**ORDER MYCTOPHIFORMES: Blackchins and Lanternfishes** **By H. Geoffrey Moser and William Watson**

The order Myctophiformes includes two families of luminous (most species), pelagic or benthopelagic fishes that occupy deep-sea habitats in all oceans. Worldwide, the Neoscopelidae is represented by six species in three genera and the Myctophidae by >235 species in 32 genera (Hulley 1994; Nelson 1994). Stiassny (1996) reviewed myctophiform systematics, presented new evidence for monophyly of the order and of the two constituent families, and supported Rosen (1973) and Johnson (1992) in placing myctophiforms as the sister group to acanthomorph fishes.

Information on life history, habitat, and distribution of adults of the two families is based largely on Nafpaktitis (1977), Nafpaktitis et al. (1977), Hulley (1981, 1984a,b, 1986), Bekker (1983), and Gartner et al. (1987). Meristic characters of adults are summarized in tables in the introduction to each family. These tables include modal counts and ranges for vertebrae, fin rays, rakers on the first gill arch, and AO photophores (myctophids). The gill raker count for the lower limb includes the raker at the angle of the arch. Information in these tables was gathered from literature sources listed in the table and from original observations.

In the species descriptions only the ranges of meristic characters are given for vertebrae, fins, and for gill rakers and branchiostegal rays, when known. Specimen size is given as "body length" (BL); whether the indicated body length is "notochord length" (NL) or "standard length" (SL) can be ascertained by referring to size-at-stage data given in each species description. Other abbreviations are as follows: Ad, adipose fin; BD, body depth at pectoral fin base; Br, branchiostegal; C, caudal fin; C1, principal caudal fin rays; C2, procurrent caudal fin rays; D, dorsal fin; ED, eye diameter (in round eye); EL, eye length (long axis of oval or elliptical eye); EW, eye width (short axis of oval or elliptical eye); GR, gill rakers; HL, head length; P1, pectoral fin; P2, pelvic fin; PdL, distance from tip of snout to D origin; Sn-A, distance from the tip of snout to anus; SnL, snout length. The sequence of fin formation is based on the first appearance of fin support elements or fin rays for each fin. This was based on the literature or on original observations. The sequence is given in a formula with the abbreviations for successively appearing fins separated by a comma and simultaneously appearing fins united by an "&".

Species descriptions emphasize the typical melanophore patterns of each developmental stage. Some myctophid species develop photophores during the larval period and these aid in identification. Body length at first appearance of each photophore is given, if known. The diagnostic features section lists characteristics that will help separate larvae of a species from others in the same family or genus.

Sources of illustrations from the literature are cited. Station or museum catalogue numbers for specimens used for original illustrations are listed and the illustrator’s name (s) is enclosed in brackets. Most of the material used for original illustrations was from the collection under the care of William Richards at the NMFS Miami Laboratory. Localities for these stations are listed in an appendix to this chapter. These illustration specimens are presently archived at the Miami Laboratory and will ultimately be transferred to the Florida Museum of Natural History, University of Florida, Gainesville.

We thank William Richards for specimen loans and for his support and encouragement throughout this project. The hospitality he and Carol Richards extended to the senior author during productive and enjoyable research visits to the Miami Laboratory is deeply appreciated. Karsten Hartel and Karel Liem, Museum of Comparative Zoology (MCZ), Harvard University, provided critical specimens and support and hospitality to the senior author during research visits to the MCZ. Extensive background study for this guide was carried out by the senior author during a visit to the Zoological Museum, University of Copenhagen, under the sponsorship of Jørgen Nielsen and the late Eric Bertelsen, who also loaned numerous specimens subsequent to that visit. The visit was funded in part by the Johannes Schmidt

Stipendium for Oceanographers. We thank Walter Nellen, former Director of the Institute for Hydrobiology and Fisheries Science, University of Hamburg, for the loan of material from the Meteor Seamount. We thank Bruce Mundy (NMFS, Honolulu) for loans of specimens and for helpful discussions. P. A. Hulley (South African Museum, Cape Town) offered useful advice on the taxonomy of Myctophum and provided a manuscript key to that genus. We thank John Paxton (Australian Museum) for discussions on the taxonomic status of various groups of myctophids. We are indebted to Richard Rosenblatt, Phillip Hastings, H. J. Walker, and Cynthia Klepadlo (Scripps Institution of Oceanography) for the loan of juvenile specimens and for specimens needed to supplement published information on the meristic characters of adults. We thank R. C. Walker and C. Manning for original illustrations and J. Butler, S. Evseenko, E. Fujii, H.-C. John, B. Nafpaktitis, M. Okiyama, M.-P. Olivar, T. Ozawa, T. Pertseva-Ostroumova, T. Shiganova, A. Sparta, A. Taaning, and C. Zelck for the use of illustrations from their publications.

## NEOSCOPELIDAE: Blackchins

By H. Geoffrey Moser and William Watson

The family Neoscopelidae consists of six species in three genera. Scopelengys and Neoscopelus occur in the Atlantic, Pacific, and Indian Oceans. S. tristis, N. macrolepidotus, and N. microchir have been reported from the western central Atlantic (Nafpaktitis 1977; Hulley 1984b, 1986).

Neoscopelids are small to medium in size (<30cm) with a compressed head and body. Jaws are large, extend to the back of the orbit, and bear villiform teeth. An adipose fin is present. The fins are large; the dorsal fin origin lies above the pelvic fin and the anal fin origin is well behind the dorsal fin insertion. The large pectorals extend posteriad to the anus or anal fin origin. The eyes are small (eye diameter >7 times in head length) in Scopelengys and larger (eye diameter  5 times in head length) in Neoscopelus. Scopelengys has an elongate body covered with large, highly deciduous cycloid scales, and lacks light organs. Neoscopelus is moderately stout, covered with large cycloid somewhat deciduous scales, and has ventrolateral rows of photophores and a series of light organs on the periphery of the tongue (Figure 1). The bathypelagic Scopelengys is brown to black, weakly ossified, and lacks a gas bladder. In contrast, the benthopelagic Neoscopelus is reddish to dark red on the upper regions of the head and body and silvery below, with pinkish fins; members of the genus are well ossified with firm musculature, and the gas bladder is large and well developed. The two species of Neoscopelus that occur in the region can be distinguished as follows: 1) in N. microchir the lateral series of photophores (LO series) extends posteriad to or beyond a vertical from the anal-fin insertion whereas in N. macrolepidotus the series stops short of the anal-fin origin; 2) N. microchir has 14-6 total gill rakers whereas N. macrolepidotus has 10-12 (Nafpaktitis 1977; Hulley 1984b, 1986).

Neoscopelids are assumed to be oviparous but planktonic eggs have not been identified. The larvae are deep bodied and robust with a somewhat massive gut. The head and jaws are large; teeth are sharp and enlarged anteriorly in the jaws. The pectorals are the first fins to develop rays and become elongate, extending posteriad beyond the anus. Larvae of Scopelengys have a large pigment blotch over the gut. Larvae of S. tristis develop a stripe through the eye (Okiyama 1974, 1984, 1988; Butler and Ahlstrom 1976). Larvae of S. tristis resemble larvae of some species of the myctophid genus Lampanyctus but have a more posteriad placement of the anal fin, a more massive gut, and lack the $Br_2$ photophore present in larval myctophids. Larvae of Neoscopelus differ from those of Scopelengys in having a relatively shorter snout, longer gut, smaller pectoral fins, and have preopercular spination (Okiyama 1988).

The description of *N. macrolepidotus* larvae is based on Okiyama (1974, 1984, 1988) and on three central Pacific specimens (4.0-5.1 mm), provided by Bruce Mundy (NMFS, Honolulu); that of *N. microchir* is based on a description of a *Neoscopelus* sp. larva (Okiyama 1988) and 9 larvae from the Meteor Seamount region (29° 33'-30° 32' N, 28° 23'-28° 47' W) provided by Dr. W. Nellen; that of *S. tristis* is based on Okiyama (1974, 1984, 1988), Butler and Ahlstrom (1976), and Moser (1996). A late transformation specimen of *N. macrolepidotus* (19.8 mm SL) and a mid- transformation specimen of *N. microchir* (17.9 mm) were loaned by Karsten Hartel (MCZ). The specimen of *N. microchir* made it possible to identify the larva of *Neoscopelus* sp. illustrated by Okiyama (1988) as *N. microchir*. Meristic data (Neoscopelidae Table 1) and ecological information were obtained largely from Nafpaktitis (1977) and Hulley (1984b, 1986).

Table Neoscopelidae 1. Meristics for neoscopelids in the western central Atlantic (based on Nafpaktitis 1977; Hulley 1984b, 1986). Typical counts are followed by ranges (in parentheses).

| **Species** | **D rays** | **A rays** | **$P_1$ rays** | **$P_2$ rays** | **Br rays** | **Gill rakers** | **Vertebrae** |
|---|---|---|---|---|---|---|---|
| *Neoscopelus macrolepidotus* | 12-13 | 12(11-13) | 18-19 | 8-9 | 8-9 | 2+9(8- 10) | 30-31 |
| *Neoscopelus microchir* | 13(12- 13) | 11(10-13) | 15-17 | 8-9 | 8-9 | 3(3-5)+11(11-14) | 30-31 |
| *Scopelengys tristis* | 11-12(11- 13) | 13(11-14) | 15-16(14-17) | 8 | 8 | 1+8(7-9) | 30-31(29- 32) |

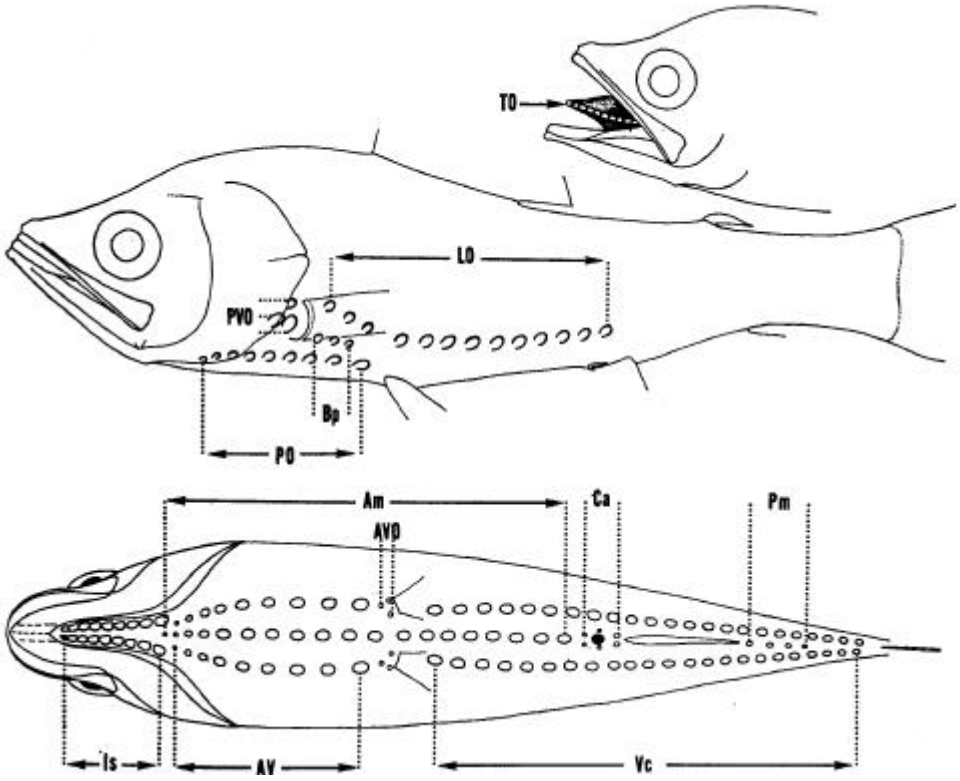



Figure 1. Arrangement of the photopores in *Neoscopelus* (from Nafpaktitis 1977).

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | |
| Caudal | |
| Total | 30-31 |
| Number of fin rays | |
| Dorsal | 12-13 |
| Anal | 11-13 |
| Pectoral | 18-19 |
| Pelvic | 8-9 |
| Caudal | |
| Dorsal Secondary | 6 |
| Principal | 10+9 |
| Ventral Secondary | 6 |
| Total | |
| Gillrakers on first arch | |
| Upper | 2 |
| Lower | 8-10 |
| Total | 10-12 |
| Branchiostegals | 8-9 |

## LIFE HISTORY

Range: Tropical to subtropical western Atlantic, eastern South African coast, off Hawaii, southern Japan, the Australian Bight

Habitat: Benthopelagic in slope waters, 300-800 m depth

ELH pattern: Oviparous, planktonic eggs and larvae

## LITERATURE

Matarese et al. 1989
Okiyama 1974, 1984, 1988

## EARLY LIFE HISTORY DESCRIPTION*

**LARVAE:**

Length at flexion: ~ 6-7 mm

Length at transformation: ~ 19 mm

Sequence of fin development: $P_1$, $C_1$, D & A, $P_2$, $C_2$

Pigmentation: *Preflexion-postflexion*—Patch above terminal section of gut & above developing gas bladder; some pigment above brain in postflexion larvae. *Transformation-juvenile*—Solidly pigmented except for interorbital, occipital, & postorbital regions of head; myosepta accentuated on posterior half of body.

Diagnostic features: Body stout (BD 24% BL in preflexion stage; 25-29% in flexion-postflexion larvae); gut robust, & elongate (Sn-A 61-74% BL), foregut somewhat saccular in flexion-postflexion stage; head & jaws large (HL 28-36% BL); eyes round, moderate in size (23-30% HL); $P_1$ forms early in preflexion stage & becomes large & fan-shaped ($P_1$L 26-28% BL in preflexion-flexion larvae & ~ 20% BL in postflexion larvae); $P_2$ relatively shorter than in *N. microchir* ($P_2$L ~ 11% BL vs 22-24% BL in postflexion larvae); short needle-like teeth on premaxillary; larvae lack pigment streak through eye (present in *Scopelengys tristis*); preopercular spines form at flexion stage (lacking in *S. tristis*); $P_1$ & $P_2$ lack pigment (present on *N. microchir*); *Transformation-juvenile*— Gill raker count 2+9; Sn-A, HL, & BD proportionally less than in *N. microchir* (Sn-A 62% SL vs 68%, HL 30% SL vs 35%, BD 23% SL vs 29%); paired fins lack pigment; photophores forming on 19.8 mm specimen (7 on each side of tongue, the posteriormost larger than the others; 9 in isthmus series; large suborbital organ mesial to end of maxilla; 2 on preopercular region; 1 PVO; ventral organs forming on body but difficult to distinguish from melanophores).

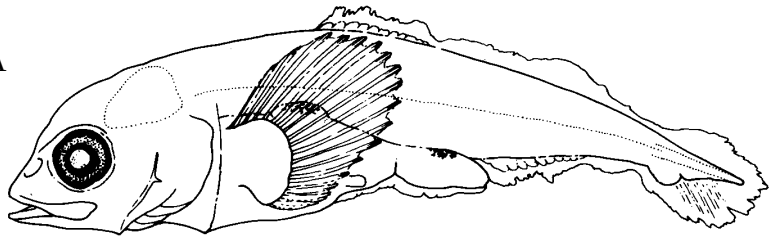
## ILLUSTRATIONS

A & B, from Okiyama (1988); C, original [R. C. Walker/ W. Watson]

C, MCZ 60705

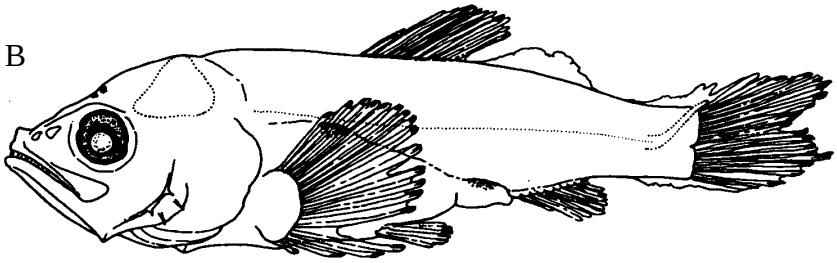
* Description of larvae based on descriptions and illustrations of Okiyama (1988), & on 3 preflexion stage larvae provided by Bruce Mundy (NMFS, Honolulu).

A



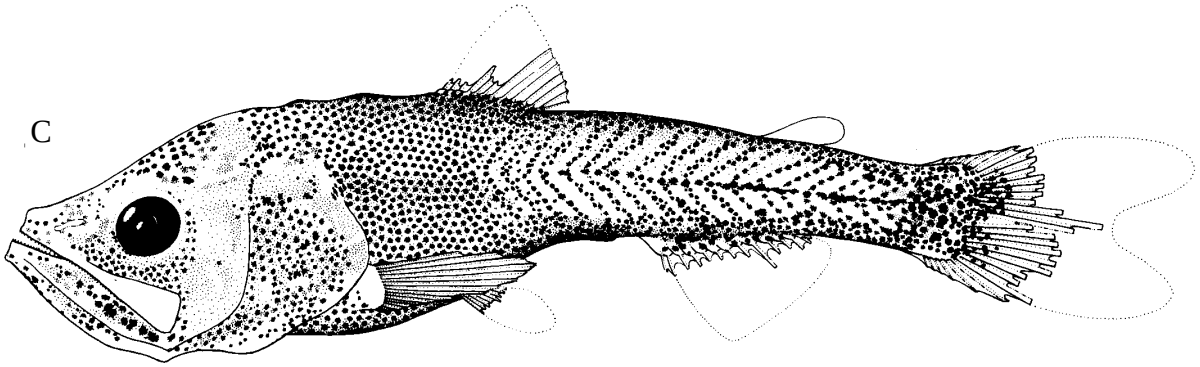
5.3 mm

B



7.9 mm

C



19.6 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | |
| Caudal | |
| Total | 30-31 |
| Number of fin rays | |
| Dorsal | 12-13 |
| Anal | 10-13 |
| Pectoral | 15-17 |
| Pelvic | 8-9 |
| Caudal | |
| Dorsal Secondary | |
| Principal | 10+9 |
| Ventral Secondary | |
| Total | |
| Gillrakers on first arch | |
| Upper | 3-5 |
| Lower | 11-14 |
| Total | 14-18 |
| Branchiostegals | 8-9 |

## LIFE HISTORY

Range: Tropical to subtropical western Atlantic; most western Atlantic records are from the Caribbean, few records from the eastern Atlantic; Indo-Pacific to eastern South African coast

Habitat: Benthopelagic in slope waters, 250-700m in depth

ELH pattern: Oviparous, planktonic eggs and larvae

## LITERATURE

Okiyama 1988, as *Neoscopelus* sp.

## EARLY LIFE HISTORY DESCRIPTION

**LARVAE:**

Length at flexion: ~ 7 mm

Length at transformation: ~ 18 mm

Sequence of fin development: $P_1$ & $P_2$, $C_1$ & D & A, $C_2$

Pigmentation: *Preflexion*—Embedded blotch above the anteriorly located gas bladder; paired embedded series extending posteriad from gas bladder blotch to slightly beyond gut terminus. *Postflexion-transformation*— Pigment above gas bladder and gut obscured by musculature; patch present above terminal section of gut, extending sparsely above gut onto side of body; 1 or more embedded at nape and a patch above brain; concentrated patch on $P_1$, dorsally at base of rays; similar patch basally on $P_2$ rays; juvenile pigment forming at 18 mm.

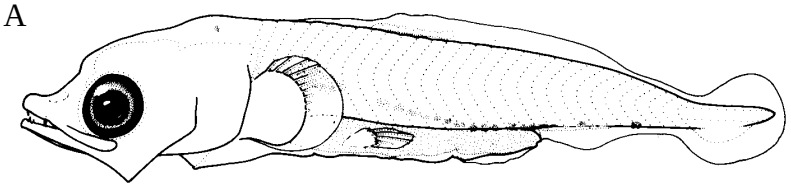
Diagnostic features: *Postflexion*— Lacks pigment stripe through the eye present in *S. tristis*; $P_1$ somewhat fan-shaped, moderate in size ($P_1$L ~ 21-22% BL in postflexion stage); $P_2$ relatively longer than in *N. macrolepidotus* ($P_2$L ~ 28% BL vs 11% BL in postflexion stage); pigment patches on bases of $P_1$ and $P_2$ fins (not present in *N. macrolepidotus*); massive gut relatively longer than in *N. macrolepidotus* (Sn-A 81-92% BL vs 74% BL in postflexion stage); terminal section of gut may extend beyond ventral body margin in some specimens; preopercular spination (not present in *S. tristis*); needle-like teeth anteriorly on premaxillary. *Transforming*C Gill raker count 3+11; pigment patches on bases of $P_1$ & $P_2$ rays; relative BD, Sn-A, & HL greater than in slightly more advanced transforming specimen of *N. macrolepidotus* (BD 28% BL vs 23%, Sn-A 68% BL vs 62%, HL 35% BL vs 30%); needle-like teeth anteriorly on premaxillary; photophores forming on 17.9 mm specimen (large suborbital organ mesial to end of maxilla; 2 on preopercular region; 1 PVO; organs on tongue, isthmus, & ventral margin of body just beginning to form).

## ILLUSTRATIONS

A, original [W. Watson]; B, from Okiyama (1988); C, original [R. C. Walker/ W. Watson]

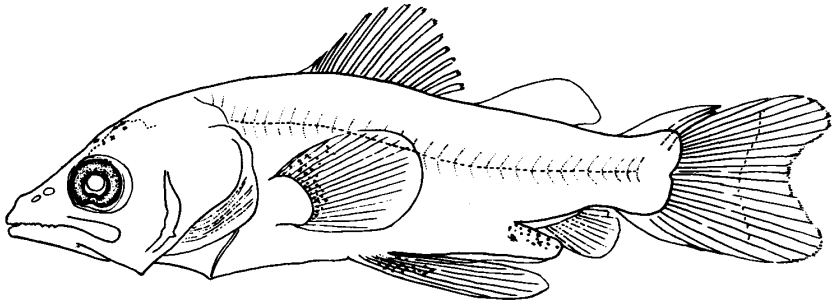
A, Nellen/Meteor Sta. 122 (29° 42' N, 28° 23' W); C, MCZ60704

A



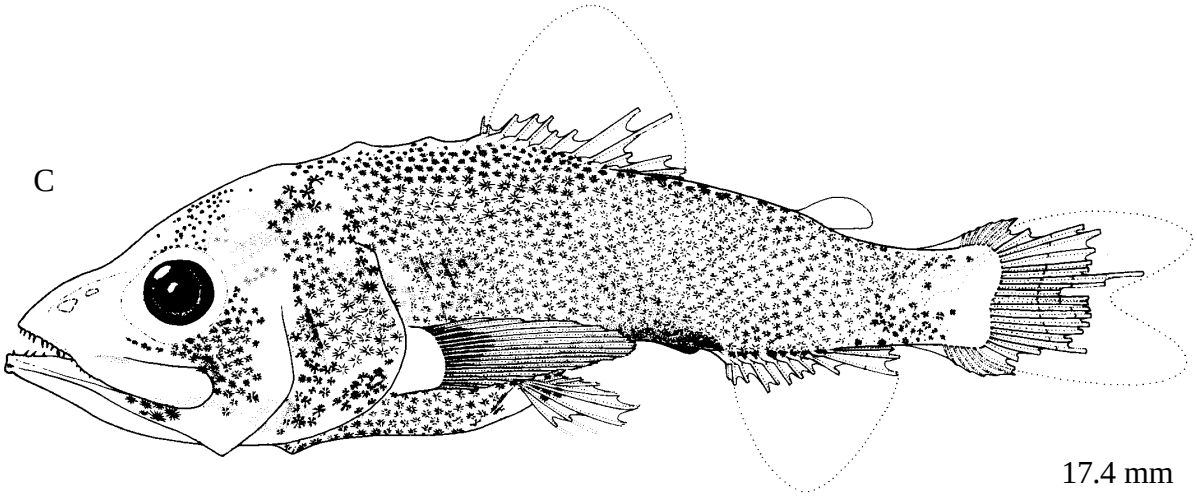
5.3 mm

B



8.6 mm

C



17.4 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 12-13 |
| Caudal | 17-19 |
| Total | 29-32 |
| Number of fin rays | |
| Dorsal | 11-13 |
| Anal | 11-14 |
| Pectoral | 14-17 |
| Pelvic | 8 |
| Caudal | |
| Dorsal Secondary | 6-9 |
| Principal | 10+9 |
| Ventral Secondary | 7-8 |
| Total | |
| Gillrakers on first arch | |
| Upper | 1 |
| Lower | 7-9 |
| Total | 9 (8-10) |
| Branchiostegals | 8 |

## LIFE HISTORY

Range: Worldwide in subtropics
Habitat: Epi- and mesopelagic
ELH pattern: Oviparous, planktonic eggs and larvae

## LITERATURE

Butler & Ahlstrom 1976
Moser 1996
Okiyama 1974, 1984, 1988

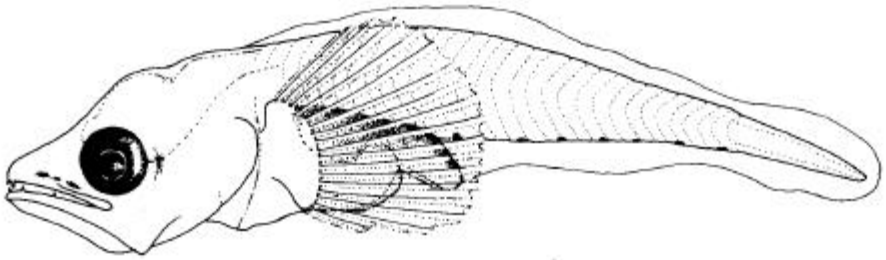
## EARLY LIFE HISTORY DESCRIPTION*

**LARVAE:**
Length at flexion: ~ 6.0-8.0 mm
Length at transformation: ~ 21.0 mm
Sequence of fin development: $P_1$, $C_1$, D, A, $C_2$, $P_2$
Pigmentation: *Preflexion*—Smallest larvae have a blotch above gut & ~ 7 melanophores in a postanal median ventral series; by 4.6 mm, an embedded linear blotch in snout & an embedded post-orbital blotch form a streak through eye. *Flexion-postflexion*—Postanal series reduced to 1-5, or absent; blotch above gut becomes elongate.
Diagnostic features: Body deep & robust; gut moderate in length, robust, strongly sigmoid (Sn-A 48-56% BL in preflexion larvae); 60-66% BL in flexion-postflexion larvae; head & jaws large, snout elongate & more acute than in flexion-postflexion *Neoscopelus* larvae (SnL 32-41% HL vs 27-30% HL in *Neoscopelus*); jaws large with needle-like teeth, larger at tip of jaws; eyes round & small (preflexion, ED 24-28% HL; flexion, 20-21%; postflexion, 14-19%); $P_1$ forms early in preflexion stage, becomes large & fan-shaped, extending past anus ($P_1$L 25-40% BL in flexion-postflexion larvae vs 17-20% BL in postflexion *Neoscopelus* larvae); pigment streak through eye lacking in *Neoscopelus*; a similar species *S. clarkei* (not known from Atlantic) lacks eye stripe & has mandibular, posterior head, & nape pigment after flexion stage.

## ILLUSTRATIONS

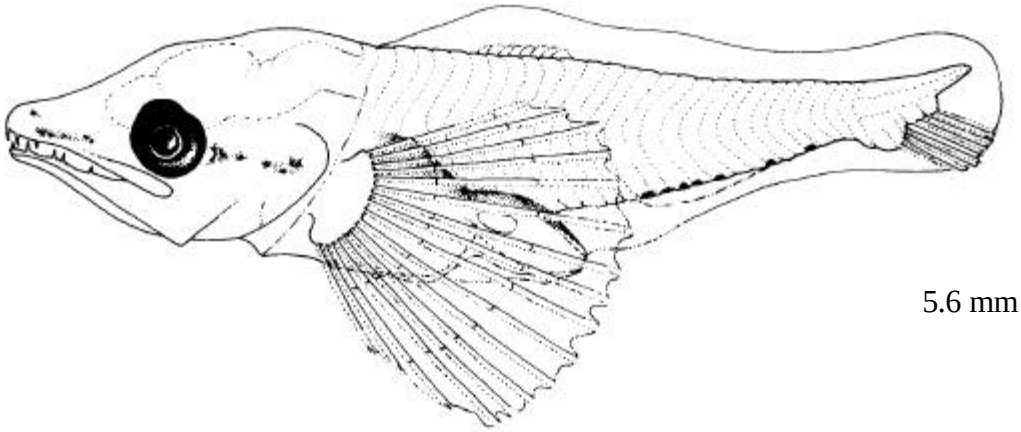
A & B, from Moser (1996); C, from Butler & Ahlstrom (1976)
***** Description based on Moser (1996)

A



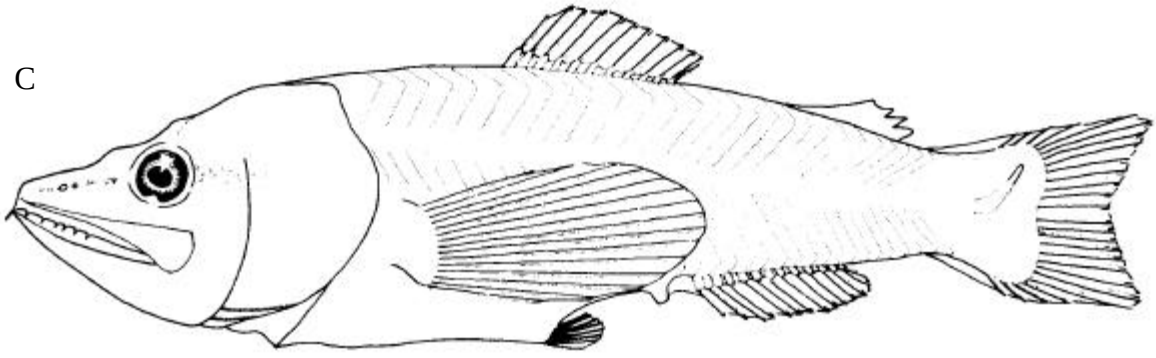
3.7 mm

B



5.6 mm

C



13.9 mm

## MYCTOPHIDAE: Lanternfishes

By H. Geoffrey Moser and William Watson

Lanternfishes are the most ubiquitous fishes in the world ocean with a total biomass estimated at >600 million tons (Hulley 1994). There are at least 70 species representing approximately 20 genera in the western central Atlantic (Nafpaktitis et al. 1977; Hulley 1981; Bekker 1983, Gartner et al. 1987, Richards 1990). Larval stages are known for approximately 40 species representing all 20 genera in the region (Table Myctophidae 1). Lanternfish larvae are among the most abundant larvae encountered in plankton samples from this region and rank first in total abundance in SEFSC collections (Richards et al. 1993).

Myctophids are small to medium-size (3-35 cm) deep-sea fishes with a compressed body and head, large eyes, and moderate to large jaws with bands of small, closely set teeth. The mouth is terminal in most species and the maxillary is completely excluded from the gape. There is a single dorsal fin followed by an adipose fin supported by a cartilaginous plate. The anal fin origin is under or slightly posterior to the dorsal fin base; the pelvic fins are abdominal and have eight rays in most species. Pectoral fins range from large and well developed to small and weakly formed or even absent in some species. There is a rudimentary spine at the base of the first dorsal ray, the first anal ray, the upper pectoral ray, and the outermost pelvic ray. Color of live specimens ranges from iridescent blue, green, or silver in shallow-living species to dark brown or black in deep-living species. The body is covered with rounded cycloid scales; a few species have ctenoid scales. A gas bladder is present in juveniles but may become reduced or invested with fatty tissue in adults. Lanternfishes are harvested commercially only off South Africa and in the sub-antarctic; however, their enormous biomass may mark them for much greater commercial exploitation in the future (Nafpaktitis et al. 1977; Hulley 1994).

Lanternfishes have a variety of luminous organs, the most prominent of which are the paired rows or groups of photophores on the ventral and lateral regions of the body. Photophores are complex structures consisting of a modified cup-like scale containing photogenic tissue overlain by a scale modified as a lens. Photophores of similar structure are arranged on the head. Myctophid photophores have a fundamental pattern (Figure 2) but most species and genera (to some degree) have a unique arrangement within the basic pattern. Other kinds of luminous organs are: small secondary photophores on the head and body, supra- and infracaudal glands (often sexually dimorphic) of various form and complexity, specialized photophores associated with the eyes, and luminous patches or scales on the bases of fins and elsewhere on the body (Nafpaktitis et al. 1977; Hulley 1994).

Almost all myctophids undergo diel vertical migrations, probably associated with foraging on planktonic crustaceans. At night, many lanternfishes migrate upward to the mixed layer from daytime depths of 300-2000 m. Some species come to the surface where they may be dipnetted or captured by neuston nets. Deep-living species tend to undergo little or no vertical migration. For some species, the degree and pattern of vertical migration is different for juveniles and adults (Nafpaktitis et al. 1977; Hulley 1994). Larvae of myctophids are generally found in the upper mixed layer; however, larvae of the subfamily Myctophinae have deeper distributions (to 500 m for some species) than do those of the Lampanyctinae (Moser and Smith 1993).

Myctophids are oviparous and presumably all have planktonic eggs; however, their planktonic eggs are collected infrequently and none has been identified to species in the region covered by this guide. The great disparity between the apparent paucity of planktonic eggs and high larval abundance may be explained by the disintegration of the eggs during capture. Eggs are approximately 0.70-0.90 mm in diameter, have segmented yolk, a moderately large perivitelline space, a single oil globule ( ~ 0.1-0.3 mm diam.), and a fragile chorion. It is likely that the thin chorion is broken during the tow and subsequently the embryo is disintegrated and passed through the meshes. Similarly, disintegration and extrusion of yolk-sac larvae could explain their near absence from the samples.

Larvae of lanternfishes are among the most extensively studied of all fish larvae. They hatch at ~ 2.0 mm and range in size at transformation from 10 to 30 mm, depending on the species. Myctophid larvae have a vast array of morphological and pigment characters that permit identification of

species and are useful in systematic analyses of genera and subfamilies (Moser et al. 1984; Paxton et al. 1984; Moser and Ahlstrom 1996). Head, gut, and body shape are distinctive for most species and genera have a recognizable morph. Although most species are moderately slender, body shape ranges from highly attenuate to markedly robust or deep-bodied and compressed. Eyes are elliptical in the Myctophinae and round or nearly round in most Lampanyctinae. Many of the narrow-eyed myctophine species have a well developed mass of choroid tissue on the ventral surface of the eye and several genera have stalked eyes. Typically, the gut is slightly sigmoid, extends to the midbody, and has distinctive transverse mucosal folds; however, gut length can range from extremely short (preflexion *Lampanyctus*) to elongate and trailing free from the body (*Myctophum aurolaternatum*, a Pacific and Indian Ocean species). The pectoral fins may be large and distinctly shaped; some species have a higher pectoral ray count in larvae than in adults and some have elongate, ornamented lower pectoral rays. The pelvic fin is usually the last to form, although it is precocious in some species. Usually, the median finfold is well developed and is voluminous in *Loweina* and related genera. In all but two genera, the $Br_2$ photophore develops during the larval period and in many genera (3 in Myctophinae and 11 in Lampanyctinae) other photophores develop during the larval period.

Except for the large genus *Diaphus*, the larvae of most lanternfish species have a unique melanophore pattern that allows their identification and a recurring pattern of pigment loci can be recognized for most genera (Moser et al. 1984; Moser and Ahlstrom 1996). Identification of larval *Diaphus* species has proven to be extremely difficult. Two forms of *Diaphus* larvae have been described (Moser et al. 1984; Moser and Ahlstrom 1996): a slender morph with numerous persistent postanal ventral melanophores and a stout morph with fewer postanal melanophores that coalesce before flexion. Within these two morphs, few characters are available for distinguishing species. In the region covered by this guide larvae of only a few species have been described in the literature (Myctophidae Table 1). Larvae of *D. rafinesquii* (Taaning 1918) and *D. metopoclampus* (Sparta 1952) are of the stout type with early coalescing postanal melanophore series. Larvae of *D. holti*, an eastern Atlantic species (not included in this guide), are the slender type with a persistent postanal melanophore series (Taaning 1918).

Taxonomic confusion of the larvae of *Hygophum macrochir* and *H. taaningi* requires special comment. Zhudova (1969) identified and illustrated larvae of *H. macrochir* as *H. taaningi* and those of *H. taaningi* as *H. macrochir*. This error was confounded futher by Shiganova (1974, 1975a) who described larvae of *H. macrochir* as *H. benoiti* and larvae of *H. taaningi* as *H. macrochir*. In 1970, one of us (HGM) examined *Hygophum* larvae from Dana stations in the tropical-subtropical eastern Atlantic and found two distinct larval forms that shared gut morphology unique within the genus (Moser & Ahlstrom 1974). Transformation series from the same samples containing their larvae indicated that the more slender form with a heavy pigment patch dorsolateral to the hindgut was the larva of *H. macrochir* and the deeper-bodied form, usually with a single pair of melanophores at the hindgut, was *H. taaningi*. Although adults of both species occur in the eastern Gulf of Mexico, *H. taaningi* is approximately ten times more abundant than *H. macrochir* (Gartner et al. 1987). One of us (HGM) found only the larvae of the deep-bodied form in samples from this region and they are described here as *H. taaningi*. There was considerable variation in the amount of pigment dorsolateral to the hindgut; however, none of the specimens examined had the heavy patch of melanophores typical of the slender-bodied form identified as *H. macrochir* from Dana stations in the eastern Atlantic examined in 1970. The problem surrounding the larvae of these two species deserves additional research as does the taxonomic status and zoogeography of this complex within *Hygophum*.

The following descriptions are based on original observations and on published literature where applicable (Table Myctophidae 1). Meristic data (Tables Myctophidae 2 and 3) were obtained primarily from Nafpaktitis et al. (1977), Hulley (1981, 1986), Zahuranec (2000), and Moser and Ahlstrom (1996) and from counts made during this

study, primarily on specimens borrowed from the Scripps Institution of Oceanography Marine Vertebrates Collection. Ecological information was obtained from Nafpaktitis et al. (1977), Hulley (1981, 1984b, 1986), and Gartner et al. (1987).

Illustrations made by Holly Zadoretsky (formally at USNM) of postflexion larvae of several *Nannobrachium* species were helpful in establishing the identification of larvae of *N. atrum*, *N. cuprarium*, and *N. lineatum*.

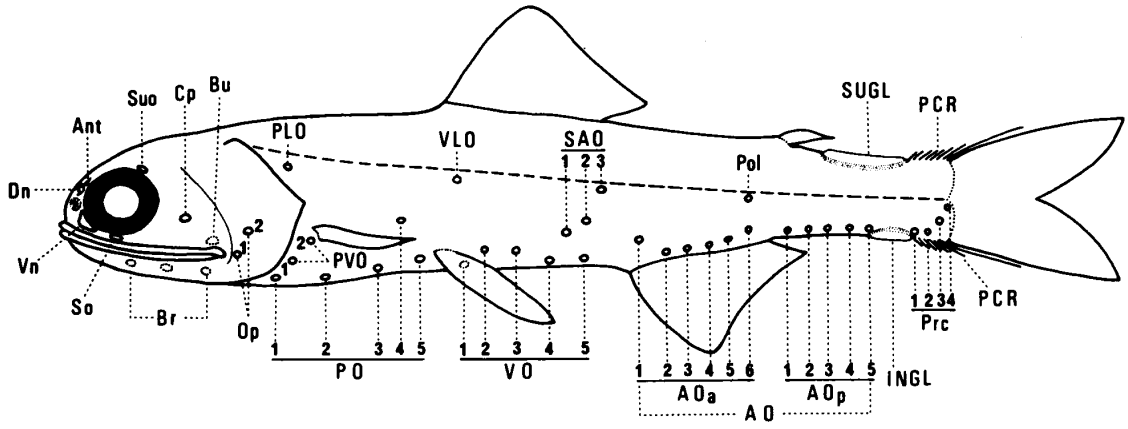



Figure 2. Generalized photophore arrangement in Myctophidae (from Fujii 1984).

Table Myctophidae 1. Geographic distribution and ELH literature for myctophid species in the western central Atlantic. Abbreviations: Ant, Antilles; Bah, Bahamas; Ber, Bermuda; Car, Caribbean Sea; FS, Straits of Florida; GM, Gulf of Mexico; Guy, Guyana; PR, Puerto Rico; Sur, Surinam. Distribution information based on Nafpaktitis et al. (1977), Hulley (1981, 1984b), Bekker (1983), and Zahuranec (2000).

| Species | Distribution | ELH literature | | |
|---|---|---|---|---|
| | | Preflexion larvae | Flexion or Postflexion larvae | Transforming or Juvenile |
| Myctophinae | | | | |
| *Benthosema suborbitale* | Throughout area | 9, 16, 23, 24, 25, 35 | 1, 9, 15, 16, 17, 23, 24, 25, 26, 27, 35 | 9, 16, 24, 25, 27, 35 |
| *Centrobranchus nigroocellatus* | Throughout area | 13, 16, 25 | 13, 15, 16, 17, 24, 25, 26, 27 | 13, 16, 24, 25 |
| *Diogenichthys atlanticus* | Throughout area | 9, 13, 16, 21, 24, 25, 35 | 9, 12, 13, 16, 17, 21, 24, 25, 26, 27, 35, 37 | 9, 13, 16, 21, 24, 25, 27, 35, 37 |
| *Electrona risso* | Sur, Bah(?) | 7, 9, 10, 13, 16, 31, 37 | 9, 10, 13, 16, 17, 31, 37, 38 | 9, 10, 13, 16, 31, 37, 38 |
| *Gonichthys cocco* | Throughout area, except Car | 7, 9, 35, 37, 38 | 7, 9, 26, 35, 37, 38 | 35, 37, 38 |
| *Hygophum benoiti* | GM, FS, e of Bah | 6, 9, 22, 37, 38 | 6, 7, 9, 22, 28, 37, 38 | 6, 9, 28, 37, 38 |
| *hygomii* | GM, FS, e of Bah | 4, 22, 35 | 4, 7, 9, 15, 21, 22, 27, 29, 35, 37, 38 | 4, 9, 21, 27, 29, 35, 37, 38 |
| *macrochir* | GM, FS, Car, e of Car | 19, 21, 32, 40 | 9, 15, 19, 21, 32, 40 | 19, 21, 32 |
| *reinhardtii* | GM, FS, e of Bah, Car, e of Car | 9, 13, 16, 21, 24, 25, 35 | 9, 12, 13, 15, 16, 17, 21, 24, 25, 35 | 9, 13, 16, 24, 25, 35 |
| *taaningi* | Throughout area | 33 | 9, 15, 17, 33, 40 | 33 |
| *Loweina interrupta* | Ber area (?) | | 8 | |
| *rara* | e of Ber | 8, 9, 10, 13, 16, 21 | 8, 9, 10, 12, 13, 15, 16, 17, 21, 26 | 9, 10, 13, 16, 21 |

| Species | Distribution | ELH literature | | |
|---|---|---|---|---|
| | | Preflexion larvae | Flexion or Postflexion larvae | Transforming or Juvenile |
| *Myctophum affine* | GM, FS, Car, e of Car | | | |
| *asperum* | GM, FS, Car, e of Car | 24, 25 | 9, 12, 15, 16, 17, 24, 25, 26, 27 | 24, 25, 27 |
| *nitidulum* | Throughout area | 9, 13, 16, 21, 24, 25, 27 | 9, 13, 15, 16, 21, 24, 25, 27 | 9, 13, 16, 24, 25 |
| *obtusirostre* | GM, FS, Car, e of Car | 24, 25 | 9, 15, 16, 24, 25, 27 | 24, 25, 27 |
| *selenops* | Throughout area | 23 | 9, 15, 16, 17, 23, 27 | |
| *Symbolophorus rufinus* | GM, e of Car, e of Ber | 39 | 39 | |
| Lampanyctinae *Bolinichthys distofax* | Guy | | 9, 15, 17, 24, 25 | 24, 25 |
| *indicus* | n of Ant, Ber area | | | |
| *photothorax* | Throughout area | | | |
| *supralateralis* | Throughout area | | | |
| *Ceratoscopelus maderensis* | Ber area | 7, 9, 35, 37, 38 | 7, 9, 14, 35, 37, 38 | 9, 35, 37, 38 |
| *warmingii* | Throughout area | 10, 11, 24, 25, 35 | 2, 9, 23, 24, 25, 35 | 25, 35 |
| *Diaphus ademomus* | GM, Car, e of Bah | | | |
| *anderseni* | GM, Ant | | | |
| *bertelseni* | Throughout area | | | |
| *brachycephalus* | Throughout area | | 3 | 3 |

| Species | Distribution | ELH literature | | |
|---|---|---|---|---|
| | | Preflexion larvae | Flexion or Postflexion larvae | Transforming or Juvenile |
| *dumerilii* | Throughout area | | | |
| *effulgens* | Car, n of PR, Ber | | | |
| *fragilis* | Throughout area | | | |
| *garmani* | Throughout area | | | |
| *lucidus* | Throughout area | | | |
| *luetkeni* | Throughout area | | | |
| *metopoclampus* | GM, Berm, Sur | 36 | 36 | 36 |
| *minax* | GM, C, FS | | | |
| *mollis* | Throughout area | | 35 | 35 |
| *perspicillatus* | Throughout area | | | |
| *problematicus* | Throughout area | | | |
| *rafinesquii* | GM, Ber | 7 | 7, 9, 37, 38 | 9, 37, 38 |
| *roei* | Ant | | | |
| *splendidus* | Throughout area | | | |
| *subtilus* | Throughout area | | | |
| *taaningi* | GM, Car, e of Car | | | |
| *termophilus* | Throughout area | | | |
| *Lampadena anomala* | Bermuda area | | | |
| *chavesi* | Ber area | | | |

| Species | Distribution | ELH literature | | |
|---|---|---|---|---|
| | | Preflexion larvae | Flexion or Postflexion larvae | Transforming or Juvenile |
| *luminosa* | Throughout area | 10, 11, 23, 24, 25 | 9, 15, 16, 23, 24, 25 | |
| *speculiger* | e of Ber | | | |
| *urophaos atlantica* | e of Bah, Ber | 16 | 9, 10, 12, 14, 16 | 9, 10, 14, 16 |
| *Lampanyctus alatus* | Throughout area | 20 | 20 | |
| *crocodilus* | Ber area | 7, 9, 37, 38 | 9, 17, 37, 38 | 9, 37, 38 |
| *festivus* | Ber area | | | |
| *nobilis* | Throughout area | 11, 16 | 16, 17, 20 | 16 |
| *photonotus* | nw Car, n & e of Ant, Ber area | | | |
| *pusillus* | Ber area | 7 | 7, 9, 17, 20, 21, 37, 38 | 9, 21, 37, 38 |
| *tenuiformis* | GM, Car, e of Car | 16 | 16 | |
| *Lepidophanes gaussi* | rare in GM & nw Car, common off U.S., Ber | | 9, 12, 15, 17 | |
| *guentheri* | Throughout area | | 9, 14, 35, 40 | 9, 14, 35 |
| *Lobianchia dofleini* | Ber area | 7, 23, 35 | 7, 9, 12, 15, 17, 21, 35, 37, 38 | 9, 21, 35, 37, 38 |
| *gemellarii* | Throughout area | 16, 23, 24, 25 | 5, 9, 15, 16, 17, 23, 24, 25, 26, 30, 37, 38 | 5, 9, 16, 37, 38 |
| *Nannobrachium atrum* | GM, Ber area | 18 | 18 | |
| *cuprarium* | Throughout area | | | |
| *lineatum* | Throughout area | | | |

| Species | Distribution | ELH literature | | |
|---|---|---|---|---|
| | | Preflexion larvae | Flexion or Postflexion larvae | Transforming or Juvenile |
| *nigrum* | Possibly in region | | | |
| *Notolychnus valdiviae* | Throughout area | 16, 34 | 9, 12, 15, 16, 17, 25, 26, 34, 37 | 9, 16, 25, 34, 37 |
| *Notoscopelus caudispinosus* | Throughout area | 23, 24, 25 | 2, 23, 24, 25 | |
| *resplendens* | Throughout area | 1, 9, 10, 16, 24, 25, 35 | 1, 9, 10, 12, 14, 15, 16, 24, 25, 35, 37, 38, 40 | 9, 14, 16, 35, 37, 38 |
| *Taaningichthys bathyphilus* | Throughout area | | | |
| *minimus* | e of Bah, Guy, e of Ber | 16, 24, 25 | 9, 10, 14, 16, 17, 24, 25 | 16, 24, 25 |
| *paurolychnus* | Car, Ber | | | |

1 Badcock and Merrett 1976
2 Belyanina 1982
3 Belyanina 1986
4 Berdar and Cavaliere 1979
5 Cavaliere and Berdar 1976
6 Cavaliere and Berdar 1977
7 Dekhnik and Sinukova 1966
8 Evseenko et al. 1998
9 Fahay, 1983
10 Matarese et al. 1989
11 Miller et al. 1979
12 Moser 1981
13 Moser and Ahlstrom 1970
14 Moser and Ahlstrom 1972
15 Moser and Ahlstrom 1974
16 Moser and Ahlstrom 1996
17 Moser et al. 1984
18 Olivar 1985
19 Olivar 1988
20 Olivar and Beckley 1997
21 Olivar and Fortuño 1991
22 Olivar and Palomera 1994
23 Olivar et. al. 1999
24 Ozawa 1986
25 Ozawa 1988
26 Pertseva-Ostroumova 1964
27 Pertseva-Ostroumova 1974
28 Sanzo 1918a
29 Sanzo 1918b
30 Sanzo 1931
31 Sanzo 1939
32 Shiganova 1974
33 Shiganova 1975a
34 Shiganova 1975b
35 Shiganova 1977
36 Sparta 1952
37 Taaning 1918
38 Tortonese 1956
39 Zelck et al. 1993
40 Zhudova 1969

Table Myctophidae 2. Numbers of vertebrae and fin rays of myctophid species in the western central Atlantic. All myctophiform species have 10+9 principal caudal-fin rays. Typical counts are followed by ranges in parentheses. Data from Nafpatitis et al. (1977), Hulley (1981, 1984), Moser and Ahlstrom (1996), Zahuranec (2000), and original counts.

| Species | PrCV | CV | Total | D | A | $P_1$ | $P_2$ | $C_2$ |
|---|---|---|---|---|---|---|---|---|
| Myctophinae | | | | | | | | |
| *Benthosema suborbitale* | 15 | 18-20 | 33-35 | 12-13(11-14) | 17(16-19) | 13-14(12-15) | 8 | 6-8+7-8 |
| *Centrobranchus nigroocellatus* | 14-15 | 22-25 | 35-40 | 10-11(9-11) | 17-18(16-19) | 13-17 | 8 | 5-7+5-7 |
| *Diogenichthys atlanticus* | 13-14 | 18-20 | 31-35 | 11-12(10-12) | 15-17(14-18) | 13(12-15) | 8 | 8-9+8-9 |
| *Electrona risso* | 14-16 | 17-20 | 32-34 | 13-14(12-15) | 19(18-20) | 15(13-16) | 8 | 6-8+6-7 |
| *Gonichthys cocco* | 15-16 | 24-26 | 40-41 | 11-12(10-13) | 20-22(20-23) | 14(13-16) | 7-8 | 5-7+5-6 |
| *Hygophum benoiti* | 15 | 21 | 36(34-37) | (12-14) | 20(19-21) | 14(13-15) | 8 | 7-8+7-8 |
| *hygomii* | 15-16 | 20-22 | 36-38 | 14(13-15) | 21(20-22) | 15-16(14-17) | 8 | 8-9+7-8 |
| *macrochir* | 16 | 19 | 35 | 13(12-14) | 19(17-21) | 14(13-15) | 8 | 9+8 |
| *reinhardtii* | 16-17 | 21-23 | 38-40 | 13-14(13-15) | 22-24(21-25) | 14(13-16) | 8 | 7-9+7-8 |
| *taaningi* | 15-16 | 19-21 | 35-36 | 13-14(12-14) | 19-20(17-23) | 13-14(12-15) | 8 | 8-9+8-9 |
| *Loweina interrupta* | 19 | 20-21 | 39-40 | 10-12 | 15-16 | 11-12 | 8 | |
| *rara* | 17-19 | 19-21 | 37-39 | 11-13(10-13) | 15-16(13-17) | 11(9-13) | 8 | 6-7+6-7 |
| *Myctophum affine* | 15-16 | 21-23 | 37-38 | 12-13(12-14) | 18(17-20) | 13-14(12-14) | 8 | 8-9+7-8 |

| Species | PrCV | CV | Total | D | A | $P_1$ | $P_2$ | $C_2$ |
|---|---|---|---|---|---|---|---|---|
| *asperum* | 15-17 | 19-22 | 35-38 | 13(12-14) | 17-18(17-19) | 14-15(12-16) | 8 | 8-9+8-9 |
| *nitidulum* | 15-16 | 21-23 | 36-39 | 13-14(12-14) | 19-20(18-21) | 13-14(12-16) | 8 | 7-9+7-9 |
| *obtusirostre* | 15-16 | 19-21 | 35-36 | 13(12-14) | 18(17-19) | 16-18(16-20) | 8 | 8-9+7-8 |
| *selenops* | 15-16 | 19-20 | 34-35 | 13(12-14) | 17-18(17-19) | 16-18(15-18) | 8 | 8+7-8 |
| *Symbolophorus rufinus* | 15-16 | 21-22 | 37 | 15(14-16) | 20-21(20-22) | 15(14-17) | 8 | 8-10+8-9 |
| Lampanyctinae | | | | | | | | |
| *Bolinichthys distofax* | 16 | 18 | 34 | 13(12-14) | 14(13-15) | 12-13(11-14) | 8 | 6-7+6-8 |
| *indicus* | 15-16 | 17-18 | 33-34 | 12-13(11-14) | 13(12-14) | 13(12-14) | 8 | 6-8+7-8 |
| *photothorax* | 16 | 19 | 35 | 13(12-14) | 14(13-15) | 13(12-14) | 8 | 7+7 |
| *supralateralis* | 15-16 | 18-19 | 34 | 13-14(12-15) | 14(13-15) | 13(12-14) | 8 | 6-7+6-7 |
| *Ceratoscopelus maderensis* | 16 | 21 | 37 | 14(13-15) | 14(13-15) | 13-14 | 8 | 7+6-7 |
| *warmingii* | 16 | 19-20 | 35-36 | 14(13-15) | 14(13-15) | 13-15(12-15) | 8 | 6+6-7 |
| *Diaphus ademomus* | 15- 16 | 19-20 | 34-36 | 15(14-16) | 15(14-16) | 12(11-12) | 8 | 6+5-6 |
| *anderseni* | 16 | 16-18 | 32-34 | 13(12-14) | 12(11-13) | 11(10-12) | 8 | 6-7+6-7 |
| *bertelseni* | 15-16 | 17-19 | 33-34 | 15(14-15) | 15 | 11(11-12) | 8 | 6+6 |
| *brachycephalus* | 16-17 | 16-17 | 33 | 13(12-14) | 13(12-14) | 11(10-12) | 8 | 7-8+7 |
| *dumerilii* | 15-16 | 19-20 | 35 | 14(14-15) | 15(14-16) | 12(10-13) | 8 | 6+6 |
| *effulgens* | 16 | 19-20 | 35-36 | 16(15-17) | 15(14-16) | 12(11-13) | 8 | 6+6 |

| Species | PrCV | CV | Total | D | A | $P_1$ | $P_2$ | $C_2$ |
|---|---|---|---|---|---|---|---|---|
| *fragilis* | 16 | 19 | 35 | 18(17-19) | 17(16-18) | 12(11-13) | 8 | 6-7+6 |
| *garmani* | 16 | 19-20 | 35-36 | 15(14-16) | 16(15-17) | 12(11-12) | 8 | 5-7+6-7 |
| *lucidus* | 15-16 | 20-21 | 36 | 17(16-18) | 18(17-19) | 11(11-12) | 8 | 6+6 |
| *luetkeni* | 15-17 | 18-20 | 34-36 | 16(15-17) | 15(14-16) | 11(11-12) | 8 | 6-7+6 |
| *metopoclampus* | 16 | 19 | 35 | 15(14-16) | 15(14-16) | 10-11 | 8 | 6+6 |
| *minax* | | | | 14(13-14) | 14(13-14) | 11 | 8 | |
| *mollis* | 16 | 17-18 | 33-34 | 13(12-14) | 13(12-14) | 10-11(9-12) | 8 | 7-8+7 |
| *perspicillatus* | 16 | 19-20 | 35-36 | 16(15-17) | 15(14-16) | 11(10-12) | 8 | 6+6 |
| *rafinesquii* | 16 | 17-18 | 33-34 | 13(12-14) | 14(13-15) | 10(9-11) | 8 | 6-8+6-7 |
| *roei* | | | | 15 | 14(13-14) | 11-12 | 8 | |
| *splendidus* | 16 | 20-21 | 36-37 | 15(14-16) | 16(15-17) | 12(11-12) | | 6-7+6-7 |
| *subtilus* | 16 | 18 | 34 | 13(12-14) | 13 | 10-11(10-12) | | 7+6-7 |
| *taaningi* | 15 | 19 | 34 | 14 | 14(14-15) | 11 | | 8+8 |
| *termophilus* | 16 | 17-19 | 34-35 | 14(13-15) | 15 | 11(11-12) | | 6-8+6-7 |
| *Lampadena anomala* | 15-16 | 21 | 36-37 | 14-16 | 13-14 | 16-18 | | |
| *chavesi* | 16 | 22 | 38 | 14(13-15) | 13-14(12-14) | 15-17 | | |
| *luminosa* | 15-17 | 20-22 | 35-37 | 15(14-15) | 14(13-15) | 16(15-17) | 8 | 8+8 |
| *speculigera* | 16 | 21 | 37 | 14(13-15) | 14(13-15) | 14(13-15) | | 8+8 |
| *urophaos atlantica* | 16 | 20-22 | 35-38 | 14-15(14-16) | 14(13-14) | 16(14-17) | 8 | 8-9+8-9 |

| Species | PrCV | CV | Total | D | A | $P_1$ | $P_2$ | $C_2$ |
|---|---|---|---|---|---|---|---|---|
| *Lampanyctus alatus* | 15 | 19-21 | 34(33-36) | 12(11-13) | 17(16-18) | 12(11-13) | 8 | 7+7-8 |
| *crocodilus* | 15 | 20-21 | 36(35-36) | 14(13-15) | 17(16-18) | 14-15(13-16) | 8 | 8+8 |
| *festivus* | 15 | 19-20 | 34-35 | 13(13-14) | 19(18-20) | 16(15-17) | | 6-7+6-8 |
| *nobilis* | 15-16 | 21-23 | 37-39 | 15(14-16) | 18(17-20) | 14(13-15) | 8 | 6-7+6-7 |
| *photonotus* | | | 35(34-36) | 13(12-15) | 16-17(16-18) | 12-13(11-14) | | |
| *pusillus* | | | 31-32(30-32) | 12(11-13) | 14-15(13-16) | 14(13-15) | 8 | |
| *tenuiformis* | 14-16 | 19-21 | 34-37 | 13-14(13-15) | 18(17-19) | 13-14(12-15) | 8 | 7-8+7-8 |
| *Lepidophanes gaussi* | 16 | 19-20 | 35-36 | 14(12-15) | 14(13-15) | 12-13(11-13) | 8 | 7-8+7-8 |
| *guentheri* | 16 | 20 | 36 | 14(13-15) | 14(13-16) | 13(11-14) | 8 | 7-8+7-8 |
| *Lobianchia dofleini* | 15-16 | 17-19 | 33-35 | 16(15-17) | 14(13-15) | 12(11-13) | 8 | 5-6+5 |
| *gemellarii* | 15-17 | 18-20 | 34-35 | 17(16-18) | 14(13-15) | 12(11-13) | 8 | 6-7+5-6 |
| *Nannobrachium atrum* | 16(15-16) | 21-22(20-23) | 37-38(36-39) | 13-14(12-16) | 19(17-21) | 11-12 | 8 | |
| *cuprarium* | 15(14-16) | 19(18-19) | 34(32-34) | 17(16-19) | 18(17-20) | 11-12 | 8 | 8-10+8-9 |
| *lineatum* | 16(16-17) | 22-23(21-23) | 38-39(37-40) | 16-17(15-19) | 20-21(19-23) | 13(12-14) | 8 | |
| *Notolychnus valdiviae* | 12-13 | 16-18 | 27-31 | 11(10-12) | 13(12-15) | 12-15 | 6 | 6-8+6-8 |
| *Notoscopelus caudispinosus* | 16 | 21 | 37 | 26-27(24-27) | 20-21(19-21) | 12(11-13) | 8 | 10-11+11-12 |
| *resplendens* | 16 | 21-22 | 35-38 | 21-23(21-24) | 18-19(17-20) | 12-13(11-13) | 8 | 11-14+10-14 |

| Species | PrCV | CV | Total | D | A | $P_1$ | $P_2$ | $C_2$ |
|---|---|---|---|---|---|---|---|---|
| *Taaningichthys bathyphilus* | | | 34-36 | 12-13(11-14) | 13(12-14) | 12-14 | | 7+6 |
| *minimus* | 18-20 | 20-22 | 39-41 | 12(11-13) | 12-13(11-14) | 16(15-17) | 8 | 8-10+8-10 |
| *paurolychnus* | | | 35-36 | 12-13(11-13) | 13(11-14) | 14(13-15) | 8 | 7+6-7 |

Table Myctophidae 3. Numbers of gill rakers and AO photophores of myctophid species in the western central Atlantic. When available, typical counts are followed by ranges in parentheses. Gill raker at angle of arch is included in the count for the lower limb. AO photophores are separated into anterior series (AOa) and posterior series (AOp). Data from Nafpaktitis et al. (1977), Hulley (1981, 1984), Moser and Ahlstrom (1996), Zahuranec (2000), and original counts.

| | Gill rakers | | | AO photophores | | |
|---|---|---|---|---|---|---|
| Species | Upper limb | Lower limb | Total | AOa | AOp | Total |
| Myctophinae | | | | | | |
| *Benthosema suborbitale* | 3(3-4) | 11(10-12) | 14(13-15) | 6(5-7) | 5(4-6) | 11(10-12) |
| *Centrobranchus nigroocellatus* | 0 | 0 | 0 | 6(4-7) | 8-10(8-11) | 13-16(12-17) |
| *Diogenichthys atlanticus* | 2 | 11-12(10-13) | 13-14(12-14) | 6-7(5-8) | 3(2-4) | 9-10(8-11) |
| *Electrona risso* | 9(8-10) | 20(17-21) | 29(26-32) | | | 11(10-13) |
| *Gonichthys cocco* | 3-4(3-5) | 8(6-9) | 9-12(9-13) | 5-6(4-8) | 12-13(10-14) | 18-19(16-20) |
| *Hygophum benoiti* | 4(4-5) | 14(12-16) | 18(16-20) | 6(5-7) | 6(5-7) | 12(11-13) |
| *hygomii* | 5(4-6) | 15(14-16) | 20(18-21) | 7(6-8) | 6(5-7) | 13(12-14) |
| *macrochir* | 5(4-6) | 15(13-16) | 20(17-22) | 4-5(3-5) | 7(5-8) | 11(10-13) |
| *reinhardtii* | 4-5(3-5) | 13-15(12-16) | 18(16-20) | 7(5-9) | 7(6-9) | 14-15(13-16) |
| *taaningi* | 4-5 | 13(12-16) | 17(16-21) | 5(3-7) | 5-7(3-8) | 10-12(9-13) |
| *Loweina interrupta* | 3 | 9-10(8-11) | 12-13(11-14) | 6-7(5-8) | 5-7 | 11-14(10-15) |
| *rara* | 2 | 7(6-7) | 9(8-9) | 6-7(5-7) | 6-7(5-7) | 12-13(11-14) |

| | Gill rakers | | | AO photophores | | |
|---|---|---|---|---|---|---|
| Species | Upper limb | Lower limb | Total | AOa | AOp | Total |
| *Myctophum* | | | | | | |
| *affine* | 5(5-6) | 13-14(12-14) | 18(17-22) | 8(6-9) | 5(3-6) | 13-14(11-15) |
| *asperum* | 4(3-5) | 11(10-12) | 15(13-17) | 7(6-8) | 6(5-7) | 13(11-15) |
| *nitidulum* | 5-6(4-8) | 14-15(12-19) | 19-20(17-22) | 9(7-10) | 5(4-7) | 14(12-15) |
| *obtusirostre* | 6-7 | 17(16-19) | 23-24(22-26) | 7(6-8) | 4(2-5) | 11(9-12) |
| *selenops* | 7(6-7) | 16(15-17) | 23(21-24) | 7(6-8) | 3(2-4) | 10(9-11) |
| *Symbolophorus* | | | | | | |
| *rufinus* | 6(5-6) | 15-16(14-17) | 21-22(20-23) | 8(7-9) | 6(5-7) | 14(13-15) |
| Lampanyctinae | | | | | | |
| *Bolinichthys* | | | | | | |
| *distofax* | 5(5-6) | 12-13(11-13) | 17(16-19) | 6(5-7) | 4(3-5) | 10(9-11) |
| *indicus* | 4(3-5) | 12(11-13) | 16(15-18) | 5-6(4-7) | 4(3-5) | 9-10(8-11) |
| *photothorax* | 6(5-7) | 15(13-17) | 20-22(18-23) | 5-7(5-8) | 4-5(3-6) | 11(10-12) |
| *supralateralis* | 6(5-7) | 14(13-16) | 20(18-22) | 5-6(4-7) | 4(3-5) | 9-10(8-11) |
| *Ceratoscopelus* | | | | | | |
| *maderensis* | 5-6(4-6) | 14-15(13-16) | 19-21(17-22) | 6-7(5-8) | 6(5-7) | 12-13(11-14) |
| *warmingii* | 4(3-5) | 10-11(9-12) | 14-15(13-16) | 6-7(5-9) | 5(4-7) | 11-12(10-14) |
| *Diaphus* | | | | | | |
| *ademomus* | 5 | 12(11-13) | 17(16-18) | 6(6-7) | 5(4-6) | 11(11-13) |
| *anderseni* | 5(4-6) | 13(11-15) | 18(15-20) | 4(3-5) | 5(4-6) | 9(8-11) |
| *bertelseni* | 5(5-6) | 13(12-14) | 18(17-19) | 6(6-7) | 4(3-4) | 10(9-10) |
| *brachycephalus* | 6(5-7) | 13-14(12-15) | 19-20(17-22) | 5(4-6) | 4(3-5) | 9(8-10) |
| *dumerilii* | 6-8(5-9) | 15-18(14-19) | 20-26(19-27) | 7(6-8) | 5(4-7) | 12(10-14) |

| | Gill rakers | | | AO photophores | | |
|---|---|---|---|---|---|---|
| Species | Upper limb | Lower limb | Total | AOa | AOp | Total |
| *effulgens* | 6(6-7) | 14(13-15) | 20-21(19-22) | 6(5-7) | 5(4-6) | 11(10-12) |
| *fragilis* | 5(4-6) | 12-13 | 17-18(17-19) | 6(5-7) | 5(4-6) | 11(10-12) |
| *garmani* | 7(6-8) | 13-15(13-16) | 21-22(20-23) | 7(6-8) | 5(4-7) | 12(11-14) |
| *lucidus* | 5(5-6) | 12(11-13) | 17(16-19) | 7(6-8) | 5(4-6) | 12(10-13) |
| *luetkeni* | 6(6-7) | 15(14-16) | 21(20-23) | 6(5-7) | 5(4-6) | 11(10-12) |
| *metopoclampus* | 8(7-9) | 15-16(14-17) | 23-24(22-26) | 6(5-7) | 6(5-7) | 12(11-13) |
| *minax* | 6(5-6) | 13-14(12-15) | 19-20(18-21) | 6(5-6) | 5(4-5) | 11(10-11) |
| *mollis* | 5(4-6) | 12-13(11-14) | 16-18(15-19) | 5(4-7) | 4(3-5) | 9(8-10) |
| *perspicillatus* | 9-10(8-10) | 17-18(16-19) | 26-28(25-29) | 6(5-7) | 5(4-7) | 11(10-13) |
| *problematicus* | 4(3-4) | 10-(9-10) | 14(13-14) | 6(5-7) | 5(4-6) | 11(10-12) |
| *rafinesquii* | 7-8 | 15-16(14-17) | 22-24(21-25) | 6(5-7) | 4(3-5) | 10(9-11) |
| *roei* | 7(6-8) | 16-17 | 23-24(22-25) | 6 | 5(4-6) | 11(10-12) |
| *splendidus* | 5(4-6) | 13(12-14) | 18(17-20) | 6(5-7) | 6(5-7) | 12(11-13) |
| *subtilus* | 6-7 | 14-16 | 20-23 | 5(5-6) | 6-7(5-7) | 11-12(10-12) |
| *taaningi* | 6-7(6-8) | 14-15(13-15) | 20-22(19-23) | 5-6 | 5(4-6) | 10-11(9-11) |
| *termophilus* | 8(7-9) | 16(15-17) | 23-25(23-26) | 6(5-6) | 4-5(4-6) | 10-11(10-12) |
| *Lampadena anomala* | 5 | 12(11-13) | 17(16-18) | 3(3-4) | 2 | 5(5-6) |
| *chavesi* | 6-7 | 14(13-15) | 20-22 | 7-8(6-8) | 2(1-3) | 9(8-11) |
| *luminosa* | 4 | 10(9-11) | 14(13-15) | 5-6(5-7) | 2 | 7-8(7-9) |

| | Gill rakers | | | AO photophores | | |
|---|---|---|---|---|---|---|
| Species | Upper limb | Lower limb | Total | AOa | AOp | Total |
| *speculiger* | 6-7 | 14(12-16) | 19-22(19-23) | 6-7(5-9) | 3-4(2-5) | 10(7-12) |
| *urophaos atlantica* | 4(3-5) | 10(9-11) | 14(13-14) | 5-6(4-6) | 2 | 7-8(6-8) |
| *Lampanyctus alatus* | 4(2-4) | 10(9-11) | 14(13-15) | 6(5-7) | 6-7(5-8) | 12-13(11-14) |
| *crocodilus* | 5(4-5) | 12(11-13) | 16-17(15-18) | 6-7((5-8) | 8-9(7-9) | 14-15(13-16) |
| *festivus* | 4 | 10(9-10) | 14(13-14) | 7(6-8) | 9(8-10) | 16(15-16) |
| *nobilis* | 3(3-4) | 10(9-11) | 14(13-15) | 6(5-7) | 9(8-10) | 15(14-16) |
| *photonotus* | 4(3-5) | 10(9-11) | 14(13-15) | 6(5-7) | 7(6-8) | 13(11-14) |
| *pusillus* | 3 | 9(8-10) | 12(11-13) | 4-5(4-6) | 5-6(5-7) | 10(9-12) |
| *tenuiformis* | 4 | 10(9-11) | 14(13-15) | 6(6-7) | 7(6-8) | 13(12-14) |
| *Lepidophanes gaussi* | 3 | 9(8-9) | 12(11-12) | 5-6(5-7) | 6(5-8) | 12(11-13) |
| *guentheri* | 4 | 10(9-11) | 14(13-15) | 5-6(5-7) | 6(4-7) | 12(11-14) |
| *Lobianchia dofleini* | 5(4-6) | 13-15(13-16) | 19(17-21) | 5(4-6) | 5(4-6) | 10(9-12) |
| *gemellarii* | 4-5(4-6) | 11-13(11-15) | 15-18(15-21) | 5(4-6) | 6(5-7) | 11(10-12) |
| *Nannobrachium atrum* | 5(4-5) | 12(11-13) | 17(16-18) | 6-7(6-9) | 7-8(6-9) | 14(12-15) |
| *cuprarium* | 5 | 12(11-13) | 17(16-18) | 5-6(5-7) | 5(4-6) | 10-11(9-12) |
| *lineatum* | 5(4-6) | 12-13(11-14) | 17-18(15-19) | 7-8(7-9) | 7-8(6-9) | 14-15(14-17) |
| *Notolychnus valdiviae* | 2 | 8-9 | 10-11 | 4 | 4(3-4) | 7-8 |

| | Gill rakers | | | AO photophores | | |
|---|---|---|---|---|---|---|
| Species | Upper limb | Lower limb | Total | AOa | AOp | Total |
| *Notoscopelus caudispinosus* | 4 | 10(9-11) | 14-15(13-15) | 7(6-8) | 4(3-5) | 11(10-12) |
| *resplendens* | 6(5-7) | 14-15(13-16) | 20-21(19-23) | 8(7-9) | 5(4-7) | 13(12-14) |
| *Taaningichthys bathyphilus* | 3(2-4) | 8-9(6-10) | 11-12(9-14) | 3(1-4) | 1(1-2) | 4(2-5) |
| *minimus* | 4(4-5) | 12(10-14) | 16-17(14-18) | 6(4-7) | 5(4-6) | 11(9-13) |
| *paurolychnus* | 3-4 | 10-11(9-12) | 13-15(12-16) | 0 | 0 | 0 |

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 15 |
| Caudal | 18-20 |
| Total | 33-35 |
| Number of fin rays | |
| Dorsal | 11-14 |
| Anal | 16-19 |
| Pectoral | 12-15 |
| Pelvic | 8 |
| Caudal | |
| Dorsal Secondary | 6-8 |
| Principal | 10+9 |
| Ventral Secondary | 7-8 |
| Gillrakers on first arch | |
| Upper | 3-4 |
| Lower | 10-12 |
| Total | 13-15 |
| Branchiostegals | |

## LIFE HISTORY

Range: Throughout tropical & sub-tropical Atlantic; also in tropical & subtropical Indian & Pacific Oceans
Habitat: Epi- to mesopelagic
ELH pattern: Oviparous; pelagic eggs & larvae
Migration: Part of population migrates at night from mesopelagic to epipelagic zone

## LITERATURE

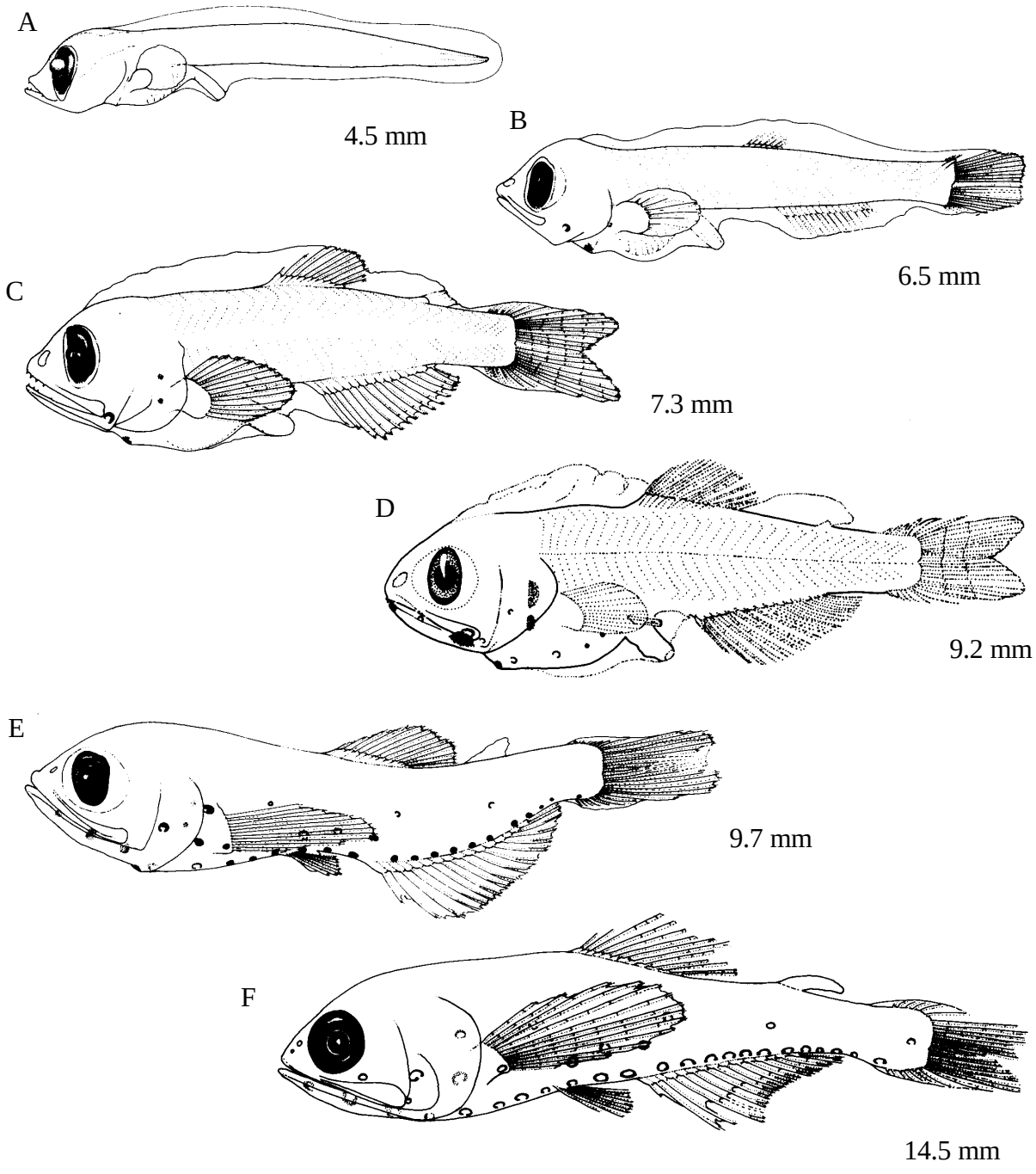
Badcock & Merrett 1976
Fahay 1983
Moser & Ahlstrom 1974, 1996
Moser et al. 1984
Olivar et al. 1999
Ozawa 1986, 1988
Pertseva-Ostroumova 1964, 1974
Shiganova 1977

## EARLY LIFE HISTORY DESCRIPTION*

**LARVAE:**
Length at hatching: ~ 2.0 mm
Length at flexion: 5.2-6.5 mm
Length at transformation: ~ 10.0 mm
Sequence of fin development: $P_1$, $C_1$, A, $C_2$, D, $P_2$
Pigment: *Preflexion*—Pair of melanophores just anterior to cleithral symphysis at ~ 4 mm, later coalesces in midline. *Flexion*—At lower jaw symphysis by ~ 5.5 mm; two embedded blotches anterior to $P_1$ base, one near top & the other near bottom of fin base.
Diagnostic characters: Short, deep body; narrow eyes with lunate mass of choroid tissue on ventral surface; gut short, terminal section deflected acutely ventrad, Sn-A <50% BL in preflexion & flexion stages; middle Br photophore forms at ~ 5.0 mm; first & second PO's form at ~ 9 mm; pigment scanty; embedded blotches anterior to $P_1$ base; similar to *Electrona risso* which has relatively longer gut & pigment on $P_1$ rays but lacks blotches anterior to $P_1$ base.

## ILLUSTRATIONS

ABF, from Moser & Ahlstrom (1996)
***** Description based on Moser & Ahlstrom (1996)


A
4.5 mm
B
6.5 mm
C
7.3 mm
D
9.2 mm
E
9.7 mm
F
14.5 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 14-15 |
| Caudal | 22-25 |
| Total | 35-40 |
| Number of fin rays | |
| Dorsal | 9-11 |
| Anal | 16-19 |
| Pectoral | 13-17 |
| Pelvic | 8 |
| Caudal | |
| Dorsal Secondary | 5-7 |
| Principal | 10+9 |
| Ventral Secondary | 5-7 |
| Gillrakers on first arch | |
| Upper | 0 |
| Lower | 0 |
| Total | 0 |
| Branchiostegals | 7-8 |

## LIFE HISTORY

Range: Tropical & subtropical regions of Atlantic, Pacific, & Indian Oceans
Habitat: Epi- & mesopelagic; neustonic at night
ELH pattern: Oviparous, planktonic eggs & larvae
Migration: Migrates at night from mesopelagic zone to surface or shallow epipelagic waters

## LITERATURE

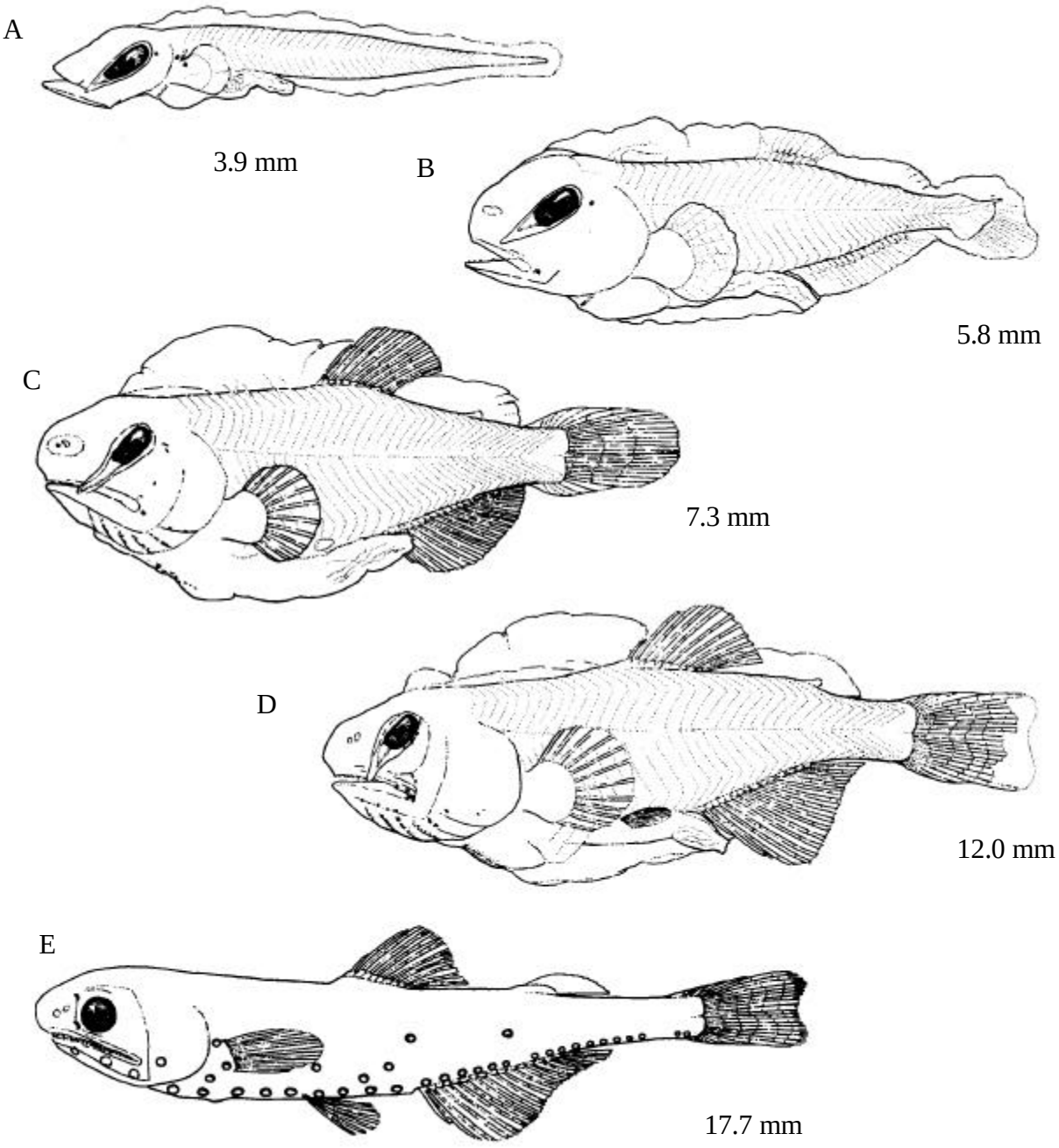
Moser & Ahlstrom 1970, 1974, 1996
Moser et al. 1984
Ozawa 1986, 1988
Perseva-Ostroumova 1964, 1974

## EARLY LIFE HISTORY DESCRIPTION*

**LARVAE:**
Length at hatching: < 2.8 mm
Length at flexion: ~ 5.4-6.3 mm
Length at transformation: ~ 12.0 mm
Sequence of fin development: $C_1$ & $P_1$, $C_2$ & D & A, $P_2$
Pigment: *Preflexion*—At <4.0 mm, anterodorsal to $P_1$ base, on trunk near axilla, on upper & lower jaw tips, posterior margin of orbit, anteromesial to mid- & forebrain, & lateral to terminal gut; all but postorbital pigment lost by end of stage. *Flexion*—By ~ 6.0 mm, a series outlines each Br ray, & patch on ventral surface of liver. *Postflexion*—On largest larvae, on posteroventral margin of orbit & posteriorly on upper & lower jaws.
Diagnostic characters: Initially moderately slender, becoming deep-bodied & highly compressed; head large with narrow elliptical eyes; conical choroid tissue extremely elongate, unpigmented; terminal gut section only slightly deflected; snout becomes bulbous; large finfolds; early pigment, except postorbital, lost; pigment on branchiostegal membrane & liver forms in postflexion stage; $Br_2$ photophores form at ~ 5.0 mm.

## ILLUSTRATIONS

ABE, from Moser & Ahlstrom (1970)
***** Description based on Moser & Ahlstrom (1996)


A
3.9 mm
B
5.8 mm
C
7.3 mm
D
12.0 mm
E
17.7 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 13-14 |
| Caudal | 18-20 |
| Total | 31-35 |
| Number of fin rays | |
| Dorsal | 10-12 |
| Anal | 14-18 |
| Pectoral | 12-15 |
| Pelvic | 8 |
| Caudal | |
| Dorsal Secondary | 8-9 |
| Principal | 10+9 |
| Ventral Secondary | 8-9 |
| Gillrakers on first arch | |
| Upper | 2 |
| Lower | 10-13 |
| Total | 12-14 |
| Branchiostegals | 6-8 |

## LIFE HISTORY

Range: Tropical-subtropical cosmopolite
Habitat: Epi- to mesopelagic
ELH pattern: oviparous, pelagic eggs & larvae
Migration: Part of population migrates at night from mesopelagic to epipelagic zone

## LITERATURE

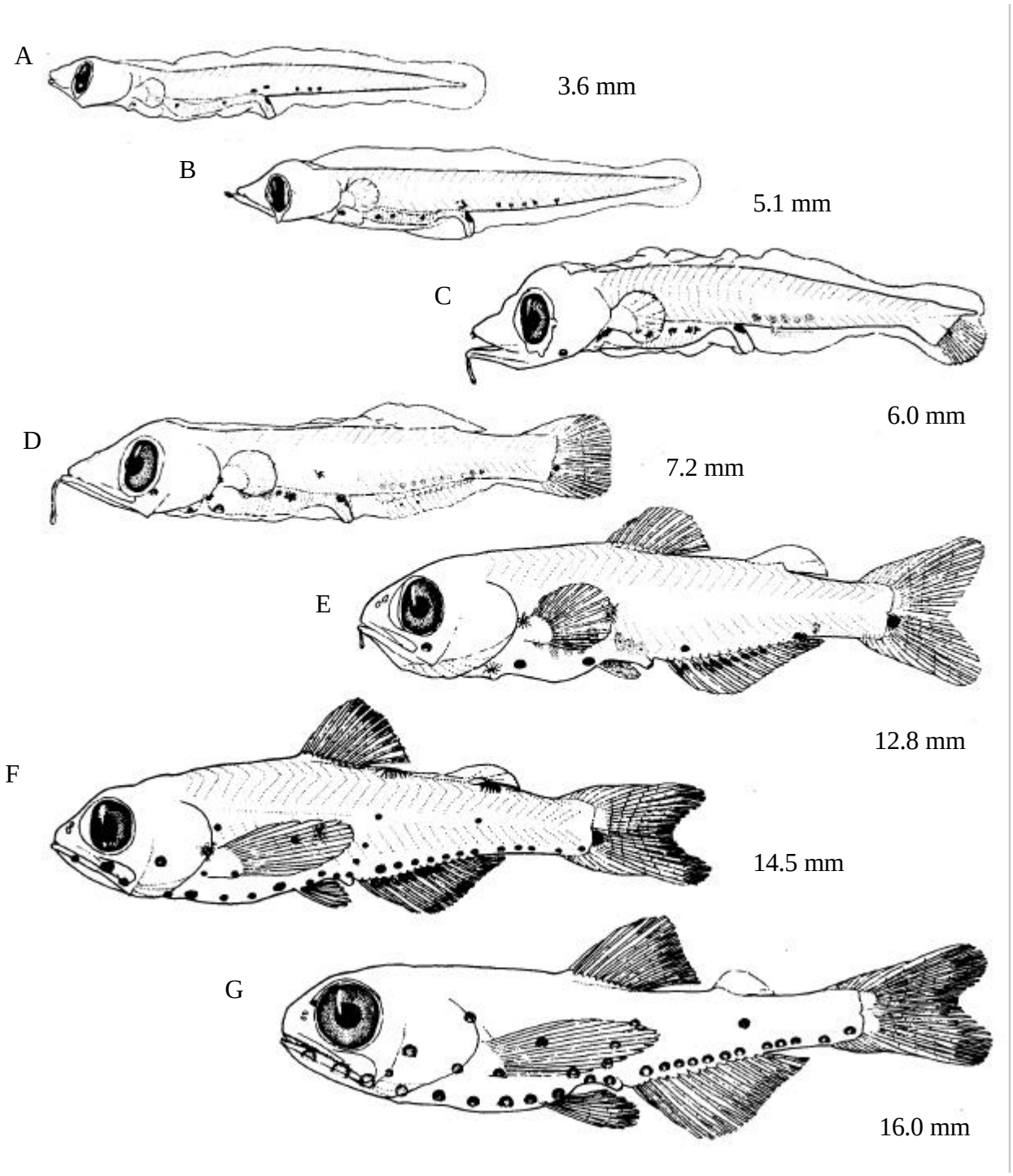
Fahay 1983
Moser 1981
Moser & Ahlstrom 1970, 1996
Moser et al. 1984
Olivar & Fortuño 1991
Ozawa 1986, 1988
Pertseva-Ostroumova 1964, 1974
Shiganova 1977
Taaning 1918

## EARLY LIFE HISTORY DESCRIPTION*

**LARVAE:**
Length at hatching: <2.9 mm
Length at flexion: 6.0-6.9 mm
Length at transformation: 13.5-14.5 mm
Sequence of fin development: $C_1$, $C_2$ & A & $P_1$, D & $P_2$
Pigment: *Preflexion*—By ~ 3.0 mm, ventrolateral pair of melanophores just posterior to cleithrum, dorsolateral pair on terminal gut, 2 lateral pairs on midgut, & ~ 3 melanophores in postanal series at ventral margin; 1 laterally above preanal arch of gut; at ~ 5.0 mm, first of 3 on dorsal surface of symphyseal barbel; 1 or 2 laterally on gut & up to 4 more postanally by end of stage. *Flexion*—1 large melanophore at base of rays on C; a pair embedded below & pair above hindbrain (not shown on illustration); 1 on anterior part of $P_1$ base. *Postflexion*—At ~ 7.0 mm, paired series begin to form at bases of A rays; in largest larvae, up to 6 laterally on gut & 12 in postanal ventral midline; 1 posterior to D & 1 posterior to Ad in largest larvae.
Diagnostic features: Moderately slender body, becoming somewhat compressed; gut to midbody, slightly sigmoid; head size moderate; snout acute, becoming relatively shorter; eye elliptical, becoming wider in later stages, ventral choroid tissue absent, although the scleral envelope may extend ventrad from the eye through the early postflexion stage; symphyseal barbel forms at ~ 5.0 mm; melanophore on trunk above preanal arch of gut; $Br_2$ photophores form at ~ 6.0 mm; $PO_2$ at ~ 7.0 mm; $PO_5$ at ~ 8.5 mm; $AOa_1$ at ~ 11.0 mm.

## ILLUSTRATIONS

ABG, Moser & Ahlstrom (1996)
Description based on Moser & Ahlstrom (1996)


A
3.6 mm
B
5.1 mm
C
6.0 mm
D
7.2 mm
E
12.8 mm
F
14.5 mm
G
16.0 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 14-16 |
| Caudal | 17-20 |
| Total | 32-34 |
| Number of fin rays | |
| Dorsal | 12-15 |
| Anal | 18-20 |
| Pectoral | 13-16 |
| Pelvic | 8 |
| Caudal | |
| Dorsal Secondary | 6-8 |
| Principal | 10+9 |
| Ventral Secondary | 6-7 |
| Gillrakers on first arch | |
| Upper | 8-10 |
| Lower | 17-21 |
| Total | 26-32 |
| Branchiostegals | 7-9 |

## LIFE HISTORY

Range: Recorded from eastern Atlantic & from disjunct localities in the Pacific, Indian, & Southern Oceans; may occur in western Atlantic
Habitat: Epi- to mesopelagic
ELH pattern: Oviparous, planktonic eggs & larvae
Migration: Apparently some portion of the population migrates at night from mesopelagic to epipelagic zone

## LITERATURE

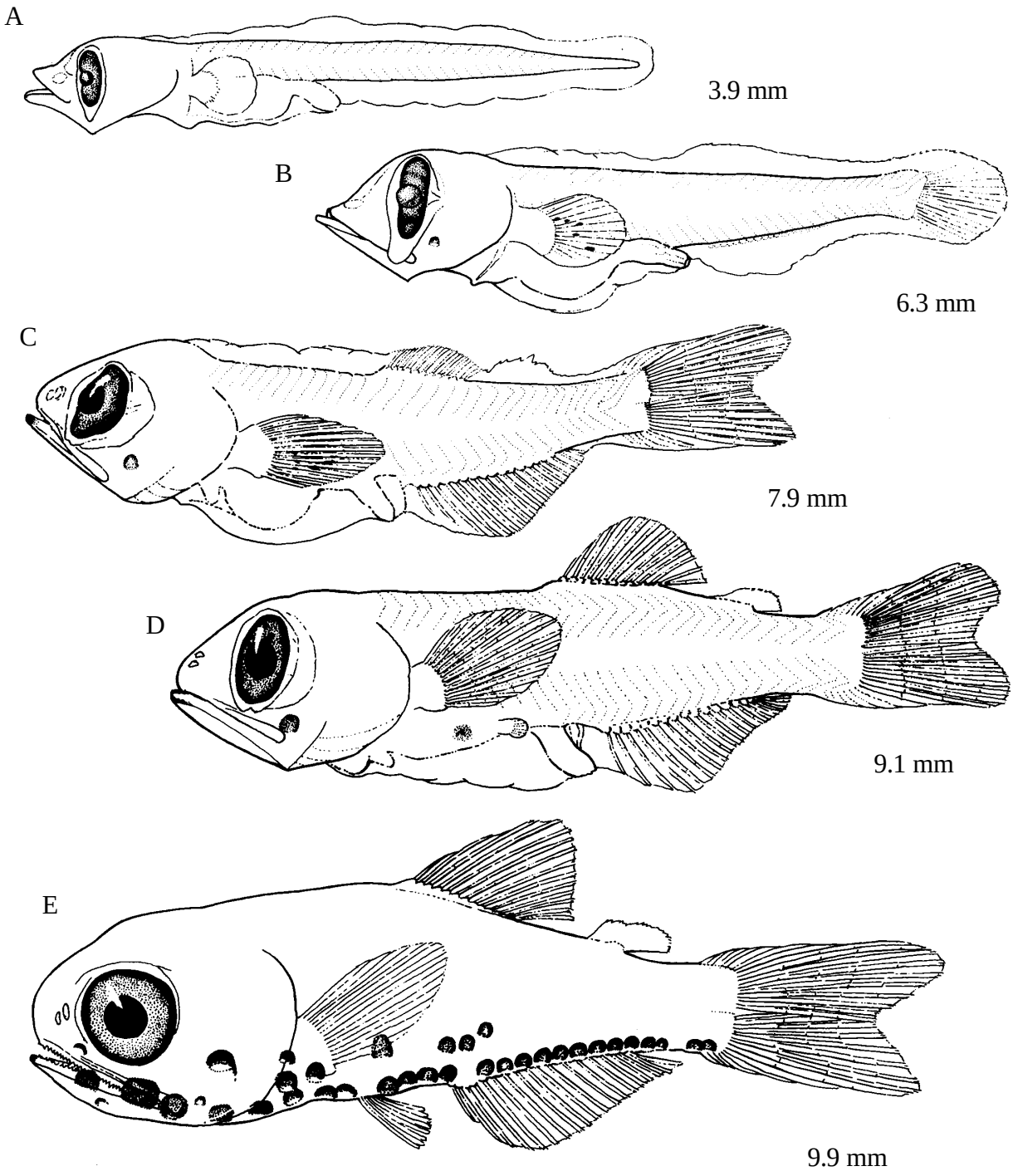
Dekhnik & Sinyukova 1966
Fahay 1983
Matarese et. al. 1989
Moser & Ahlstrom 1970, 1996
Moser et al. 1984
Sanzo 1939
Taaning 1918
Tortonese 1956

## EARLY LIFE HISTORY DESCRIPTION*

**LARVAE:**
Length at hatching: <3.8 mm
Length at flexion: ~ 6.0-7.0 mm
Length at transformation: ~ 9.5-10.0 mm
Sequence of fin development: $C_1$, $P_1$, $C_2$, A, D & $P_2$
Pigment: *Preflexion*—None. *Flexion*—By ~ 6.0 mm, a pair of melanophores at lower jaw tip & a patch on $P_1$ blade; by 7.0 mm, above developing gas bladder. *Postflexion*—Some larvae >9.0 mm have a melanophore on each side of foregut.
Diagnostic features: Stout; gut slightly sigmoid, extends to about midbody; foregut relatively thick, becoming somewhat saccular; head large & broad; eye large but narrow; pigment scanty; transforms at small size ( ~ 10.0 mm); $Br_2$ photophores begin to form at ~ 5.8 mm; PO series the first to form at transformation; similar to *Benthosema suborbitale* which differs in having cleithral pigment, a shorter gut, & no pigment on $P_1$ rays.

## ILLUSTRATIONS

ABE, from Moser & Ahlstrom (1996)
***** Description based on Moser & Ahlstrom (1996)


A
3.9 mm
B
6.3 mm
C
7.9 mm
D
9.1 mm
E
9.9 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 15-16 |
| Caudal | 24-26 |
| Total | 40-41 |
| Number of fin rays | |
| Dorsal | 10-13 |
| Anal | 20-23 |
| Pectoral | 13-16 |
| Pelvic | 7-8 |
| Caudal | |
| Dorsal Secondary | 5-7 |
| Principal | 10+9 |
| Ventral Secondary | 5-6 |
| Gillrakers on first arch | |
| Upper | 3-5 |
| Lower | 6-9 |
| Total | 9-13 |
| Branchiostegals | |

## LIFE HISTORY

Range: Tropical-subtropical Atlantic & Mediterranean, absent from the Caribbean
Habitat: Epi- & mesopelagic
ELH pattern: Oviparous, planktonic eggs & larvae
Migration: Migrates at night from mesopelagic and epipelagic zones to surface or shallow epipelagic waters

## LITERATURE

Fahay 1983
Pertseva-Ostroumova 1964
Shiganova 1977
Taaning 1918
Tortonese 1956

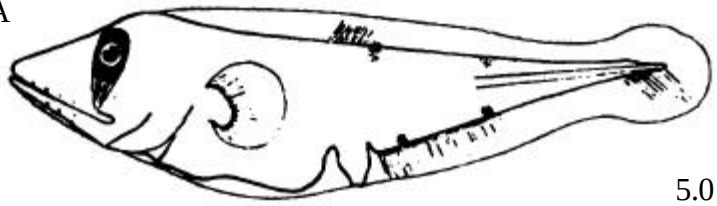
## EARLY LIFE HISTORY DESCRIPTION*

**LARVAE:**
Length at flexion: 5.0-7.5 mm
Length at transformation: >12 mm
Sequence of fin development: $C_1$ & $P_1$, D & A & $C_2$, $P_2$
Pigment: *Preflexion*—Opposing blotches dorsally & ventrally on tail, one pair just posterior to juncture of trunk & tail & the other at mid-tail; series of minute melanophores along upper & lower jaws. *Flexion-postflexion*—Blotch added on dorsal midline anterior to D origin & eventually a blotch added between blotch at D insertion & the blotch at Ad insertion; basally on anteriormost A fin rays; basally on $P_1$ rays; embedded series above gut & minute melanophores ventrally on gut & on ventral finfold below gut; group of minute melanophores on snout at nostrils; some at angular region of lower jaw; scattered on preopercle & opercle; along Br rays; 1 at base of C at juncture of C rays & hypural margin; some on C rays.
Diagnostic characters: Initially slender but becomes highly compressed, with deep head & body & large median finfold; strongly sigmoid gut with terminal section deflected ventrad; snout large, initially pointed, becoming blunt in later larvae; $P_1$ large, early-forming; head & jaws large; eye narrow with conical choroid mass equal in length to eye, pigmented at tip; $Br_2$ photophore forms at flexion stage.

## ILLUSTRATIONS

ABC, from Taaning (1918)
***** Description based primarily on Taaning (1918)

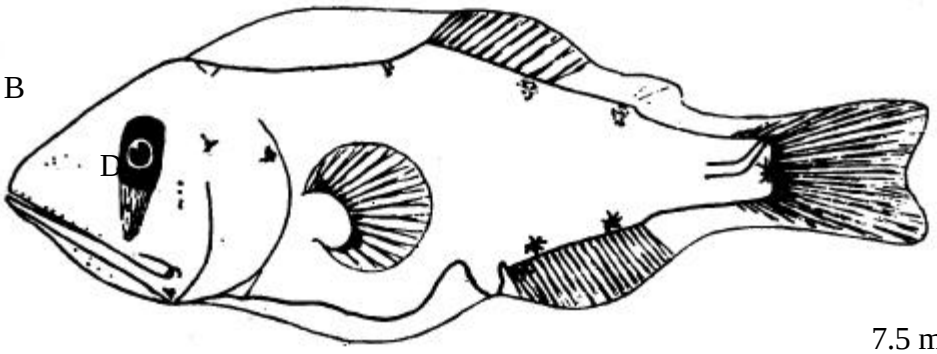
A



5.0 mm

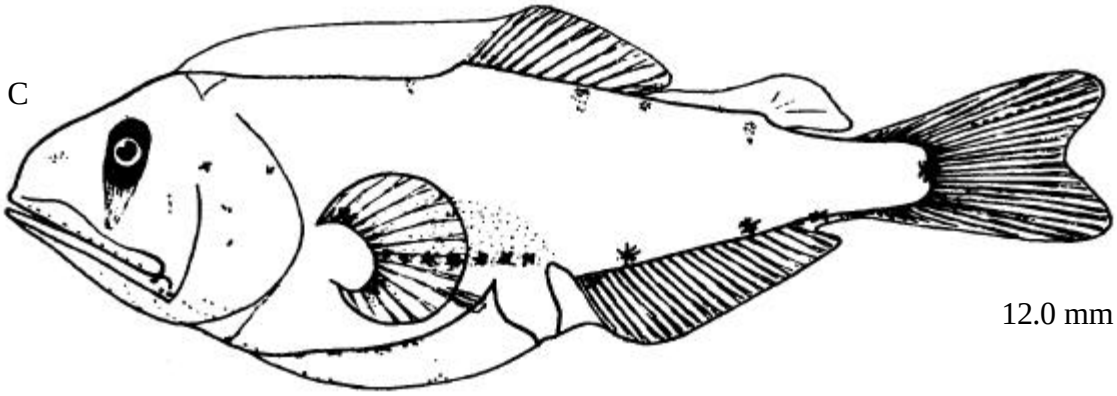
B

D



7.5 mm

C



12.0 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 15 |
| Caudal | 21 |
| Total | 34-37 |
| Number of fin rays | |
| Dorsal | 12-14 |
| Anal | 19-21 |
| Pectoral | 13-15 |
| Pelvic | 8 |
| Caudal | |
| Dorsal Secondary | 7-8 |
| Principal | 10+9 |
| Ventral Secondary | 7-8 |
| Gillrakers on first arch | |
| Upper | 4-5 |
| Lower | 12-16 |
| Total | 16-20 |
| Branchiostegals | |

## LIFE HISTORY

Range: Subtropical-temperate North Atlantic
Habitat: Epi- & mesopelagic
ELH pattern: Oviparous, planktonic eggs & larvae
Migration: Part of population migrates at night from mesopelagic to epipelagic zone

## LITERATURE

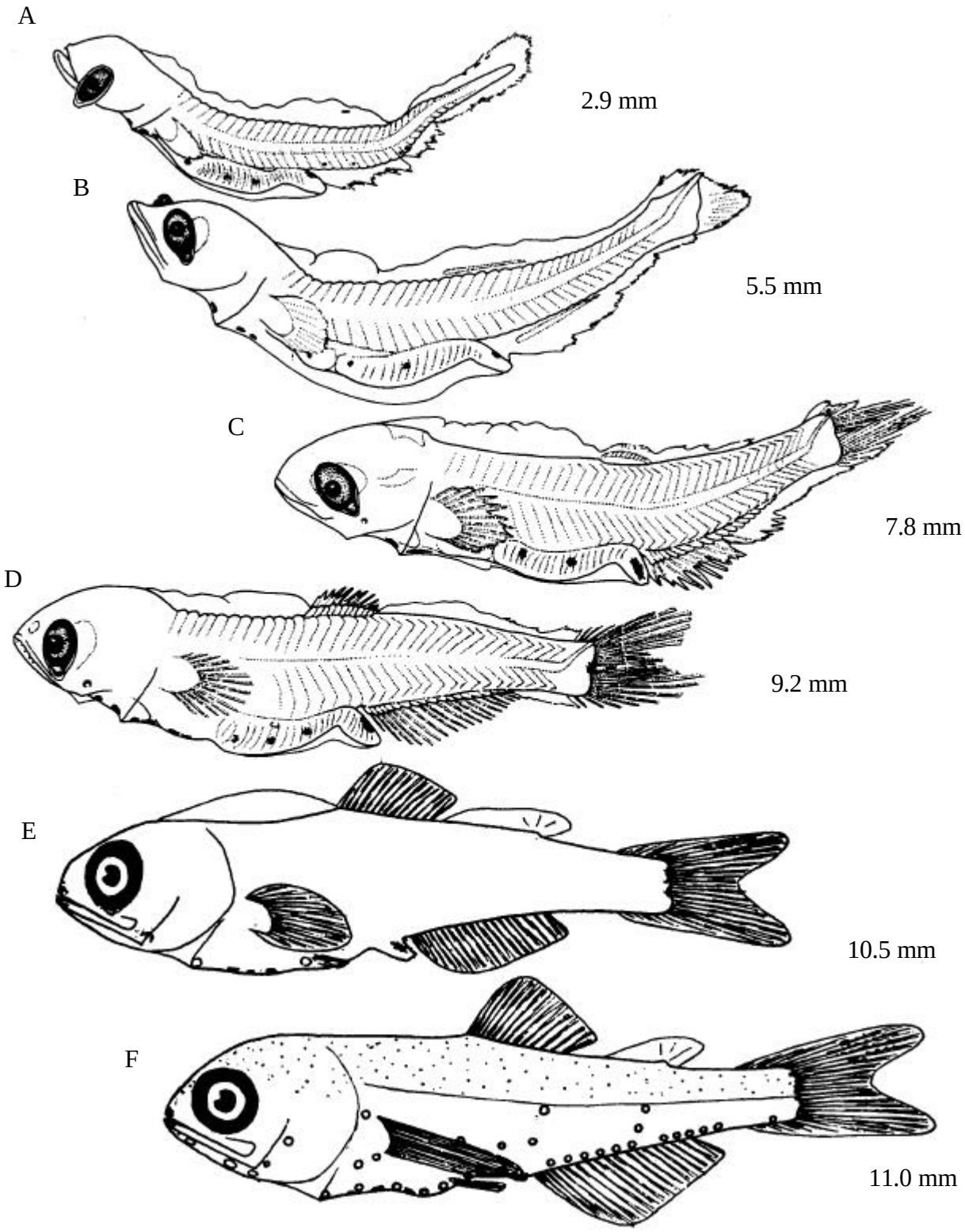
Cavaliere & Berdar 1977
Dekhnik & Sinukova 1966
Fahay 1983
Olivar & Palomera 1994
Sanzo 1918a
Taaning 1918
Tortonese 1956

## EARLY LIFE HISTORY DESCRIPTION*

**LARVAE:**
Length at flexion: 5.0-5.5 mm
Length at transformation: 10.0-12.5 mm
Sequence of fin development: $C_1$, A & $P_1$, D, $C_2$, $P_2$
Pigment: *Preflexion*—Paired series ventrally on isthmus & just posterior to cleithrum; lateral gut series consisting of 1 on foregut, 2 on midgut, & 1 or more large melanophores dorsolaterally on the terminal section; 1-4 in postanal midventral series (not always present); some on dorsal finfold at midbody & on ventral finfold, ~ 5 myomeres posterior to the anus; dorsally & ventrally on caudal finfold. *Flexion-postflexion*—Finfold pigment & postanal series lost early in postflexion; minute melanophore at tip of notochord in some, larger one at base of C rays between hypural plates; some on C rays.
Diagnostic characters: Ventral pigment series on isthmus, continuing posterior to cleithrum, indicative of genus; eyes moderately elliptical with brownish choroid mass ventrally; body & gut moderate in form, Sn-A >60% BL vs <60% in *H. hygomii*; foregut relatively longer and more slender than in *H. hygomii*; cleithrum to anus distance 32-34% BL vs 25-27% in *H. hygomii*; PdL decreases with development from 56% to 49% BL (decreases from 50% to 44% in *H. hygomii*); pigment on ventral & caudal finfolds; 1-4 minute melanophores midventrally on tail in preflexion stage; pigment on caudal rays & large melanophore at posterior margin of hypurals; $Br_2$ photophores appear at ~ 7 mm, 1 or more PO photophores appear just before transformation.

## ILLUSTRATIONS

ABD, from Olivar & Palomera (1994); E & F, from Taaning (1918)
***** Description based primarily on Olivar & Palomera (1994)


A
2.9 mm
B
5.5 mm
C
7.8 mm
D
9.2 mm
E
10.5 mm
F
11.0 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 15-16 |
| Caudal | 20-22 |
| Total | 36-38 |
| Number of fin rays | |
| Dorsal | 13-15 |
| Anal | 20-22 |
| Pectoral | 14-17 |
| Pelvic | 8 |
| Caudal | |
| Dorsal Secondary | 8-9 |
| Principal | 10+9 |
| Ventral Secondary | 7-8 |
| Gillrakers on first arch | |
| Upper | 4-6 |
| Lower | 14-16 |
| Total | 18-21 |
| Branchiostegals | |

## LIFE HISTORY

Range: Temperate-subtropical in the North Atlantic; possibly circumglobal in the southern hemisphere
Habitat: Epipelagic to upper bathypelagic
ELH pattern: Oviparous, planktonic eggs & larvae
Migration: Migrates at night from mesopelagic & upper bathypelagic zones to epipelagic zone

## LITERATURE

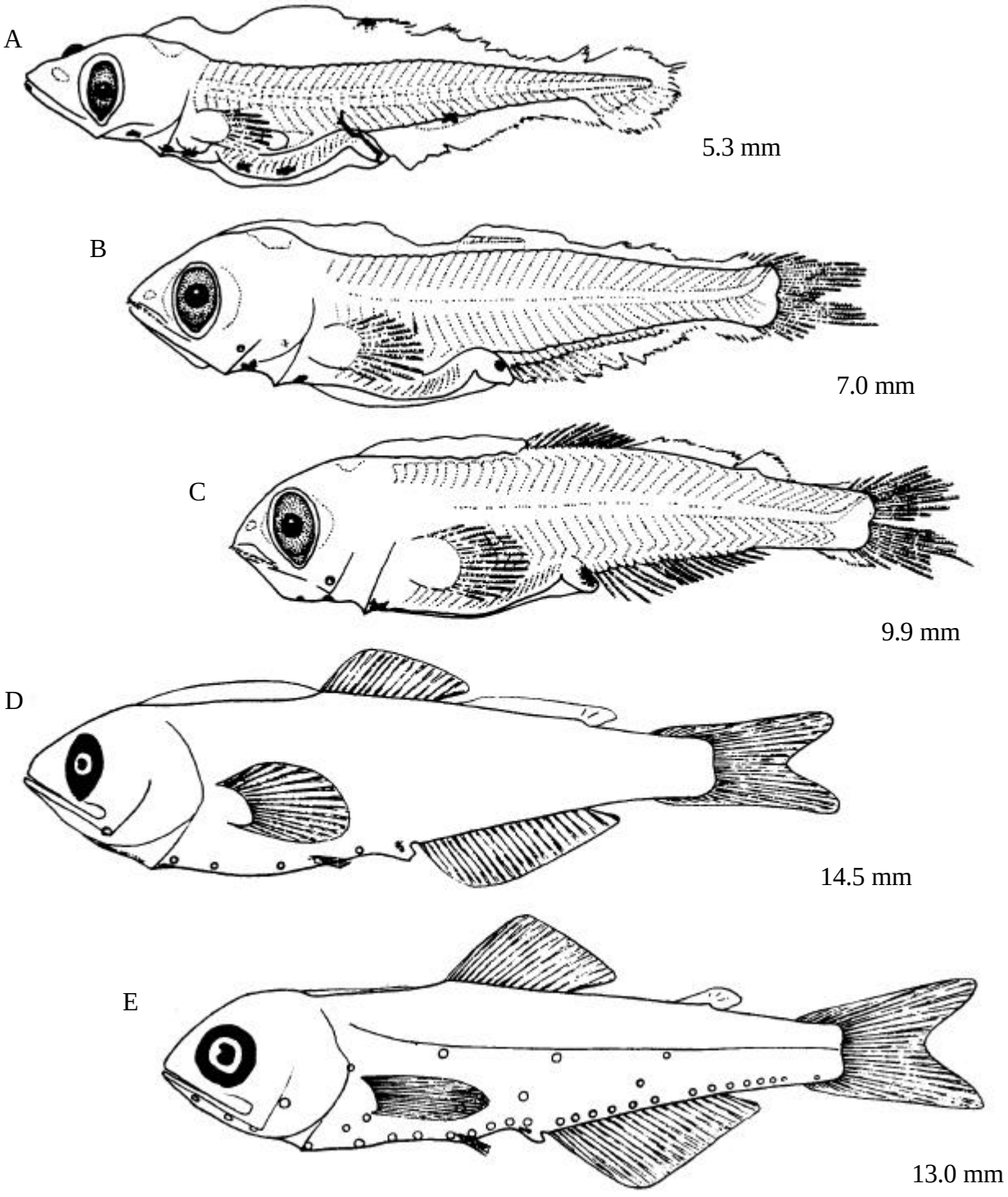
Berdar & Cavaliere 1979
Dekhnik & Sinukova 1966
Fahay 1983
Moser & Ahlstrom 1974
Olivar & Fortuño 1991
Olivar & Palomera 1994
Pertseva-Ostroumova 1974
Sanzo 1918b
Shiganova 1977
Taaning 1918
Tortonese 1956

## EARLY LIFE HISTORY DESCRIPTION*

**LARVAE:**
Length at flexion: 6-7 mm
Length at transformation: 13-14.5 mm
Sequence of fin development: $C_1$, A & $P_1$, D, $C_2$, $P_2$
Pigment: *Preflexion*—Paired series ventrally on isthmus & just posterior to cleithrum; lateral gut series consisting of 1 on foregut, 2 on midgut, & 1 or more large melanophores dorsolaterally on the terminal section; 1 large melanophore midventrally, 6-8 myomeres posterior to the anus; 1 on dorsal finfold at midbody in some specimens; on $P_1$ rays; on lower jaw in some specimens. *Flexion-postflexion*—$P_1$ pigment & midventral tail melanophore persist (midventral tail pigment not shown in Figures BBE).
Diagnostic characters: Ventral pigment series on isthmus, continuing posterior to cleithrum indicative of genus; eyes moderately elliptical with brownish choroid mass ventrally; body & gut moderate in form, Sn-A <60% BL vs >60% in *H. benoiti*; foregut shorter than in *H. benoiti*; cleithrum to anus distance 25-27% BL vs 32-34% in *H. benoiti*; PdL shorter than in *H. benoiti*, decreases with development from 50% to 44% BL (decreases from 56% to 49% in *H. benoiti*); midventral tail melanophore & $P_1$ pigment present throughout development; $Br_2$ photophores appear at ~ 7.5 mm, 1 or more PO & VO photophores form just before transformation.

## ILLUSTRATIONS

ABC, from Olivar & Palomera (1994); D & E, from Taaning (1918)
* Description based primarily on Olivar & Palomera (1994)


A
5.3 mm
B
7.0 mm
C
9.9 mm
D
14.5 mm
E
13.0 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 16 |
| Caudal | 19 |
| Total | 35 |
| Number of fin rays | |
| Dorsal | 12-14 |
| Anal | 17-21 |
| Pectoral | 13-15 |
| Pelvic | 8 |
| Caudal | |
| Dorsal Secondary | 9 |
| Principal | 10+9 |
| Ventral Secondary | 8 |
| Gillrakers on first arch | |
| Upper | 4-6 |
| Lower | 13-16 |
| Total | 17-22 |
| Branchiostegals | |

## LIFE HISTORY

Range: Tropical Atlantic species; associated with the Equatorial & Guinea Current systems; reported in Gulf of Mexico & Caribbean.
Habitat: Epipelagic to upper bathypelagic
ELH pattern: Oviparous, planktonic eggs & larvae
Migration: Migrates at night from mesopelagic to epipelagic zone

## LITERATURE

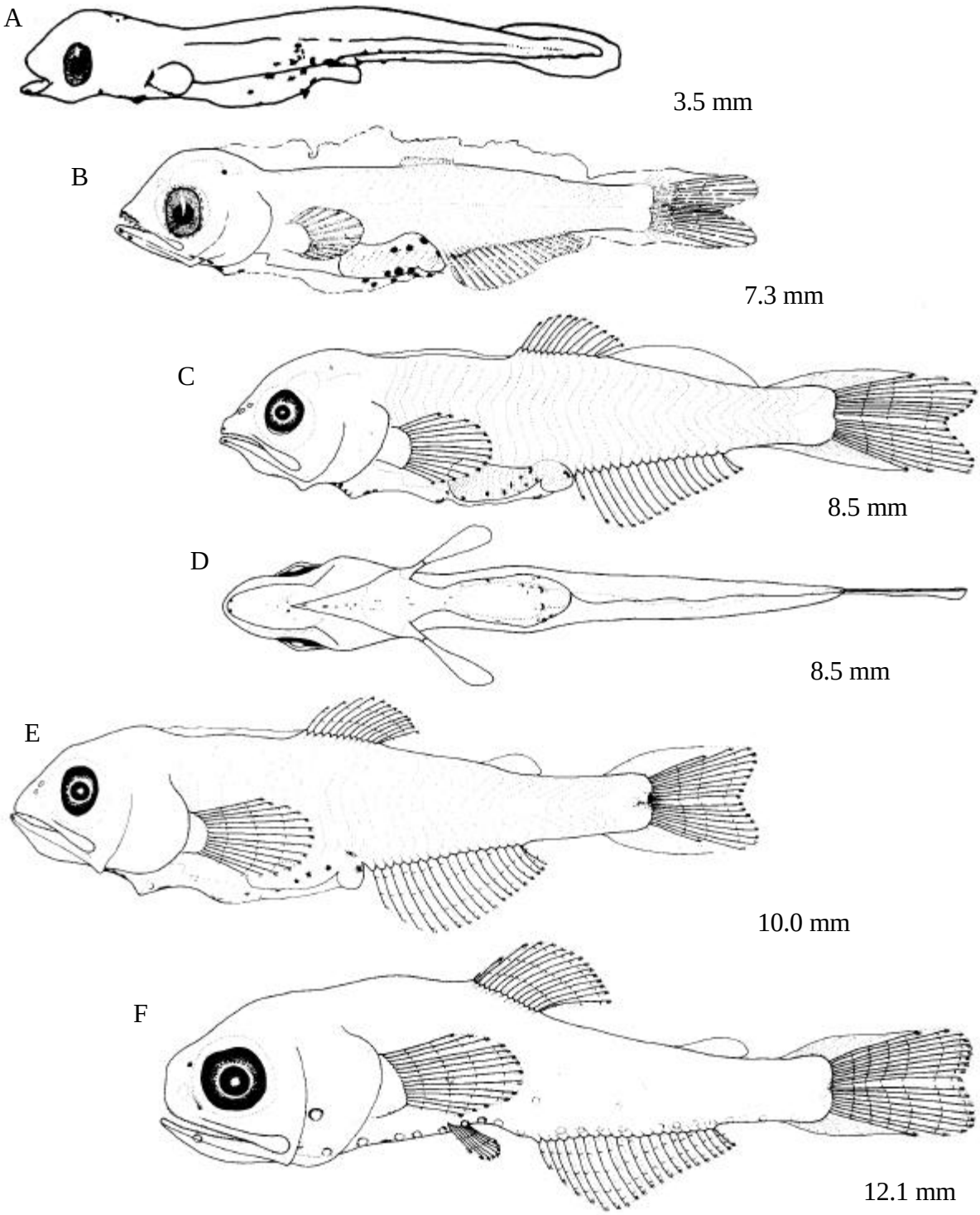
Fahay 1983
Moser & Ahlstrom 1974
Olivar 1988
Olivar & Fortuño 1991
Shiganova 1974 (as *H. benoiti*)
Zhudova 1969 (as *H. taaningi*)

## EARLY LIFE HISTORY DESCRIPTION

**LARVAE:**
Length at flexion: 5.5-6.0 mm
Length at transformation: 11.0-13.0 mm
Sequence of fin development: $C_1$, A & $P_1$, D, $C_2$, $P_2$
Pigment: *Preflexion*—Some minute postanal melanophores on ventral margin of tail in the smallest larvae; large patch of melanophores on the hindgut & terminal gut section; irregular series on the ventral margin of the isthmus, continuing posterior to the cleithrum & less regularly along the ventral margin of the gut & ventral finfold; 1 or 2 on opercular region; some anteriorly on upper & lower jaws; a pair dorsolaterally on hindbrain. Flexion-postflexion—Earlier pigment pattern persists; large melanophore at base of caudal fin at juncture of hypural plates in some late postflexion specimens.
Diagnostic characters: Ventral pigment series on isthmus, continuing posterior to cleithrum, indicative of genus; eyes slightly elliptical, wider than in all other *Hygophum* species, except *H. taaningi*; choroid tissue lacking; body relatively deep & compressed compared with other *Hygophum* species, except *H. taaningi*; BD in flexion stage larvae ~ 20% BL vs 27-28% in *H. taaningi*; BD in postflexion stage (up to 9.0 mm BL) 22-25% BL vs typically 25-31% in *H. taaningi*; foregut narrow in diameter, opening dorsally into a prominent enlarged hindgut; Sn-A ~ 60% BL; heavier pigment on hindgut, isthmus, jaws, & ventrally on gut compared with *H. taaningi*; $Br_2$ photophores begin to form at ~ 8 mm, 1 or more PO photophores appear late in postflexion.

## ILLUSTRATIONS

A, from Olivar (1988); B, from Moser & Ahlstrom (1974); C, D, E, F, original [C. Manning]
C & D, Dana Sta. 4000 II; E & F, Dana Sta. 4000 III


A
3.5 mm
B
7.3 mm
C
8.5 mm
D
8.5 mm
E
10.0 mm
F
12.1 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 16-17 |
| Caudal | 21-23 |
| Total | 38-40 |
| Number of fin rays | |
| Dorsal | 13-15 |
| Anal | 21-25 |
| Pectoral | 13-16 |
| Pelvic | 8 |
| Caudal | |
| Dorsal Secondary | 7-9 |
| Principal | 10+9 |
| Ventral Secondary | 7-8 |
| Gillrakers on first arch | |
| Upper | 3-5 |
| Lower | 12-16 |
| Total | 16-20 |
| Branchiostegals | 8-9 |

## LIFE HISTORY

Range: Northern & southern subtropical Atlantic & Pacific Oceans
Habitat: Epi- & mesopelagic
ELH pattern: Oviparous, planktonic eggs & larvae
Migration: Part of population migrates at night from mesopelagic to epipelagic zone

## LITERATURE

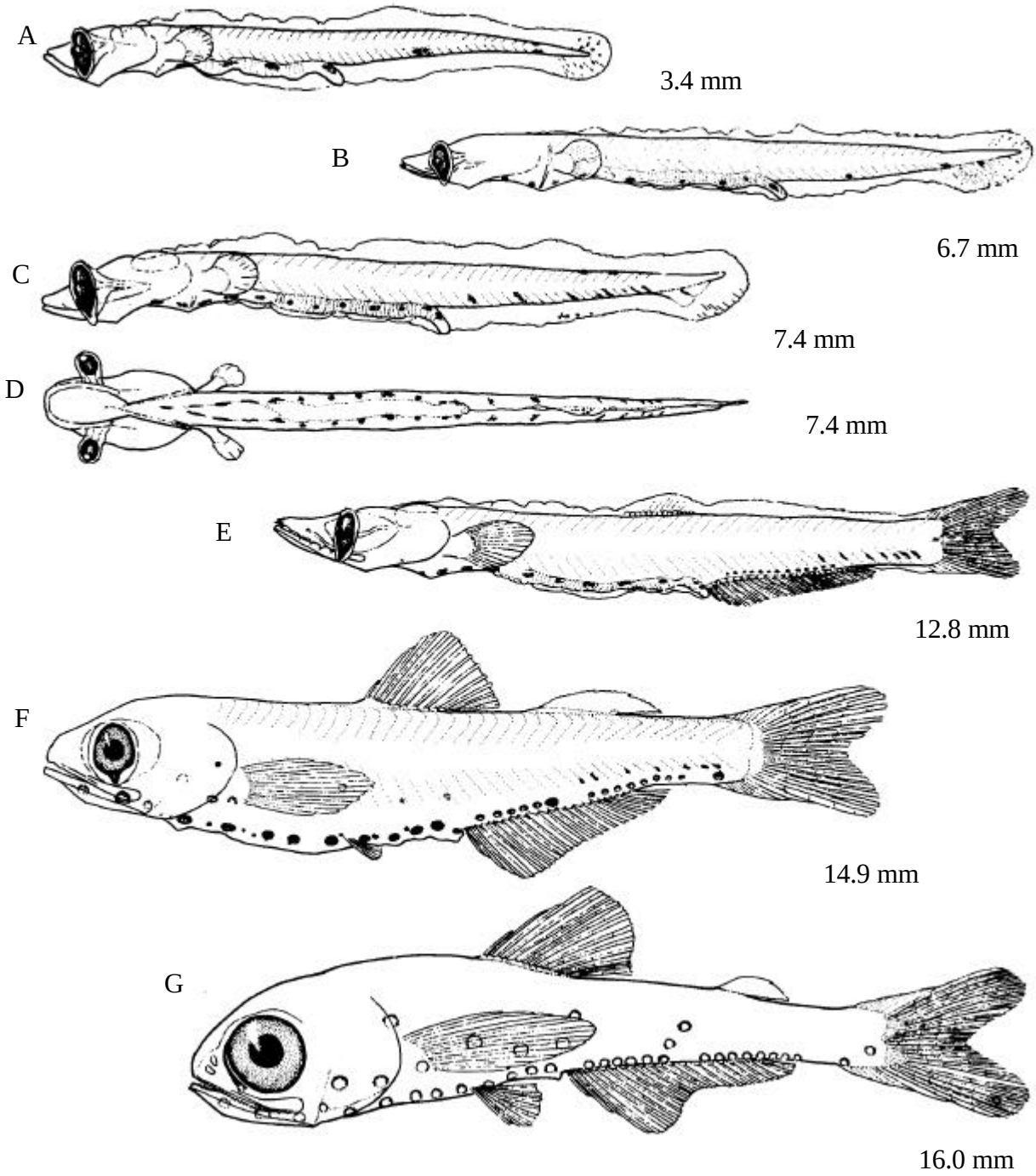
Fahay 1983
Moser 1981
Moser & Ahlstrom 1970, 1974, 1996
Moser et al. 1984
Olivar & Fortuño 1991
Ozawa 1986, 1988
Shiganova 1977

## EARLY LIFE HISTORY DESCRIPTION*

**LARVAE:**
Length at hatching: < 3.4 mm
Length at flexion: ~ 8.8-10.3 mm
Length at transformation: ~ 14.9-16.4 mm
Sequence of fin development: $C_1$, $P_1$ & $C_2$, A, D & $P_2$
Pigmentation: *Preflexion*—By 3.0 mm, ventrolateral pair of melanopores just posterior to cleithrum, dorsolateral pair on terminus of gut, 2 pairs laterally on gut, 2 in tandem on isthmus, 2 melanophores widely-spaced on postanal ventral margin, & 1 at dorsal margin; by 5.0 mm, 1 at hypural anlagen; some on ventral finfold; by end of stage, posterior dash on isthmus divided into pair, 1-3 added laterally on gut, & 1-4 pairs extending upward in myosepta on each side from ventral margin; rarely, 1at tip of lower jaw. *Flexion*—1 or 2 additional dashes on midline of isthmus; 1 on opercle; up to 8 laterally on gut; 7-12 in postanal series; beginning of series on A base. *Postflexion*— 5-10 postanal myoseptum dashes; up to 8 pairs laterally on gut; up to 15 on A base.
Diagnostic features: Isthmus pigment typical of genus; slender body, typically <12% BD; gut elongate, thin, & nearly straight; head flattened; narrow, elliptical eyes on short stalks; conical ventral choroid tissue; $Br_1$, $PO_1$, $PO_5$, $VO_4$ photophores the first to appear at transformation

## ILLUSTRATIONS

ABG, from Moser & Ahlstrom (1996)
Description based on Moser & Ahlstrom (1996)


A
3.4 mm
B
6.7 mm
C
7.4 mm
D
7.4 mm
E
12.8 mm
F
14.9 mm
G
16.0 mm

## MERISTICS

| | |
|---|---|
| Vertebrae | |
| Precaudal | 15-16 |
| Caudal | 19-21 |
| Total | 35-36 |
| Number of fin rays | |
| Dorsal | 12-14 |
| Anal | 17-23 |
| Pectoral | 12-15 |
| Pelvic | 8 |
| Caudal | |
| Dorsal Secondary | 8-9 |
| Principal | 10+9 |
| Ventral Secondary | 8-9 |
| Gillrakers on first arch | |
| Upper | 4-5 |
| Lower | 12-16 |
| Total | 16-21 |
| Branchiostegals | |

## LIFE HISTORY

Range: Tropical-subtropical Atlantic species; throughout Gulf of Mexico & Caribbean.
Habitat: Epipelagic to upper bathypelagic
ELH pattern: Oviparous, planktonic eggs & larvae
Migration: Part of population migrates at night from mesopelagic to epipelagic zone

## LITERATURE

Fahay 1983
Moser & Ahlstrom 1974
Moser et al. 1984
Shiganova 1975a (as *H. macrochir*)
Zhudova 1969 (as *H. macrochir*)

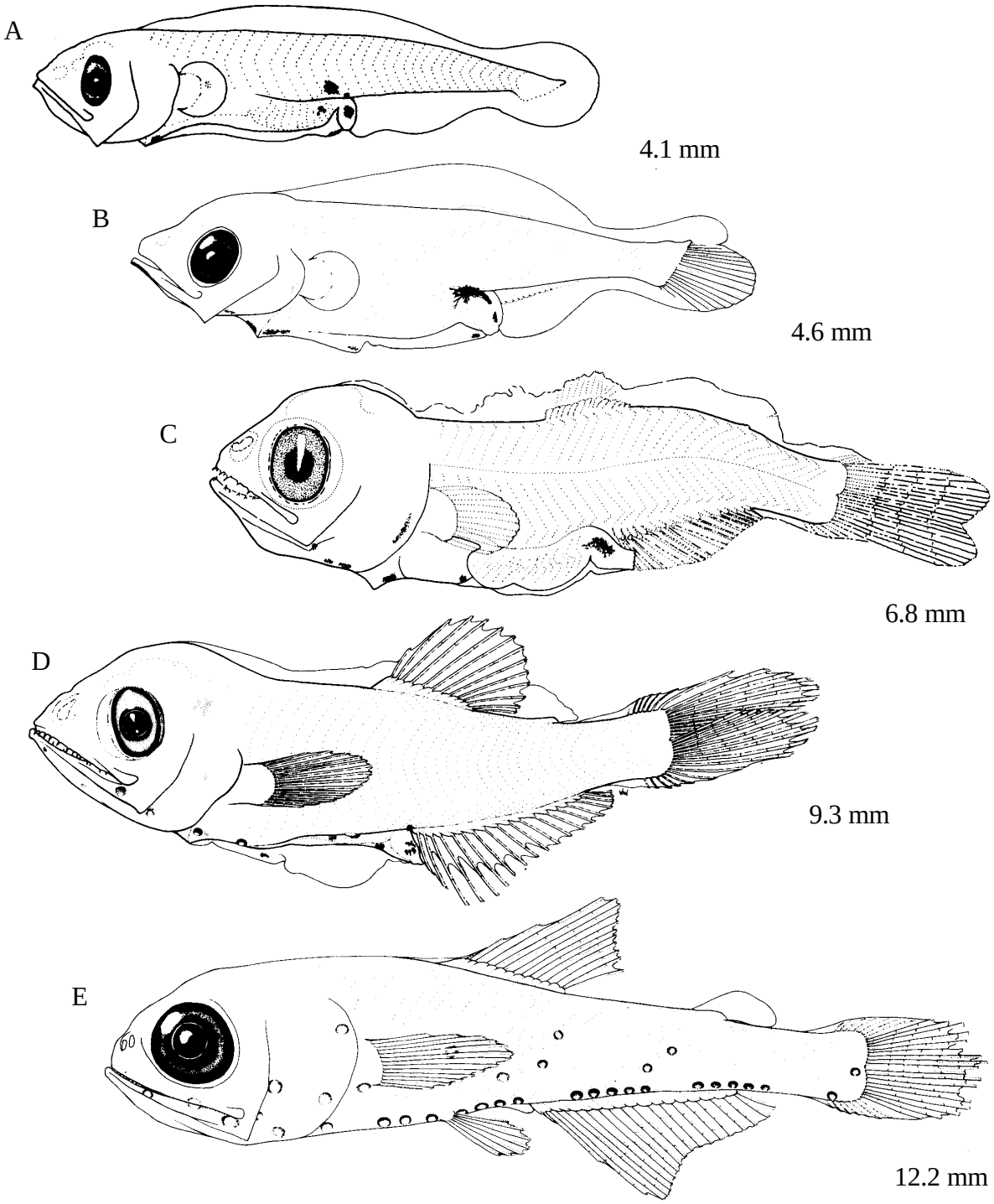
## ILLUSTRATIONS

A, B, D, E, original [A, B, E: R. C. Walker; D, W. Watson]; C, Moser & Ahlstrom (1974)
A, CA89071507; B, LH1A4507; D, LH 376A1 with some features drawn from a specimen of similar size from CA 89073303; E, OR II 7343 87 01

## EARLY LIFE HISTORY DESCRIPTION

**LARVAE:**
Length at flexion: 4.2-6.0 mm
Length at transformation: 10-12 mm
Sequence of fin development: $C_1$, $P_1$, A, D, $C_2$, $P_2$
Pigment: Preflexion—Initially, 1-3 melanophores in irregular postanal series, large pair & 1 to several smaller melanophores dorsolaterally on hindgut at divergence from body, a pair (elongate when expanded) on ventral margin just posterior to cleithra, & 1 to several scattered ventrolaterally over gut; postanal series usually absent in larvae >3 mm but may persist to late preflexion in heavily pigmented specimens. *Flexion-early postflexion*—Pair on anterolateral margin of lower jaw (rarely a pair anteriorly on upper jaw); pair (elongate when expanded) on isthmus; 1 in midline at basibranchial region; a pair on ventral margin below juncture of fore- & hindgut; 1, occasionally 2, embedded blotches anterior to $P_1$ base; embedded blotch above developing gas bladder at midgut; occasionally, a medial melanophore posteriorly on midbrain. *Mid- to late postflexion*—Usually, gut pigment reduced to large pair dorsolateral to hindgut & pair on ventral margin below juncture of mid- & hindgut; usually 1 on midline added anterior to pair on isthmus.
Diagnostic characters: Ventral pigment at cleithrum & isthmus indicative of genus; eyes slightly elliptical, wider & somewhat larger than in all other *Hygophum* species; choroid tissue lacking; body relatively deep & compressed compared with other *Hygophum* species, except *H. macrochir*; body slightly deeper than in *H. macrochir*, BD 27-28% BL in flexion stage vs ~ 20% in *H. macrochir*; in postflexion stage (up to 9.0 mm BL), BD 25-31% BL, typically vs 22-25% in *H. macrochir*; foregut narrow in diameter, opening dorsally into a prominent enlarged hindgut; sparser pigment on hindgut, isthmus, & ventrally on gut compared with *H. macrochir*; when present, melanophore at the hindbrain is mesial, in contrast to dorsolateral pair in *H. macrochir*; $Br_2$ photophores appear in early postflexion stage; $PO_1$ & $PO_2$ appear late in postflexion stage.

*See left column for list of Illustrations*


A
4.1 mm
B
4.6 mm
C
6.8 mm
D
9.3 mm
E
12.2 mm