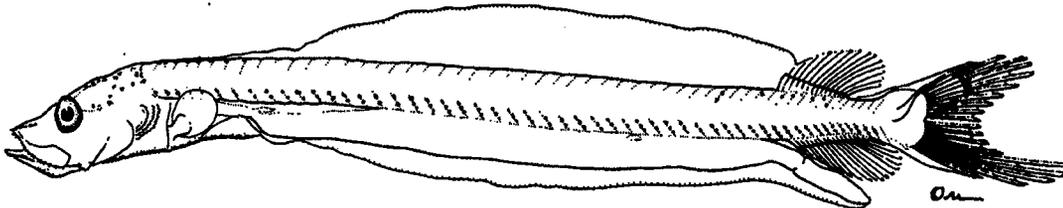
Grammatorstomias – dorsal melanophores present (1/myomere) based on adolescent pattern (see Beebe & Crane 1939: Fig. 2).

Leptostomias – dorsal melanophores present (1 large +1-several/myomere), pigment present on epaxial myosepta (1-7/myomere), pigment present on hypaxial myosepta (2-9/myomere), pigment increases with development to completely outline myosepta, pigment extensive on dorsal & ventral head, gill arches, below liver, finfold margins, dorsal gut terminus, gut slender not trailing, body somewhat deep, head moderately deep, eyes small, larvae reach 40 mm. Example shown is 12.6 mm from the Gulf of Mexico.



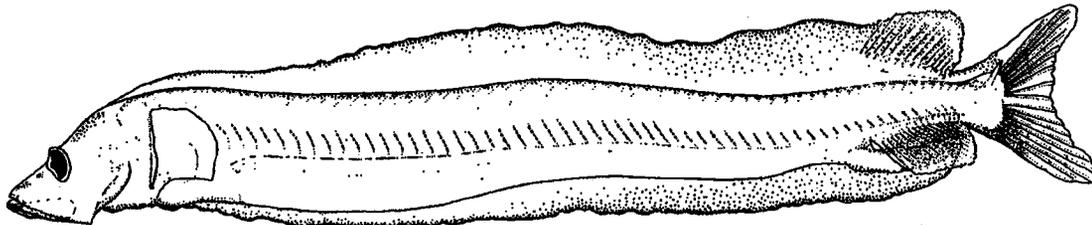
12.6 mm

Melanostomias – dorsal melanophores present in two forms: (1/myomere or area between 7th-10th myomere and dorsal fin lacks pigment), 2-3 melanophores in hypaxial myosepta, body slender, head & snout short, eye moderate, gut slender, finfold small, pigment above & below head, below liver, on gut terminus, on finfold margins, larvae may transform at 16.4 mm. (Larvae tentatively identified as *Echiostoma* have similar characters according to Kawaguchi & Moser 1984). Example shown is 16.0 mm from Kawaguchi & Moser 1984.



16.0 mm

Photonectes – dorsal melanophores have 2 types: Subgenus *Photonectes* (1 melanophore/myomere), subgenus *Trachinostomias* (3-7 melanophores/myomere), hypaxial myosepta variably pigmented according to species (2-3, 3-4, 4-5, 2-4, 5-7), extensive pattern of minute melanophores on head, finfold, & median fins, body somewhat deep, head & snout length moderate, eyes small & highly elliptical, larvae transform between 16 & 28 mm. Example shown is 22.2 mm from Kawaguchi & Moser 1984.



22.2 mm

Table Melanostomiidae 1. Meristic characters of the melanostomiid genera. Data from Morrow & Gibbs (1964), Kawaguchi & Moser (1984), & Clarke (1998).

Family & Genus	Fin Rays				Vertebrae	Branchiostegals	Species in Area
	Dorsal	Anal	Pectoral	Pelvic			
<i>Bathophilus</i>	13-17	13-18	2-37	4-26	38-45	8-14	13
<i>Chirostomias</i>	18-20	22-26	6	7	54-55	19-22	1
<i>Echiostoma</i>	11-16	13-19	4	8	57-59	13-15	1
<i>Eustomias</i>	20-29	32-46	0-13	7-8	56-71		ca. 33
<i>Flagellostomias</i>	14-17	21-26	9-11	7	ca.65	15-17	1
<i>Grammatostomias</i>	18-21	20-24	4-11	7-8	50-56	10-11	3
<i>Leptostomias</i>	14-22	23-29	5-11	7-8	75-83	16-19	6
<i>Melanostomias</i>	13-17	16-20	5	7	ca. 50-55		7
<i>Pachystomias</i>	21-24	25-27	5-6	7-9	48	ca. 9	1
<i>Photonectes</i>	15-22	18-24	0-3	6-7	49-64	11-15	12
<i>Thysanactis</i>	17-18	21-25	11	7	61		1
<i>Trigonolampa</i>	18-20	18-19	5	7	61-62	14-15	1
<i>Bathysphaera</i>	Sighted from bathysphere, no specimens collected						1

Table Melanostomiidae 2. Photophore counts in melanostomiid genera. Data from Clarke (1998), & Morrow & Gibbs (1964).

Genera	Photophore Groups					
	IP	PV	VAV	AC	OV	VAL
<i>Bathophilus</i>	4-6	12-18	11-17	5-9	10-16	8-17
<i>Chirostomias</i>	9	25-27	20	9-10	23-25	16-20
<i>Echiostoma</i>	8+2	25-28	14-18	12-13	24-27	13-17
<i>Eustomias</i>	7-8	24-36	11-20	15-25	24-37	12-21
<i>Flagellostomias</i>	9-10	32-34	14-15	16-18	31-32	14-15
<i>Grammatostomias</i>	7	15-18	20-22	11-13	15-18	19-22
<i>Leptostomias</i>	10-11	40-47	20-23	11-14	40-46	20-24
<i>Melanostomias</i>	8+2-3	23-30	12-15	9-11	22-28	11-15
<i>Pachystomias</i>	8-9	14-16	13-14	8-9	17-18	14-15
<i>Photonectes</i>	8-11	19-35	11-18	9-15	18-34	11-15
<i>Thysanactis</i>	20	31-32	14-16	11-12	30-32	14-16
<i>Trigonolampa</i>	11	23-24	22	10-11	22-24	23-24
<i>Bathysphaera</i>	Sighted from bathysphere, no specimens collected					

IDIACANTHIDAE: Black dragonfishes

W. J. Richards

The Family Idiacanthidae comprises one genus (*Idiacanthus*) with one Atlantic species *I. fasciola* and 3 additional species elsewhere. Their larvae are the most distinctive in the sea and were first described by Brauer (1906, 1908) and fully described by Beebe (1934). The body is long and slender at all stages, not greatly compressed, lacking hexagonal pigment areas and scales; pectoral fins present in young stages, absent in adults; pelvics in females in advance of mid-body, absent in males; dorsal fin long in adults, but opposite anal in young and preceded by long finfold; both dorsal and anal fins end just in advance of caudal; in adults a pair of short, bony projections anterior to and flanking each dorsal and anal ray (Gibbs (1964b). The unique feature of the larvae is the greatly extended, pencil-like eyestalks which make them the easiest of any larval form to identify. In addition, larvae have trailing guts (deflected to left of anal fin), flat heads, and unique pigment pattern of lateral melanophores and melanophores on the trailing gut (Kawaguchi & Moser 1984). Beebe (1934) provides a great deal of detail on the development. Novikova (1967) and Moser (1996g) also provide information on young stages. Meristics are given in Table Stomioidea 1 and photophore data in Table Stomioidea 2. Suffice it to say these are the easiest to identify in early stages by the long eye stalks in larvae and meristics in juveniles and adults. In our waters only *Bathylagus* has long eye stalks (a few *Myctophum* sp. have very short eye stalks), but they are short in comparison to *Idiacanthus*. They are also unique in the sexual dimorphism of late larvae, juveniles and adults due to the absence of pelvic fins in males.

MERISTICS

Vertebrae:

Total	ca.78
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Number of Fin Rays:

Dorsal	54-65(74)
Anal	39-47(38-49)
Pectoral	0
Pelvic	6
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Total	

Branchiostegals 17

LIFE HISTORY

Range: Throughout area
 Habitat: Meso- & bathypelagic
 ELH Pattern: Oviparous, planktonic eggs & larvae

LITERATURE

Beebe 1934, Gibbs 1964b

EARLY LIFE HISTORY DESCRIPTION

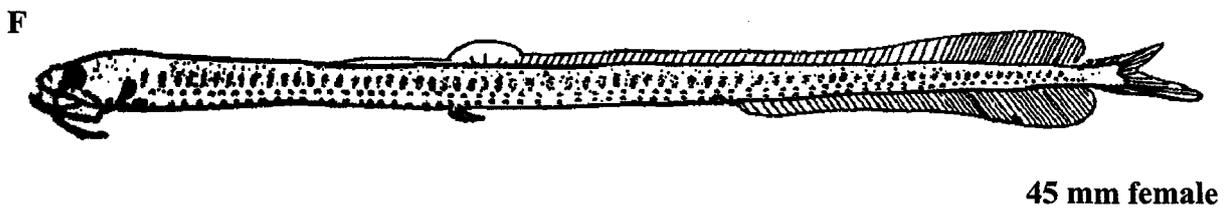
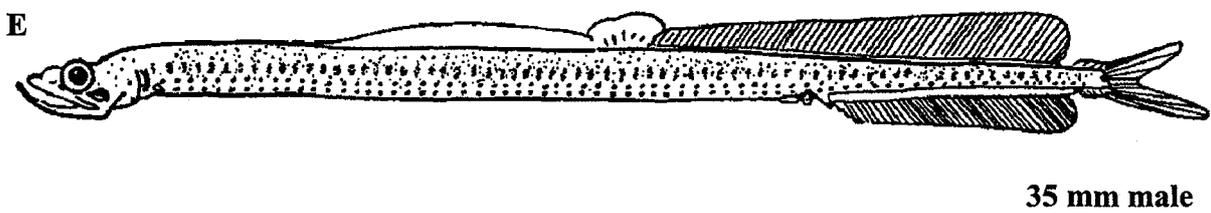
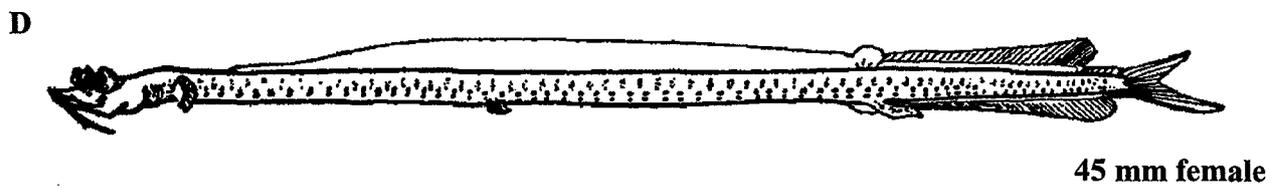
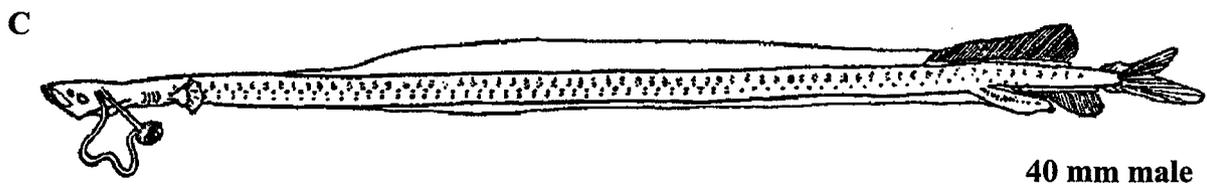
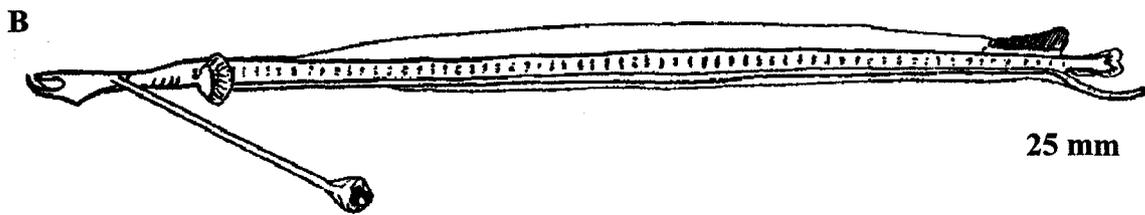
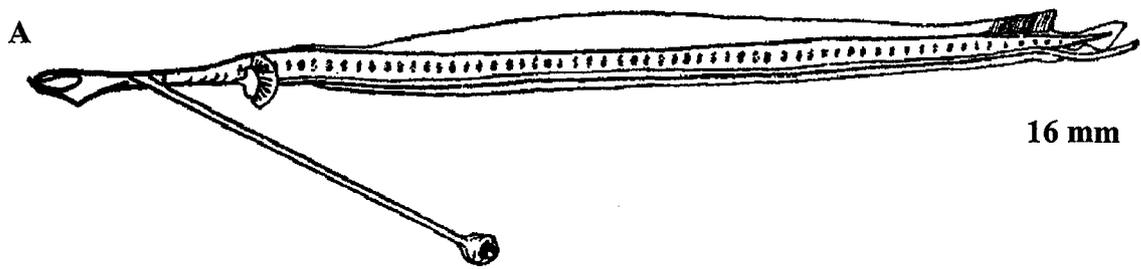
EGGS: Ovarian eggs 0.5-0.6 mm in diameter, yolks 0.4-0.45 mm in diameter, 2-8 small oil globules.

LARVAE:

Length at Flexion: ca. 16-25 mm
 Length at Transformation: 35 mm (males), 45 mm (females)
 Sequence of Fin Development: D, P₁, C, A, , & P₂ (P₂ absent in males, P₁ lost at transition in both sexes)
 Pigmentation: 64 midlateral blotches from the head to caudal base in the middle of each myomere; 6 small melanophores on midline of isthmus, row of melanophores on trailing gut; head and fins lack pigmentation. Pigmentation on the trunk increases at transformation including pigmentation on the head.
 Diagnostic Characters: Eliptical eyes on long, cartilaginous eye stalks in larvae that decreases in length at transformation, pigmentation pattern, lack of P₂ in males, loss of P₁ in both sexes, development of barbel in transitional females, no barbel in males, long dorsal fin reaching mid-body at transition, meristics, trailing gut deflected to left of A fin.

ILLUSTRATIONS

Gibbs 1964b: A-F) sexually indeterminate larvae 16 & 25 mm; male 40 mm, female 45 mm; male 35 mm; female 48 mm; male 35 mm; female 45 mm



MALACOSTEIDAE: Loosejaws

W. J. Richards

The Family Malacosteidae comprises 3 genera and 15 species worldwide (Nelson 1994) with all genera and 9 species found in our area (Morrow 1964c). They have elongated jaws (longer than the skull), head moves vertically (due to lack of ossification of first few vertebrae) and lack a floor to the mouth (due to lack of a membrane between the mandibular symphysis and hyoid apparatus with muscles in single sheath forming a slim cord). The dorsal fin is above the anal fin, adipose fin and scales absent, chin barbel and pectoral fins maybe absent. The body is long, slender and compressed lacking scales and with minute photophores scattered over the head and body. They are small predators in the meso- and bathypelagic zone with large teeth. The unusual lack of a mouth floor and long jaws allows for an extraordinary large mouth opening (Moser 1996f).

Malacosteid eggs are unknown and only 2 larvae have been described. Beebe & Crane (1939) as *?Eustomias* but apparently *Aristostomias* (Kawaguchi & Moser (1984). Kawaguchi & Moser (1984) give some information on *Aristostomias* and *Photostomias* and Moser (1996f) describes an *Aristostomias* from the eastern tropical Pacific. The larvae are very slender with a large flattened head, elongate snout, and large jaws. The gut is slender and trailing with pigmentation on the trailing part. Pigmentation on the trunk may be lacking or 8 to 14 large melanophores on the dorsal myomeres including many below the dorsal fin. Ventral melanophores may be lacking or present. In *Aristostomias* the number of ventral melanophores increases with development from about 12 to many. There are no melanophores associated with epaxial or hypaxial myosepta. As with other stomiiforms every effort should be made to retain specimens for study due to their rarity. Meristic characters are given in Tables Stomioidea 1 & 2. Illustrations for two specimens are shown below – A) is a *Photostomias* 26.7 mm from Kawaguchi & Moser (1984), B) is original drawing of a 22.8 mm SL specimen from the Gulf of Mexico (OREGON II Cr. 166, Sta. 45395 R6B3).

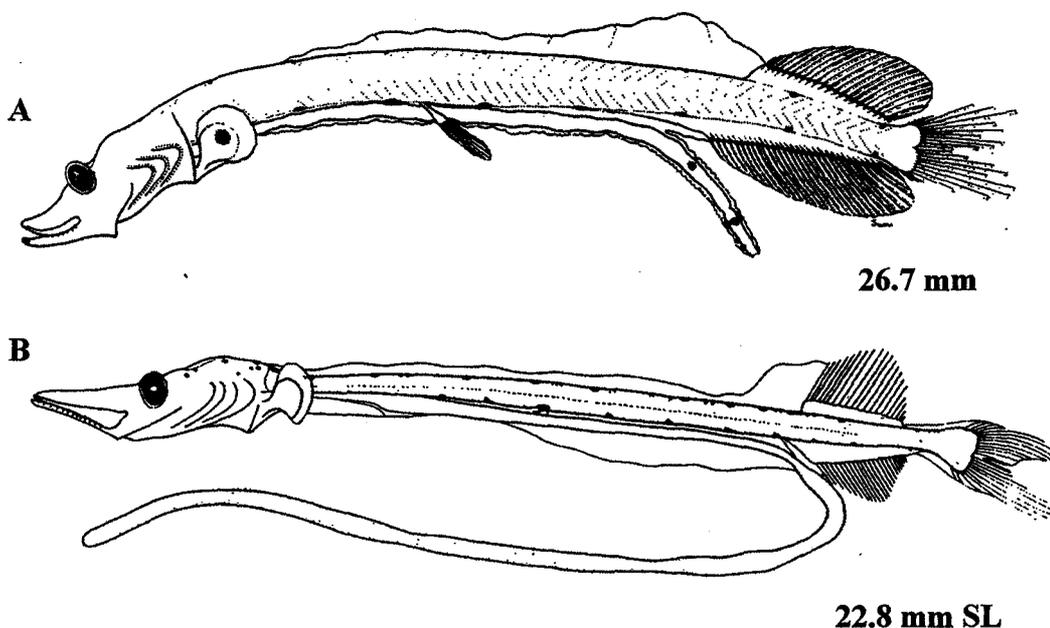


Table Malacosteidae 1. Meristic characters of the malacosteid genera. Data from Clarke (1998) & Morrow (1964 c).

Genus	Fin Rays				Vertebrae	Branchiostegals	Species in Area
	Dorsal	Anal	Pectoral	Pelvic			
<i>Aristostomias</i>	18-26	24-32	6-17	6	44-52	ca.15	6
<i>Malacosteus</i>	14-20	17-23	3-5	6	49		1
<i>Photostomias</i>	22-28	25-32	0	5-6	52-58	9-12	2

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