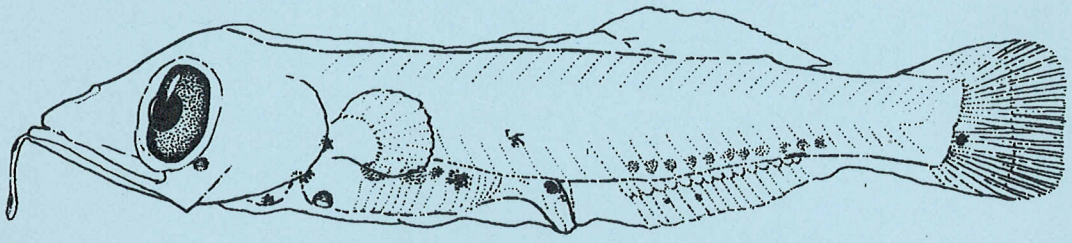
NOAA Technical Memorandum NMFS-SEFSC-453

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

BY

H. GEOFFREY MOSER AND WILLIAM WATSON



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March 2001

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CONTENTS

ORDER MYCTOPHIFORMES: Blackchins and Lanternfishes

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; C_1, principal caudal fin rays; C_2, 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; P_1, pectoral fin; P_2, 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

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 14–16 total gill rakers whereas *N. macrolepidotus* has 10–12 (Nafpaktitis1977; 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)

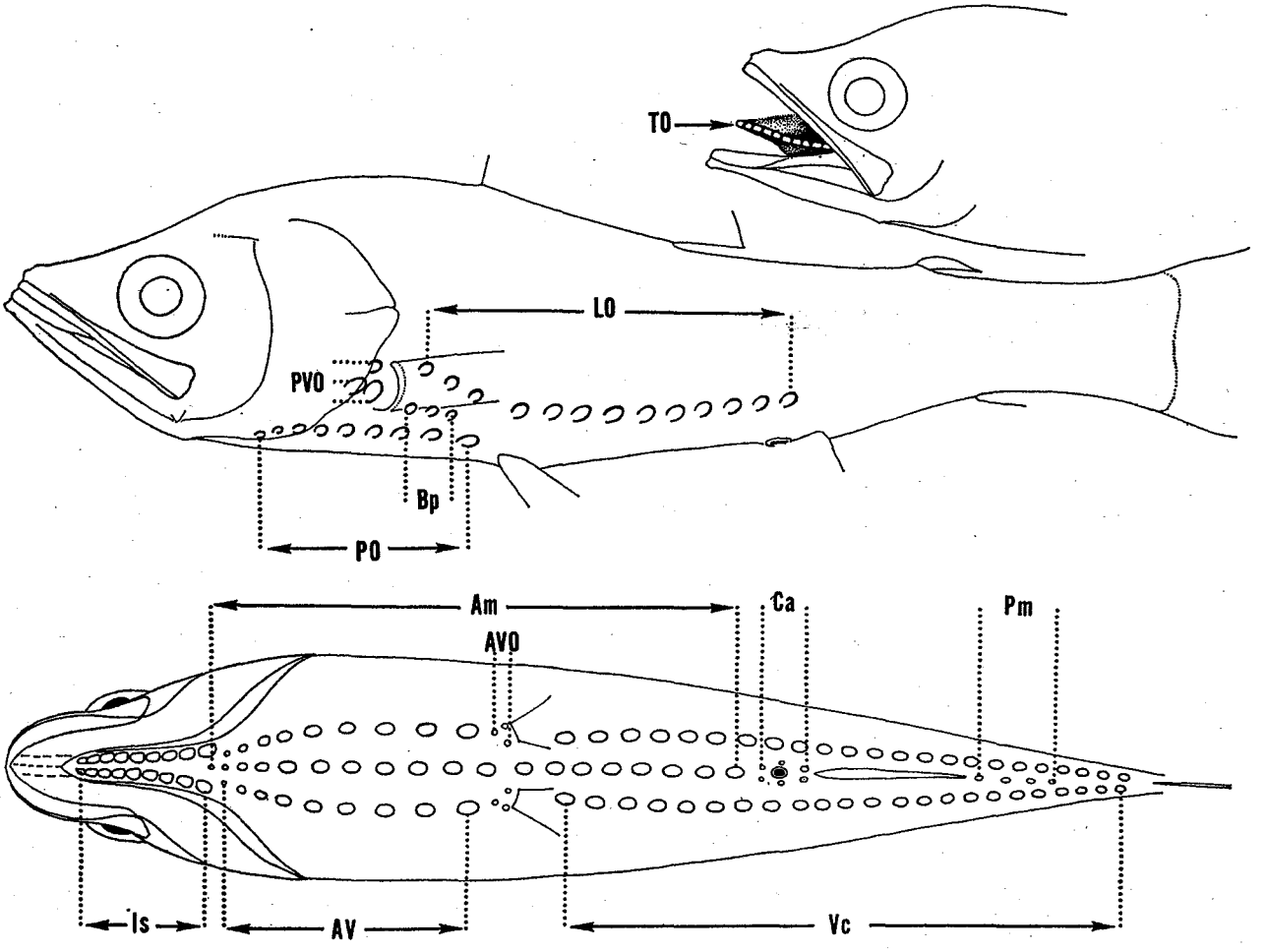


Figure 1. Arrangement of the photopores in *Neoscopelus* (from Nafpaktitis 1977).

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

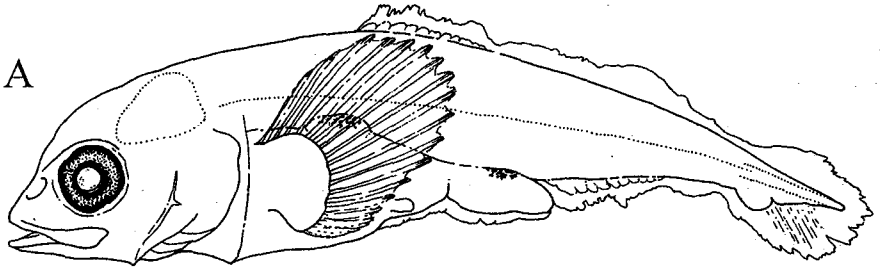
Pigmentation: *Preflexion–postflexion*—Patch above terminal section of gut & above developing gas bladder; some pigment above brain in postflexion larvae. *Transformation–juvenile*— Solidly pigmented except for interorbital, occipital, & postorbital regions of head; myosepta accentuated on posterior 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_1L 26–28% BL in preflexion–flexion larvae & ~20% BL in postflexion larvae); P_2 relatively shorter than in *N. microchir* (P_2L ~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).

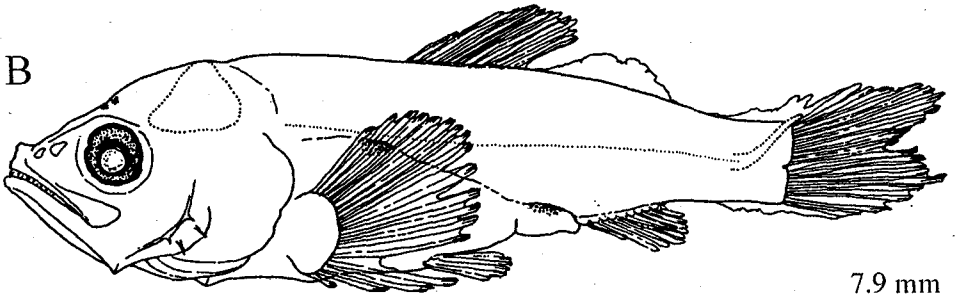
ILLUSTRATIONS

A & B, from Okiyama (1988); C, original [R. C. Walker/ W. Watson]
C, MCZ 60705

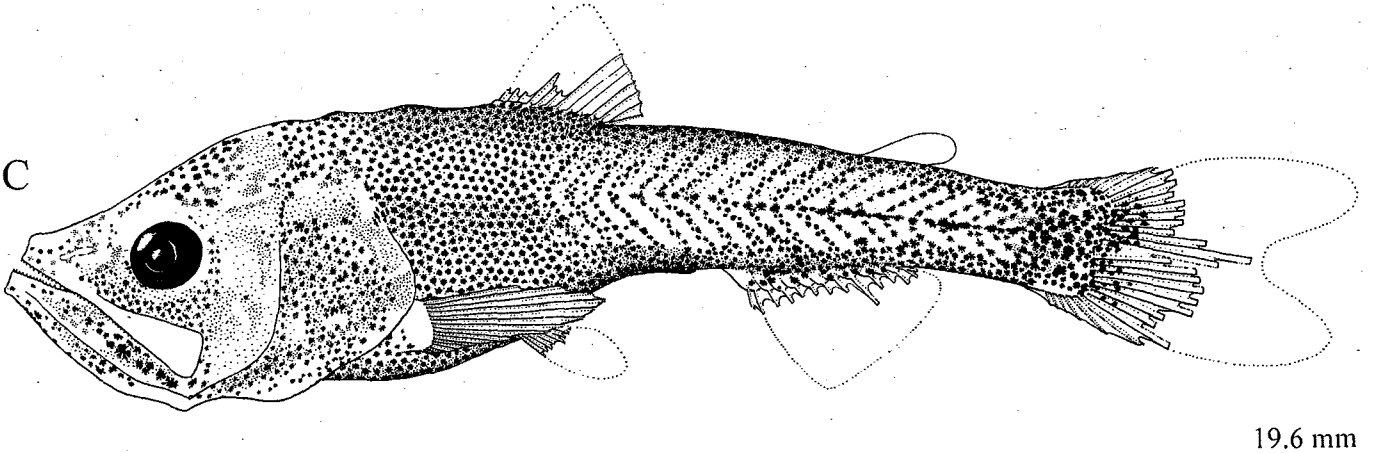
* Description of larvae based on descriptions and illustrations of Okiyama (1988), & on 3 preflexion stage larvae provided by Bruce Mundy (NMFS, Honolulu).



5.3 mm



7.9 mm



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

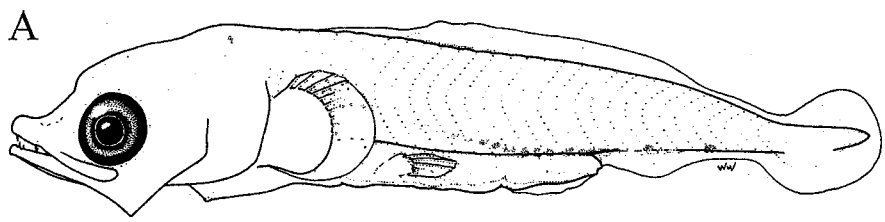
Pigmentation: *Preflexion*—Embedded blotch above the anteriorly located gas bladder; paired embedded series extending posteriad from gas bladder blotch to slightly beyond gut terminus; 1 or more melanophores on ventral margin of tail. Postflexion–*transformation*—Pigment above gas bladder and gut obscured 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_1L ~21–22% BL in postflexion stage); P_2 relatively longer than in *N. macrolepidotus* (P_2L ~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*— 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).

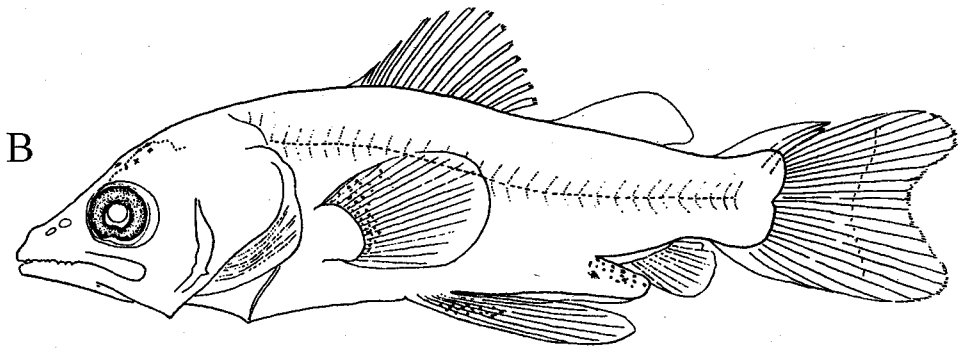
ILLUSTRATIONS

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

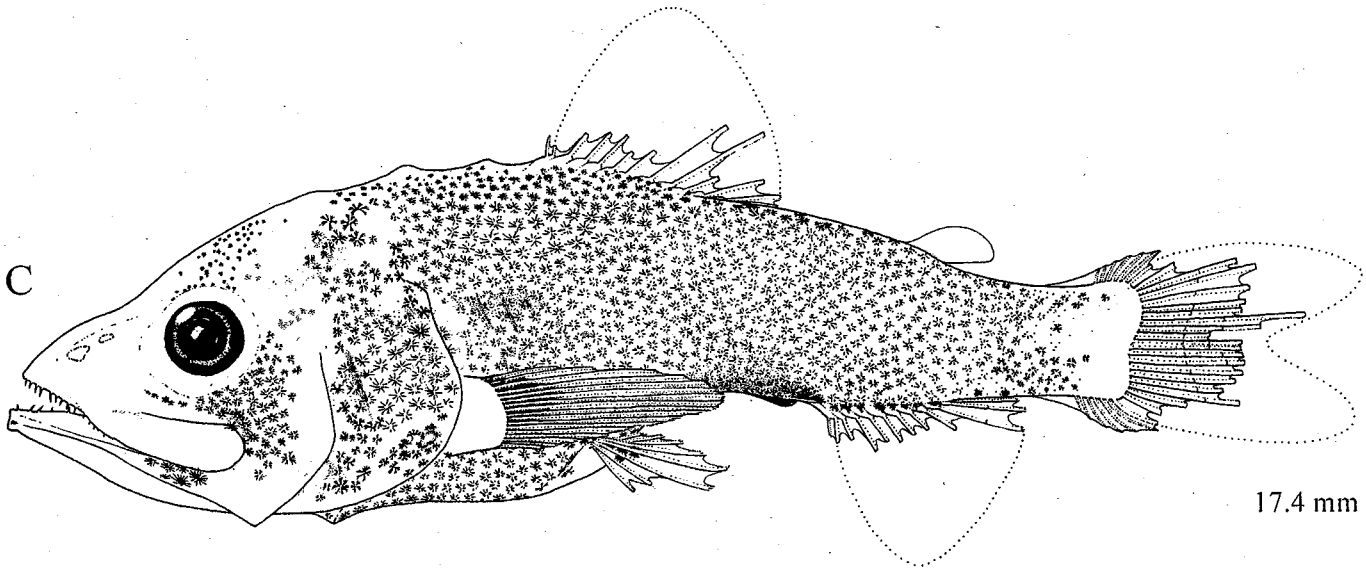
A, Nellen/Meteor Sta.122 (28° 42', 28° 23' W) ; C, MCZ 60704



5.3 mm



8.6 mm



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

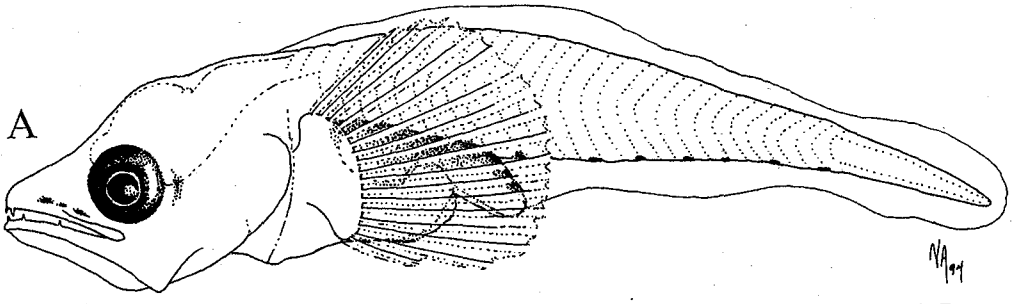
Pigmentation: *Preflexion*—Smallest larvae have a blotch above gut & ~ 7 melanophores in a postanal median ventral series; by 4.6 mm, an embedded linear blotch in snout & an embedded post-orbital blotch form a streak through eye. *Flexion–postflexion*—Postanal series reduced to 1–5, or absent; blotch 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_1L 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.

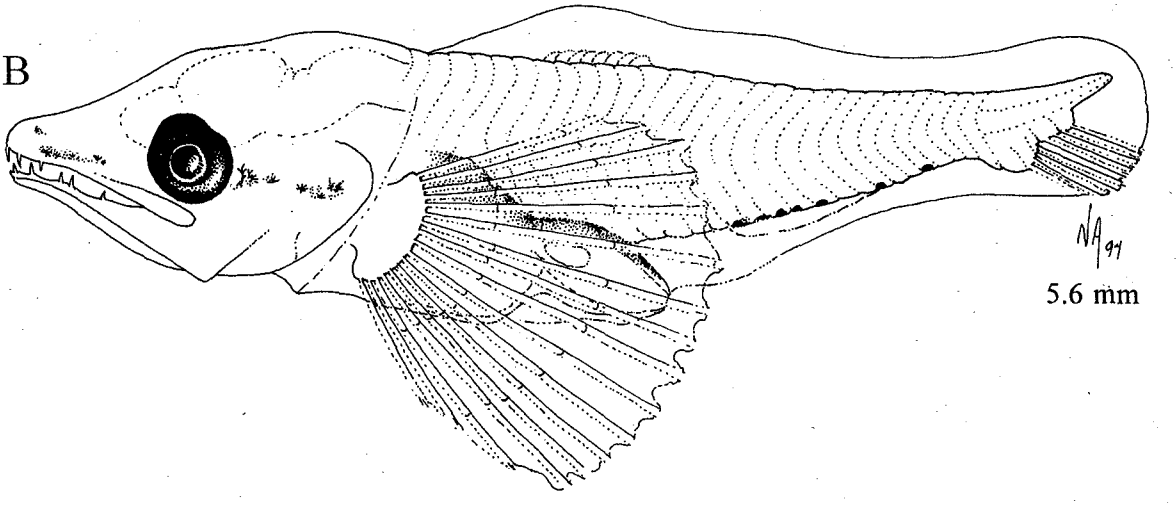
ILLUSTRATIONS

A & B, from Moser (1996); C, from Butler & Ahlstrom (1976)

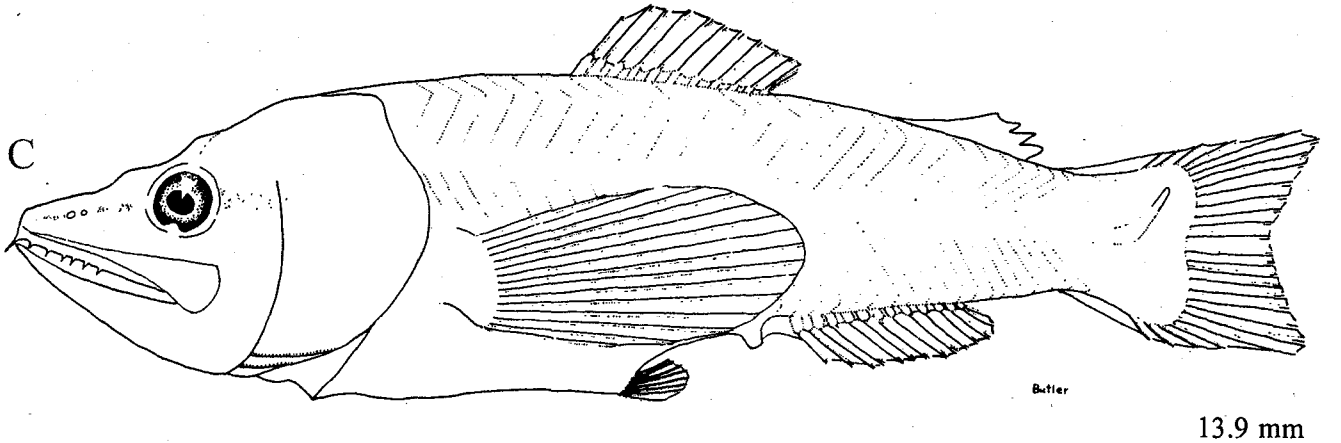
* Description based on Moser (1996)



3.7 mm



5.6 mm



13.9 mm

MYCTOPHIDAE: Lanternfishes

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

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, 1984, 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*.

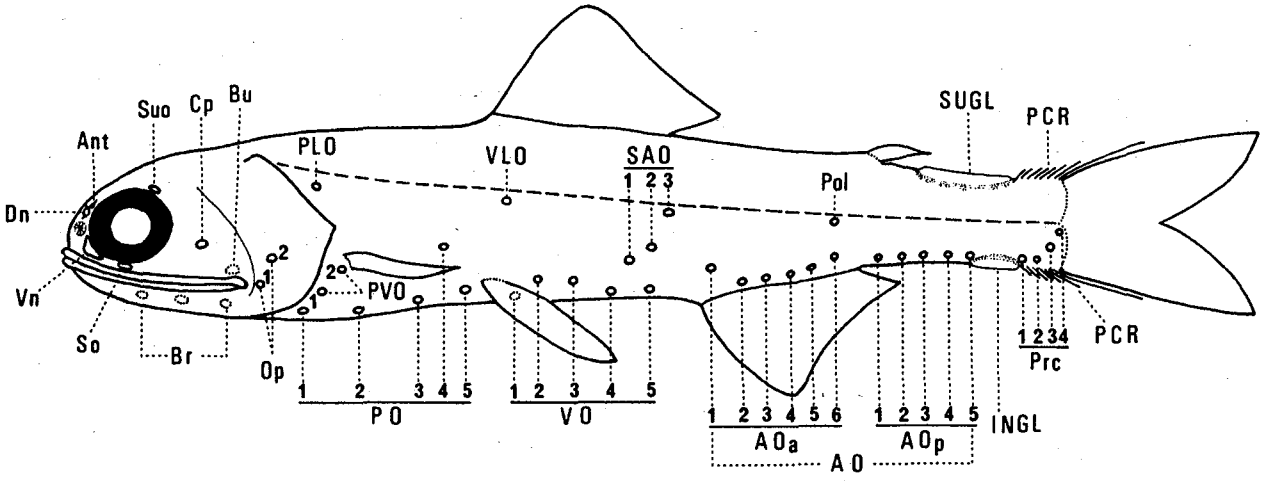


Figure 2. Generalized photophore arrangement in Myctophidae (from Fujii 1984).

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
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			

Species	Distribution	ELH literature		
		Preflexion larvae	Flexion or Postflexion larvae	Transforming or Juvenile
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
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			
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	

Species	Distribution	ELH literature		
		Preflexion larvae	Flexion or Postflexion larvae	Transforming or Juvenile
Lepidophanes	rare in GM & nw Car, common			
gaussi	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			
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	Vertebrae			Fin rays				
	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
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

Species	Vertebrae			Fin rays				
	PrCV	CV	Total	D	A	P_1	P_2	C_2
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
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
problematicus	16	19	35	16(15–17)	17(16–19)	11(11–12)	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	16	20–22	35–38	14–15(14–16)	14(13–14)	16(14–17)	8	8–9+8–9
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

Species	Vertebrae			Fin rays				
	PrCV	CV	Total	D	A	P_1	P_2	C_2
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
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)
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)

Species	Gill rakers			AO photophores		
	Upper limb	Lower limb	Total	AOa	AOp	Total
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)
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)
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)

Species	Gill rakers			AO photophores		
	Upper limb	Lower limb	Total	AOa	AOp	Total
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
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

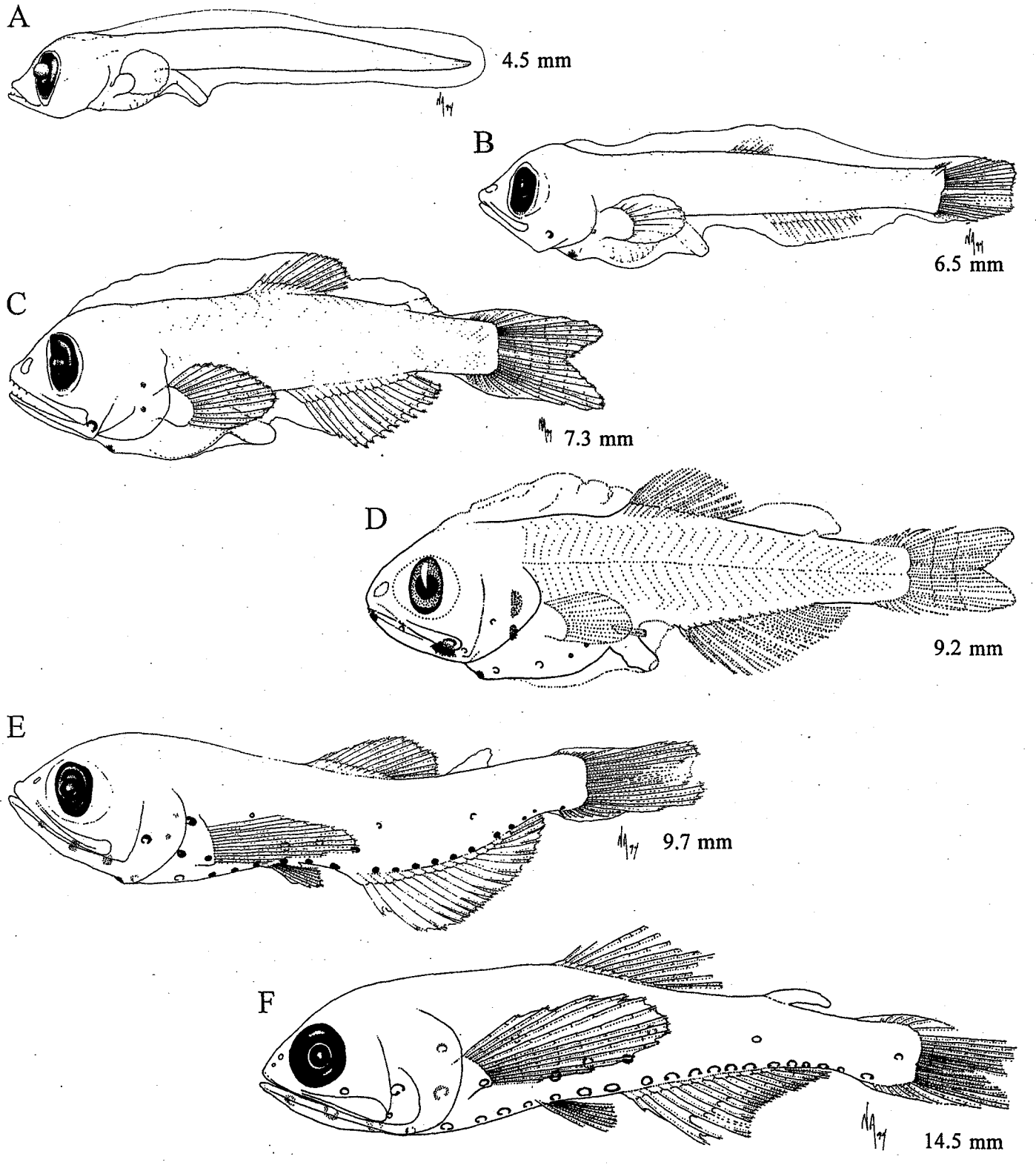
Pigment: *Preflexion*—Pair of melanophores just anterior to cleithral symphysis at ~4 mm, later coalesces in midline. *Flexion*—At lower jaw symphysis by ~5.5 mm; two embedded blotches anterior to P_1 base, one near top & the other near bottom of fin base.

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

A–F, 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

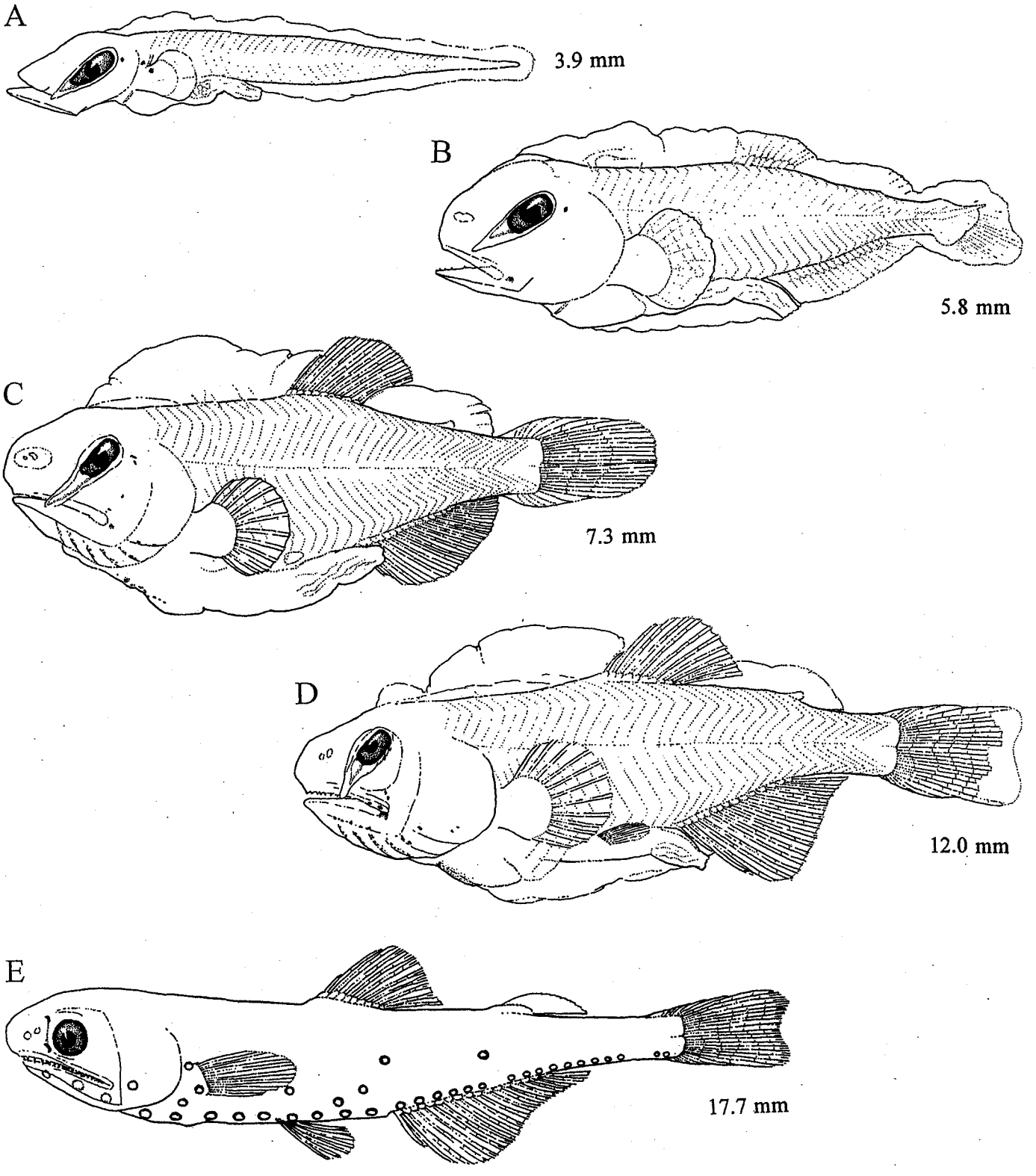
Pigment: *Preflexion*—At <4.0 mm, anterodorsal to P_1 base, on trunk near axilla, on upper & lower jaw tips, posterior margin of orbit, anteromesial to mid- & forebrain, & lateral to terminal gut; all but postorbital pigment lost by end of stage. *Flexion*—By ~ 6.0 mm, a series outlines each Br ray, & 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

A–E, 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

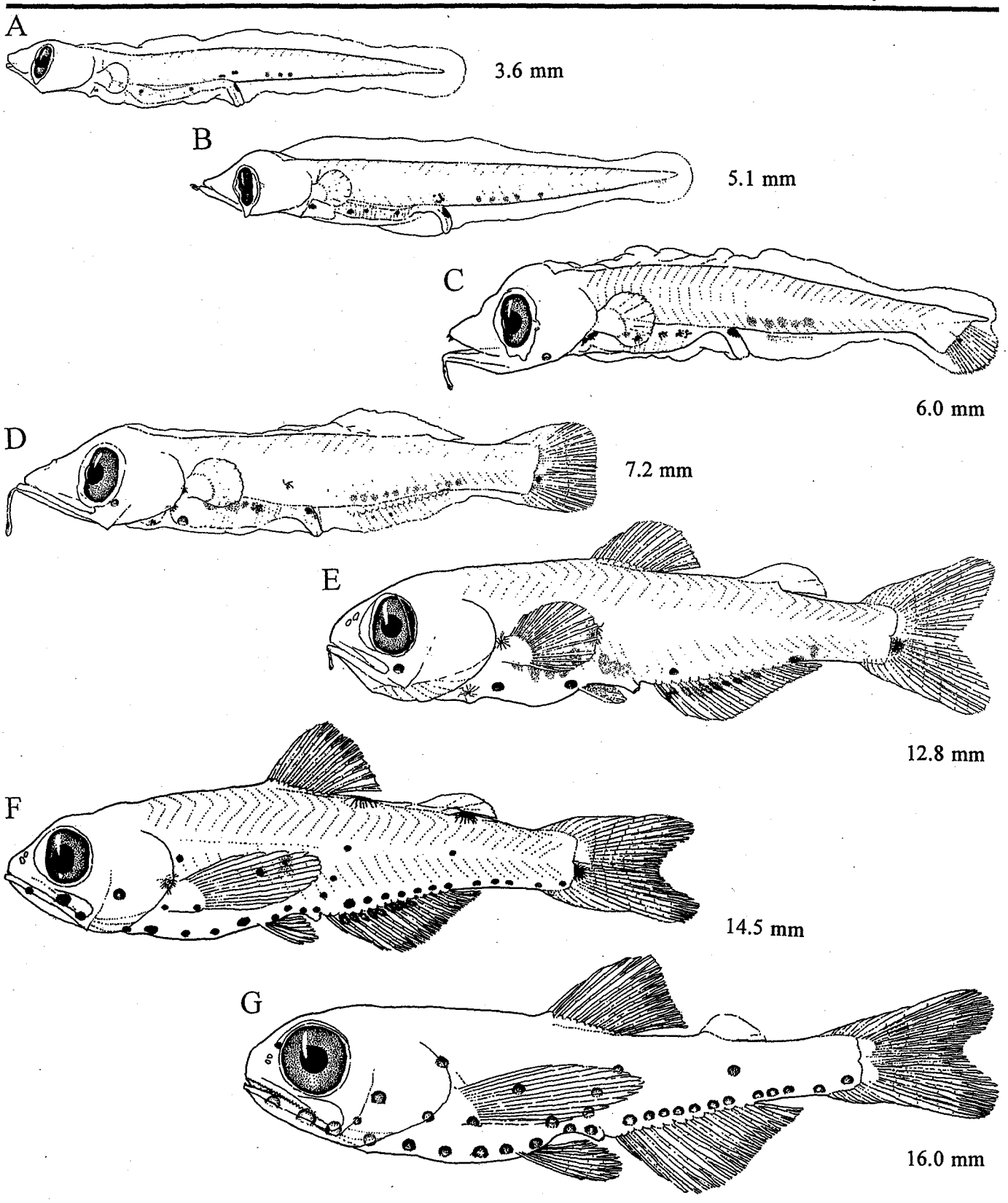
Pigment: *Preflexion*—By ~ 3.0 mm, ventrolateral pair of melanophores just posterior to cleithrum, dorsolateral pair on terminal gut, 2 lateral pairs on midgut, & ~3 melanophores in postanal series at ventral margin; 1 laterally above preanal arch of gut; at ~ 5.0 mm, first of 3 on dorsal surface of 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

A–G, 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

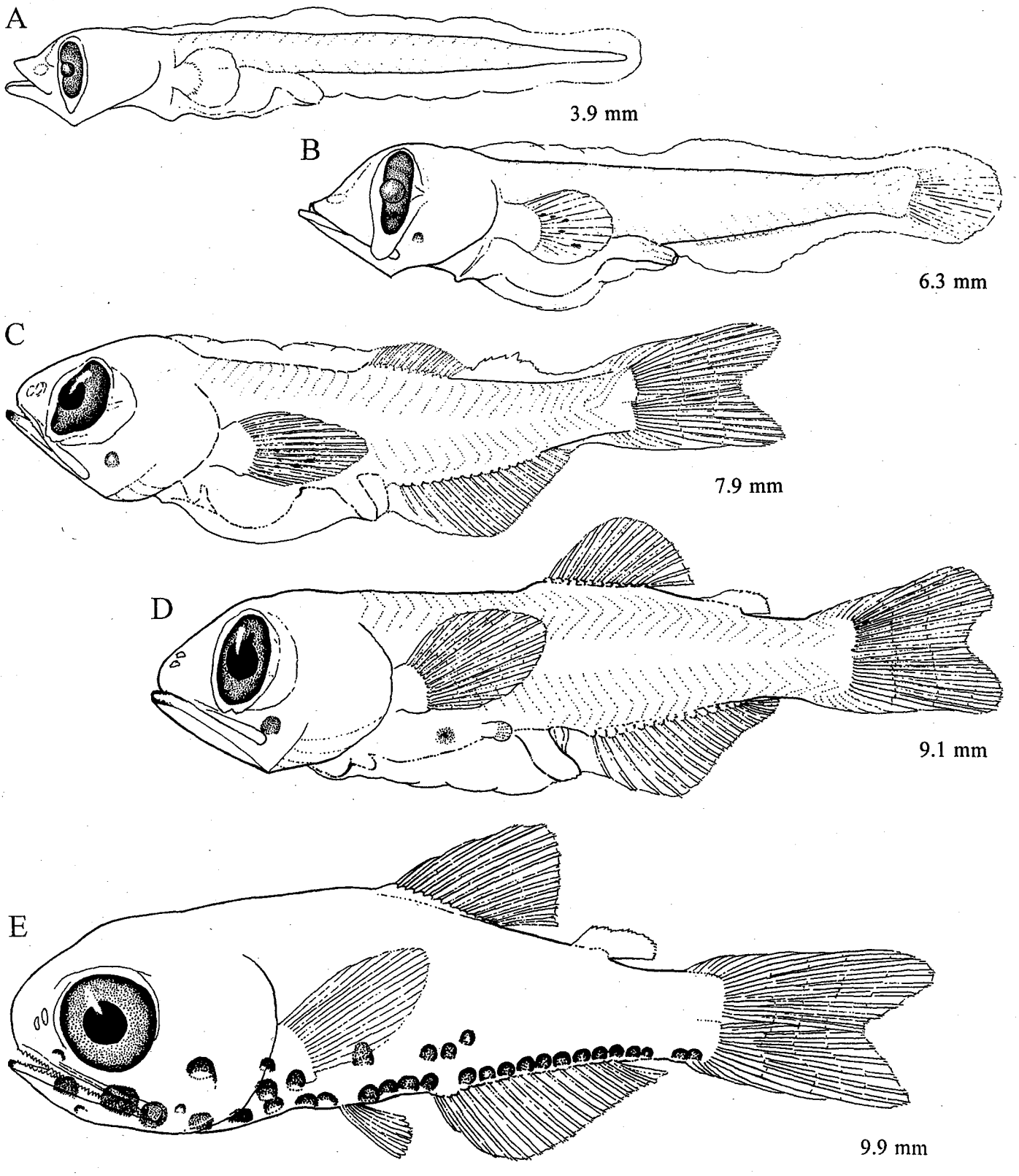
Sequence of fin development: C_1, P_1, C_2, A, D & P_2
Pigment: *Preflexion*—None. *Flexion*—By ~ 6.0 mm, a pair of melanophores at lower jaw tip & a patch on P_1 blade; by 7.0 mm, above developing gas bladder. *Postflexion*—Some larvae >9.0 mm have a melanophore on each side of foregut.

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

A–E, 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

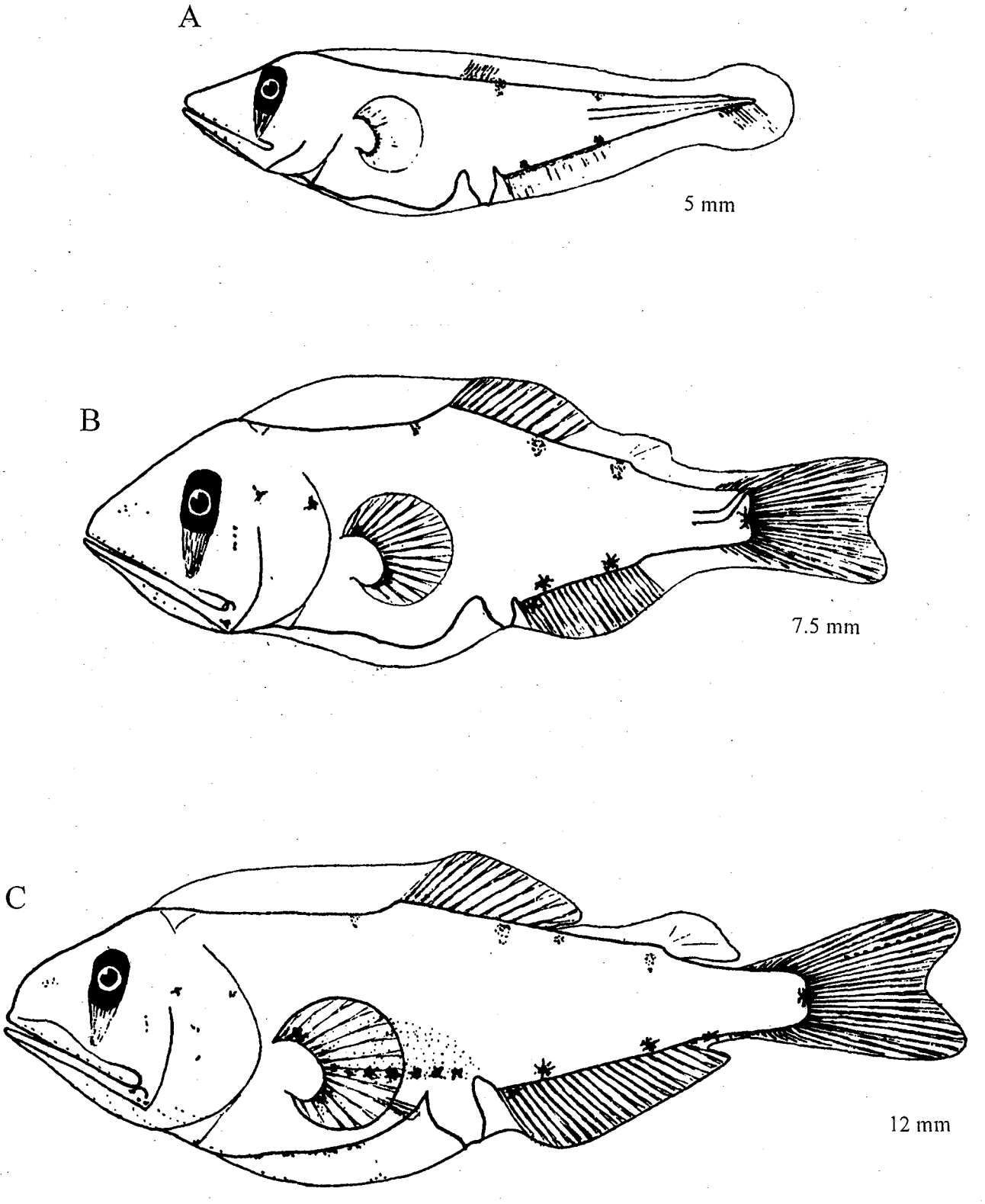
Pigment: *Preflexion*—Opposing blotches dorsally & ventrally on tail, one pair just posterior to juncture of trunk & tail & the other at mid-tail; series of minute melanophores along upper & lower jaws. *Flexion–postflexion*—Blotch added on dorsal midline anterior to D origin & eventually a blotch added 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

A–C, from Taaning (1918)

* Description based primarily on Taaning (1918)


A
5 mm
B
7.5 mm
C
12 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

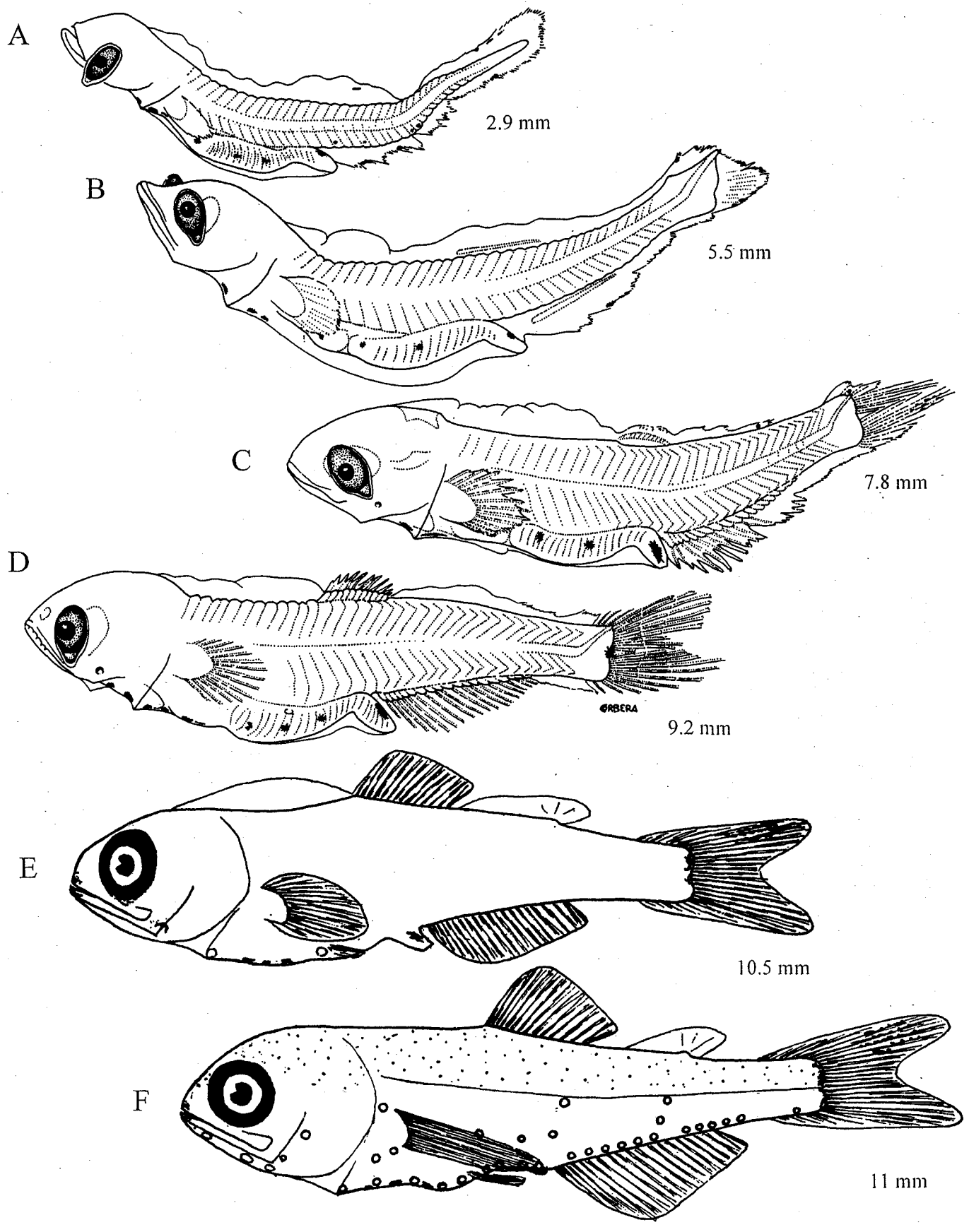
Pigment: *Preflexion*— Paired series ventrally on isthmus & just posterior to cleithrum; lateral gut series consisting of 1 on foregut, 2 on midgut, & 1 or more large melanophores dorsolaterally on the terminal section; 1–4 in postanal midventral series (not always present); some on dorsal finfold at 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

A–D, 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
ORBERA
9.2 mm
E
10.5 mm
F
11 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

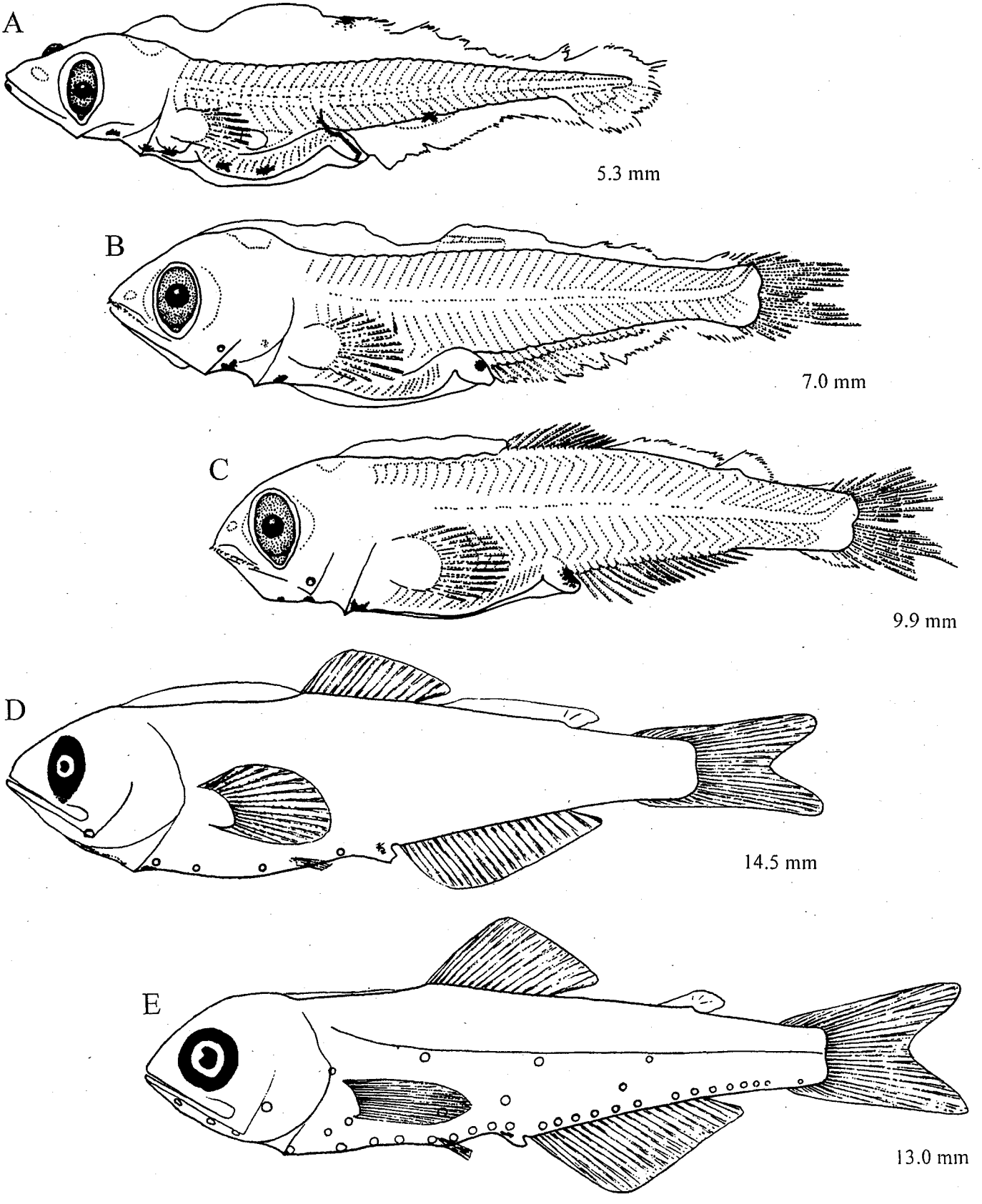
Pigment: *Preflexion*— Paired series ventrally on isthmus & just posterior to cleithrum; lateral gut series consisting of 1 on foregut, 2 on midgut, & 1 or more large melanophores dorsolaterally on the terminal section; 1 large melanophore midventrally, 6–8 myomeres posterior to the anus; 1 on dorsal 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 B–E).

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

A–C, 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

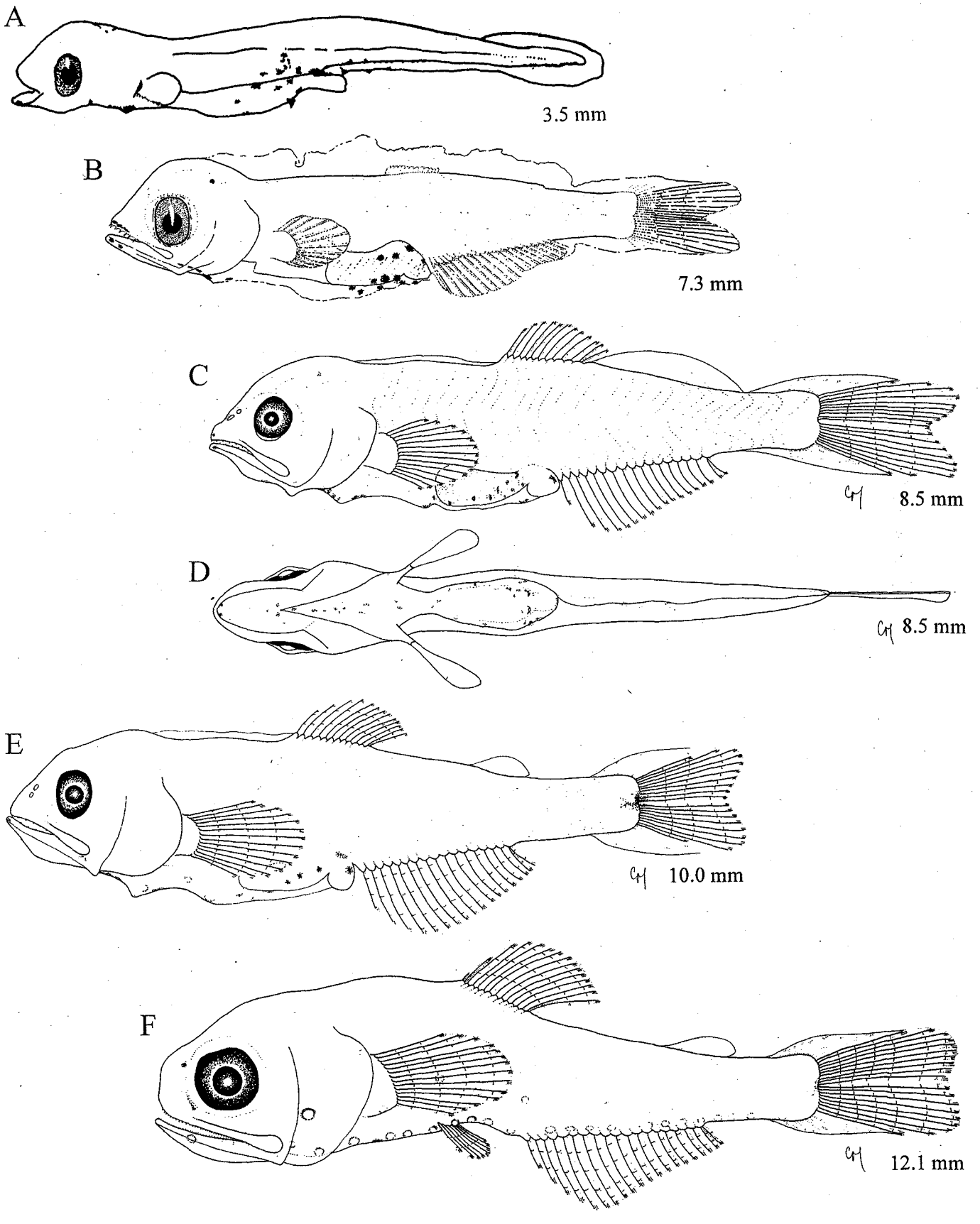
Pigment: *Preflexion*—Some minute postanal melanophores on ventral margin of tail in the smallest larvae; large patch of melanophores on the hindgut & terminal gut section; irregular series on the ventral margin of the isthmus, continuing posterior to the cleithrum & less regularly along the ventral 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

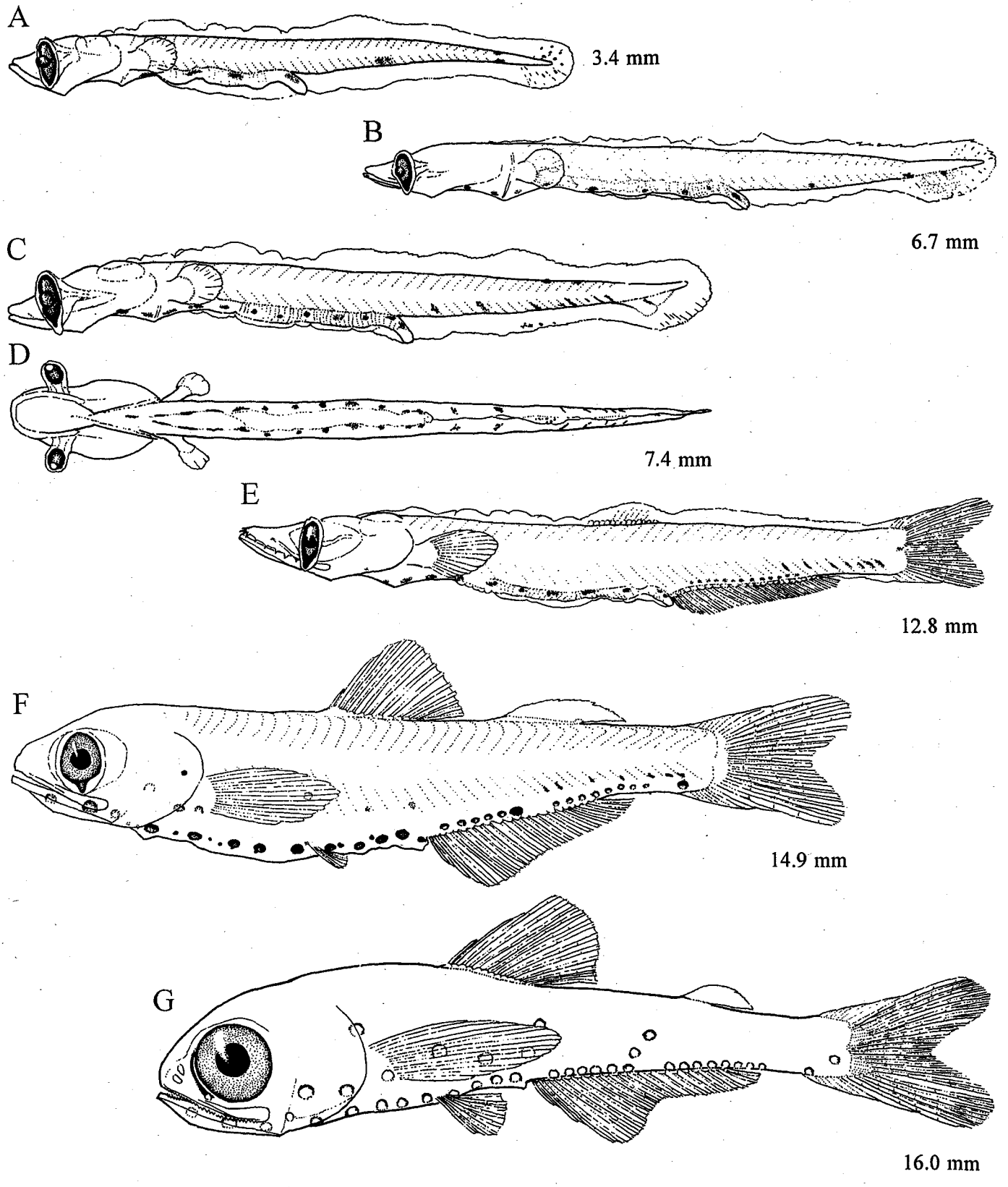
Pigmentation: *Preflexion*—By 3.0 mm, ventrolateral pair of melanopores just posterior to cleithrum, dorsolateral pair on terminus of gut, 2 pairs laterally on gut, 2 in tandem on isthmus, 2 melanophores widely-spaced on postanal ventral margin, & 1 at dorsal margin; by 5.0 mm, 1 at hypural anlagen; 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

A–G, from Moser & Ahlstrom (1996)

* Description based on Moser & Ahlstrom (1996)


A
3.4 mm
B
6.7 mm
C
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*)

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

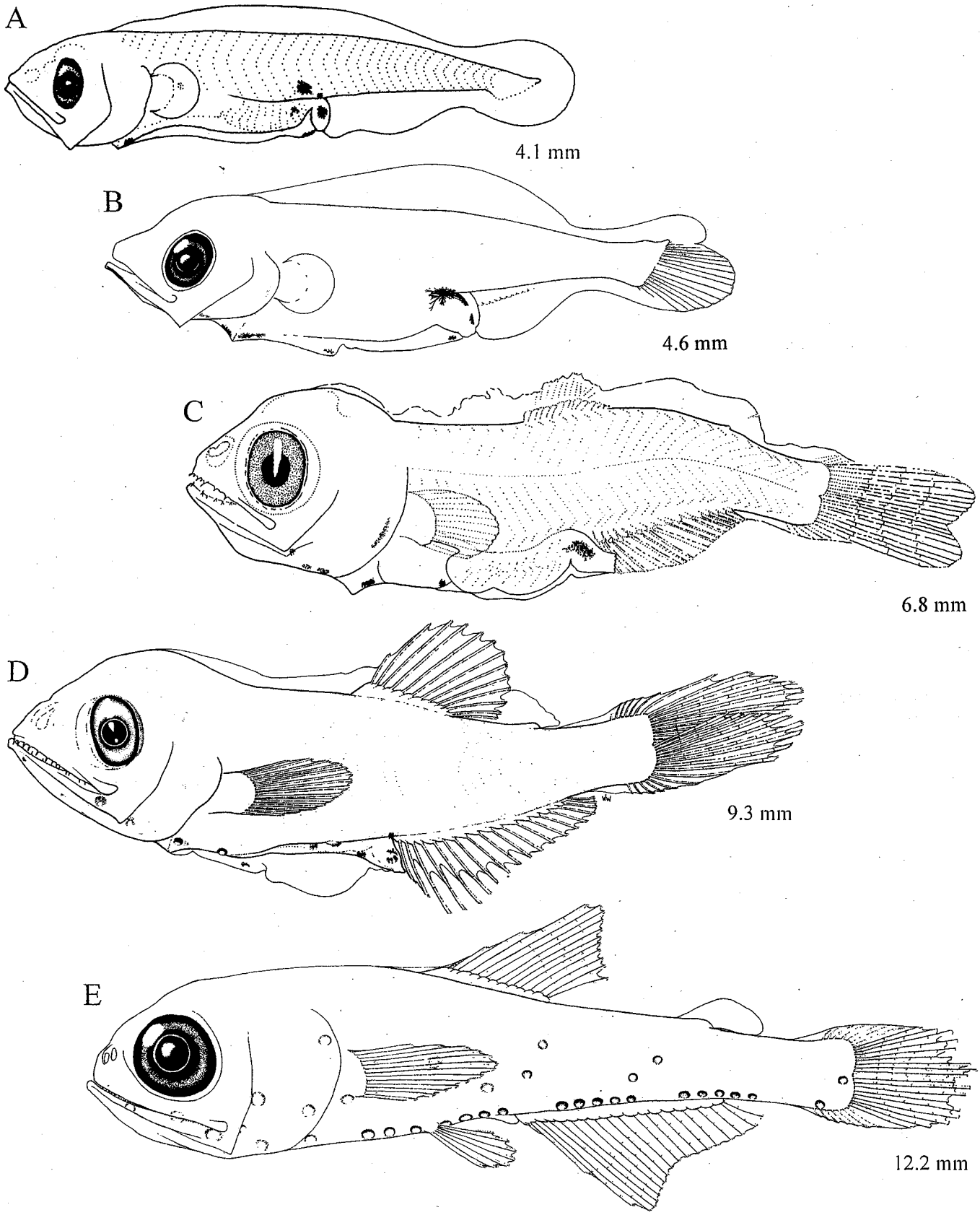
Pigment: *Preflexion*—Initially, 1–3 melanophores in irregular postanal series, large pair & 1 to several smaller melanophores dorsolaterally on hindgut at divergence from body, a pair (elongate when expanded) on ventral margin just posterior to cleithra, & 1 to several scattered ventrolaterally over 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 (very 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.

ILLUSTRATIONS

A, B, D, E, original [A, B, E: R. C. Walker; D, W. Watson]; C, Moser & Ahlstrom (1974)

A, CA89071507; B, LH1A4507; D, LH376A1 with some features drawn from a specimen of similar size from CA 89073303; E, OR II 7343 87 01


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

MERISTICS

Vertebrae	
Precaudal	19
Caudal	20–21
Total	39–40
Number of fin rays	
Dorsal	10–12
Anal	15–16
Pectoral	11–12
Pelvic	8
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Gillrakers on first arch	
Upper	3
Lower	8–11
Total	11–14
Branchiostegals	

LIFE HISTORY

Range: Apparently bitemperate in all oceans

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Evseenko et al. 1998

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at flexion: <12.6 mm
Length at transformation: >17.2 mm

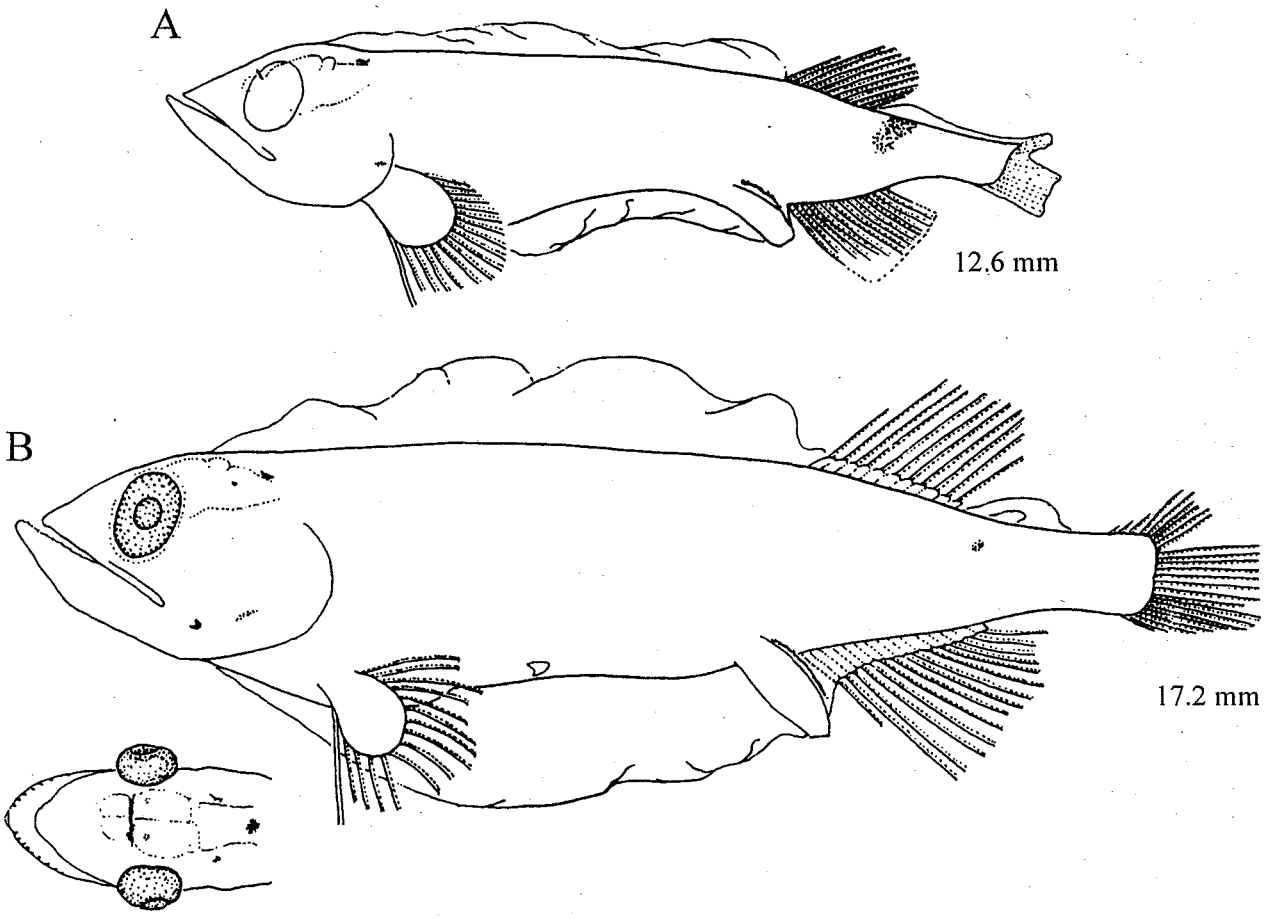
Pigmentation: *Postflexion*—Interorbital bar & some mesially above hindbrain & pair embedded ventrolaterally at hindbrain; embedded pigment in branchial region; superficial & embedded blotches dorsally at Ad base; elongate blotch above free terminal section of gut.

Diagnostic features: Compressed body with voluminous dorsal & ventral finfolds; postflexion larvae have deep furrow in dorsal longitudinal septum; head large; relatively wide oval eyes; no ventral choroid tissue; elongate gut with large terminal section; large P_1 with elongate, ornamented (presumably) lower ray; D & A far posteriad; distinctive pigment pattern, including transverse bar between fore- & midbrain; lighter pigmentation than in *L. rara*; embedded branchial blotch(s) apparently in different position; blotch at Ad apparently more anterior in position compared with *L. rara.*

ILLUSTRATIONS

A & B, from Evseenko et al. (1998)

* Description based on Evseenko et al. (1998)


A
12.6 mm
B
17.2 mm

MERISTICS

Vertebrae	
Precaudal	17–19
Caudal	19–21
Total	37–39
Number of fin rays	
Dorsal	10–13
Anal	13–17
Pectoral	9–13
Pelvic	8
Caudal	
Dorsal Secondary	6–7
Principal	10+9
Ventral Secondary	6–7
Gillrakers on first arch	
Upper	2
Lower	6–7
Total	8–9
Branchiostegals	8–9

LIFE HISTORY

Range: Tropical- subtropical in Atlantic, Pacific, & Indian Oceans

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Evseenko et al. 1998
Fahay 1983
Matarese et al. 1989
Moser 1981
Moser & Ahlstrom 1970, 1974, 1996
Moser et al. 1984
Olivar & Fortuño 1991
Pertseva-Ostroumova 1964.

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: <2.8 mm
Length at flexion: ~8.4–10.8 mm
Length at transformation: ~20.0–21.0 mm
Sequence of fin development: P_1, C_1, A, D & C_2, P_2

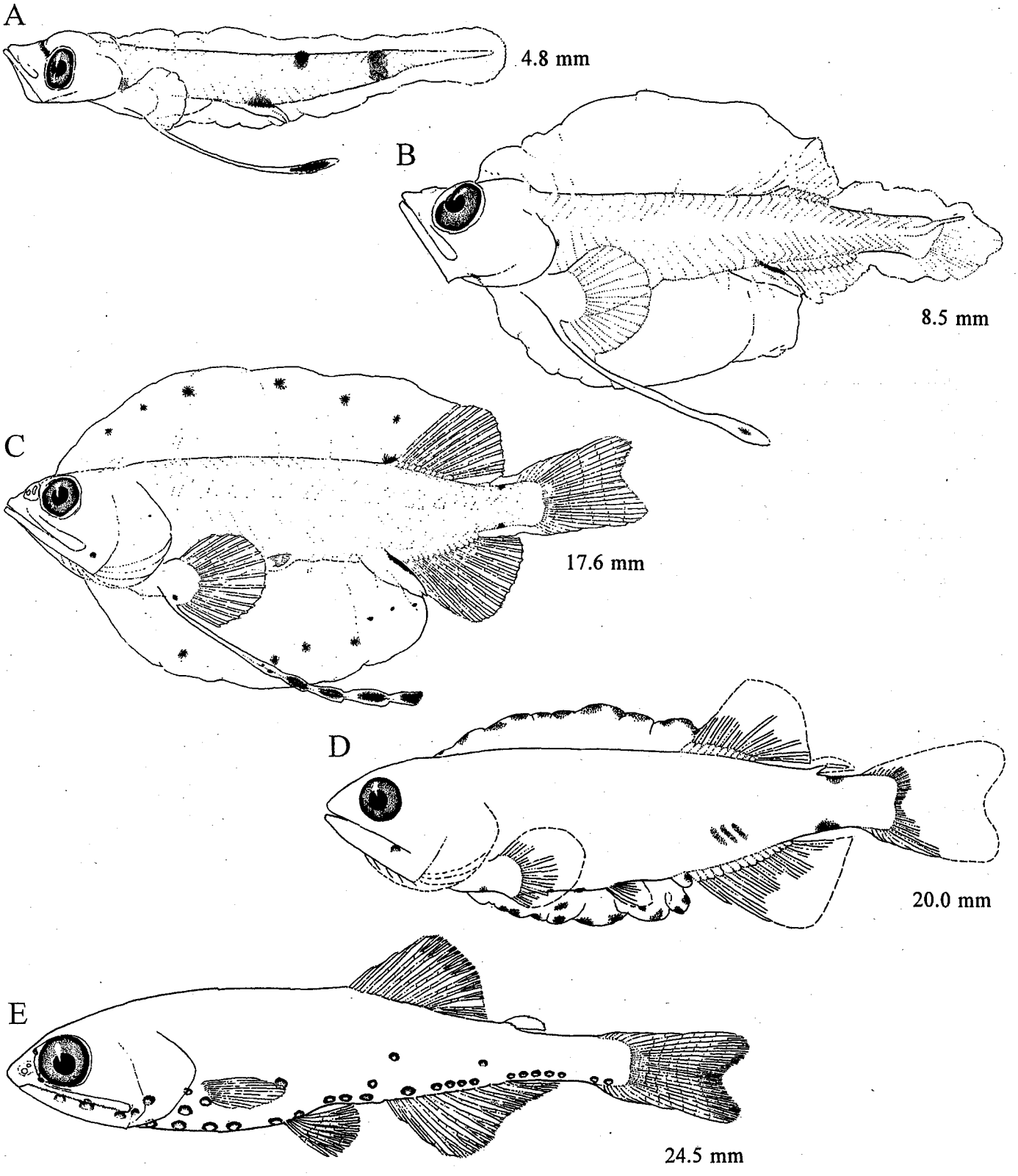
Pigmentation: *Preflexion*—By 4.0 mm, a heavy transverse bar between fore- & midbrain, an embedded blotch anterior to P_1 base, a blotch embedded above midgut, a blotch on dorsal surface of terminal section of gut, opposing dorsal & ventral blotches in mid-postanal region, & another dorsal blotch more anterior in position; by 6.0 mm, a median blotch embedded in isthmus, an embedded melanophore at nape, & a blotch on each spatulate swelling of elongate lower P_1 ray; by end of stage, embedded blotches at P_1 base & isthmus expand & outline ventral border of gill cavity & the postanal blotches are absent in some specimens. Postflexion—Numerous blotches in voluminous finfold; several embedded in postanal hypaxial myosepta; several on P_1 base.

Diagnostic features: Larvae of this genus have a compressed body with voluminous dorsal & ventral finfolds; postflexion larvae have deep furrow in dorsal longitudinal septum; head large; relatively wide oval eyes; no ventral choroid tissue; elongate gut with large terminal section; large P_1 with elongate ornamented lower ray; D & A far posteriad; distinctive pigment pattern, including transverse bar between fore- & midbrain; apparently there are slight differences in pigmentation between larvae of *L. rara* and *L. interrupta* (see description for *L. interrupta*).

ILLUSTRATIONS

A-E, from Moser & Ahlstrom (1996)

* Description based on Moser & Ahlstrom (1996)


A
4.8 mm
B
8.5 mm
C
17.6 mm
D
20.0 mm
E
24.5 mm

MERISTICS

Vertebrae	
Precaudal	15–16
Caudal	21–23
Total	37–38
Number of fin rays	
Dorsal	12–14
Anal	17–20
Pectoral	12–14
Pelvic	8
Caudal	
Dorsal Secondary	8–9
Principal	10+9
Ventral Secondary	7–8
Gillrakers on first arch	
Upper	5–6
Lower	12–14
Total	17–22
Branchiostegals	

LIFE HISTORY

Range: Tropical Atlantic, particularly in high productivity regions; throughout Gulf of Mexico, Caribbean, & the Mauritanian upwelling region of the eastern tropical Atlantic.

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic zone to surface or shallow epipelagic waters

LITERATURE

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at hatching: <2.5 mm
Length at flexion: 4.2– 6.0 mm
Length at transformation: 11.5–13 mm
Sequence of fin development: P_1, C_1, D & A, C_2, P_2

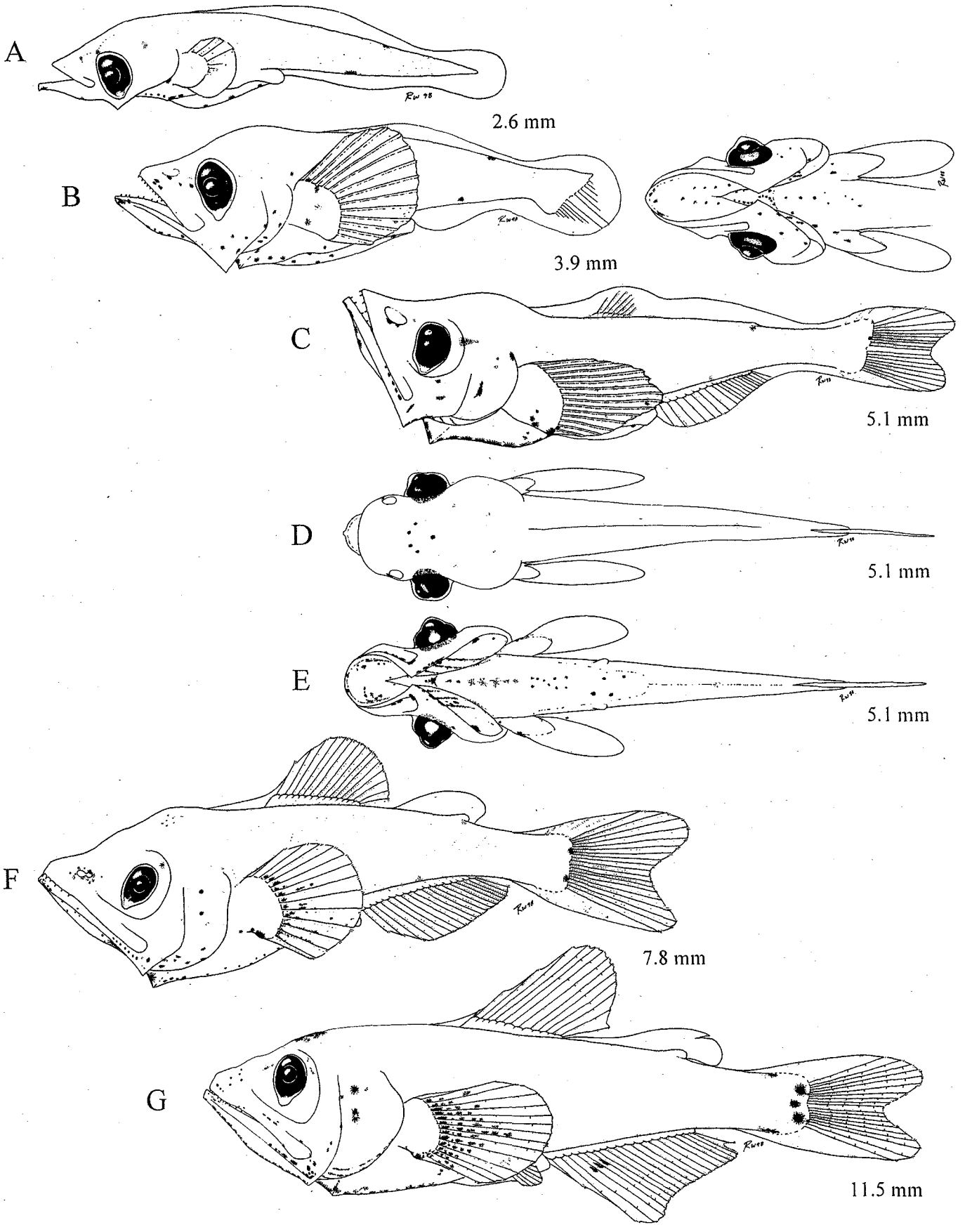
Pigmentation: *Preflexion-Flexion*—By 2.7 mm, anterolaterally on upper & lower jaws, on branchiostegal membrane, gular region, cleithrum, series on isthmus & ventral surface of gut, 1 or more above & below terminal gut section, 1 on ventral margin of each nostril, 2 pairs at anterolateral margins of forebrain, a pair ventrolaterally at hindbrain, on P_1 base & rays, 1 on ventral midline midway along tail & on dorsal midline at Ad base; by flexion stage, 1 or more anterior to forebrain, a pair lateral to midbrain, 1 or 2 melanophores on inner surface & 1 or 2 on ventral margin of P_1base, 1 or 2 on opercle, & 1 below D base. *Postflexion*—at nape, dorsal to brain; 1–3 at posterior hypural margin & 1 or more dorsally & ventrally on C base; some added ventrally on gut & on trunk above P_1base.

Diagnostic features: Body stout; BD 19–22% BL in preflexion, 24–30% in flexion stage, & 27–33% in postflexion vs 14–19%, 20–27%, & 24–30% BL, respectively, in *M. nitidulum*; head massive, slightly wider than in *M. nitidulum*; HW 75–83% HL in preflexion, 72–77% in flexion, & 62–75% in postflexion vs 60–78%, 56–68%, & 56–64% in *M. nitidulum*; jaws large; eyes slightly elliptical, stalked, with small conical mass of ventral choroid tissue; gut large, somewhat saccular, terminal section prominent; Sn–A 48–56% BL in preflexion, 55–63% in flexion, & 60–67% in postflexion; P_1 large, base & blade fan-shaped, rays precocious; a pair of melanophores at anterolateral margins of forebrain, 1 or more melanophores mesially at anterior margin of forebrain, & a pair ventrolaterally at posterior end of forebrain (none of these present in *M. nitidulum*); only 1 or 2 melanophores present on the inner surface of the P_1 fin base whereas *M. nitidulum* has numerous large melanophores on inner surface that appear ring-shaped when expanded; photophores form simultaneously at transformation.

ILLUSTRATIONS

A–G, original, [R. C. Walker]

A, CA 90025803; B & F, 90025002; C–E, CA 9002504; G, CA 90023804


A
2.6 mm
B
3.9 mm
C
5.1 mm
D
5.1 mm
E
5.1 mm
F
7.8 mm
G
11.5 mm

MERISTICS

Vertebrae	
Precaudal	15–17
Caudal	19–22
Total	35–38
Number of fin rays	
Dorsal	12–14
Anal	17–19
Pectoral	12–16
Pelvic	8
Caudal	
Dorsal Secondary	8–9
Principal	10+9
Ventral Secondary	8–9
Gillrakers on first arch	
Upper	3–5
Lower	10–12
Total	13–17
Branchiostegals	

LIFE HISTORY

Range: Tropical Atlantic, Pacific, & Indian Oceans, associated with Equatorial Currents & Countercurrents in these oceans.

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic zone to surface & epipelagic waters

LITERATURE

Fahay 1983
Moser 1981
Moser & Ahlstrom 1974, 1996
Moser et al. 1984
Ozawa 1986, 1988
Pertseva-Ostroumova 1964, 1974

EARLY LIFE HISTORY DESCRIPTION

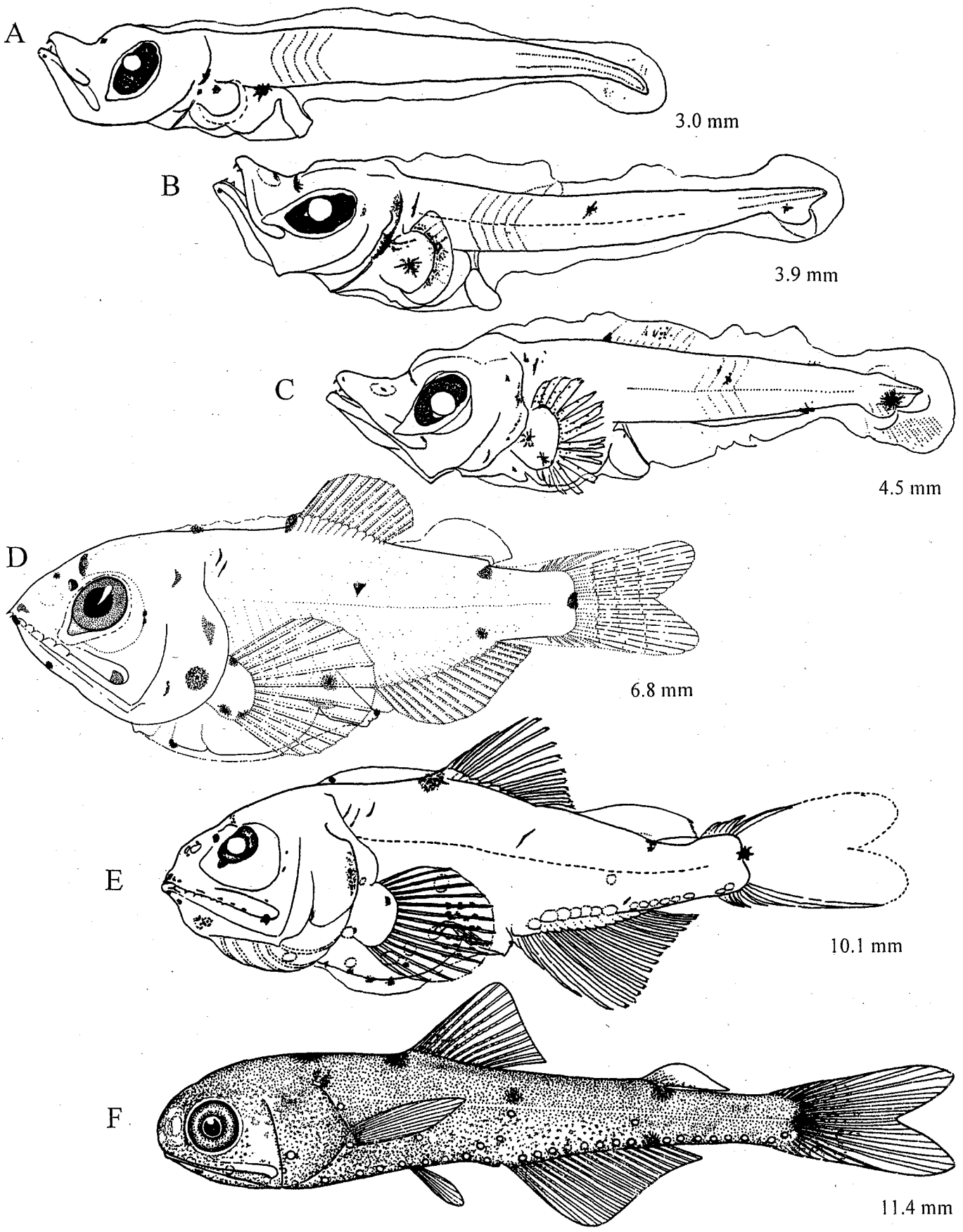
LARVAE:
Length at hatching: <2.3 mm
Length at flexion: 4.5–6.0 mm
Length at transformation: 10–13 mm
Sequence of fin development: C_1, D & A & P_1, C_2, P_2

Pigment: *Preflexion*— Initially, 1 at tip of upper jaw, on lower jaw, in midline anterior to forebrain, anterior to each midbrain lobe, embedded in otic region, on inner surface of P_1 base near axilla, & on cleithrum anterior to P_1 base; subsequently, single melanophores added ventrolateral to hindbrain, on cleithrum ventral to original melanophore, ventrally on margin of P_1 base, anteriorly on ventral margin of gut, at hypural region, on opercle, & 1 or 2 embedded in epaxial mysepta just posterior to supracleithrum; by end of preflexion stage, 1 added in dorsal midline at D origin & anterolateral pair on upper jaw instead of 1 at midline. *Flexion*— 1 on dorsal midline at Ad base, 1 on ventral midline at A insertion; a pair ventrally on gut posterior to median melanophore; dorsally on terminal gut section; transverse pair at basibranchial region; 1 or 2 embedded in epaxial myosepta above A origin. *Postflexion*— 1 at nape; more in gular region & ventrally on gut; lateral pair at flexure of terminal gut section; more added to anterior epaxial patch.

Diagnostic characters: Stout, deep body, broad head; BD 17–24%, 26–31%, & 31–40% BL in preflexion, flexion, & postflexion stages, respectively; gut short in preflexion (Sn–A 40–48% BL), becoming robust in flexion (47–55%) & postflexion (56–64%) stages; jaws large; eyes oval with short conical mass of choroid tissue beneath; unique pigmentation; Br_2 forms early in flexion stage & Dn forms late in flexion stage.

ILLUSTRATIONS

A, B, C, E, from Ozawa (1986); D, from Moser & Ahlstrom (1974); F, from Pertseva-Ostroumova (1974)


A
3.0 mm
B
3.9 mm
C
4.5 mm
D
6.8 mm
E
10.1 mm
F
11.4 mm

MERISTICS

Vertebrae	
Precaudal	15–16
Caudal	21–23
Total	36–39
Number of fin rays	
Dorsal	12–14
Anal	18–21
Pectoral	12–16
Pelvic	8
Caudal	
Dorsal Secondary	7–9
Principal	10+9
Ventral Secondary	7–9
Gillrakers on first arch	
Upper	4–8
Lower	12–19
Total	17-22
Branchiostegals	9–10

LIFE HISTORY

Range: Tropical & subtropical Atlantic, Pacific, & Indian Oceans

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic zone to surface & shallow epipelagic waters

LITERATURE

Fahay 1983
Moser & Ahlstrom 1970, 1974, 1996
Moser et al. 1984
Olivar & Fortuño 1991
Ozawa 1986, 1988
Pertseva-Ostroumova 1974

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: < 3.1 mm
Length at flexion: ~6.5–7.0 mm
Length at transformation: ~11 mm
Sequence of fin development: P_1, C_1, C_2 & A & D, P_2

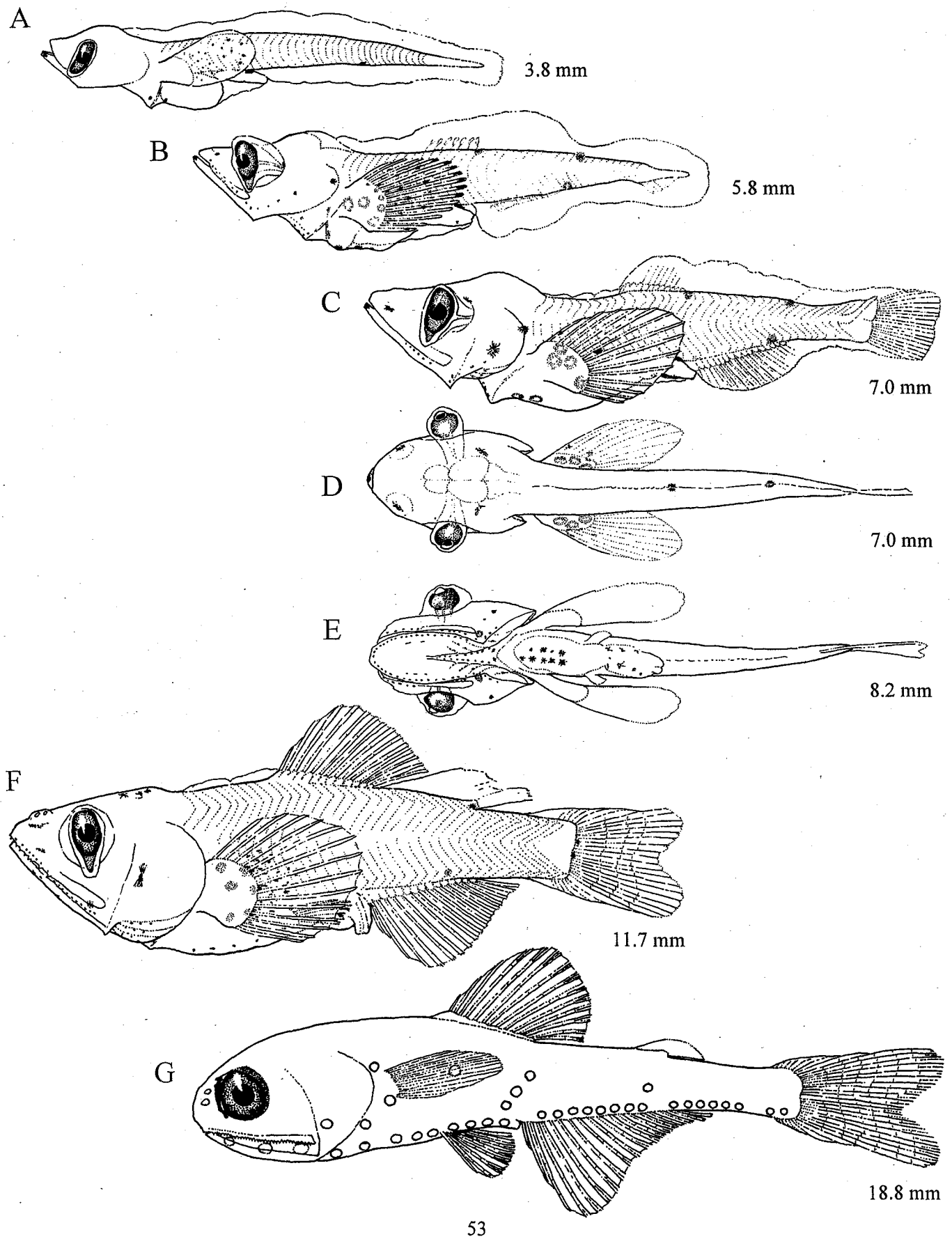
Pigmentation: *Preflexion*—In larvae <4.0 mm, on tip of lower jaw, 1 midway along postanal ventral midline, 2 pairs on anterior ventral surface of gut, a dorsolateral pair on terminal section of gut, ~ 4 (ring-like when expanded) on inner surface of P_1 base, & peppering on P_1 blade; at ~ 4.0 mm, series on isthmus & upper & lower jaws, 1 on nostril, at posterior region of orbit, ventrolaterally on hindbrain, on opercle, & on dorsal midline slightly posterior to melanophore on ventral margin; by 6.0 mm, 1 on head above P_1 base, a series ventrally on cleithrum, a series along each Br ray, 2 pairs on ventral surface of terminal section of gut, 1 at A insertion, a pair lateral to midbrain, a pair lateral to junctures of mid- & forebrain. *Flexion*—1 added to nostril, 1 or more in midline above brain; most series augmented. *Postflexion*—Beginning of vertical series at posterior hypural margin.

Diagnostic features: Stout body with broad massive head & robust gut; not as deep-bodied as *M. affine*; slightly oval eyes on short stalks in preflexion larvae; conical ventral choroid tissue; notochord flexion at 6.5–7.0 mm vs 4.0–6.0 mm in *M. affine*; P_1 precocious with large fan-shaped base & blade; P_2 forms somewhat earlier than in *M. affine*; complex pigment pattern similar to that of *M. affine*; melanophores absent at anterolateral margins of forebrain (present in *M. affine)* although 1 or 2 may be present beneath forebrain in some specimens; a pair of ventrolateral melanophores present at juncture of fore- & midbrain vs pair located in a more anterior position at posterior end of forebrain in *M. affine*; numerous large melanophores on the inner surface of P_1 base that appear ring-shaped when expanded vs only 1 or 2 in *M. affine*; Br_2 photophores appear at ~7.0 mm vs late in postflexion stage larvae of *M. affine*.

ILLUSTRATIONS

A–G, from Moser & Ahlstrom (1996)

* Description based on Moser & Ahlstrom (1996)


A
3.8 mm
B
5.8 mm
C
7.0 mm
D
7.0 mm
E
8.2 mm
F
11.7 mm
G
18.8 mm

MERISTICS

Vertebrae	
Precaudal	15–16
Caudal	19–21
Total	35–36
Number of fin rays	
Dorsal	12–14
Anal	17–19
Pectoral	16–20
Pelvic	8
Caudal	
Dorsal Secondary	8–9
Principal	10+9
Ventral Secondary	7–8
Gillrakers on first arch	
Upper	6–7
Lower	16–19
Total	22–26
Branchiostegals	

LIFE HISTORY

Range: Tropical Atlantic, Pacific, & Indian Oceans, typically between 20°N & 11°S; more abundant in the western region of the tropical Atlantic

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic zone to surface & epipelagic waters

LITERATURE

Fahay 1983
Moser & Ahlstrom 1974, 1996
Moser et al. 1984
Ozawa 1986, 1988
Pertseva-Ostroumova 1974 (apparently, as *M. selenops*).

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at hatching: <2.5 mm
Length at flexion: ~4.0–4.6 mm
Length at transformation: 10–13 mm
Sequence of fin development: P_1, C_1, D & A, C_2, P_2

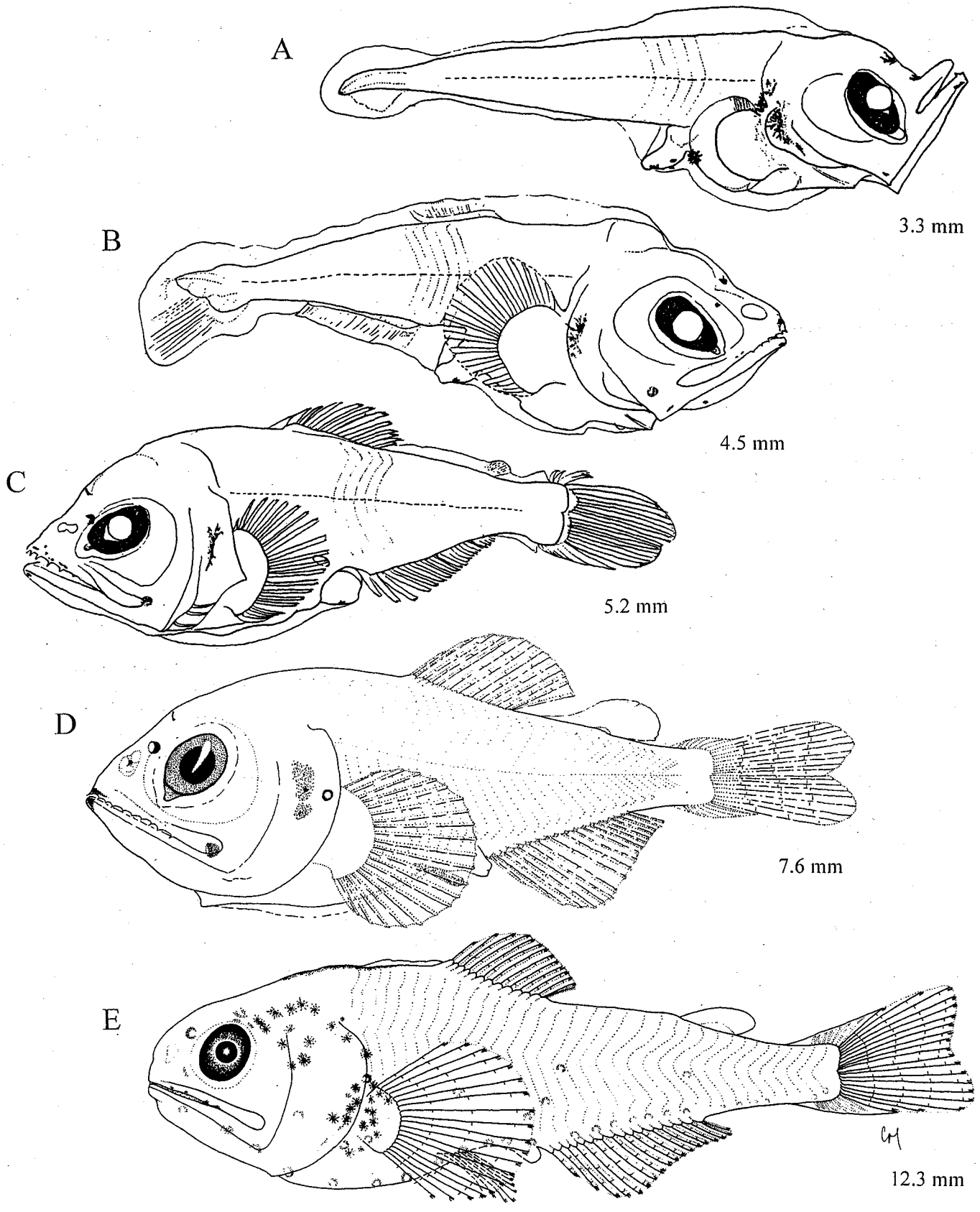
Pigment: *Preflexion-flexion*— Initially, at tips of upper & lower jaws, in midline anterior to forebrain, in midline anterior to midbrain, on each side ventrolateral to hindbrain, laterally on gut anterior to the point of deflexion of the terminal section, in axillary region of inner surface of P_1base, & an embedded blotch anterior to cleithrum & P_1 base. *Postflexion*— midline pigment on upper jaw expands laterally along upper jaw; axillary pigment becomes hidden by developing fin base. *Transformation*— Dense patch of melanophores develops on outer surface of P_1 base, continuing dorsad on posterior region of head, & in the myosepta dorsal to the P_1 base; an irregular double row of melanophores develops in the dorsal midline, extending from the occipital region to ~ two-thirds of the distance to the D origin.

Diagnostic characters: Stout, deep body & broad head; BD 23–31%, 31–35%, & 32–40% BL in preflexion, flexion, & postflexion, respectively; gut moderate in length in preflexion (Sn–A 52–57% BL), becoming robust in flexion & postflexion (Sn–A 55–61% & 57–63% BL, respectively); jaws large; eyes oval with short conical mass of choroid tissue beneath; midline melanophores on jaws & brain; heavy embedded blotch anterior to cleithrum; lack of pigment on trunk & tail, except at transformation, when posterior region of head & anterior trunk become heavily pigmented; Br_2 & Dn form early in flexion stage.

ILLUSTRATIONS

A, B, C, Ozawa (1986); D, Moser & Ahlstrom (1974); E, original [C. Manning]

E, MCZ 147821


A
3.3 mm
B
4.5 mm
C
5.2 mm
D
7.6 mm
E
12.3 mm

MERISTICS

Vertebrae	
Precaudal	15–16
Caudal	19–20
Total	34–35
Number of fin rays	
Dorsal	12–14
Anal	17–19
Pectoral	15–18
Pelvic	8
Caudal	
Dorsal Secondary	8
Principal	10+9
Ventral Secondary	7–8
Gillrakers on first arch	
Upper	6–7
Lower	15–17
Total	21–24
Branchiostegals	

LIFE HISTORY

Range: Tropical-subtropical Atlantic, Indian, & western & central Pacific

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic zone to epipelagic zone; according to Nafpaktitis et al. (1977), *M. selenops* is the only *Myctophum* species in the Atlantic that does not come to the surface at night.

LITERATURE

Fahay 1983
Moser & Ahlstrom 1974, 1996
Moser et al. 1984
Olivar et al. 1999
Ozawa 1986, 1988 (Larvae described as *M. orientale* appear to be identical to those of *M. selenops*, suggesting that these two nominal species may be synonymous).
Pertseva-Ostroumova 1974 (as *Gonichthys barnesi*).

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at hatching: <2.3 mm
Length at flexion: 4.5–6.0 mm
Length at transformation: 10–13 mm
Sequence of fin development: C_1, D & A & P_1, C_2, P_2

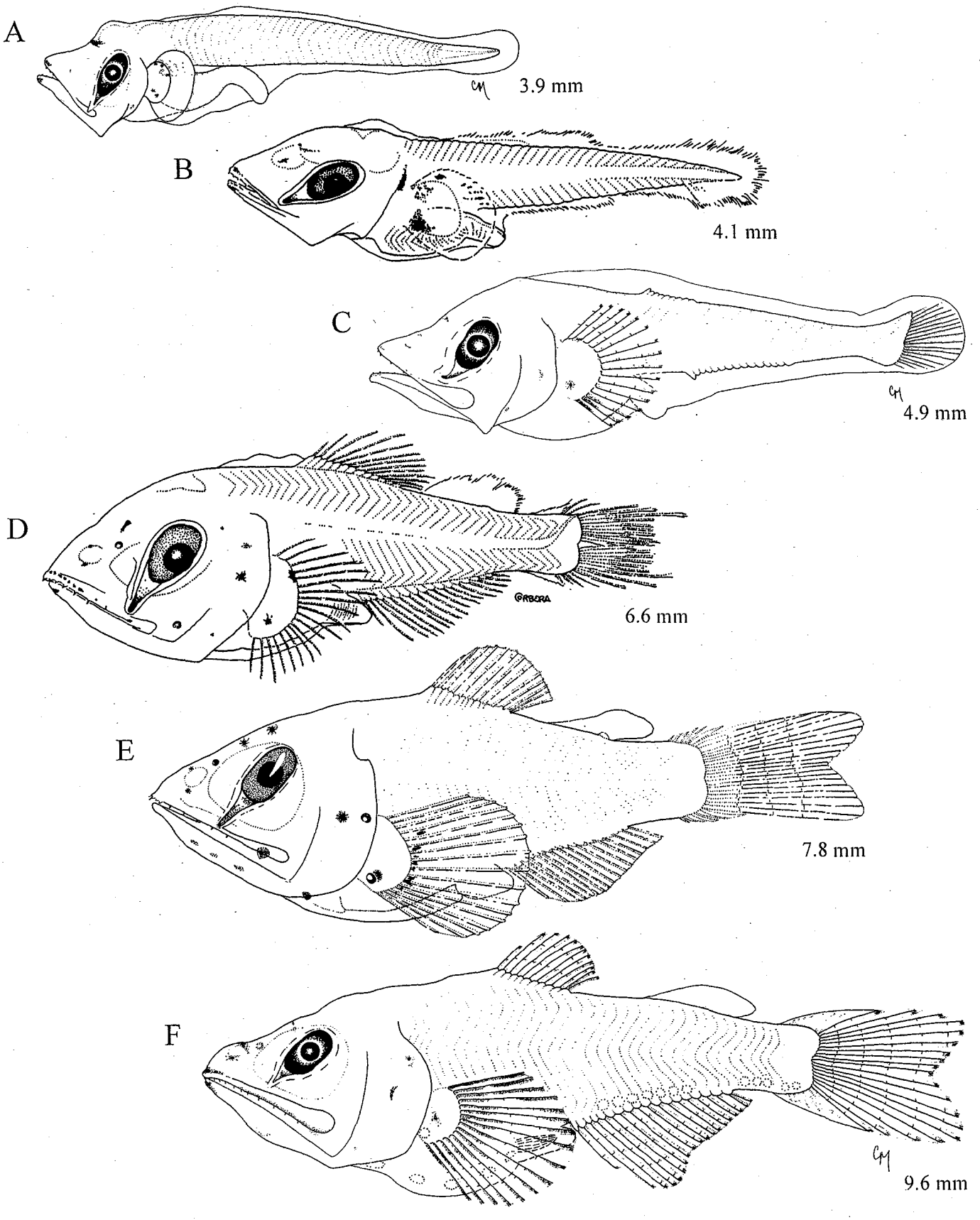
Pigment: *Preflexion*— Initially, at tips of upper & lower jaws, in midline anterior to forebrain, pair anterior to midbrain, some ventrolateral to hindbrain, 1 on each side of midgut, an embedded blotch anterior & slightly above P_1 base, 1 on upper mesial surface of P_1 base, 1 on lower outer surface of P_1 base, speckling on P_1 rays; by 4.0 mm, anteriorly & posteriorly on rim of each nostril, at gular region, ventrolaterally on opercle, laterally along upper jaw, on tip of elongate choroid tissue; by late preflexion, melanophore added to posterolateral margin of opercle, lateral gut pigment lost or may migrate anteriorly to trunk anterior to P_1 base; *Flexion–Postflexion*—Similar to late preflexion but additional melanophores at some loci.

Diagnostic characters: By mid-preflexion body stout & deep, head broad; BD 16–24%, 26–30%, & 31–36% BL in preflexion, flexion, & postflexion, respectively; gut short in early preflexion, becoming robust in late preflexion, flexion, & postflexion (Sn–A 50–53%, 53–57%, & 61–64% BL, respectively); jaws large; eyes oval (narrower than in *M obtusirostre*) with elongate conical mass of choroid tissue that develops pigment in early preflexion (length of choroid tissue up to ~60% EL); length of choroid tissue typically <10% EL in *M. obtusirostre*; unique pigmentation pattern; paired melanophores anterior to forebrain, contrasting with median melanophore in *M. obtusirostre*; lack of pigment on trunk & tail; Br_2 & Dn form in early mid-flexion stage.

ILLUSTRATIONS

A, C, F, original [C. Manning]; B&D, Olivar et al., (1999); E, Moser & Ahlstrom (1974)

A & C, OR II 16645232 R6B3; F, OR II 16645255 R6B3


A
3.9 mm
B
4.1 mm
C
4.9 mm
D
6.6 mm
E
7.8 mm
F
9.6 mm

MERISTICS

Vertebrae	
Precaudal	15–16
Caudal	21–22
Total	37
Number of fin rays	
Dorsal	14–16
Anal	20–22
Pectoral	14–17
Pelvic	8
Caudal	
Dorsal Secondary	8–10
Principal	10+9
Ventral Secondary	8–9
Gillrakers on first arch	
Upper	5–6
Lower	14–17
Total	20–23
Branchiostegals	

LIFE HISTORY

Range: Tropical & subtropical Atlantic & tropical western Indian Ocean

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic zone to surface & epipelagic waters

LITERATURE

Zelck et al. 1993

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: <4.9 mm
Length at flexion: ~6.5–7.5 mm
Length at transformation: >15.7 mm
Sequence of fin development: P_1, C_1, C_2, A, P_2, D

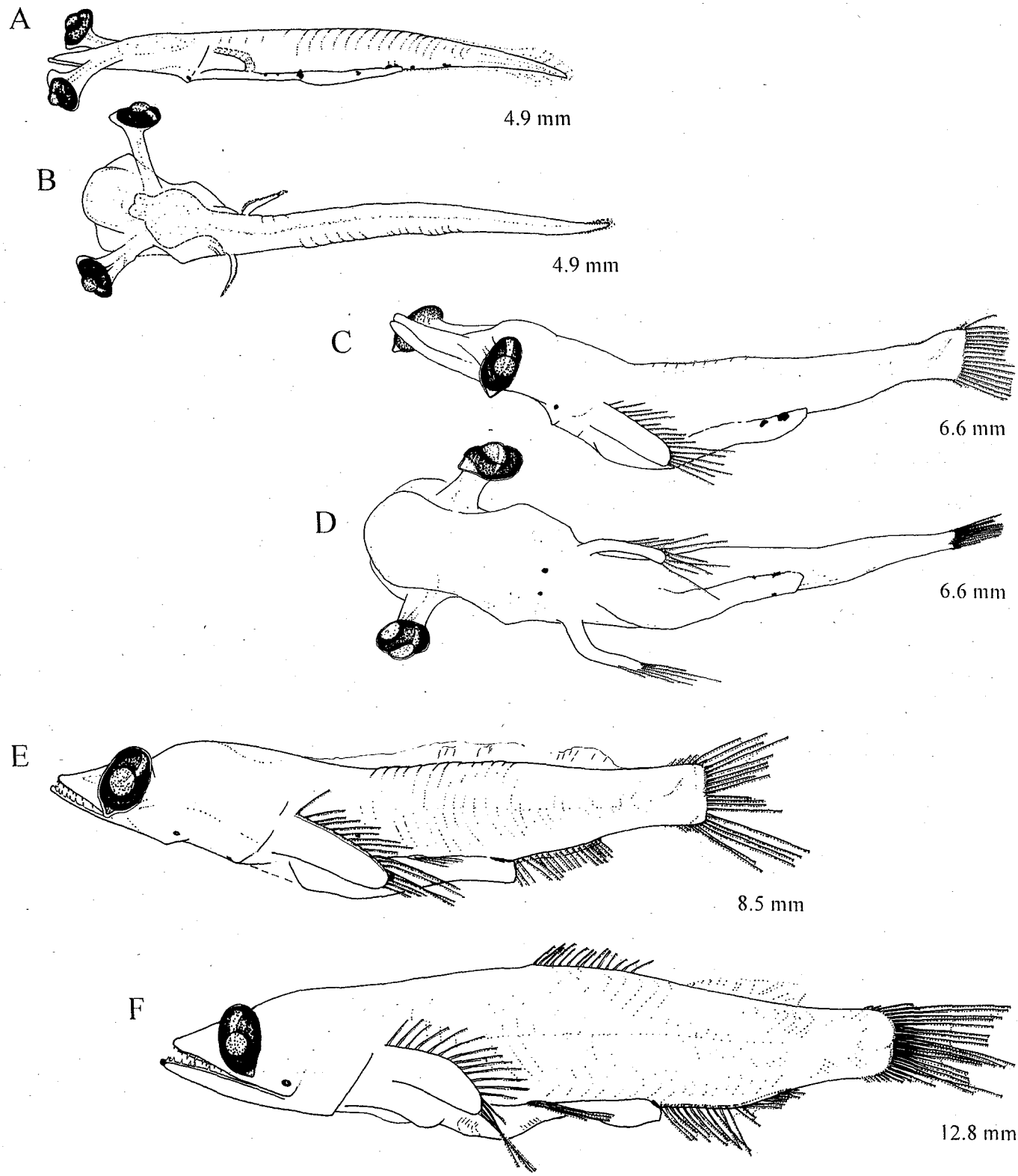
Pigmentation: *Preflexion*—Pair on isthmus just anterior to cleithrum; series of 2–3 melanophores on lateral surfaces of gut; above terminal section of gut; at tip of lower jaw (some specimens); postanal series of 2–4 at ventral margin of tail. *Flexion– Postflexion*— Lateral gut & postanal series not present; at tip of upper jaw in some specimens; on P_1 blade in some specimens.

Diagnostic features: Moderately stout body with broad flattened head; eyes oval with small conical choroid tissue; eyes conspicuously stalked in preflexion & flexion stages; gut longer in preflexion stage compared with congeners (Sn–A 67–71% BL); P_1 precocious, large & aliform; Br_2 photophores present at flexion stage.

ILLUSTRATIONS

A–F, from Zelck et al. (1993)

*Description based on Zelck et al. (1993)


A
4.9 mm
B
4.9 mm
C
6.6 mm
D
6.6 mm
E
8.5 mm
F
12.8 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	18
Total	34
Number of fin rays	
Dorsal	12–14
Anal	13–15
Pectoral	11–14
Pelvic	8
Caudal	
Dorsal Secondary	6–7
Principal	10+9
Ventral Secondary	6–8
Gillrakers on first arch	
Upper	5–6
Lower	11–13
Total	16–19
Branchiostegals	

LIFE HISTORY

Range: Tropical & subtropical South Atlantic & scattered records in the tropical North & South Pacific

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Some subadults migrate at night from mesopelagic to epipelagic zone; some subadults & largest individuals may not migrate (Clarke 1973)

LITERATURE

Fahay 1983
Moser & Ahlstrom 1974
Moser et al. 1984
Ozawa 1986,1988

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: < 2.6 mm
Length at flexion: ~ 4–5 mm
Length at transformation: ~12 mm

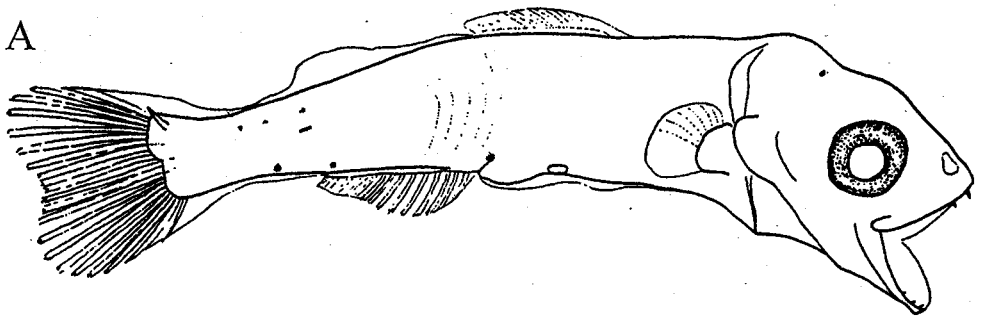
Pigmentation: *Flexion*—Embedded in otic region; at midline on dorsal surface of terminal gut section; 1 or more on lateral midline above A insertion; series embedded above spinal column at caudal peduncle; ~ 1 in ventral midline of tail at A insertion & 1 on ventral midline of caudal peduncle (apparently these are the coalesced remnants of a postanal midline series present in preflexion larvae). *Postflexion*— A pair of melanophores present on occipital region; melanophores on ventral midline of tail and on terminal gut section become obscured; by late postflexion stage, up to 8 melanophores in series on lateral midline of tail. *Transformation*— Lateral midline series remain visible.

Diagnostic features: Large eye, embedded melanophores in otic region, & sparse series on the ventral margin of the tail (that eventually coalesces and becomes obscured) are typical of genus; the lateral midline series on the tail apparently is unique to *B. distofax*.

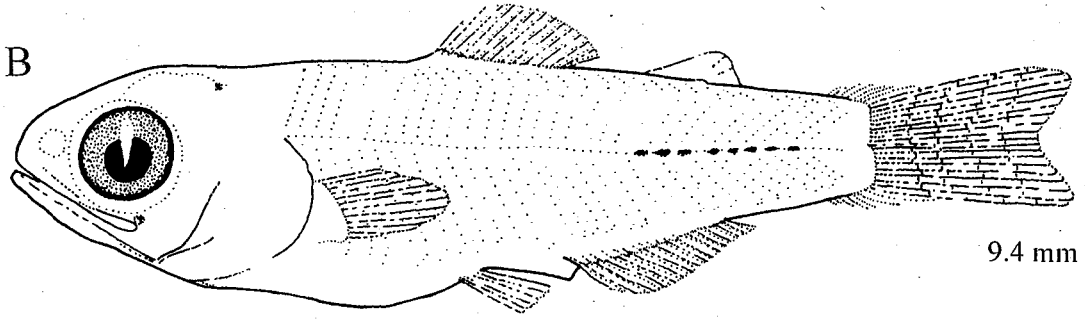
ILLUSTRATIONS

A & C, Ozawa (1986); B, Moser & Ahlstrom (1974)

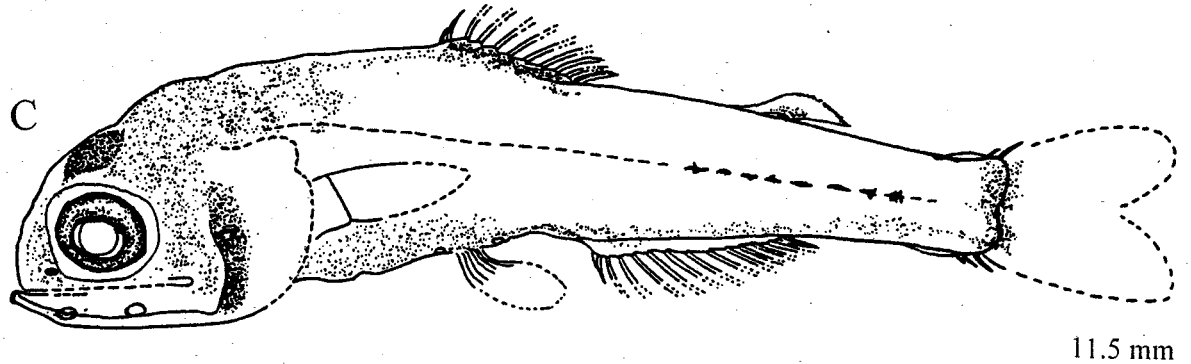
* The larvae described by Ozawa (1986) as *Bolinichthys* sp. II appears to be the same species as the postflexion larvae identified as *B. distofax* by Moser et al. (1984). This description is based primarily on Ozawa's (1986) description of *Bolinichthys* sp. II.



4.8 mm



9.4 mm



11.5 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	21
Total	37
Number of fin rays	
Dorsal	13–15
Anal	13–15
Pectoral	13–14
Pelvic	8
Caudal	
Dorsal Secondary	7
Principal	10+9
Ventral Secondary	6–7
Gillrakers on first arch	
Upper	4–6
Lower	13–16
Total	17–22
Branchiostegals	

LIFE HISTORY

Range: Temperate North Atlantic with some part of the population extending into subtropical western & eastern North Atlantic; larvae of this species do not occur in the Gulf of Mexico but may occur in the northernmost part of the central western Atlantic.

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Part of population migrates at night from mesopelagic to epipelagic zone

LITERATURE

Dekhnik & Sinukova 1966
Fahay 1983
Moser & Ahlstrom 1972
Shiganova 1977
Taaning 1918
Tortonese 1956

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: < 5.0 mm
Length at flexion: ~6 mm
Length at transformation: ~16 mm

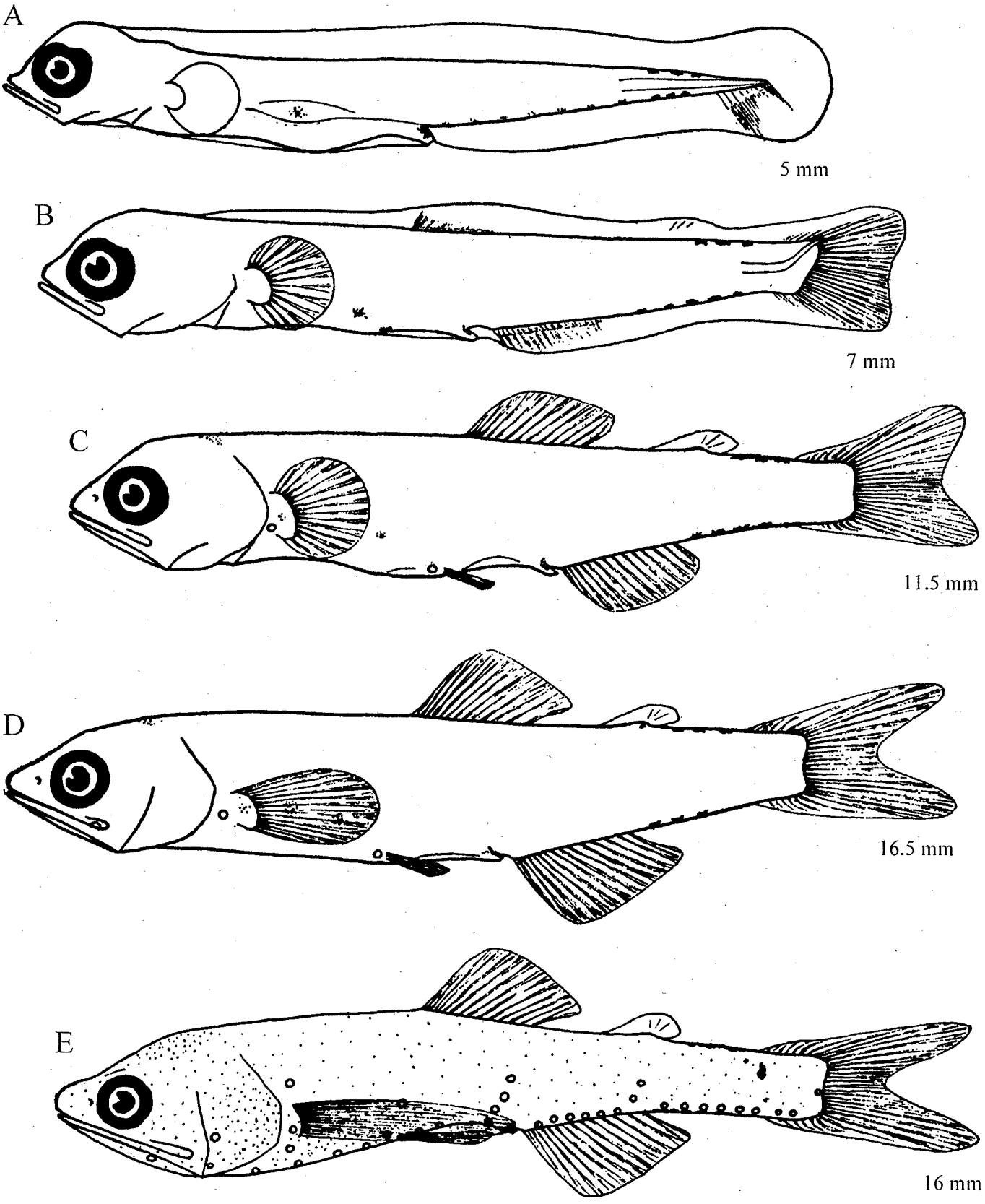
Pigmentation: *Preflexion*—Postanal series extends to caudal peduncle region where the melanophores are larger than the more anterior ones in the series; 3–4 large melanophores mid-dorsally on the caudal peduncle; in occipital region; laterally on gut & at terminal gut section; postanal series becomes embedded & obscured, except for the few prominent melanophores on the caudal peduncle; *Flexion–Postflexion*—Opposing dorsal & ventral series on caudal peduncle remain prominent.

Diagnostic features: Moderately slender body; head relatively small; eyes rounded, not as large as in *Bolinichthys*; gut slender, slightly sigmoid, extends to midbody; dorsal & ventral caudal pecuncle pigment series; similar to larvae of *Lepidophanes guentheri* but lack the melanophores on the lateral foregut diagnostic for larvae of that species & are deeper-bodied than larvae of *L. guentheri* & *L. gaussi*; Br_2, Vn, PLO, & PO_5 photophores form at 7–11 mm.

ILLUSTRATIONS

A–E, from Taaning (1918)

* Description based on Taaning (1918)


A
5 mm
B
7 mm
C
11.5 mm
D
16.5 mm
E
16 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	19–20
Total	35–36
Number of fin rays	
Dorsal	13–15
Anal	13–15
Pectoral	12–15
Pelvic	8
Caudal	
Dorsal Secondary	6
Principal	10+9
Ventral Secondary	6–7
Gillrakers on first arch	
Upper	3–5
Lower	9–12
Total	13–16
Branchiostegals	

LIFE HISTORY

Range: Tropical & subtropical Atlantic, Pacific, & Indian Oceans

Habitat: Epi- & mesopelagic & upper bathypelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Part of population migrates at night from mesopelagic to epipelagic zone

LITERATURE

Belyanina 1982
Fahay 1983
Matarese et al. 1989
Miller et. al. 1979
Olivar et al. 1999
Ozawa 1986, 1988
Shiganova 1977

* Badcock & Araujo (1988) suggested that *C. warmingii* & *C. townsendi* form a species complex that should be referred to as *C. townsendi* but some other workers (Moser & Ahlstrom 1996; John Paxton, pers. comm.) consider *C. warmingii* to be a tropical-subtropical cosmopolite that is specifically distinct from *C. townsendi*, a species of the California Current region.

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at hatching: <3.0 mm
Length at flexion: ~ 5.0–6.0 mm
Length at transformation: >15 mm
Sequence of fin development: C_1, A & D & P_1, C_2, P_2

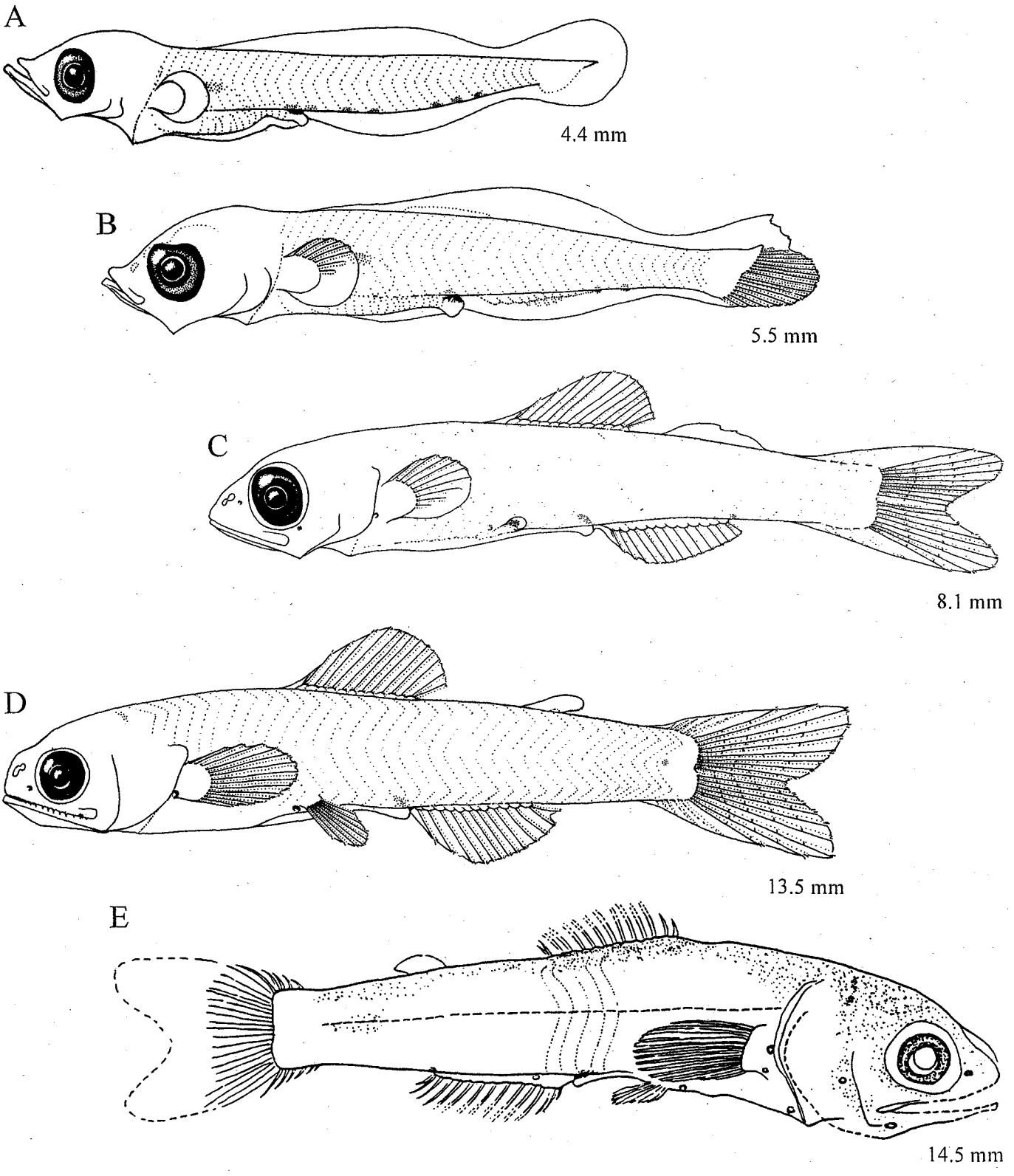
Pigmentation: *Preflexion*— 6–7 dashes in postanal median ventral series; above developing gas bladder; a pair on terminal section of gut. *Flexion*—Postanal series coalesces to 1 at A insertion by end of stage; embedded series of 1–4 above vertebral column in caudal peduncle region. *Postflexion*—Embedded in otic region in some late larvae; 1 above hindbrain in some late larvae.

Diagnostic features: Moderately slender body; gut to ca. midbody, slightly sigmoid; head relatively small; eyes large, slightly elliptical, with lunate sliver of choroid tissue in preflexion larvae; snout acute, becoming blunted in late larvae; Br_2 & Vn photophores form at ~5.0 mm, PLO & PO_5 at ~8.0 mm; upper OP & PO_1 form first during transformation; larvae similar to *Bolinichthys distofax* but more slender, with relatively smaller & narrower eyes, a more acute snout, & distinct larval photophores (lacking in *B. distofax*); lacks pigment on midlateral region of gut, on anterior ventral margin of gut, & on hypural region (present in *Diaphus*); similar to *C. maderensis* larvae but lack the prominent dorsal and ventral midline series at the caudal peduncle present in larvae of that species.

ILLUSTRATIONS

A–D, original [R. C. Walker/W. Watson]; E, Ozawa (1986)

A–C, 45288; D, 45230


A
4.4 mm
B
5.5 mm
C
8.1 mm
D
13.5 mm
E
14.5 mm

MERISTICS

Vertebrae	
Precaudal	
Caudal	
Total	~36 (myomeres)
Number of fin rays	
Dorsal	~13
Anal	~15
Pectoral	~11
Pelvic	8
Caudal	
Dorsal Secondary	~6
Principal	10+9
Ventral Secondary	~6
Gillrakers on first arch	
Upper	
Lower	
Total	
Branchiostegals	

LIFE HISTORY

Range: Larvae from Gulf of Mexico

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Adult *Diaphus* usually migrate at night from mesopelagic to epipelagic zone; common at surface at night

LITERATURE

* Two forms of *Diaphus* larvae have been described (Moser et al. 1984): a slender form with numerous persistent postanal ventral midline melanophores & a stout form with fewer postanal melanophores that coalesce before flexion. Within these two morphs, few characters are available for distinguishing species. Numerous *Diaphus* species are known from the western central Atlantic & Gulf of Mexico & identifying their larvae will be difficult. The form described & illustrated here belongs to the stout *Diaphus* morph & may represent a single, common species in the Gulf of Mexico.

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at hatching: <3.0 mm
Length at flexion: ~3.8–4.8 mm
Length at transformation: ~11 mm
Sequence of fin development: C_1, D & A & C_2, P_1, P_2

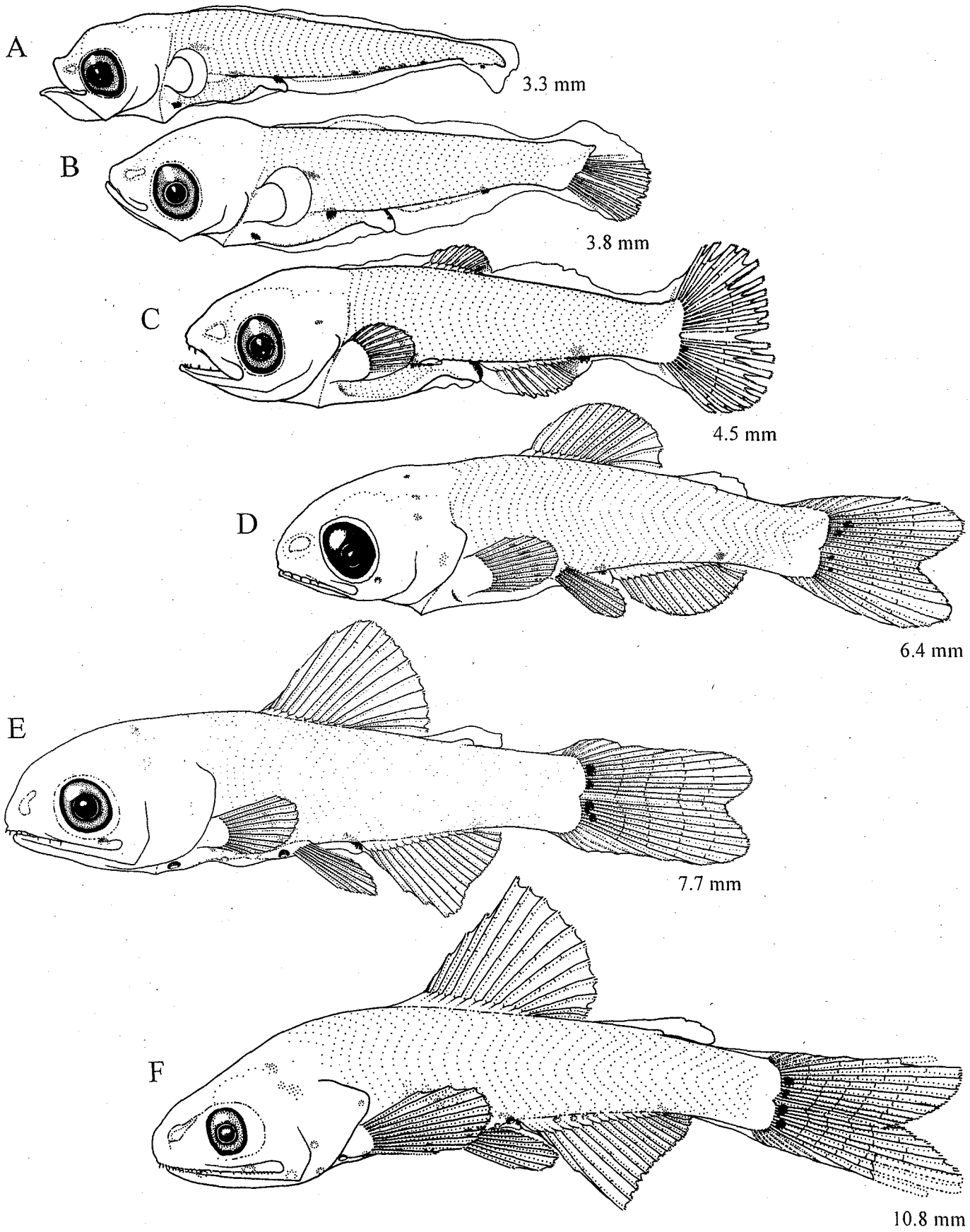
Pigmentation: *Preflexion*—By 3.0 mm, ~4 dashes in postanal median ventral series, 1 at future hypural region, 1 anteriorly on ventral margin of gut posterior to cleithral symphysis, a pair dorsally on terminal gut section, 1 melanophore on each side of midgut, 1 embedded above developing gas bladder; by ~3.3 mm, an embedded pair ventrolaterally on hindbrain & the series on the ventral midline of the tail has coalesced to 1 at future A insertion; *Flexion–postflexion*—Similar to above but melanophores added to posterior margin of hypural plate, forming a vertical series, & lateral gut melanophores absent; by ~7mm 1 or more dorsal to hindbrain & 1 or more embedded in posterior region of gut cavity.

Diagnostic features: Relatively deep-bodied & compressed, becoming somewhat stout (BD 23–28% BL); head relatively large (HL 24–34% BL), gut relatively slender, extends to about midbody; eyes slightly elliptical with lunate choroid sliver; notochord flexion & transformation at small size; caudal melanophore typical of genus; early coalescense of postanal series compared with elongate larval form of *Diaphus*; melanophore anteriorly on ventral margin of gut (lacking in *Ceratoscopelus*); Br_2, PO_1, & PO_5 photophores form by ~6.6 mm; other PO photophores by ~8 mm; most photophores forming by 11mm.

ILLUSTRATIONS

A–F, original [A-C, E & F, W. Watson; D, R. C. Walker]

A, CA 90025803; B–E, CA 90025804; F, CA 9002802


A
3.3 mm
B
3.8 mm
C
4.5 mm
D
6.4 mm
E
7.7 mm
F
10.8 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	19
Total	35
Number of fin rays	
Dorsal	14–16
Anal	14–16
Pectoral	10–11
Pelvic	8
Caudal	
Dorsal Secondary	6
Principal	10+9
Ventral Secondary	6
Gillrakers on first arch	
Upper	7–9
Lower	14–17
Total	22–26
Branchiostegals	

LIFE HISTORY

Range: Anti-tropical to possibly bipolar distribution in the Atlantic; also known from tropical-subtropical Pacific & Indian Oceans.

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Sparta 1952

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: <4.5 mm
Length at flexion: ~5 mm
Length at transformation: ~11 mm

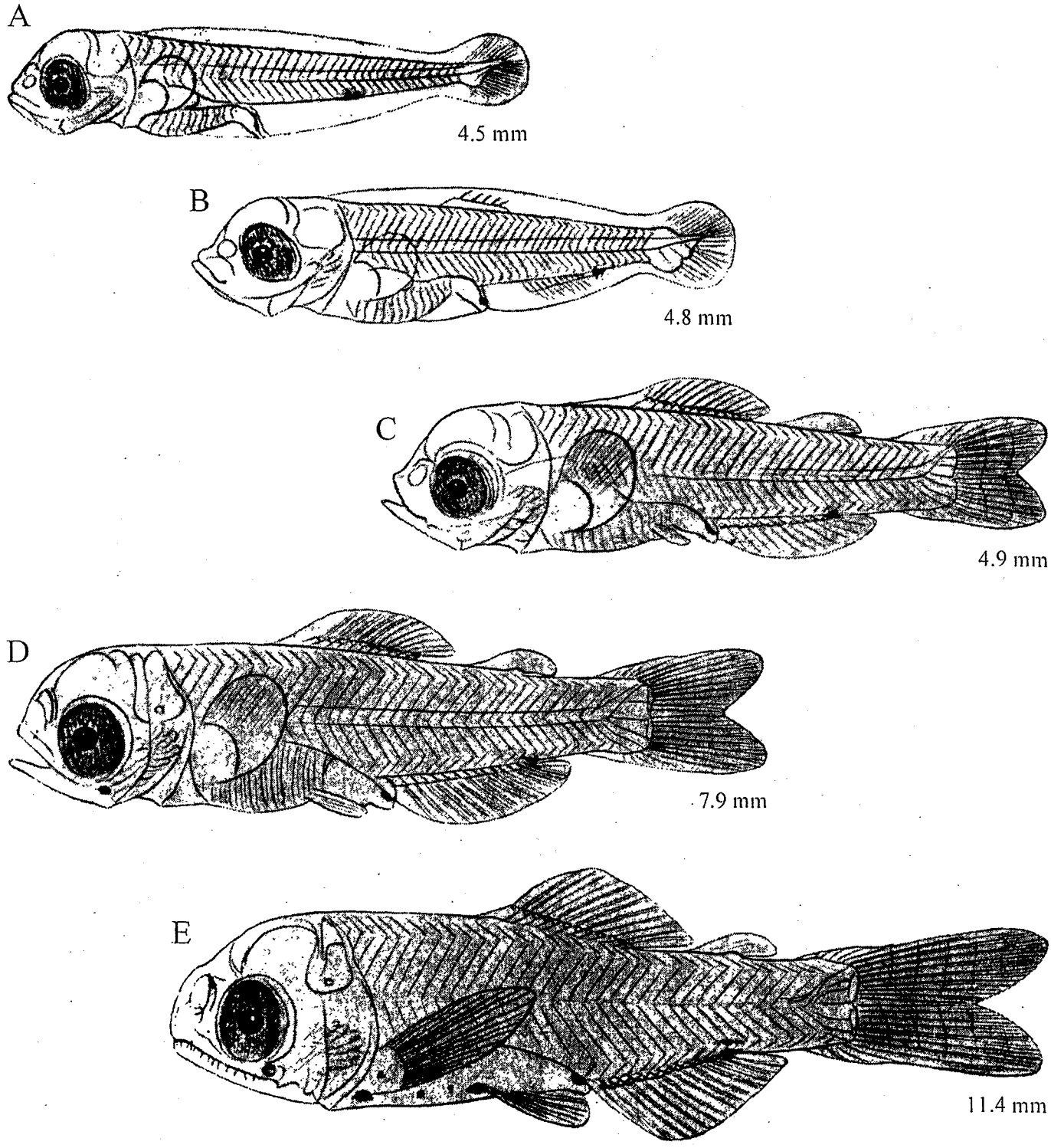
Pigmentation: *Preflexion*—By 4.5 mm, postanal median ventral series has coalesced to 1 at the future A insertion, a pair dorsally on terminal gut section; melanophores at hypural region & on ventral margin of gut are typical of the genus *Diaphus* but are not shown on Sparta's (1952) illustrations. *Flexion-postflexion*—As above.

Diagnostic features: Larvae that Sparta (1952) ascribed to *D. metopoclampus* are the deep-bodied larval form, similar to the larvae of *Diaphus* sp. described previously in this guide; Sparta's (1952) illustrations lack melanophores at the hypural region & on the ventral gut margin & probably are incomplete.

ILLUSTRATIONS

A–E, from Sparta (1952)

*Description based on Sparta (1952)


A
4.5 mm
B
4.8 mm
C
4.9 mm
D
7.9 mm
E
11.4 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	17–18
Total	33–34
Number of fin rays	
Dorsal	12–14
Anal	12–14
Pectoral	9–12
Pelvic	8
Caudal	
Dorsal Secondary	7–8
Principal	10+9
Ventral Secondary	7
Gillrakers on first arch	
Upper	4–6
Lower	11–14
Total	15–19
Branchiostegals	

LIFE HISTORY

Range: Common in tropical-subtropical Atlantic & Pacific Oceans

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Shiganova 1977

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at flexion: < 5.1 mm
Length at transformation: ~10 mm

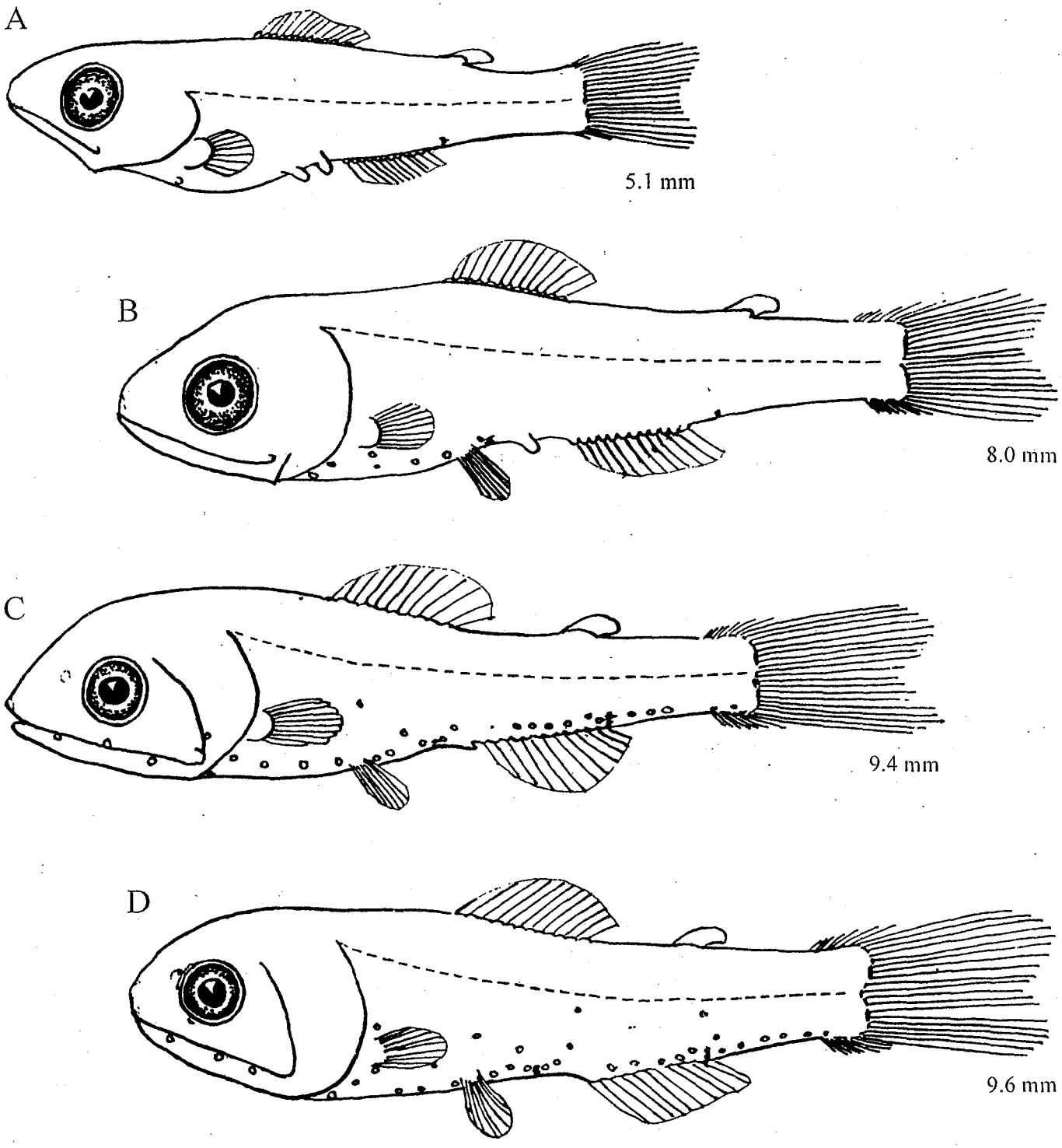
Pigmentation: *Flexion–Postflexion*—The only pigment shown in Shiganova's (1977) illustrations is on the posterior margin of the hypural & on the ventral midline of the tail near the A insertion.

Diagnostic features: Larvae that Shiganova (1977) ascribed to *D. mollis* are apparently the deep-bodied larval form, similar to the larvae of *Diaphus* sp. described previously in this guide; Shiganova's (1977) illustrations lack pigment on the ventral gut margin.

ILLUSTRATIONS

A–D, Shiganova (1977)

* Description of postflexion larvae based on Shiganova (1977)


A
5.1 mm
B
8.0 mm
C
9.4 mm
D
9.6 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	17–18
Total	33–34
Number of fin rays	
Dorsal	12–14
Anal	13–15
Pectoral	9–11
Pelvic	8
Caudal	
Dorsal Secondary	6–8
Principal	10+9
Ventral Secondary	6–7
Gillrakers on first arch	
Upper	7–8
Lower	14–17
Total	21–25
Branchiostegals	

LIFE HISTORY

Range: Temperate–subtropical North Atlantic; rare in the Gulf of Mexico

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Dekhnik & Sinukova 1966
Fahay 1983
Taaning 1918
Tortonese 1956

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at flexion: ~4–5 mm
Length at transformation: ~10 mm
Sequence of fin development: C_1, D & A, C_2, P_1, P_2

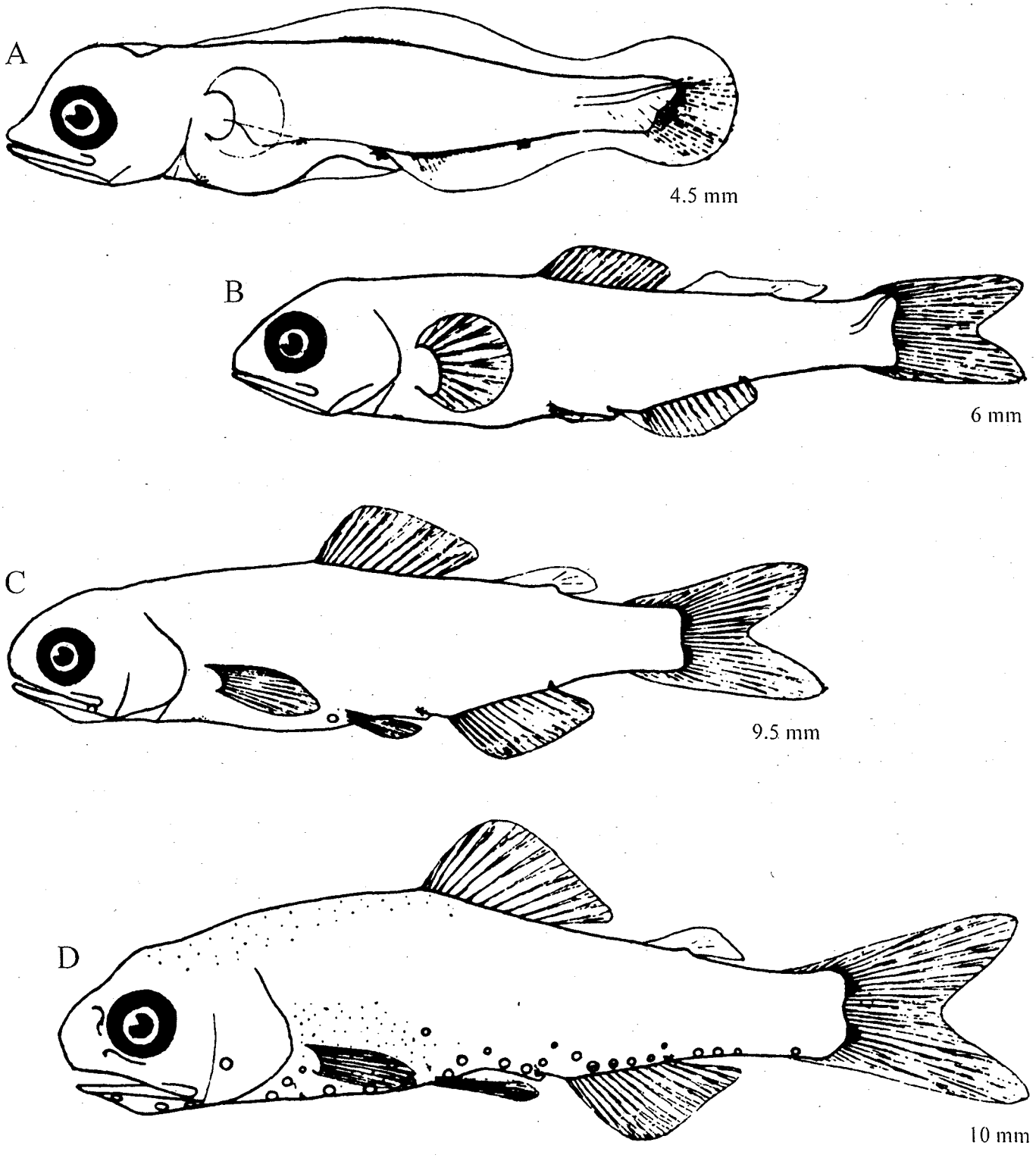
Pigmentation: *Preflexion*—By ~4.5 mm, 1 at future A insertion, 1 at posterior hypural margin of developing upper & lower hypural plates, 1 anteriorly on ventral margin of gut posterior to cleithral symphysis, 1 on each side of midgut & a pair dorsally on terminal gut section. *Flexion-postflexion*—Similar to above.

Diagnostic features: Larvae ascribed by Taaning (1918) to this species belong to the stout larval form of *Diaphus*, with notochord flexion & transformation at a small size & early coalescense of the postanal series to a single melanophore at the A insertion; Br_2 & PO_5 photophores form by ~7 mm; other photophores by ~10 mm.

ILLUSTRATIONS

A–D, from Taaning (1918)

* Description based on Taaning (1918) & Fahay (1983)


A
4.5 mm
B
6 mm
C
9.5 mm
D
10 mm

MERISTICS

Vertebrae	
Precaudal	
Caudal	
Total	~35–36 (myomeres)
Number of fin rays	
Dorsal	15
Anal	~14
Pectoral	17
Pelvic	8
Caudal	
Dorsal Secondary	6
Principal	10+9
Ventral Secondary	6
Gillrakers on first arch	
Upper	
Lower	
Total	
Branchiostegals	

LIFE HISTORY

ELH pattern: Oviparous, planktonic eggs & larvae

LITERATURE

Ozawa 1986

* The larvae described here are similar to larvae described by Ozawa (1986) as *Lampadena* sp. I & *Lampadena* sp. II; the larvae described here may be *L anomala*, a species known from the Atlantic & from the central Pacific (Nafpaktitis et al. 1977).

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at flexion: ~ 6.5 mm
Length at transformation: >11 mm

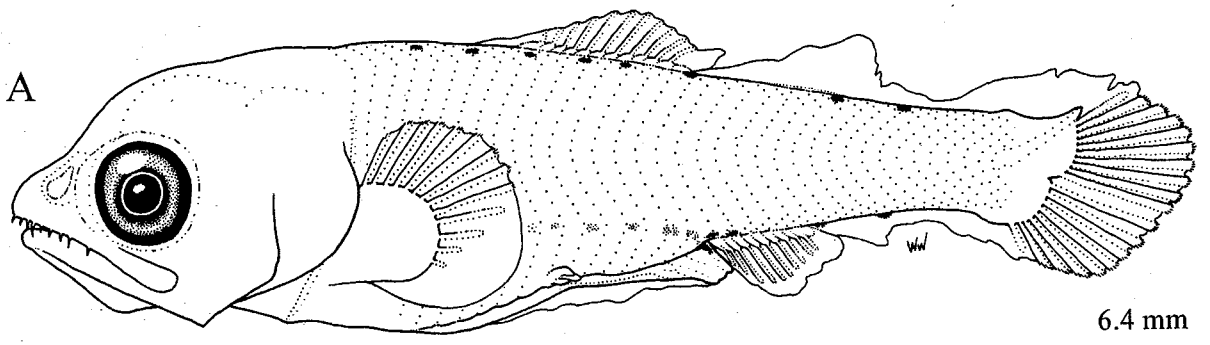
Pigmentation: *Flexion*—Series of ~6 pairs of melanophores along dorsal midline from slightly posterior to nape to D insertion; series continues posteriad but is irregular and unpaired posterior to D insertion; series of embedded melanophores above gut; irregular series on each side along A base; melanophore on ventral midline of gut below P_1base; minute melanophores beginning to form at bases of Br rays. *Postflexion*— In an 11.2 mm larva the series along dorsal midline and the series lateral to A base are irregular, & the series along bases of Br rays are more complete; a complex pattern of primarily minute melanophores has developed in the following loci: above cerebellum, at midline & laterally; several embedded ventrolaterally at hindbrain; several at tip of lower jaw; vertical series along preopercular ridges; anterior to cleithrum above P_1base; above terminal gut section; series along lateral midline of tail; vertical series at posterior margin of hypural base; some arranged symmetrically on lateral surface of hypural.

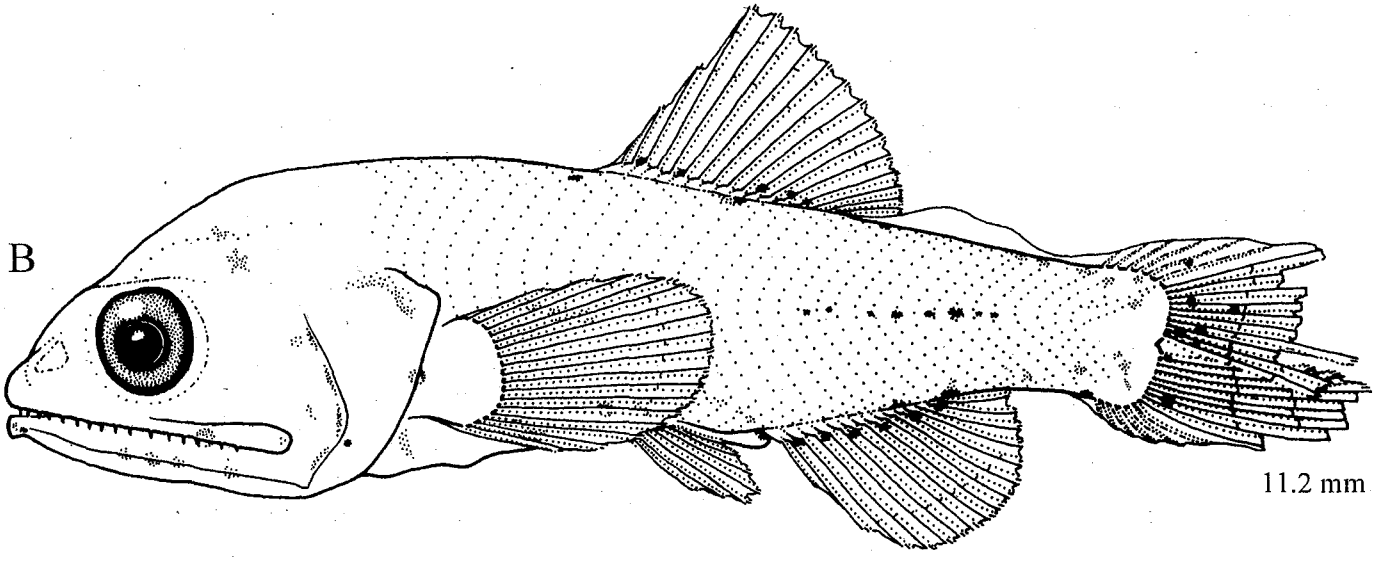
Diagnostic features: Gut elongate with large foregut (Sn–A 68% BL in flexion stage); canines large, and other teeth prominent; unique pigment pattern distinct from that of *L. urophaos* and *L. luminosa* and other series of *Lampadena* larvae that are presently unidentified to species; Br_2, PO_5, & PLO photophores early-forming, consistent with larvae of other *Lampadena* species.

ILLUSTRATIONS

A & B, original [W. Watson]

A, Nellen/Meteor Sta. 252 C; B, CH 3 76B1


A
6.4 mm


B
11.2 mm

MERISTICS

Vertebrae	
Precaudal	15–17
Caudal	20–22
Total	35–37
Number of fin rays	
Dorsal	14–15
Anal	13–15
Pectoral	15–17
Pelvic	8
Caudal	
Dorsal Secondary	8
Principal	10+9
Ventral Secondary	8
Gillrakers on first arch	
Upper	4
Lower	9–11
Total	13–15
Branchiostegals	

LIFE HISTORY

Range: Tropical -subtropical Atlantic, Pacific, & Indian Oceans

Habitat: Epi- & mesopelagic & upper bathypelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Part of population migrates at night from mesopelagic to epipelagic zone

LITERATURE

Fahay, 1983
Matarese et al. 1989
Miller et al. 1979
Moser & Ahlstrom 1974, 1996
Moser et al. 1984
Olivar et al. 1999
Ozawa 1986, 1988

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: <3.8 mm
Length at flexion: ~5.5–6.0 mm
Length at transformation: ~ 20 mm
Sequence of fin development: C_1, A , D, C_2, P_1, P_2

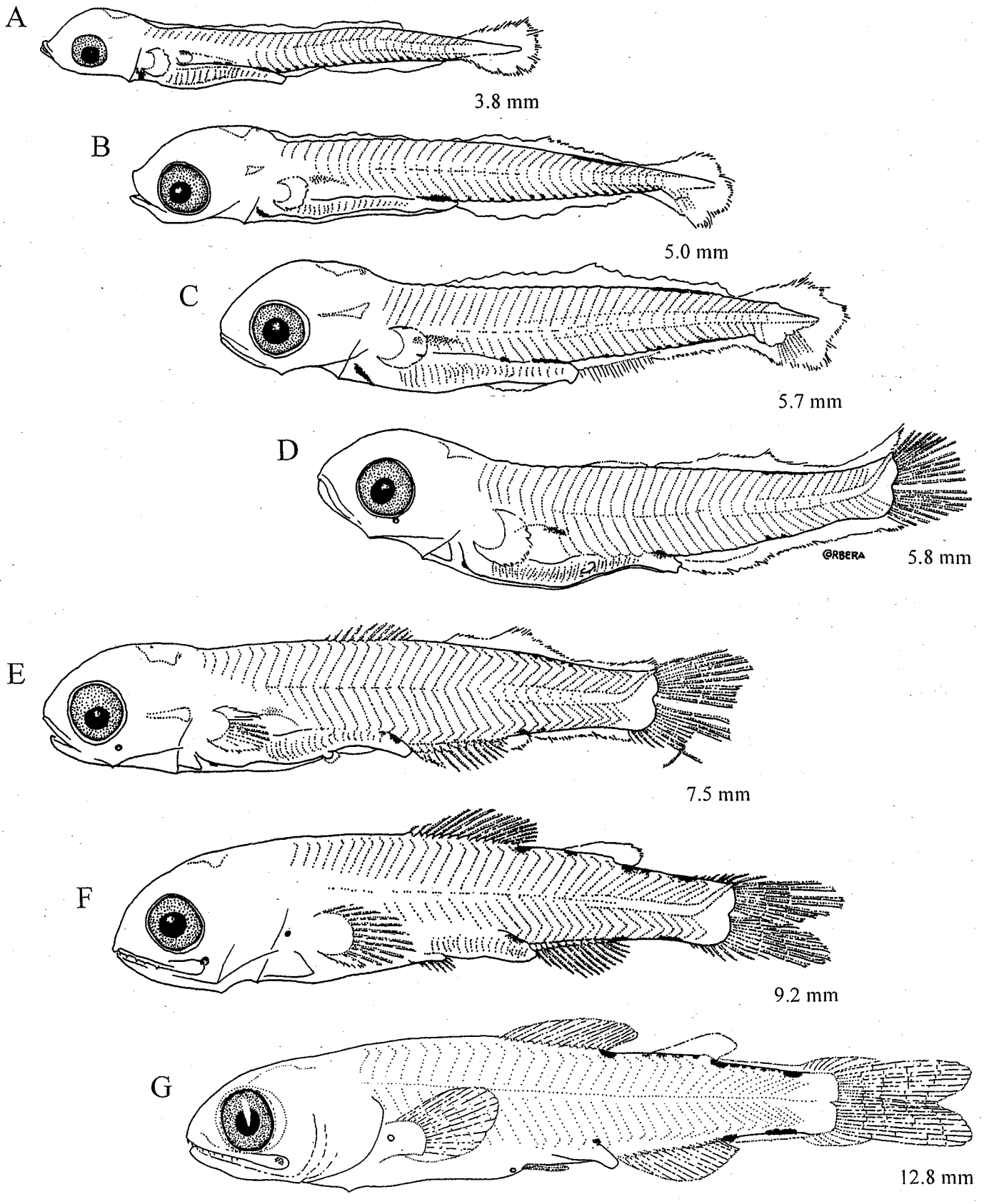
Pigmentation: *Preflexion*—By 3.8 mm, above gas bladder, in midline embedded anterior to gut, above terminal section of gut, 18–20 in series along ventral margin of tail; by ~ 5 mm, short paired series dorsally at caudal peduncle region, extending along 5–6 myomeres, ventral midline series coalescing. *Flexion*—Ventral midline series coalesced to 1 to several melanophores. *Postflexion*—Dorsal series extends from D insertion to caudal peduncle, with large midline melanophores at D insertion, Ad insertion, & posteriorly at caudal pecuncle; irregular paired series of smaller melanophores in region of developing supracaudal luminous gland; large midline melanophores at A insertion & posteriorly on caudal peduncle with irregular paired series of smaller melanophores in region of developing infracaudal luminous gland; in occipital region in late postflexion stage.

Diagnostic features: Larvae relatively slender during all developmental stages (BD <23% BL), especially during preflexion (BD 11–14% BL); gut slightly sigmoid, extending to midbody in preflexion & to ~60% BL in later stages; Br_2, PLO, & PO_5 photophores form at ~6 mm, 10 mm, & 12.5 mm, respectively; in early preflexion larvae the melanophores in the ventral postanal series are more numerous & more regularly spaced than in *Diaphus*; also, *Diaphus* has a distinct hypural melanophore not present in *L. luminosa*; *Ceratoscopelus* larvae lack the melanophore on the ventral midline of the gut that is present in *L. luminosa* and in *Diaphus*; larvae of other *Lampadena* species can be separated on the basis of pigment pattern, although some distinct larval series of *Lampadena* have not been identified to species.

ILLUSTRATIONS

A–F, Olivar et al. (1999); G, Moser & Ahlstrom (1974)

* Description based primarily on Olivar et al. (1999)


A
3.8 mm
B
5.0 mm
C
5.7 mm
D
©RBERA
5.8 mm
E
7.5 mm
F
9.2 mm
G
12.8 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	20–22
Total	35–38
Number of fin rays	
Dorsal	14–16
Anal	13–14
Pectoral	14–17
Pelvic	8
Caudal	
Dorsal Secondary	8–9
Principal	10+9
Ventral Secondary	8–9
Gillrakers on first arch	
Upper	3–5
Lower	9–11
Total	13–14
Branchiostegals	9–10

LIFE HISTORY

Range: According to Nafpaktitis et al. (1977) *L. urophaos atlantica* is restricted to the subtropical North Atlantic & *L. urophaos urophaos* occurs in the Pacific east of 160°W, at ~ 25°–42°N; adults of the two subspecies differ in the position of the PVO_1 photophore & on the relative sizes of the caudal luminous glands (Nafpaktitis et al. 1977); larvae from the western central Atlantic are similar to those from the Pacific.

Habitat: Epi- & mesopelagic

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Fahay 1983
Matarese et al. 1989
Moser 1981
Moser & Ahlstrom 1972, 1996
Moser et al. 1984

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: <2.9 mm
Length at flexion: ~6.8–8.3 mm
Length at transformation: >17–21 mm
Sequence of fin development: C_1, P_1, A & D & C_2, P_2

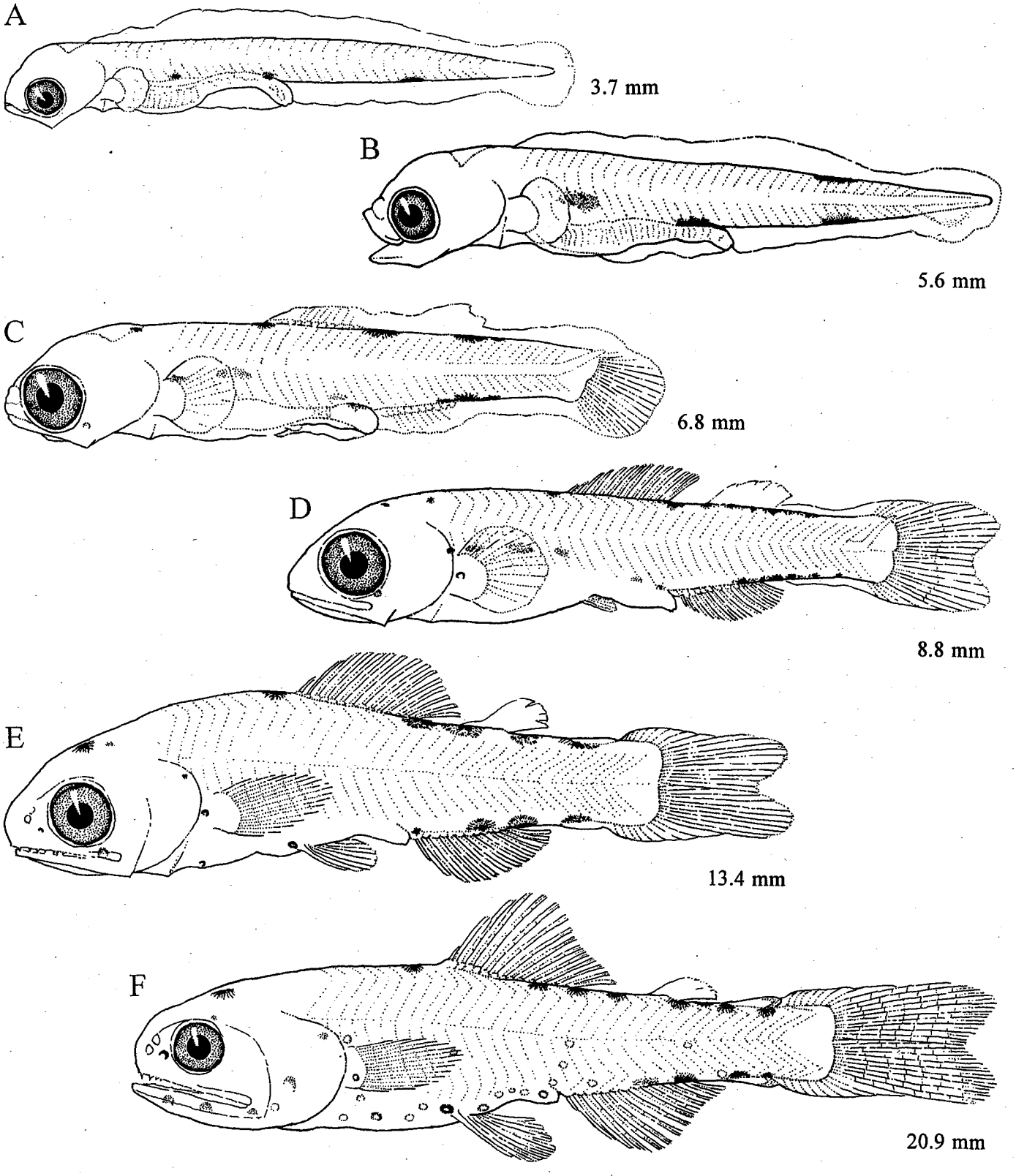
Pigmentation: *Preflexion*—Initially, 1 above developing gas bladder, 1 above preanal arch of gut, & 1 on ventral margin midway between anus & notochord tip; at ~4.2 mm, 1 on dorsal midline opposite the one at ventral midline; at ~ 6.2–6.5 mm, 1 at future D insertion, 1 embedded just posterior to P_1 base, & 1 embedded ventrolaterally on surface of hindbrain. *Flexion*—At 6.5–7.0 mm, on dorsal midline at nape & D origin, dorsally and ventrally on caudal peduncle, pair on A base, & 2 in midline embedded above gut; at 7.0–8.3 mm, on dorsal midline at cerebellum & anterior to Ad, pairs dorsally at Ad & D insertions, & 2 more in embedded midline series above gut. *Postflexion*—Additional midline & paired melanophores along dorsum & postanal ventrum in some specimens.

Diagnostic features (Pacific specimens): Moderate body depth; gut to midbody, slightly sigmoid; head size moderate; eyes relatively large, slightly elliptical with choroid sliver; distinctive pigment with large, dense melanophores; Br_2 photophores form by 6.5–7.2 mm; PLO by 7.2–8.0 mm; PO_5 by 8.5–9.5 mm; PO_1 & Vn by 13.5 mm.

ILLUSTRATIONS

A–F, from Moser & Ahlstrom (1996)

* Description based on Moser & Ahlstrom (1996) & examination of larval specimens from the Atlantic


A
3.7 mm
B
5.6 mm
C
6.8 mm
D
8.8 mm
E
13.4 mm
F
20.9 mm

MERISTICS

Vertebrae	
Precaudal	
Caudal	
Total	~37 (myomeres)
Number of fin rays	
Dorsal	14
Anal	18
Pectoral	14
Pelvic	8
Caudal	
Dorsal Secondary	6
Principal	10+9
Ventral Secondary	6
Gillrakers on first arch	
Upper	
Lower	
Total	
Branchiostegals	

LIFE HISTORY*

Range: This distinct *Lampanyctus* larva, unidentified to species, is well represented in MCZ samples from the western Atlantic from 33° S to 39° N, particularly from western Atlantic slope water; it is similar in general morphology to larvae ascribed to *L. lepidolychnus* (Olivar & Beckley 1997) & shares some of the pigment characteristics of *L. lepidolychnus* larvae; counts of fin rays & the distribution of this larval form are consistent with *L. photonotus*, particularly in its apparent absence from the Gulf of Mexico; since *L. lepidolychnus* & its close relative *L. intricarius* do not occur in the western North Atlantic, this larva is ascribed tentatively to *L. photonotus*.

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

LITERATURE

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at flexion: ~4–5 mm
Length at transformation: ~21 mm

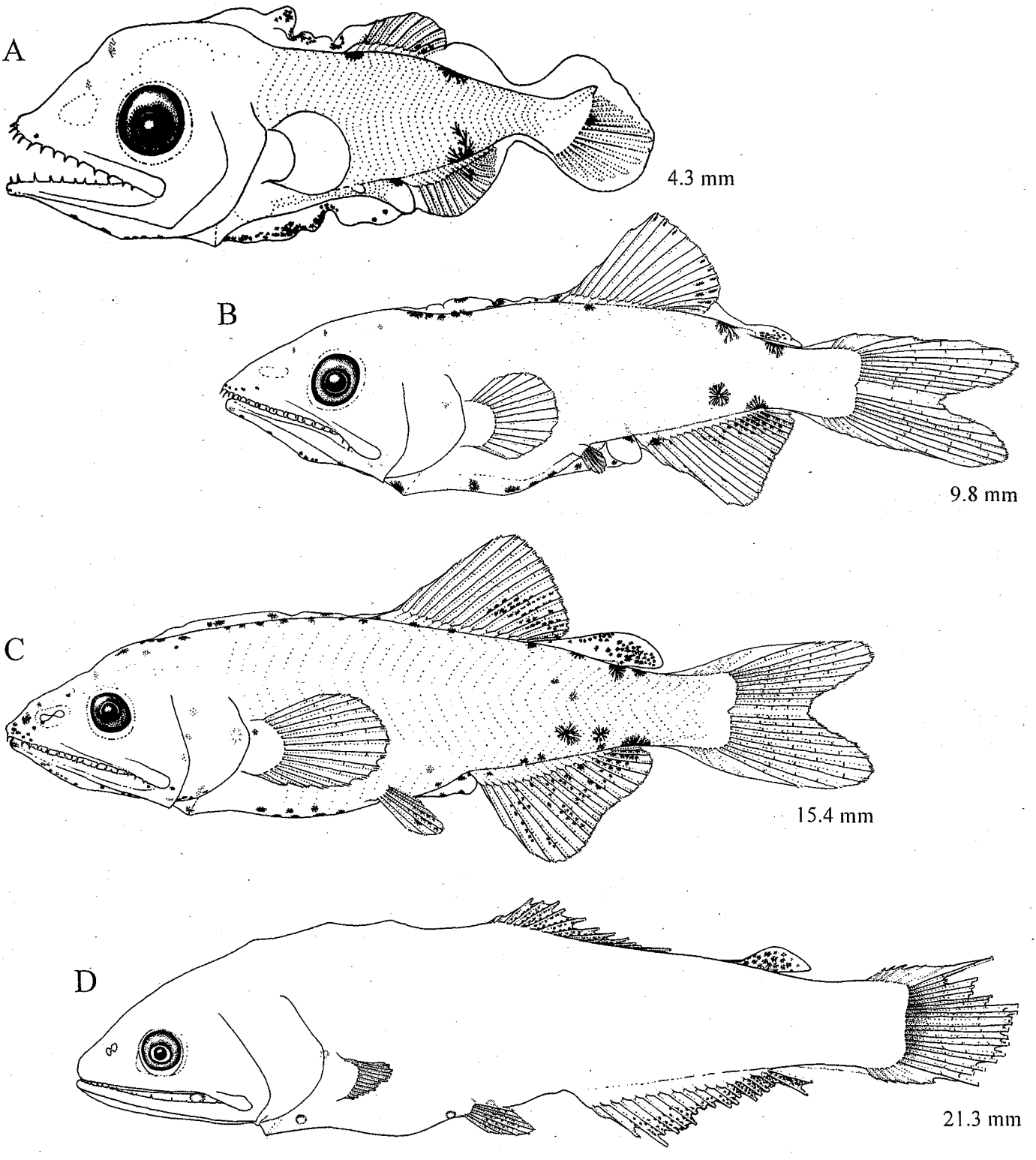
Pigmentation: *Flexion*—In midline anterior to forebrain & to midbrain;1 or more melanophores at tips of upper & lower jaws; a series extending from isthmus to gular region; paired melanophores on each side of D, just posterior to D origin; a large melanophore in dorsal midline anterior to Ad & 1 opposing it on each side of A base (these form a partial bar on tail, when expanded); above terminal gut section; series of prominent melanophores along margins of dorsal & ventral finfolds. *Postflexion*— Paired melanophores added at D insertion; melanophores added laterally on tail to form a more complete bar; patch on Ad; A, D, & P_2 rays becoming progressively more heavily pigmented; 1 or more occipital melanophores.

Diagnostic features: Deep, highly compressed body, large head, & relatively long, straight gut; BD 30–36% BL in flexion stage & in all but late postflexion larvae; Sn-A 57–64% BL; HL 32–41% BL in flexion stage & in all but late postflexion larvae; jaws large with prominent teeth & anterior tooth patch; eye small & slightly off-round (EL 28% HL at flexion, diminishing to 18% in late postflexion stage); large dorsal & ventral finfold; heavily & distinctly pigmented, especially on dorsum, & on fins & finfolds.

ILLUSTRATIONS

A–D, original [A, C, D, R. C. Walker/W. Watson; B, W. Watson]

A, MCZ 150454; B, MCZ 109724; C, MCZ 109740; D, MCZ 109725


A
4.3 mm
B
9.8 mm
C
15.4 mm
D
21.3 mm

MERISTICS

Vertebrae	
Precaudal	15
Caudal	19–21
Total	33–36
Number of fin rays	
Dorsal	11–13
Anal	16–18
Pectoral	11–13
Pelvic	8
Caudal	
Dorsal Secondary	7
Principal	10+9
Ventral Secondary	7–8
Gillrakers on first arch	
Upper	2–4
Lower	9–11
Total	13–15
Branchiostegals	

LIFE HISTORY

Range: Tropical & subtropical Atlantic & Indo-Pacific; abundant in Gulf of Mexico but not in Caribbean

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Olivar & Beckley 1997

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: <2.0 mm
Length at flexion: 4.5–5.0 mm
Length at transformation: ~11 mm
Sequence of fin development: C_1, D & A, C_2, P_1, P_2

Pigmentation: *Preflexion*—Initially, in midline anterior to forebrain & anterior to gut; by 2.2 mm, in midline anterior to midbrain, at tip of lower jaw, & embedded in otic region; by 3.0 mm, in midline of occipital region, at tip of upper jaw, at terminal section of gut, ventrally on midgut, embedded at juncture of cleithrum & P_1 base, embedded in posterior region of peritoneum, on lower region of P_1 blade; by the end of preflexion stage, a series along ventral midline of gut, several embedded in peritoneal region, a group on lower proximal part of P_1 blade, several on isthmus. *Flexion–Postflexion*— Pattern similar to late preflexion stage, with some added at occipital region & on gular region; embedded peritoneal & superficial pigment added on myosepta.

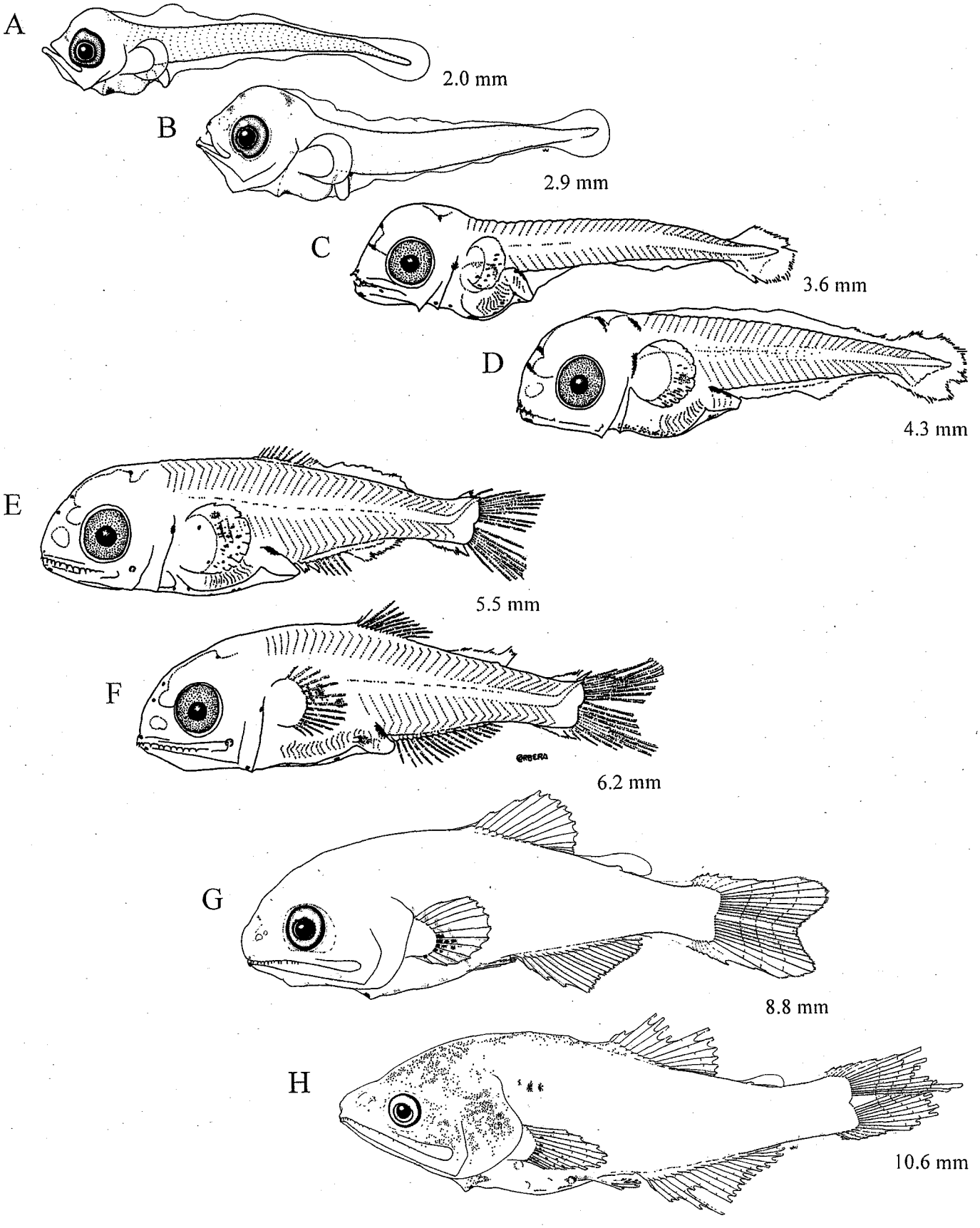
Diagnostic features: Gut short & strongly flexed in early larvae, increasing in relative length to >50% BL in later larval stages; head relatively large with blunt snout & early forming teeth; eye round & relatively large (ED almost 50% HL) in early preflexion larvae diminishing in relative size & becoming off-round in later stages; body relative deep & compressed at P_1 base; pigment pattern distinct, particularly the patch on lower region of P_1; Br_2 appears during flexion stage.

ILLUSTRATIONS

A, B, G, H, original [W. Watson]; C–F, Olivar & Beckley (1997)

A, 45399; B, 45230; G, OR II 16645232;
H, CA 90023805

* Description based on Olivar & Beckley (1997) & on original observations.


A
2.0 mm
B
2.9 mm
C
3.6 mm
D
4.3 mm
E
5.5 mm
F
6.2 mm
G
8.8 mm
H
10.6 mm

MERISTICS

Vertebrae	
Precaudal	15
Caudal	20–21
Total	35–36
Number of fin rays	
Dorsal	13–15
Anal	16–18
Pectoral	13–16
Pelvic	8
Caudal	
Dorsal Secondary	8
Principal	10+9
Ventral Secondary	8
Gillrakers on first arch	
Upper	4–5
Lower	11–13
Total	15–18
Branchiostegals	

LIFE HISTORY

Range: Temperate North Atlantic with some part of the population extending into subtropical western & eastern North Atlantic; larvae of this species do not occur in the Gulf of Mexico but may occur in the northern-most part of the central western Atlantic

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic zone to epipelagic or upper mesopelagic zones

LITERATURE

Dekhnik & Sinukova 1966
Fahay 1983
Moser et al. 1984
Taaning 1918
Tortonese 1956

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at flexion: ~6–7 mm
Length at transformation: ~20 mm

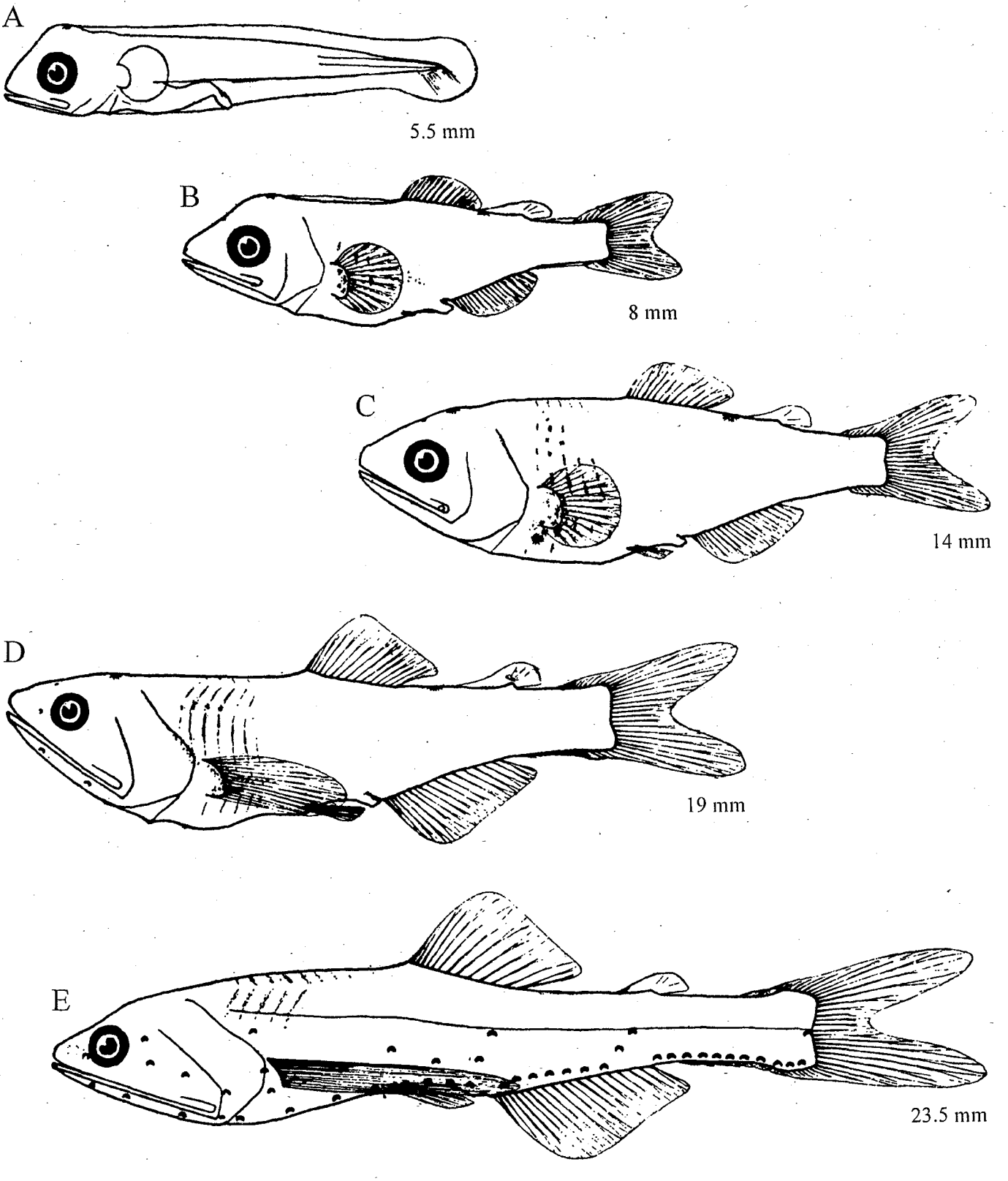
Pigmentation: *Preflexion*—Initially, at occipital midline, & dorsally on terminal gut section; large melanophore added in dorsal midline between D insertion & Ad. *Flexion–postflexion*—Melanophores embedded in peritoneum & myosepta anteriorly on trunk, increasing in number with development; some added at P_1 base & dorsally on head.

Diagnostic features: Pigment pattern, particularly the large occipital melanophore & the melanophore between D insertion & Ad base.

ILLUSTRATIONS

A–E, from Taaning (1918)

* Description based on Taaning (1918)


A
5.5 mm
B
8 mm
C
14 mm
D
19 mm
E
23.5 mm

MERISTICS

Vertebrae	
Precaudal	15–16
Caudal	21–23
Total	37–39
Number of fin rays	
Dorsal	14–16
Anal	17–20
Pectoral	13–15
Pelvic	8
Caudal	
Dorsal Secondary	6–7
Principal	10+9
Ventral Secondary	6–7
Gillrakers on first arch	
Upper	3–4
Lower	9–11
Total	13–15
Branchiostegals	

LIFE HISTORY

Range: Tropical circumglobal

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Part of population migrates at night from mesopelagic to epipelagic zone

LITERATURE

Miller et al. 1979
Moser & Ahlstrom 1996
Moser et al. 1984
Olivar & Beckley 1997

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: <3.5 mm
Length at flexion: ~5.0–6.5 mm
Length at transformation: ~20 mm
Sequence of fin development: C_1, D & A & C_2, P_1, P_2

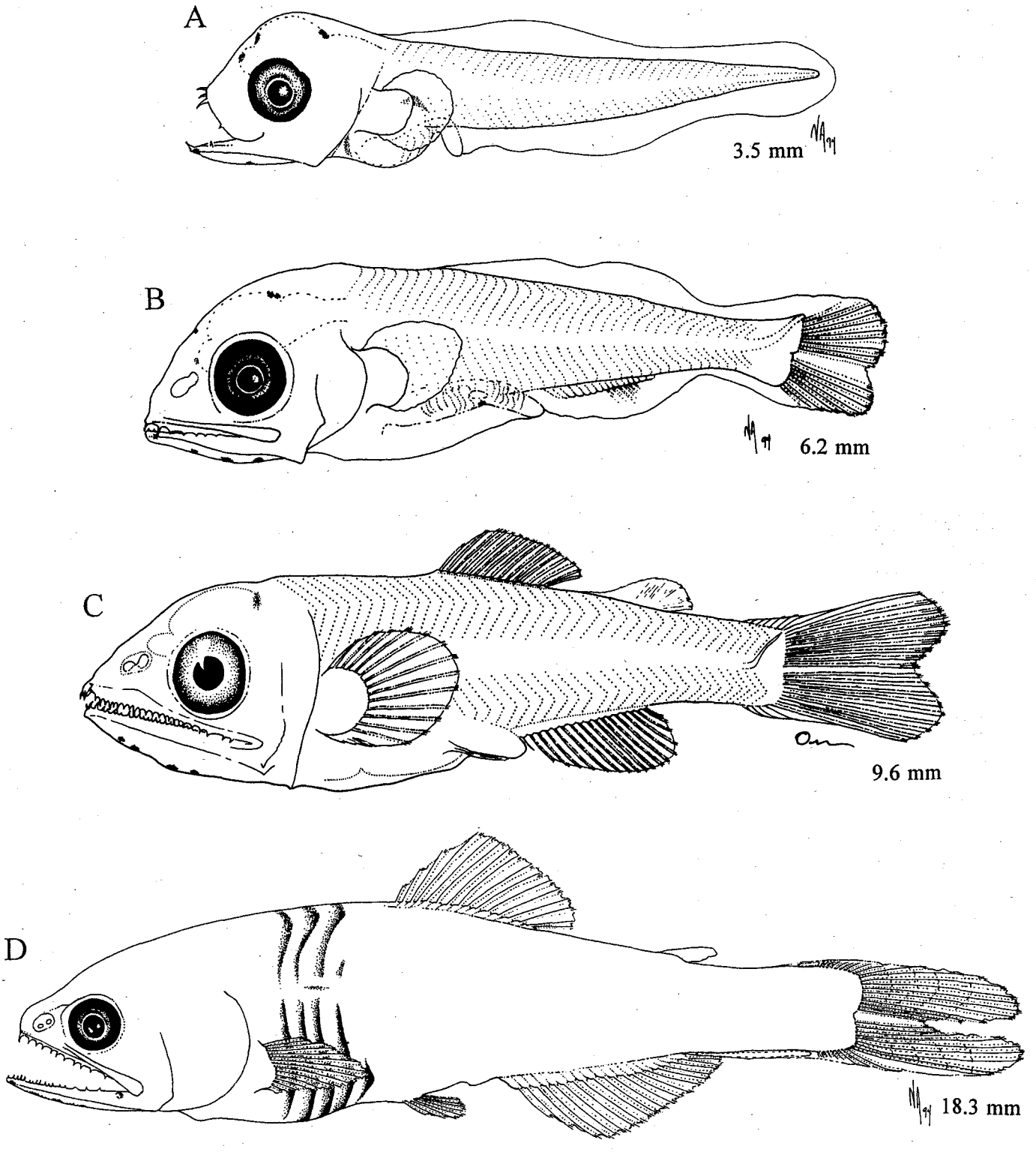
Pigmentation: *Preflexion-postflexion*— 1 above & 1 anterior to forebrain; 1 above cerebellum; at lower jaw symphysis; on midline of gular region between urohyal & symphysis, usually 1 in larvae <4.0 mm (2–4 in larger larvae); blotch above gas bladder; 1 embedded mesially anterior to gut mass; beginning at ca. 12 mm, series on myosepta anterior to P_2; in late larvae, myosepta of entire trunk outlined between P_1 & P_2 bases.

Diagnostic features: Large head; large, nearly round eyes; large jaws with prominent teeth & tooth patch at tip of upper jaw; gut short, sigmoid; body sharply tapered in early larvae, robust in late larvae; distinctive pigment pattern with median gular series; Br_2 photophores form at ~ 10 mm.

ILLUSTRATIONS

A–D, from Moser & Ahlstrom (1996)

* Description based on Moser & Ahlstrom (1996)


A
3.5 mm
B
6.2 mm
C
9.6 mm
D
18.3 mm

MERISTICS

Vertebrae	
Precaudal	
Caudal	
Total	30–32
Number of fin rays	
Dorsal	11–13
Anal	13–16
Pectoral	13–15
Pelvic	8
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Gillrakers on first arch	
Upper	3
Lower	8–10
Total	11–13
Branchiostegals	

LIFE HISTORY

Range: Temperate-subtropical Atlantic & circumglobally in the southern hemisphere

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Dekhnik & Sinukova 1966
Fahay 1983
Moser et al. 1984
Olivar & Beckley 1997
Olivar & Fortuño 1991
Taaning 1918
Tortonese 1956

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at flexion: ~4–6 mm
Length at transformation: ~12 mm
Sequence of fin development: C_1, D & A & C_2 & P_1, P_2

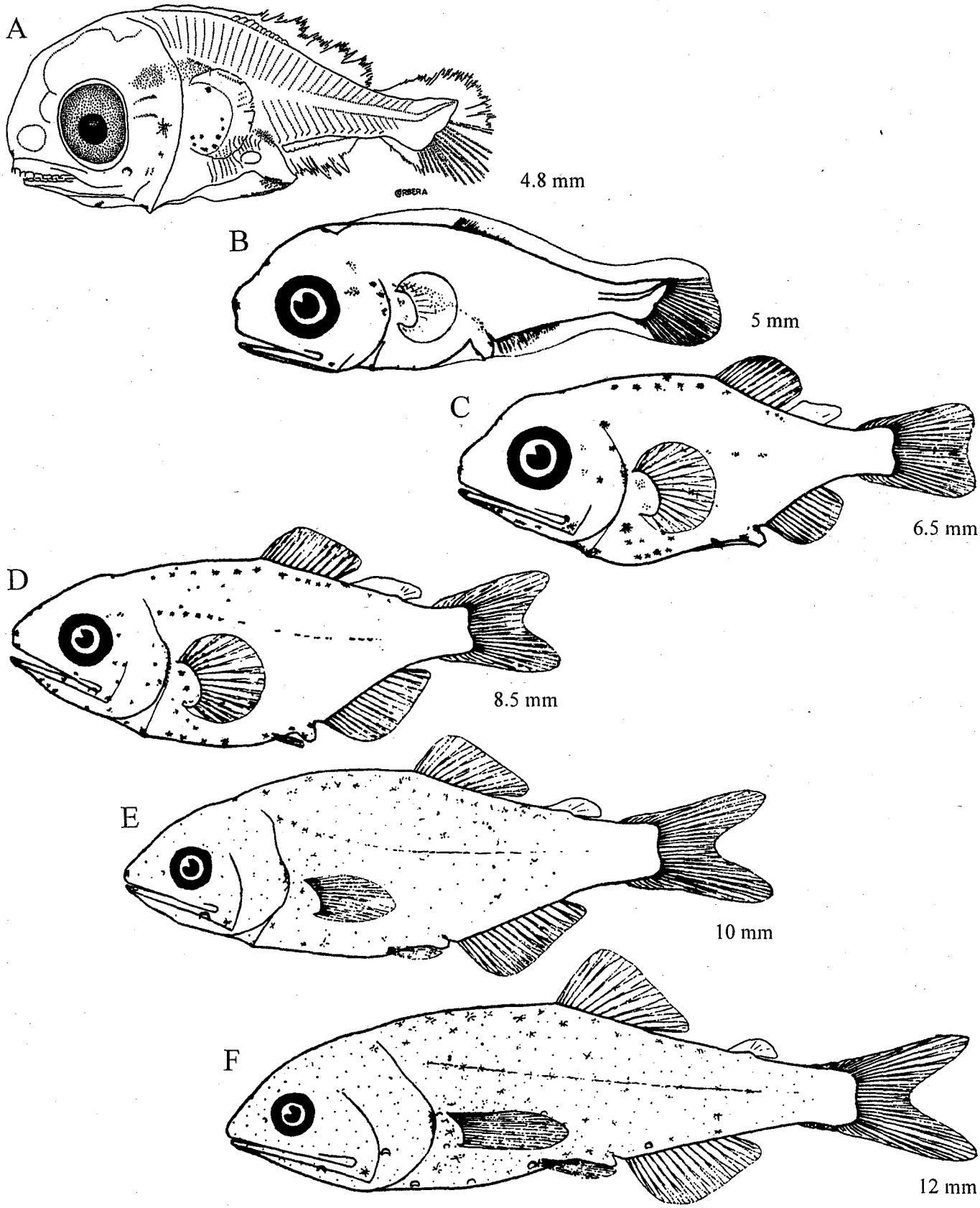
Pigmentation: *Flexion*—In midline of occipital region & 1 or more anteriorly above brain (not shown in illustration of 4.8 mm larva); at tip of snout & lower jaw; on opercle; internally in otic region & above gas bladder; ventrally at gular region & at juncture of cleithrum; dorsally and ventrally on terminal gut section; on & ventral to P_1base. *Postflexion*—Paired series along dorsum, midlateral series on trunk & tail; pigment added below P_1 base & midventrally below gut.

Diagnostic features: Deep, stout body & large head with blunt snout & large rounded eye; larvae of *L. tenuiformis* are similar in shape but have lighter pigmentation; Br_2 photophores form at flexion.

ILLUSTRATIONS

A, from Olivar & Beckley (1997); B–F, from Taaning (1918)

*Description based primarily on Taaning (1918)


A
4.8 mm
B
5 mm
C
6.5 mm
D
8.5 mm
E
10 mm
F
12 mm

MERISTICS

Vertebrae	
Precaudal	14–16
Caudal	19–21
Total	34–37
Number of fin rays	
Dorsal	13–15
Anal	17–19
Pectoral	12–15
Pelvic	8
Caudal	
Dorsal Secondary	7–8
Principal	10+9
Ventral Secondary	7–8
Gillrakers on first arch	
Upper	4
Lower	9–11
Total	13–15
Branchiostegals	

LIFE HISTORY

Range: Tropical Atlantic, Pacific, & Indian Oceans

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Moser & Ahlstrom 1996

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: <3.0 mm
Length at flexion: ~4.2–5.0 mm
Length at transformation: <20 mm
Sequence of fin development: C_1, D & A & P_1, C_2, P_2

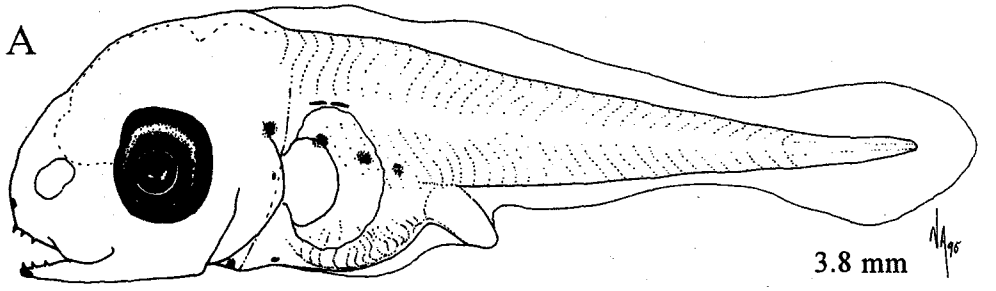
Pigmentation: *Preflexion-flexion*—Embedded in otic region; at upper & lower jaw tips; usually 1 on lateral midline above P_1 base; on inner surface of P_1 base & adjacent trunk; above gas bladder; a large melanophore on finfold just anterior to anus; on ventral midline below gut; on opercle. *Postflexion*— 1 on upper P_1 rays; much of early pigment pattern becoming embedded & masked.

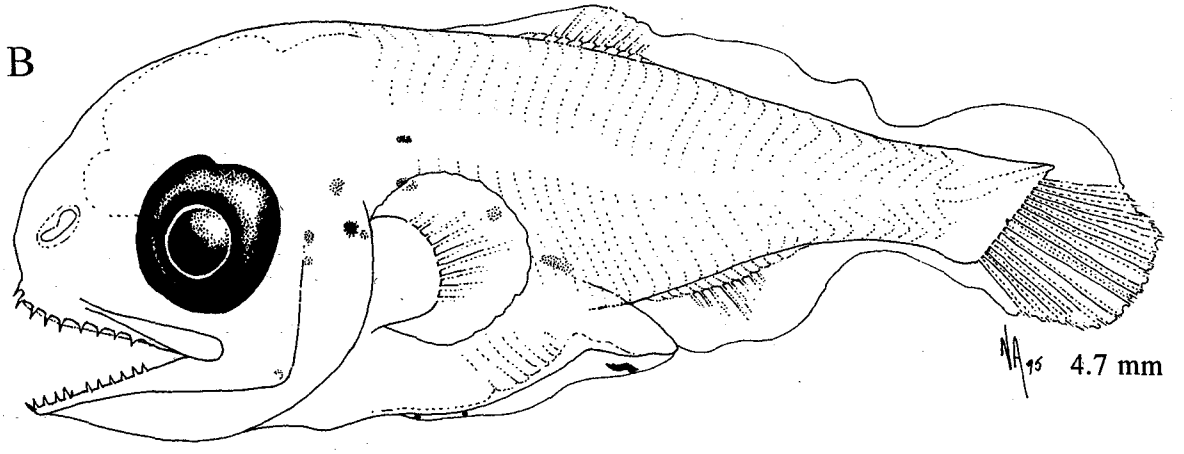
Diagnostic features: Early larvae deep bodied & strongly tapered, becoming robust & stout; head & eyes large; snout blunt; distinct pigment pattern with prominent melanophore in finfold anterior to anus; Br_2 photophores form at ~5.0 mm.

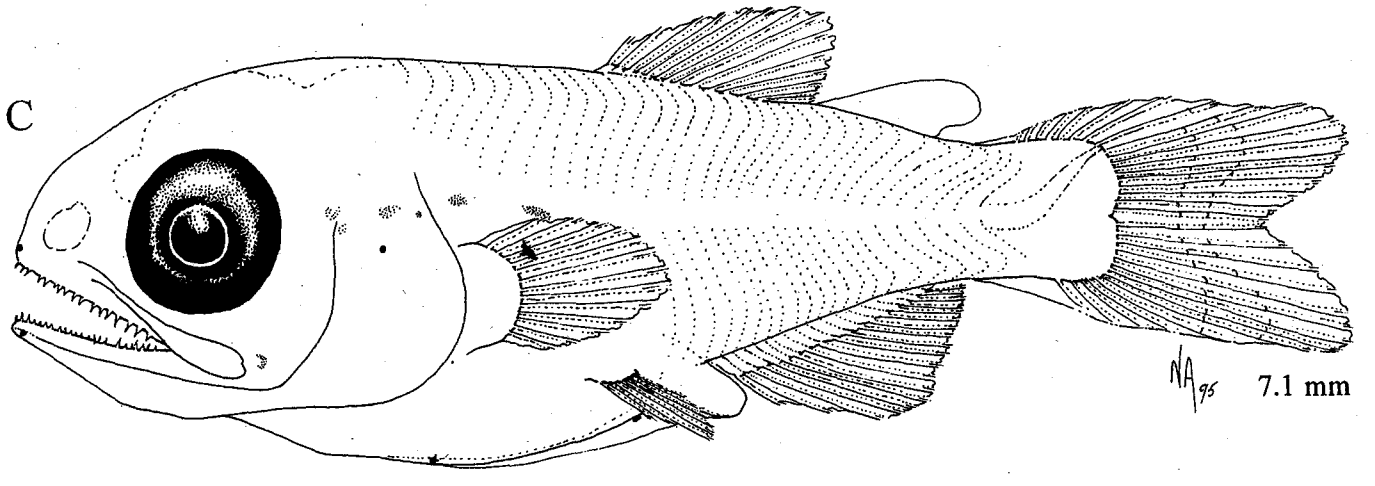
ILLUSTRATIONS

A–C, from Moser & Ahlstrom (1996)

* Description based on Moser & Ahlstrom (1996)


A
3.8 mm


B
4.7 mm


C
7.1 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	19–20
Total	35–36
Number of fin rays	
Dorsal	12–15
Anal	13–15
Pectoral	11–13
Pelvic	8
Caudal	
Dorsal Secondary	7–8
Principal	10+9
Ventral Secondary	7–8
Gillrakers on first arch	
Upper	3
Lower	8–9
Total	11–12
Branchiostegals	

LIFE HISTORY

Range: Subtropical Atlantic; *L. gaussi* is rare in the Gulf of Mexico & Caribbean but common elsewhere in the subtropical North Atlantic, except for the Mauritanian upwelling region, where it is absent; the samples containing the specimens described herein were taken at the Meteor Seamount (approximately 28° 42' N latitude, 28° 23' W longitude).

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Fahay 1983
Moser & Ahlstrom 1974
Moser et al. 1984

EARLY LIFE HISTORY DESCRIPTION

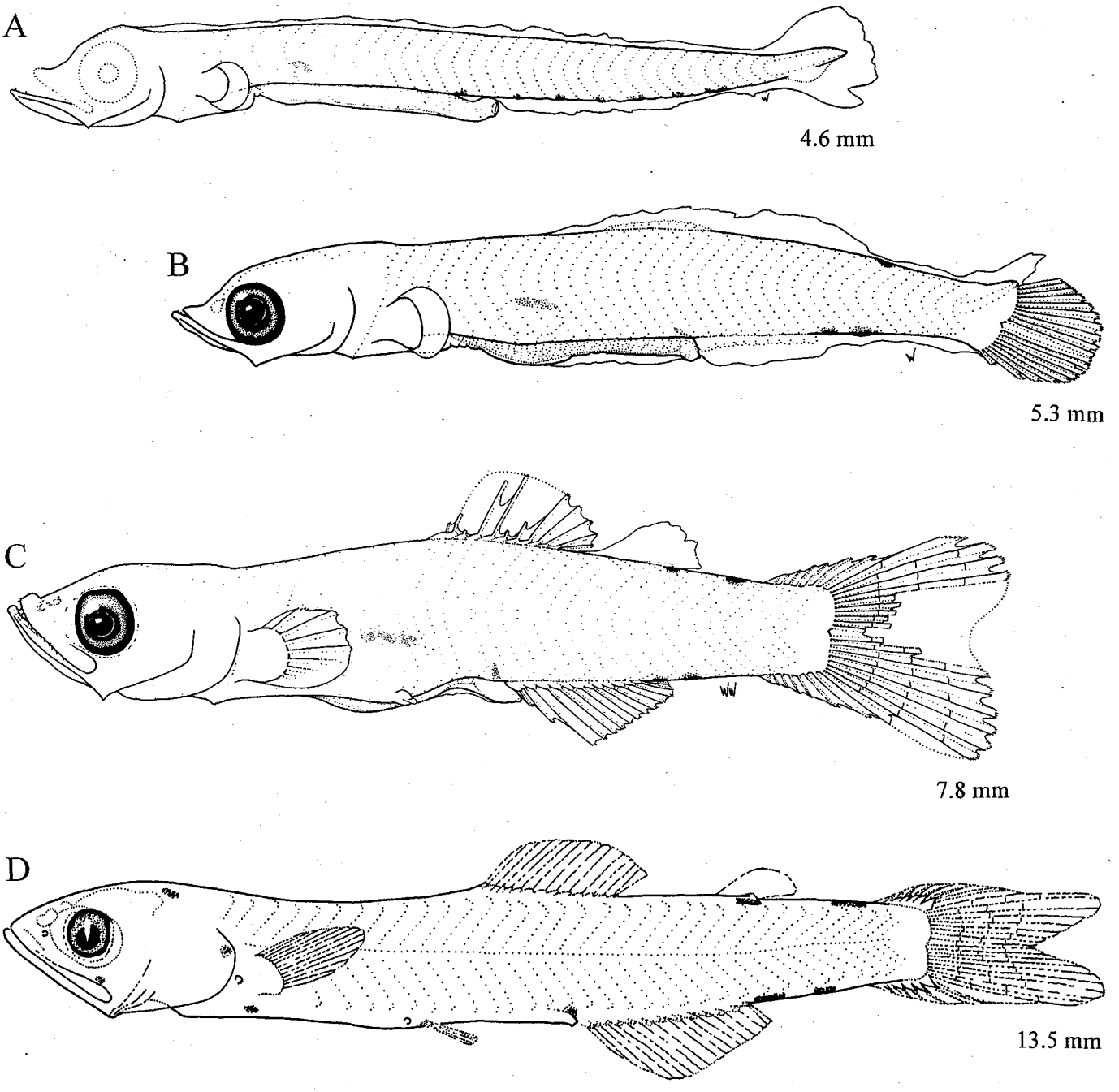
LARVAE:
Length at flexion: 5.3–5.6 mm
Length at transformation: ~13 mm
Sequence of fin development: C_1, D & A, P_1 & C_2, P_2

Pigmentation: *Preflexion*— By 4.6 mm, 1 or more embedded above gas bladder, a pair dorsolaterally on the terminal gut section, ~6 in postanal ventral midline series; postanal series coalesces to ~2 by the end of preflexion stage. *Flexion*— Postanal series consists of 1 small melanophore at A insertion (at 10^{th} -12^{th} postanal myomere) & usually 1 larger melanophore at 11^{th} -14^{th} postanal myomere; usually 1 in dorsal midline of caudal peduncle ~ 1 myomere posterior to the large ventral melanophore. *Postflexion*—By 7.0 mm, 1 present in occipital region, some specimens have 1 or 2 additional melanophores embedded in nape, a small melanophore embedded in otic region on each side, & some specimens have melanophores at posterior margin of hypural plate (usually 2 on upper plate and 2 on lower plate); by 7.8 mm, a small melanophore present in dorsal midline at Ad base; dorsal and ventral postanal melanophores typically split at horizontal septum, giving the appearance of a melanophore pair; a melanophore embedded in ventral midline below P_1 base in some specimens .

Diagnostic features: Slender body & relatively small head (BD ~11–15% BL in preflexion & flexion stages, increasing to ~17–20% by transformation; initially HL ~20% BL, increasing to 27–29 % BL); gut nearly straight increasing from ~60% BL initially to 63–67% BL in postflexion; eye rounded & relatively large (typically ED 30–33% HL); pigment pattern similar to but distinct from *Ceratoscopelus* (see *L. guentheri* description); preflexion-flexion stage larvae of *L gaussi* larvae are more slender than those of *L. guentheri* (BD 11–15% BL vs 14–16%) & have a relatively longer gut (Sn-A 59–64% BL vs 48–58%); *L. gaussi* lack the prominent lateral foregut melanophore present in *L. guentheri* & have less postanal/caudal peduncle pigment; flexion occurs at a larger size in *L. gaussi* (5.3–5.6 mm vs 4.1–4.5 mm); photophores appear later in *L. gaussi* (Br_2, Vn, PO_5, PLO are just forming at 12.3 mm.

ILLUSTRATIONS

A–C, original [W. Watson]; D, from Moser & Ahlstrom (1974)
A, Nellen/Meteor Sta.113; B, Nellen/Meteor Sta. 122; C, Nellen/Meteor Sta. 178


A
4.6 mm
B
5.3 mm
C
7.8 mm
D
13.5 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	20
Total	36
Number of fin rays	
Dorsal	13–15
Anal	13–16
Pectoral	11–14
Pelvic	8
Caudal	
Dorsal Secondary	7–8
Principal	10+9
Ventral Secondary	7–8
Gillrakers on first arch	
Upper	4
Lower	9–11
Total	13–15
Branchiostegals	

LIFE HISTORY

Range: Tropical & subtropical Atlantic

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Fahay 1983
Moser & Ahlstrom 1972
Shiganova 1977

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at hatching: <3.6 mm
Length at flexion: 4.1–5.0 mm
Length at transformation: ~13 mm
Sequence of fin development: C_1, D & A, P_1 & C_2, P_2

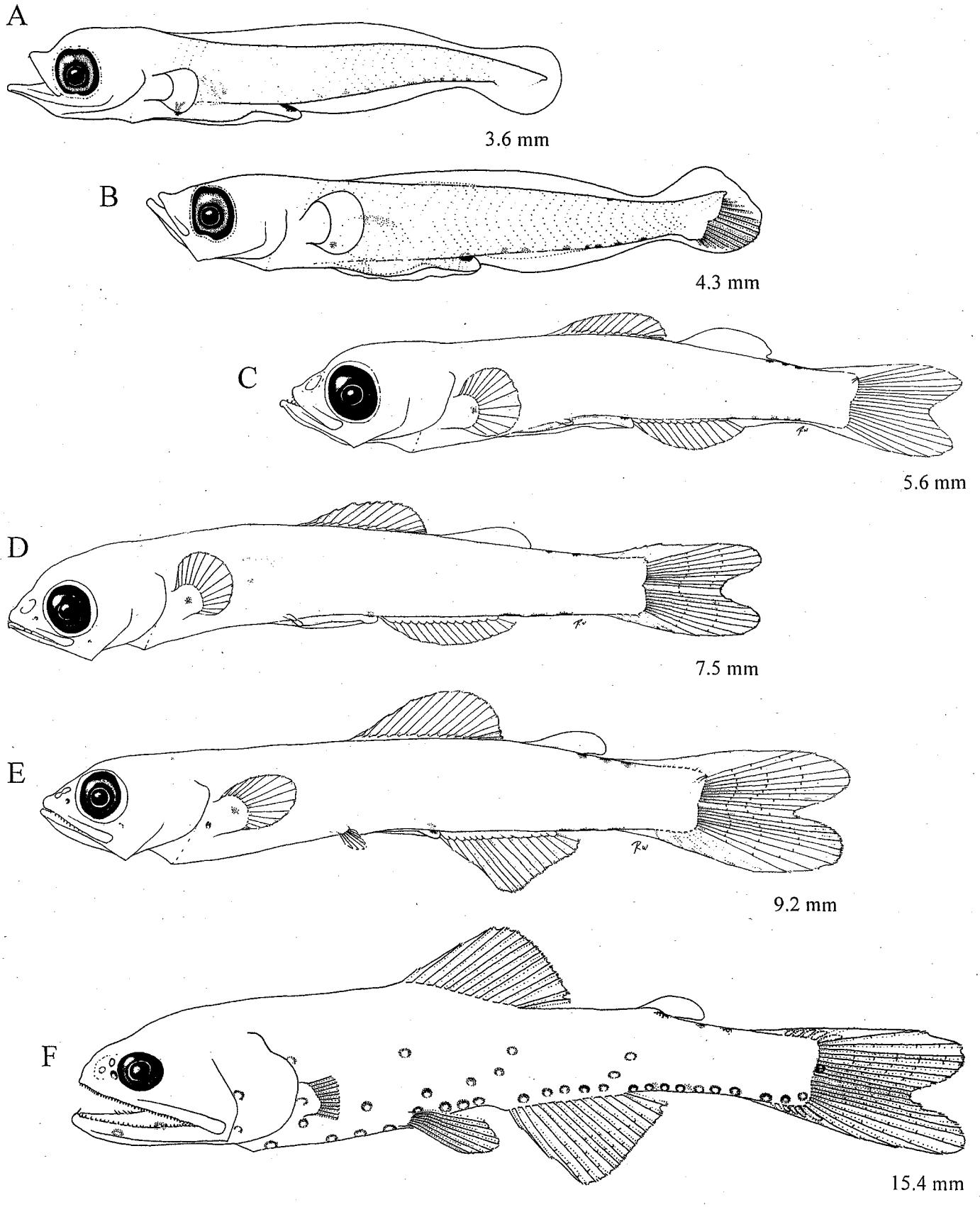
Pigmentation: *Preflexion*—By 3.6 mm, 1 laterally on each side of foregut, 1 or more embedded above gas bladder, a pair dorsolaterally on the gut terminus, a postanal ventral series with up to a dozen melanophores that coalesce to ~8–9 by end of preflexion stage. *Flexion*—Postanal series reduced to ~6; 1 or 2 appear on dorsal midline in caudal peduncle region; 1 in the occipital region by the end of flexion stage. *Postflexion*—Postanal series coalesces to 3–4 heavy dashes in ventral midline of caudal peduncle; opposite series on dorsal midline has 3 or 4 melanophores, the anteriormost divided at the Ad base; the melanophore at each side of the foregut migrates anteriorly, becoming somewhat embedded & masked by the P_1 base.

Diagnostic features: Slender body & relatively small head (BD ~16% BL in preflexion & flexion stages, increasing to ~20% BL by transformation; HL ~22% BL, increasing to 27 % BL); gut nearly straight, increasing from ~50% BL to 65% BL at transformation; eye rounded & relatively large (ED33–43% HL); pigment pattern similar to *Ceratoscopelus* but lateral foregut pigment & otic pigment lacking in *Ceratoscopelus; C. maderensis* larvae have similar postanal pigment but are deeper-bodied; *C. warmingii* larvae lack pigment dorsally on the caudal peduncle but have embedded melanophores above the notochord in the peduncle region; preflexion–flexion stage larvae of *L. guentheri* larvae are deeper-bodied than those of *L. gaussi* (BD 14–16% BL vs 11–15%) & have a relatively shorter gut (Sn–A 48–58% BL vs 59–64%); *L. gaussi* lack the prominent lateral foregut melanophore present in *L. guentheri* & have less postanal/caudal peduncle pigment; flexion occurs at a smaller size in *L. guentheri* (4.1– 4.5 mm vs 5.3– 5.6 mm) & photophores form earlier (Br_2 form at ~5.6 mm, Vn &PO_5 at ~7.5, & PLO at ~9.0 mm.

ILLUSTRATIONS

A–F, original [A& B, W. Watson; C–F, R. C. Walker]

A, CA 90025805; B, C, E, CA 90025108; D, OR II 16645290; F, MCZ 153213


A
3.6 mm
B
4.3 mm
C
5.6 mm
D
7.5 mm
E
9.2 mm
F
15.4 mm

MERISTICS

Vertebrae	
Precaudal	15–16
Caudal	17–19
Total	33–35
Number of fin rays	
Dorsal	15–17
Anal	13–15
Pectoral	11–13
Pelvic	8
Caudal	
Dorsal Secondary	5–6
Principal	10+9
Ventral Secondary	5
Gillrakers on first arch	
Upper	4–6
Lower	13–16
Total	17–21
Branchiostegals	

LIFE HISTORY

Range: Temperate-subtropical Atlantic & circumglobally in Southern Hemisphere in Subtropical Convergence region.

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic zone to epipelagic zone

LITERATURE

Dekhnik & Sinukova 1966
Fahay 1983
Moser 1981
Moser & Ahlstrom 1974
Moser et al. 1984
Olivar & Fortuño 1991
Olivar et al. 1999
Shiganova 1977
Taaning 1918
Tortonese 1956

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at flexion: 5–6 mm
Length at transformation: 10–11mm
Sequence of fin development:P_1, C_1, C_2, A, D, P_2

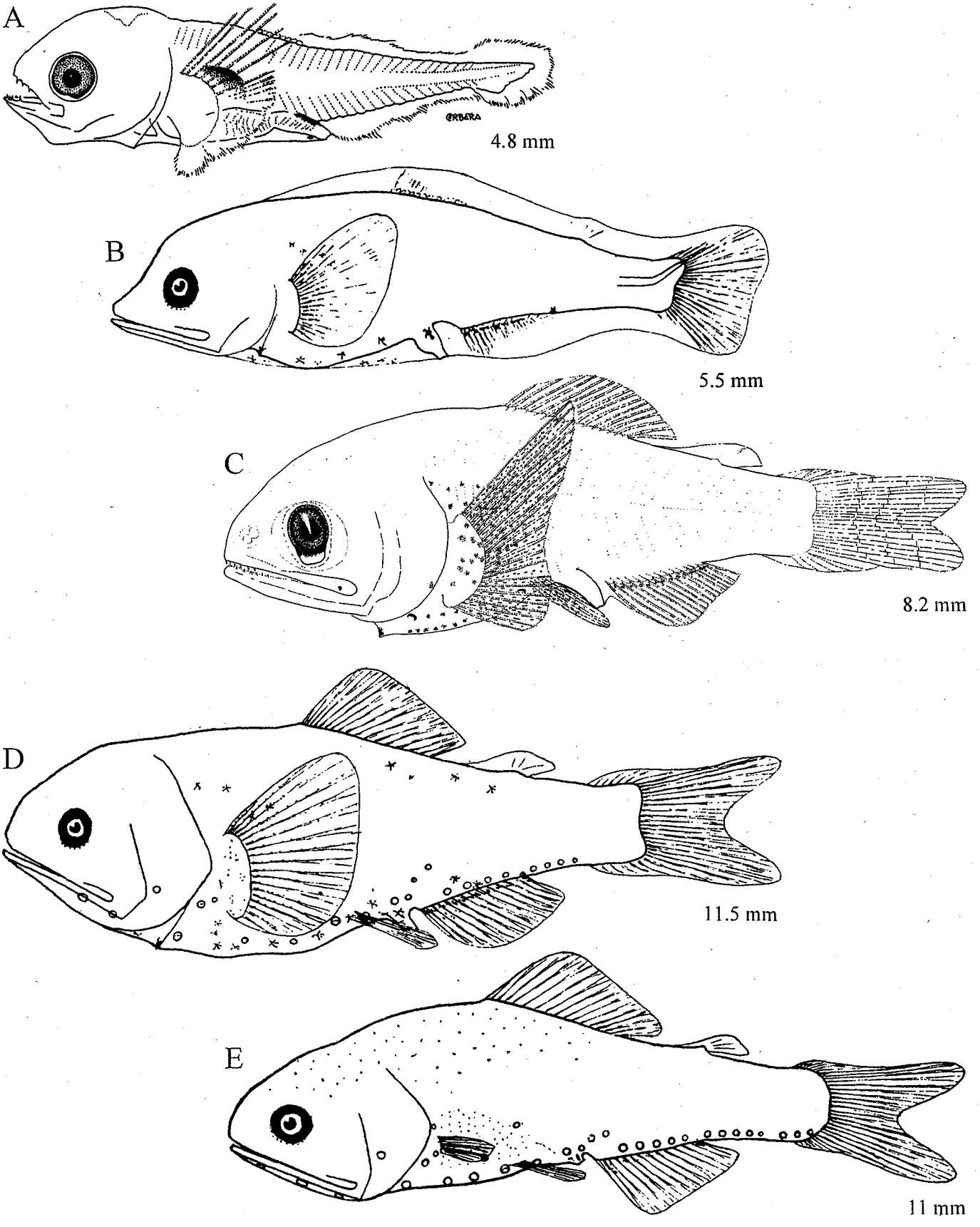
Pigmentation: *Preflexion*—Melanophores forming a shield above gas bladder; a pair above terminal gut section; 1 or more melanophores anterior to terminal gut section. *Flexion–Postflexion*—In ventral midline just anterior to the cleithral juncture; on ventral surface of gut; along A base; on P_1 base & above & below P_1 base on trunk; on P_1 rays; scattered on each side of dorsum in late postflexion stage.

Diagnostic features: Stout body, head large & broad with blunt snout in early larvae that becomes more pointed in postflexion larvae; eye small, rounded in preflexion stage, less so in later stages; a squarish mass of choroid tissue ventrally on eye; P_1 large & aliform with elongate upper rays forming before lower rays; P_1 base large; pigment pattern distinct with numerous melanophores on anterior region of trunk & gut; PO_1 & PO_5 form early in postflexion stage.

ILLUSTRATIONS

A, from Olivar et al. (1999); B, D, E, from Taaning (1918); C, from Moser & Ahlstrom (1974)

* Description based primarily on Taaning (1918)


A
4.8 mm
B
5.5 mm
C
8.2 mm
D
11.5 mm
E
11 mm

MERISTICS

Vertebrae	
Precaudal	15–17
Caudal	18–20
Total	34–35
Number of fin rays	
Dorsal	16–18
Anal	13–15
Pectoral	11–13
Pelvic	8
Caudal	
Dorsal Secondary	6–7
Principal	10+9
Ventral Secondary	5–6
Gillrakers on first arch	
Upper	4–6
Lower	11–15
Total	15–21
Branchiostegals	

LIFE HISTORY

Range: Tropical- subtropical Atlantic, Pacific, & Indian Oceans

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Cavaliere & Berdar 1976
Fahay 1983
Moser & Ahlstrom 1974, 1996
Moser et al. 1984
Olivar et al. 1999
Ozawa 1986, 1988
Pertseva-Ostroumova 1964
Sanzo 1931
Taaning 1918
Tortonese 1956

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: ~2 mm
Length at flexion: ~5.0–6.0 mm
Length at transformation: ~12–14 mm
Sequence of fin development: P_1, C_1, D & A, C_2, P_2

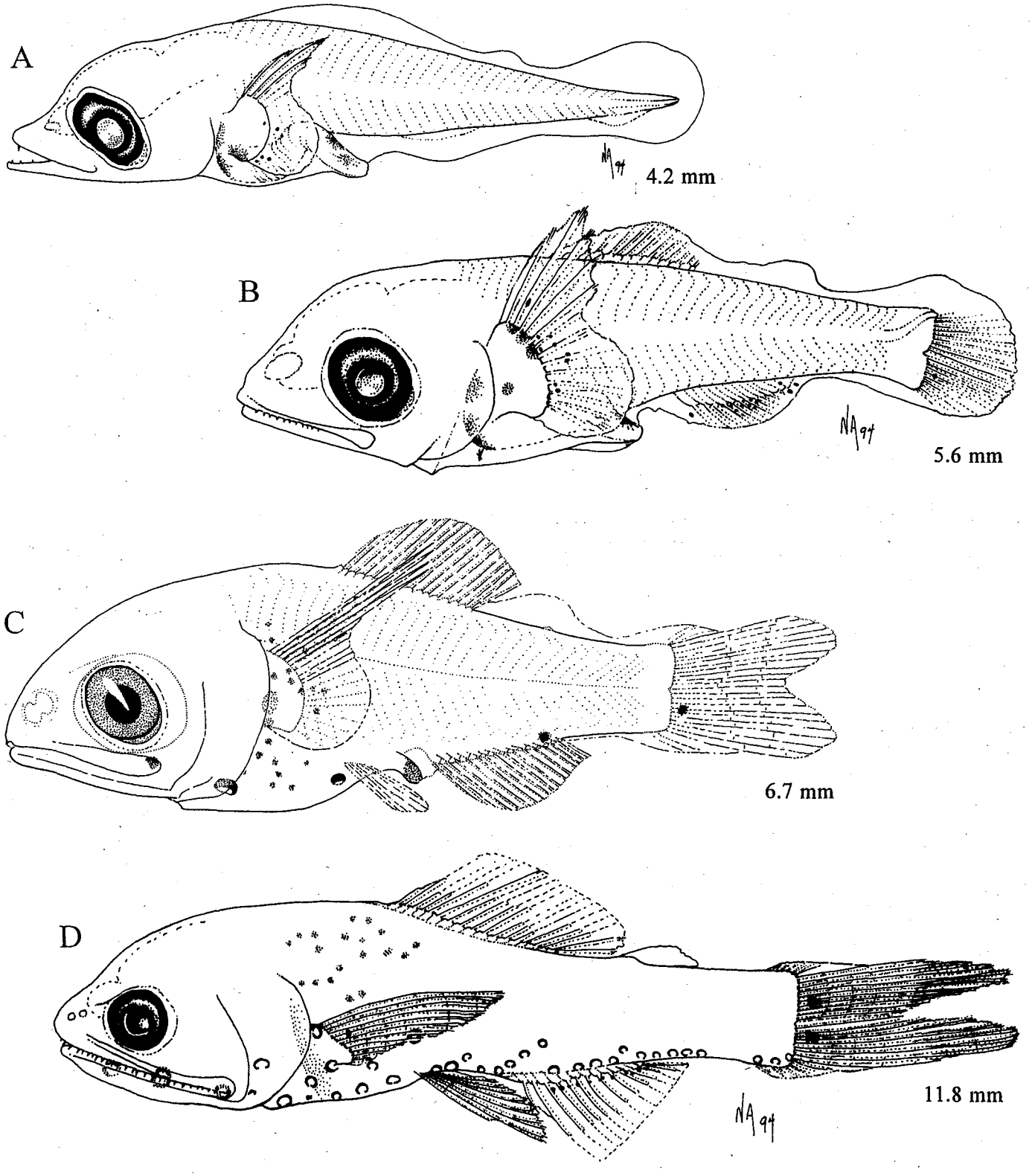
Pigmentation: *Preflexion*—At 3.0–4.0 mm, a blotch on lower inner surface of P_1 base, a deeply embedded blotch anterior to blotch at P_1 base, a ventral midline cluster on gut just posterior to cleithral symphysis, a pair on terminal section of gut, some scattered basally on P_1 rays, & an embedded blotch above gas bladder; at >4.0 mm, 1 in midline at A insertion. *Flexion*—Basally on A rays; on ventral midline below gut. *Postflexion*—Superficial & embedded melanophores on myosepta, beginning at anterior gut region &, by 7.0 mm, on epaxial region above gut; two blotches on basal region of C; some added to inner surface of P_1 base; on P_2 in some specimens.

Diagnostic features: Stout body with deep, broad head, large oval eyes with lunate ventral choroid sliver; bilobed P_1 with upper 5 rays early-forming & upper 4 rays elongate; prominent teeth in small larvae; Br_2 photophores form by 6 mm; PO_1 & PO_5 by 7 mm; VO_1, AOa_1, AOa_2, VLO, & OP by 11 mm.

ILLUSTRATIONS

A-D, from Moser & Ahlstrom (1996)

* Description based on Moser & Ahlstrom (1996)


A
4.2 mm
B
5.6 mm
C
6.7 mm
D
11.8 mm

MERISTICS

Vertebrae	
Precaudal	
Caudal	
Total	36–37 (myomeres)
Number of fin rays	
Dorsal	13
Anal	15–17
Pectoral	12–13
Pelvic	7 (?)
Caudal	
Dorsal Secondary	7–7
Principal	10+9
Ventral Secondary	7–7
Gillrakers on first arch	
Upper	
Lower	
Total	
Branchiostegals	

LIFE HISTORY

Range: Tropical & subtropical Atlantic & western Pacific

LITERATURE

Ozawa 1986

*These *Nannobrachium* larvae are apparently identical to those described by Ozawa (1986, 1988) as *Lampanyctus* sp. 4; according to Zahuranec (2000), no *Nannobrachium* species occurs in both the western central Atlantic & the western North Pacific; *Nannobrachium. regale, N. bristori, N. hawaiiensis, & N. nigrum* occur in the northwestern Pacific (Zahuranec 2000); except for *N. nigrum*, larvae are known for all of these species (Moser and Ahlstrom 1996), thus suggesting that this may be the larva of *N. nigrum* & that adults of this species occur in the western central Atlantic but have not been collected there.

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at hatching: <2.7 mm
Length at flexion: ~5–6 mm
Length at transformation: >16 mm
Sequence of fin development: P_1 & P_2, C_1 & A & D, C_2

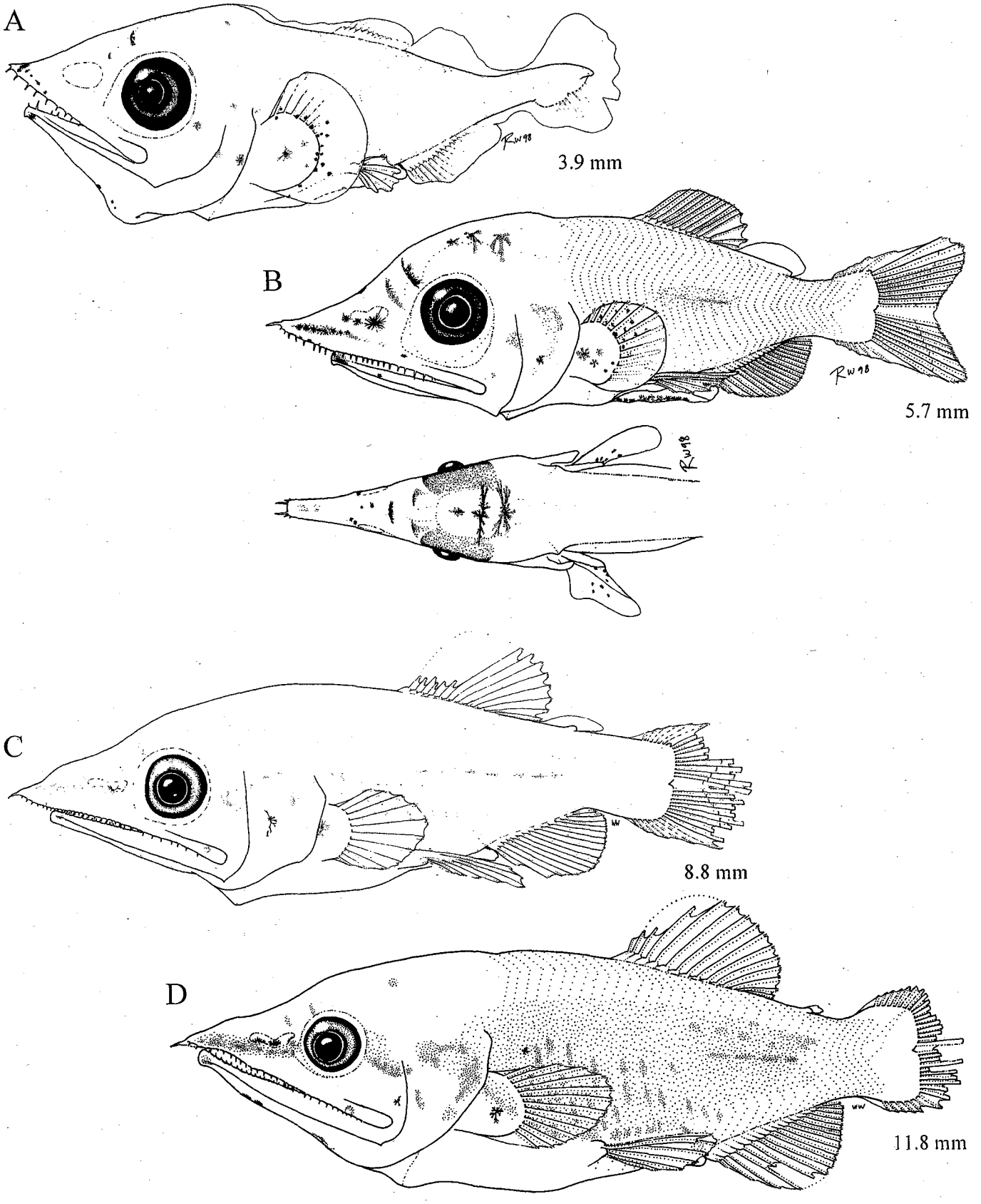
Pigmentation: *Preflexion*—The following pigment is apparent by 4 mm: melanophores on tips of upper & lower jaws; in midline anterior to forebrain; a pair anterior to lobes of midbrain; in midline above cerebellum; in midline above hindbrain; several around margin of nostrils; a large postorbital melanophore; 1 or more melanophores on posteroventral region of opercle, a large melanophore embedded in cleithral region, above & anterior to P_1 base; several in series in gular region; on inner surface of P_1 base (1 large melanophore centrally & several near margin of base); basally on P_1 rays; large melanophore in midline above terminal section of gut, a series on ventral midline of gut; 1 or more embedded in lateral midline of trunk; some basally on P_2 rays; 1 or more embedded in myosepta in peritoneal region. *Flexion–Postflexion*— Pattern as above but extension of snout becoming more heavily pigmented internally, embedded series on lateral midline extends posteriorly on tail, & many more melanophores present laterally on the peritoneal myosepta; deeply embedded midline series develop above & below notochord on tail.

Diagnostic features: Deep, moderately compressed body (BD 28–32% BL) with an elongate gut; relatively large Sn-A distance (Sn-A 63–72 % BL) due, in part, to the large head with long snout that becomes relatively more elongate & pointed with development (HL 38–46% BL); knob-like terminus of snout has cluster of teeth; large jaws with prominent teeth; eye rounded & relatively large in preflexion stage (EL 31–32% HL), becoming relatively smaller in postflexion larvae (EL 20–23% HL); P_1 base & blade large & early-forming; Br_2 forms at flexion; complex pigment pattern characterized by extensive embedded melanophores in postflexion larvae.

ILLUSTRATIONS

A–D, original [A&B, R. C. Walker; C&D, W. Watson]

A, OR C 7343-89-01; B, CA 89072708; C, MCZ 147723; D, MCZ 147724


A
3.9 mm
B
5.7 mm
C
8.8 mm
D
11.8 mm

MERISTICS

Vertebrae	
Precaudal	15–16
Caudal	20–23
Total	36–39
Number of fin rays	
Dorsal	12–16
Anal	17–21
Pectoral	11–12
Pelvic	8
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Gillrakers on first arch	
Upper	4–5
Lower	11-13
Total	16-18
Branchiostegals	

LIFE HISTORY

Range: Tropical & subtropical North & South Atlantic, South Pacific, & Indian Ocean

Habitat: Epipelagic to upper bathypelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Part of population migrates at night from upper bathypelagic & mesopelagic zones to epipelagic zone

LITERATURE

Olivar 1985

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at flexion: 5–6 mm
Length at transformation: >15 mm
Sequence of fin development: P_1 & C_1, A & D, C_2, P_2

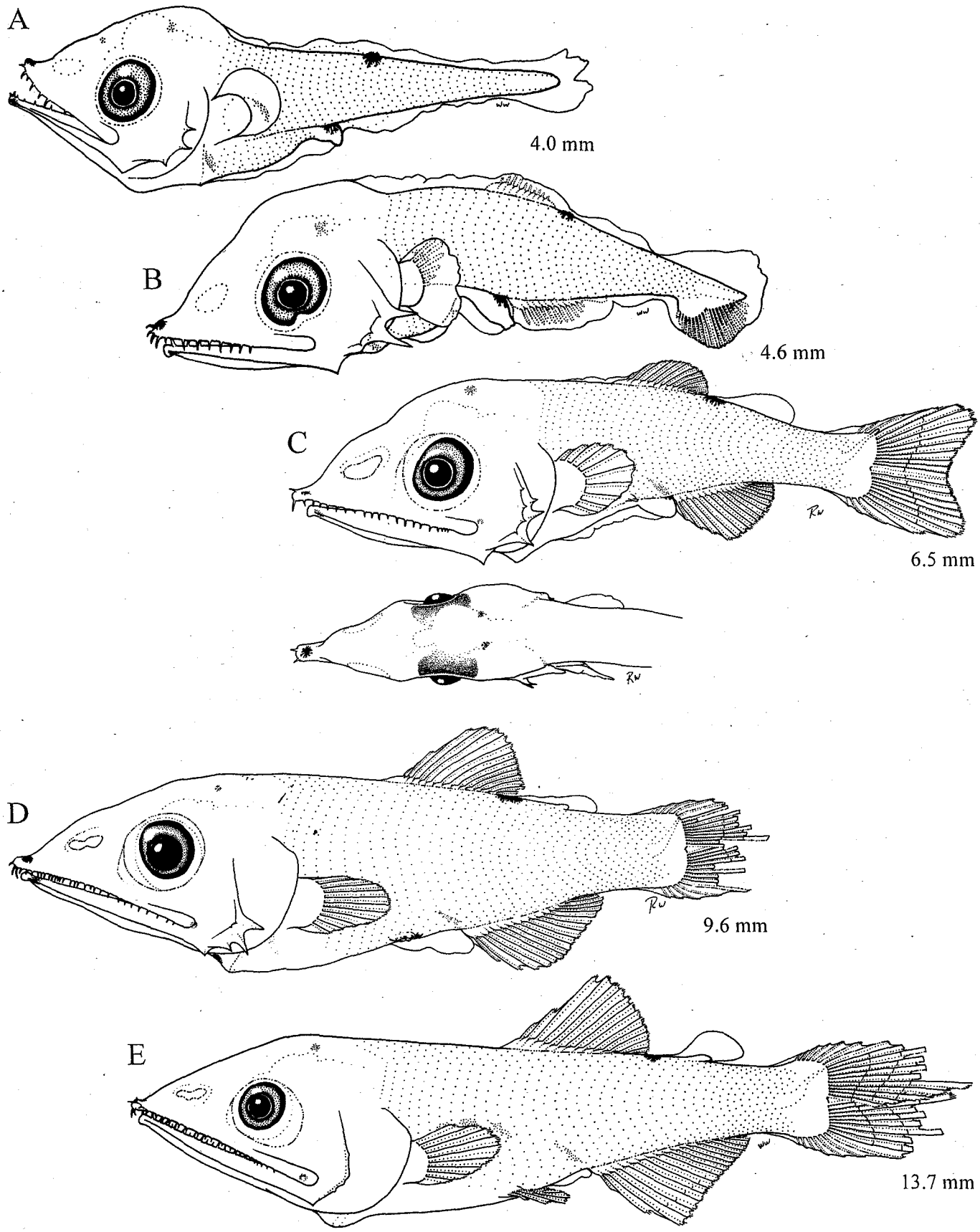
Pigmentation: *Preflexion*— By 4.0 mm, transverse pair above cerebellum, a pair above terminal gut section, melanophores at tips of upper & lower jaws, embedded in midline anterior to gut, in dorsal midline at position of future D insertion, & embedded above gas bladder. *Flexion–Postflexion*—Similar to above; jaw pigment becomes heavier; pair above cerebellum absent in some late-stage larvae.

Diagnostic features: Deep-bodied & compressed with large head, snout, & jaws (BD 25–28% BL; HL 33–42% BL); teeth well developed with pronounced tooth patch at tip of upper jaw; strong preopercular spines in 2 series; eyes slightly off-round; gut strongly flexed in earliest larvae, becoming relatively elongate in later stages (Sn-A 65–70% BL in flexion–postflexion larvae); distinctive pigment pattern consisting of a relatively few melanophores.

ILLUSTRATIONS

A–E, original [A, B, E, W. Watson; C&D, R. C. Walker]

A, CA 90025008; B, 30744; C, C 7706; D, 30744; E, MCZ 150463


A
4.0 mm
B
4.6 mm
C
6.5 mm
D
9.6 mm
E
13.7 mm

MERISTICS

Vertebrae	
Precaudal	14–16
Caudal	18–19
Total	32–34
Number of fin rays	
Dorsal	16–19
Anal	17–20
Pectoral	11–12
Pelvic	8
Caudal	
Dorsal Secondary	8–10
Principal	10+9
Ventral Secondary	8–9
Gillrakers on first arch	
Upper	5
Lower	11–13
Total	16–18
Branchiostegals	

LIFE HISTORY

Range: Tropical & subtropical Atlantic

Habitat: Epipelagic to upper bathypelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Part of population migrates at night from mesopelagic & upper bathypelagic zones to epi- & mesopelagic zones

LITERATURE

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at flexion: 4–6 mm
Length at transformation: 12–15 mm
Sequence of fin development: P_1, C_1 & D & A, C_2 & P_2

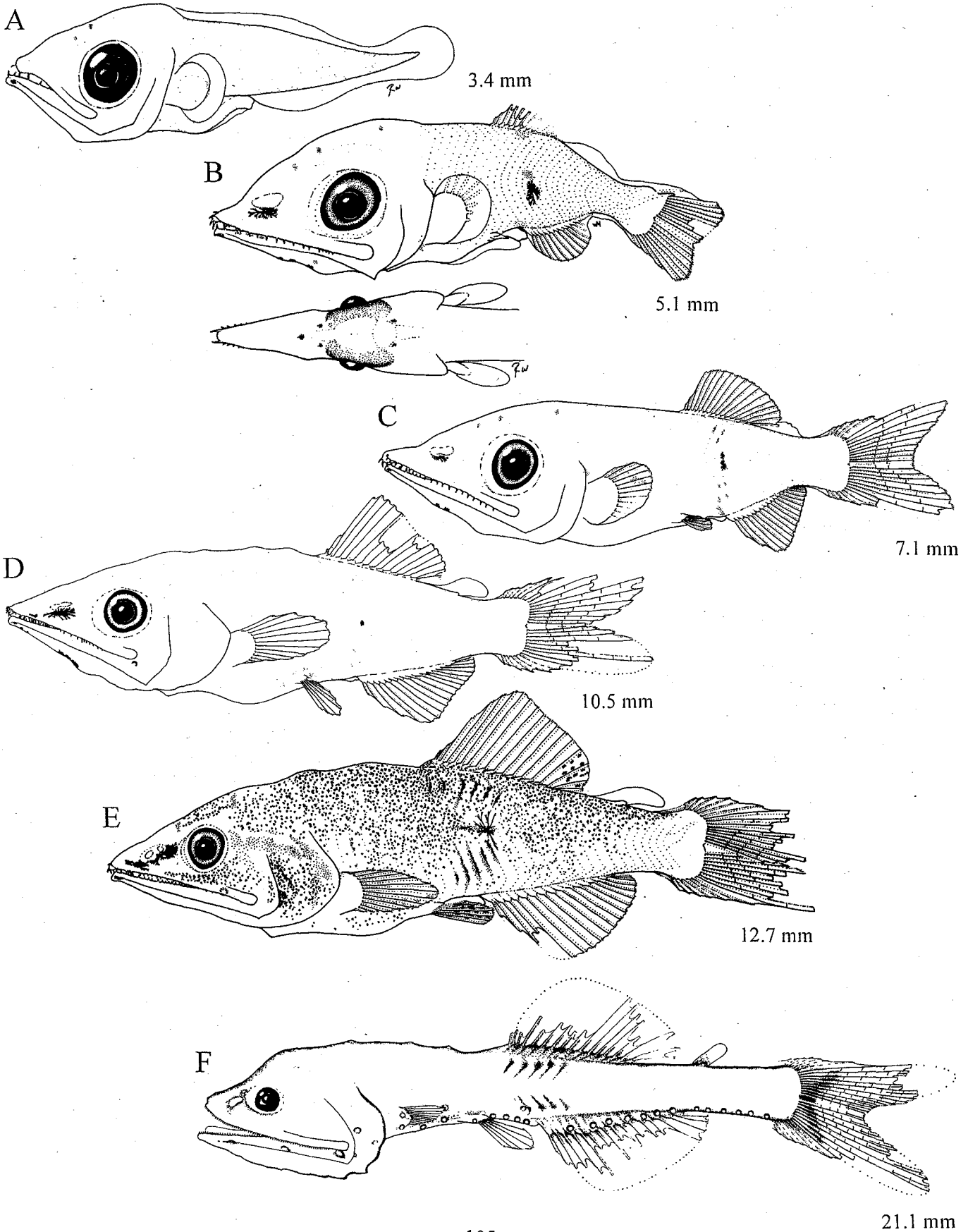
Pigmentation: *Preflexion*—By 3.4 mm, on tip of lower jaw, in midline anterior to forebrain, a pair anterior to midbrain lobes; by late preflexion, a pair above hindbrain, 1 or more at ventral margin of each nostril, at tip of upper jaw, a series internally on midline of lower jaw, series in gular region, a large embedded melanophore in midline anterior to gut, an embedded postorbital melanophore, 1 in midline above terminal section of gut, a bar-like arrangement on lateral surface of body at juncture of trunk &gut, consisting of a large superficial melanophore at lateral midline & 1 or more embedded in myosepta above & below it. *Postflexion*—Postorbital region augmented, forming a heavy blotch in upper branchial cavity which, in combination with additional pigment on snout, forms a bar through eye; melanophores (up to 5) added to epaxial & hypaxial myosepta of lateral bar on body; some on D & P_2 rays; in late flexion stage, melanophores appear in myosepta lateral to gut, initially posteriorly, but progressively more anteriorly.

Diagnostic features: Deep, moderately compressed body (BD 27–31% BL) with an elongate gut; relatively large Sn-A distance (59–72 % BL), due, in part, to the large head with long snout that becomes more acute with development (HL 38–45% BL); terminus of snout less knob-like than in larvae of *Nannobrachium* sp. (described previously in this guide), initially with a pair of forward-projecting canine-like teeth & a cluster of teeth added during postflexion; jaws large with prominent teeth; eye oval to nearly round, large in preflexion stage (EL ~37% HL), becoming relatively smaller (~20 %) in late postflexion larvae; P_1 base & blade large & early-forming; Br_2 forms at flexion; complex pigment pattern characterized by bar at midbody; Br_2 forms at ~7 mm.

ILLUSTRATIONS

A–F, original [A, B (dorsal view), F, R. C. Walker; B (lateral view), C–E, W. Watson]

A, CA 90025006; B, CA 89143906; C, MCZ 147718; D, MCZ 109785; E, a composite of MCZ 109797, another 12.7 mm (MCZ 109771, most of head), & 11.5 mm (MCZ 153208, jaws) ; F, MCZ 109801


A
3.4 mm
B
5.1 mm
C
7.1 mm
D
10.5 mm
E
12.7 mm
F
21.1 mm

MERISTICS

Vertebrae	
Precaudal	16–17
Caudal	21–23
Total	37–40
Number of fin rays	
Dorsal	15–19
Anal	19–23
Pectoral	12–14
Pelvic	8
Caudal	
Dorsal Secondary	
Principal	10+9
Ventral Secondary	
Gillrakers on first arch	
Upper	4–6
Lower	11–14
Total	15–19
Branchiostegals	

LIFE HISTORY

Range: Tropical & subtropical Atlantic, South Pacific, & Indian Ocean

Habitat: Epipelagic to upper bathypelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Part of population migrates at night from mesopelagic & upper bathypelagic zones to epi- & mesopelagic zones

LITERATURE

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at hatching: < 2.7 mm
Length at flexion: 5.0–6.0 mm
Length at transformation: ~22 mm
Sequence of fin development: P_1, C_1 & D & A, C_2, P_2

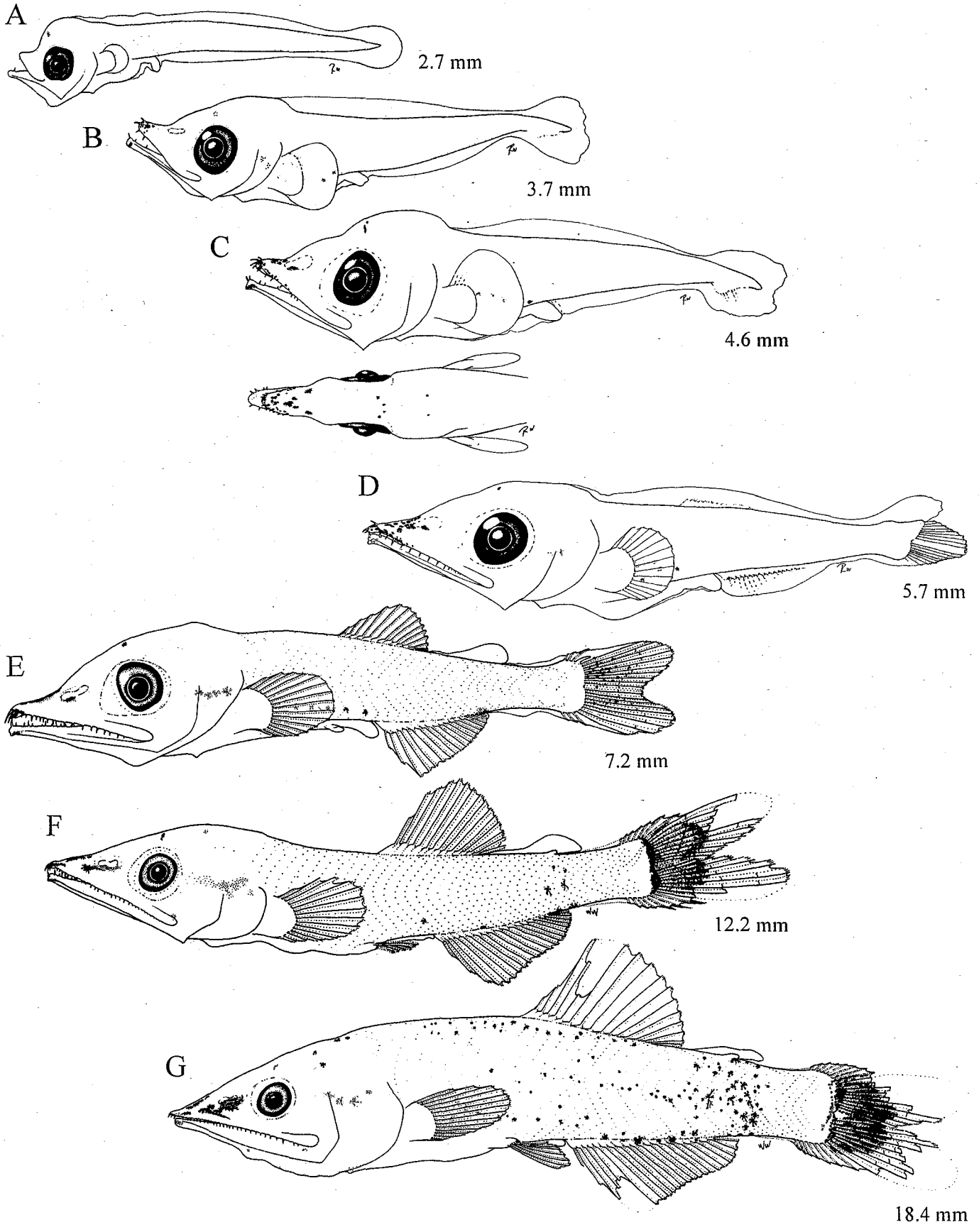
Pigmentation: *Preflexion*—Initially, a pair anterior to midbrain lobes; by 3.8 mm, on tips of upper & lower jaws, a deeply embedded postorbital melanophore, several scattered internally above gas bladder; by 4.3 mm, more in postorbital region, some anteriorly on midline of snout, & some on lateral surface of upper jaw; by end of preflexion stage, on lower margin of nostril & a series beginning to form on lower trunk above gut. *Flexion*— 1 or more on ventral midline of lower jaw. *Postflexion*—Postorbital region continues to be augmented, forming a heavy blotch in upper branchial cavity which, in combination with additional pigment on snout, forms a bar through eye; by 7 mm, some basally on lower C rays & 1 on ventral midline at A insertion; by 10 mm, large rounded patch present basally on C, a lateral series on lower trunk extends posteriad on tail, & some melanophores scattered laterally on tail above A insertion, forming a vague bar; by 12 mm, C patch more prominent, heaviest at posterior margin of hypural plate & lateral bar augmented; by end of stage, paired irregular series along dorsum.

Diagnostic features: Slender, compressed body (BD 16–22 % BL) with gut initially short & acutely sigmoid, becoming straighter & more elongate (Sn-A increases from ~16% BL early in preflexion to 64–66 % BL in postflexion); head large (HL increases from~26% BL in early preflexion stage to ~40% BL in flexion & postflexion stages; snout blunt in smallest larvae, becoming elongate & acute with dentigerous knob; jaws large with prominent teeth; eye oval, large in early preflexion stage (EL ~40% HL), becoming relatively smaller (~17–19 % BL) in late postflexion larvae; P_1 base & blade large & early forming; complex pigment pattern characterized by serial melanophores on trunk & tail; Br_2 forms at ~ 12 mm.

ILLUSTRATIONS

A–G, original; [A–D, R. C. Walker; E, R. C. Walker/W. Watson; F–G, W. Watson]

A, CA 89071507; B, LH 2 2406; C–E, CA 89070707; F, CA 89146703; G, 989145507


A
2.7 mm
B
3.7 mm
C
4.6 mm
D
5.7 mm
E
7.2 mm
F
12.2 mm
G
18.4 mm

MERISTICS

Vertebrae	
Precaudal	12–13
Caudal	16–18
Total	27–31
Number of fin rays	
Dorsal	10–12
Anal	12–15
Pectoral	12–15
Pelvic	6
Caudal	
Dorsal Secondary	6–8
Principal	10+9
Ventral Secondary	6–8
Gillrakers on first arch	
Upper	2
Lower	8–9
Total	10–11
Branchiostegals	9

LIFE HISTORY

Range: Circumglobal in tropical to temperate waters

Habitat: Epi- & mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic to epipelagic zone

LITERATURE

Fahay 1983
Moser 1981
Moser & Ahlstrom 1974, 1996
Moser et al. 1984
Ozawa 1988
Pertseva Ostroumova 1964
Shiganova 1975b
Taaning 1918

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: <2.8 mm
Length at flexion: ~ 4.4–6.2 mm
Length at transformation: ~10.0–10.8 mm
Sequence of fin development: C_1, D & A & P_1 & C_2, P_2

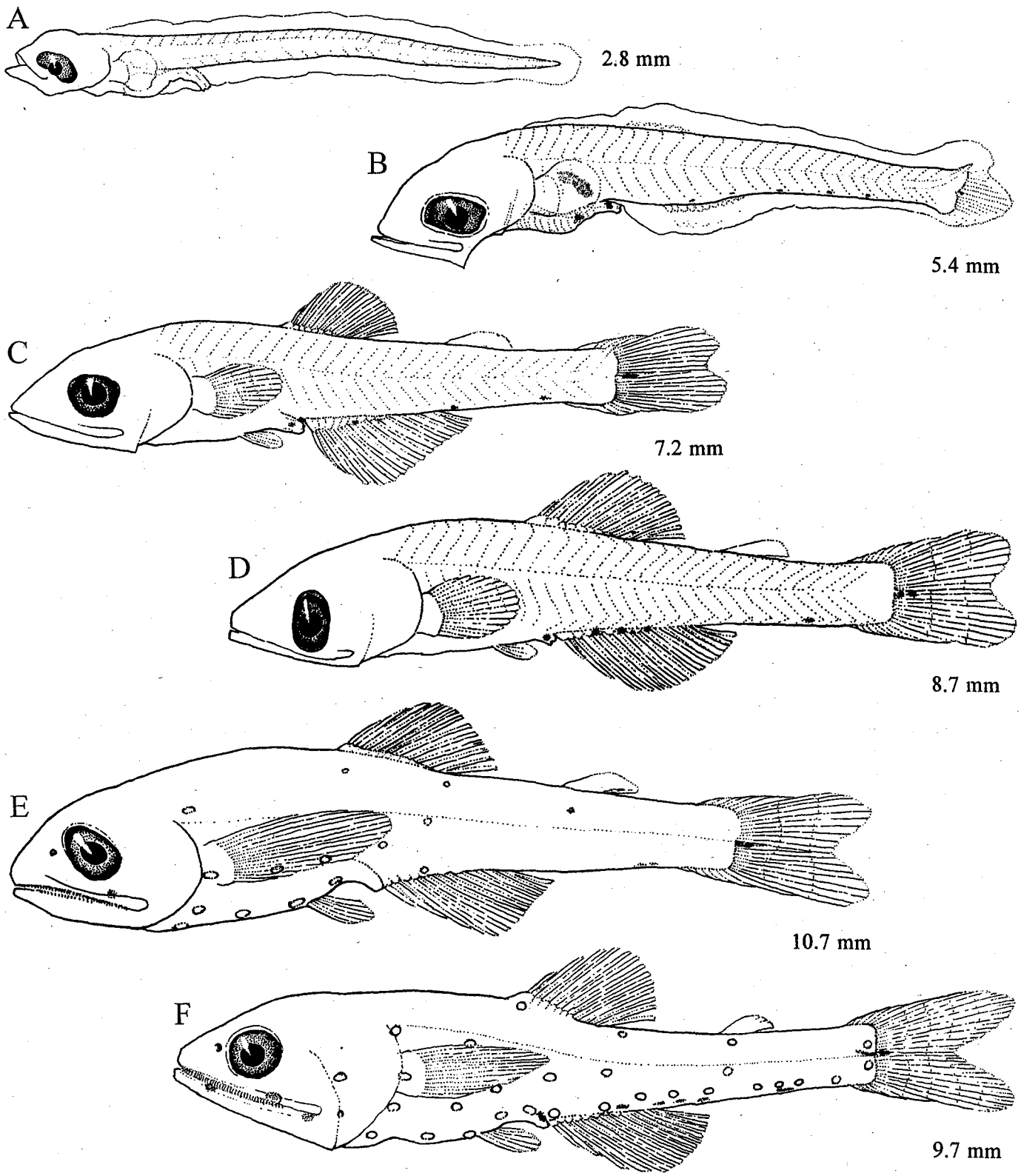
Pigmentation: *Preflexion*—By ~ 2.8 mm, 1 laterally on midgut just anterior to preanal arch of gut; by ~ 3.2 mm, 1–4 (usually 1) ventral midline postanal dashes; by ~3.8 mm, 1 above developing gas bladder & a pair on terminal gut section. *Flexion*—Usually 2 or 3 on lateral gut; by ~5.0 mm, 1 or a streak at mid-hypural margin. *Postflexion*—2–7 (usually 3 or 4) in postanal ventral midline series, displaced to either side of A base; up to 3 laterally on gut in largest larvae. *Transformation*—A blotch laterally on gut.

Diagnostic features: Low total vertebral count (27–31); uniquely low P_2 ray count (6); slender body; gut short, larger anterior section tapers gradually, with slight sigmoid curvature; head moderate in size, initially somewhat rounded; snout becomes somewhat elongate & blunt at tip; eyes narrow, becoming irregularly oval; a crescent of choroid-like tissue on dorsal surface of eye by 4.0 mm & on ventral surface by ~ 6.0 mm; teeth minute; pigment sparse but diagnostic, particularly the mid-hypural streak; the pineal organ in the interorbital region is visible in late postflexion larvae; transforms at small size; Dn, Br_2, PVO_1, PVO_2, VLO, & PO_{1-5} photophores form first; Br_2 form in adult position below eye.

ILLUSTRATIONS

A–F, from Moser & Ahlstrom (1996)

* Description based on Moser & Ahlstrom (1996)


A
2.8 mm
B
5.4 mm
C
7.2 mm
D
8.7 mm
E
10.7 mm
F
9.7 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	21
Total	37
Number of fin rays	
Dorsal	24–27
Anal	19–21
Pectoral	11–13
Pelvic	8
Caudal	
Dorsal Secondary	10–11
Principal	10+9
Ventral Secondary	11–12
Gillrakers on first arch	
Upper	4
Lower	9–11
Total	13–15
Branchiostegals	

LIFE HISTORY

Range: Tropical & subtropical Atlantic, Pacific, & Indian Oceans

Habitat: Epipelagic to upper bathypelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from meso- & upper bathypelagic zones to meso- & epipelagic zones

LITERATURE

Belyanina 1982
Olivar et al. 1999
Ozawa 1986,1988

EARLY LIFE HISTORY DESCRIPTION

LARVAE:
Length at hatching: < 3.0 mm
Length at flexion: 4.0–5.5 mm
Sequence of fin development: P_1 & C_1, C_2 & A & D, P_2

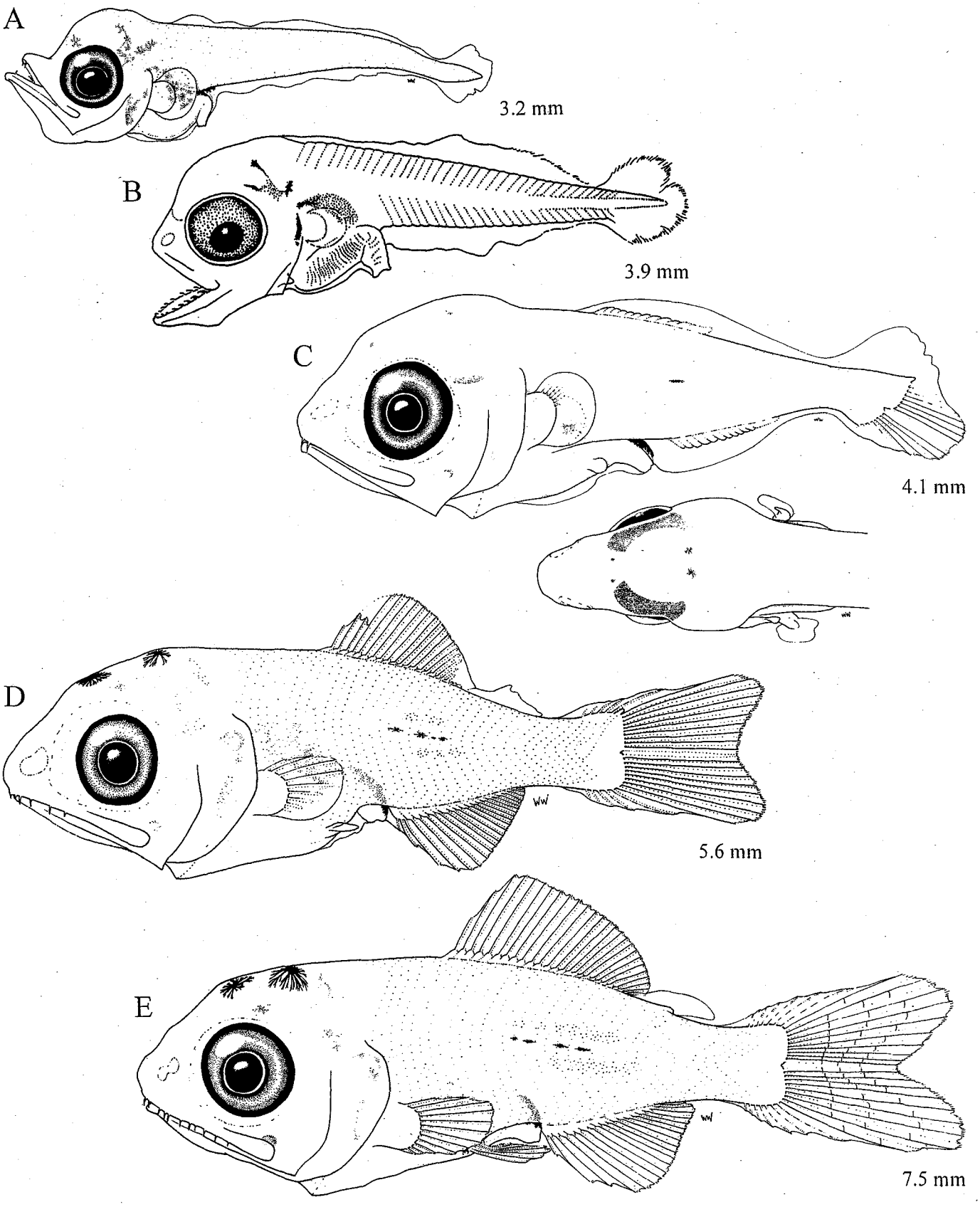
Pigmentation: *Preflexion*—Pair above & ventrolateral to hindbrain; smaller pair above forebrain; on nape; heavy embedded pigment anterior to gut mass; heavy pigment above gut, forming a shield when expanded. *Flexion*— 1 to several midlateral melanophores forming on surface of tail just posterior to juncture with trunk, & embedded melanophores above & below this series. *Postflexion*— Midlateral series & embedded series augmented; some on ventral midline below gut.

Diagnostic features: In earliest larvae, head relatively short (HL ~28% BL), rounded, with a pointed snout; head becomes relatively larger & snout becomes blunt & somewhat bulbous by end of preflexion stage (HL 32–38% BL after preflexion stage); gut short (Sn-A 43% BL), compact, & acutely sigmoid in earliest larvae, becoming straighter & relatively longer (Sn-A 61–66% BL) in postflexion larvae; eye rounded & large in smallest larvae (ED ~50% HL), becoming relatively smaller in later stages (ED 35–39% HL); body relatively deep & somewhat compressed (BD 25–35% BL); characteristic anteriorly-directed, curved teeth forming in lower jaw in 3-mm larvae; Br_2 photophores forming by 4.0 mm & PO_5 by 7.0 mm; larvae slightly deeper-bodied than those of *N. resplendens*; flexion occurs at smaller size in *N. caudispinosus*; *N. caudispinosus* larvae lack pigment on snout & jaws, the series on the dorsum & ventrum, & the caudal pigment characteristic of *N. resplendens*; midlateral series shorter & located more posteriorly than in *N. resplendens* larvae, which lack the embedded myoseptal series.

ILLUSTRATIONS

A, C–E, original [W. Watson]; B, Olivar et al. (1999)

A & E, CA90023807; C, CA 90025804; D, CA 90024905


A
3.2 mm
B
3.9 mm
C
4.1 mm
D
5.6 mm
E
7.5 mm

MERISTICS

Vertebrae	
Precaudal	16
Caudal	21–22
Total	35–38
Number of fin rays	
Dorsal	21–24
Anal	17–20
Pectoral	11–13
Pelvic	8
Caudal	
Dorsal Secondary	11–14
Principal	10+9
Ventral Secondary	10–14
Gillrakers on first arch	
Upper	5–7
Lower	13–16
Total	19–23
Branchiostegals	9–10

LIFE HISTORY

Range: Tropical to subtropical cosmopolite that apparently avoids oligotrophic regions

Habitat: Epi- & mesopelagic, & upper bathypelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Migrates at night from mesopelagic/upper bathypelagic to epipelagic zone

LITERATURE

Badcock & Merrett 1976
Fahay 1983
Matarese et al. 1989
Moser 1981
Moser & Ahlstrom 1972, 1974, 1996
Moser et al. 1984
Ozawa 1986, 1988
Shiganova 1977
Taaning 1918
Tortonese 1956
Zhudova 1969

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at hatching: <2.4 mm
Length at flexion: ~5.0–6.5 mm
Length at transformation: ~20.0 mm
Sequence of fin development: C_1, D & A & C_2, P_1 & P_2

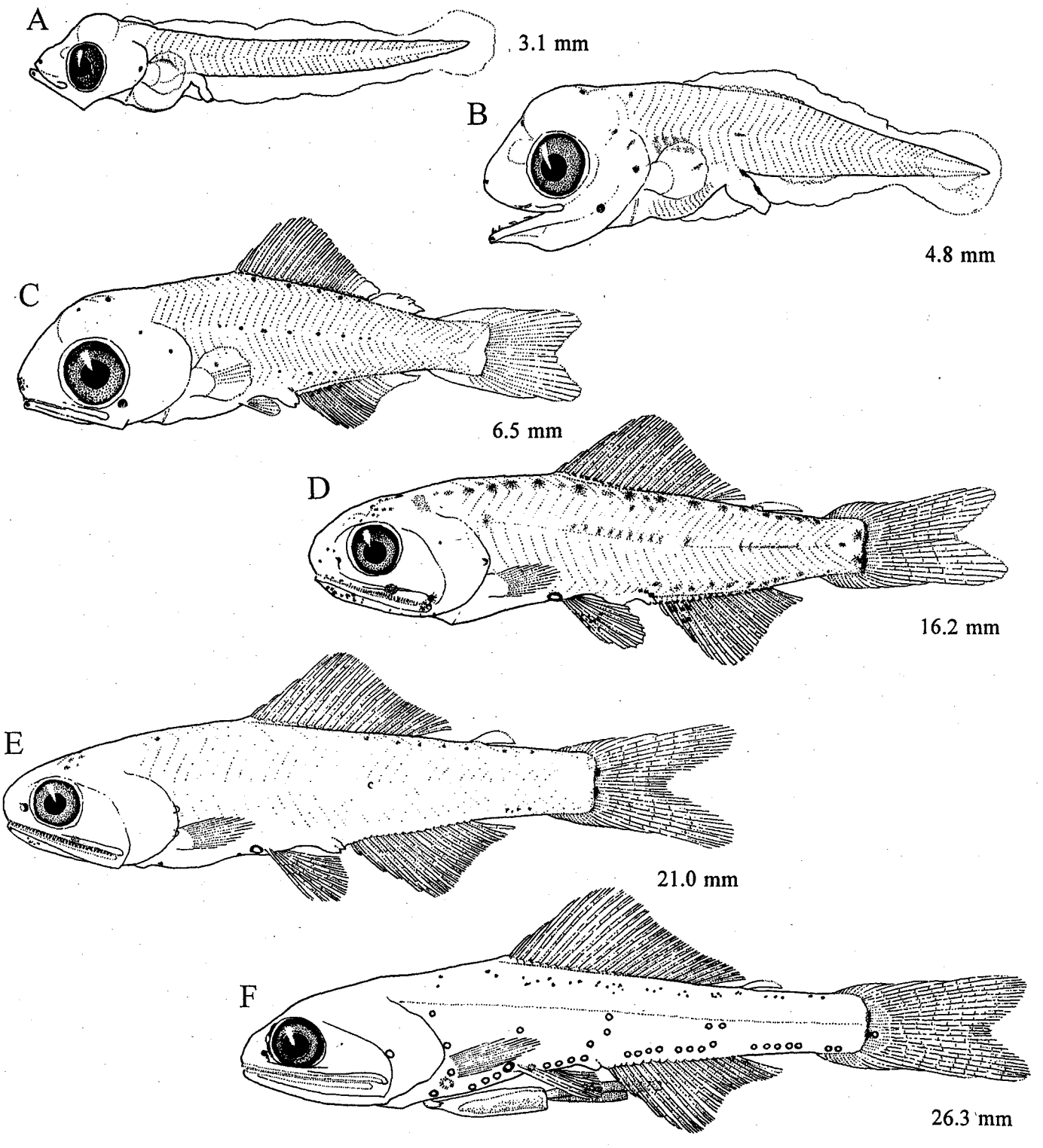
Pigmentation: *Preflexion*—Initially, at jaw tips & cleithrum; at ~ 3.0 mm, embedded above developing gas bladder & in otic region; at ~ 3.8–4.0 mm, 2 in tandem above terminal gut section & a pair above cerebellum; between 4.8 & 5.0 mm, 1 in midline at nape, 1 anterior to midbrain, 1 ventrolaterally on trunk above midgut, 1 or more dashes on lateral midline at midbody, beginning of a series on each side of D base, & beginning of a midline series on A base. *Flexion*—Transverse pair above midbrain in some larvae & beginning of a series on hypaxial region above A base (in some larvae). *Postflexion*—Paired series on dorsum extends to Ad in some larvae; by ~ 8.5 mm, 1 at angle of jaw in some; by ~ 9.5 mm, some have 1 or more in gular region & anterior to forebrain; by ~ 12.5 mm, on P_2 & A rays & hypural margin; by 14.5 mm, on edge of branchiostegal membrane.

Diagnostic features: High D ray count (21–24); high procurrent C ray count (11–14 + 10–14); initially slender, with short, strongly sigmoid gut; head & body become deep & compressed; snout acute in preflexion stage, becoming bulbous; eyes large, nearly round; teeth well developed; anteriorly hooked teeth posteriorly on lower jaw; complex pigment pattern; Br_2 photophores form at 4.2 mm; PO_5 at 6.2 mm; Vn at 9.2 mm; PLO at 16.2 mm; larvae less deep-bodied than in *N. caudispinosus*; pigment heavier, especially on head; series on dorsum & ventrum lacking in *N. caudispinosus*; lateral midline series extends farther anteriorad & posteriad than in *N. caudispinosus*.

ILLUSTRATIONS

A–F, from Moser & Ahlstrom (1996)

* Description based on Moser & Ahlstrom (1996)


A
3.1 mm
B
4.8 mm
C
6.5 mm
D
16.2 mm
E
21.0 mm
F
26.3 mm

MERISTICS

Vertebrae	
Precaudal	18–20
Caudal	20–22
Total	39–41
Number of fin rays	
Dorsal	11–13
Anal	11–14
Pectoral	15–17
Pelvic	8
Caudal	
Dorsal Secondary	8–10
Principal	10+9
Ventral Secondary	8–10
Gillrakers on first arch	
Upper	4–5
Lower	10–14
Total	14–18
Branchiostegals	

LIFE HISTORY

Range: Worldwide, subtropical

Habitat: Mesopelagic

ELH pattern: Oviparous, planktonic eggs & larvae

Migration: Part of the population migrates at night to the upper mesopelagic zone

LITERATURE

Fahay 1983
Matarese et al. 1989
Moser & Ahlstrom 1972, 1996
Moser et al. 1984
Ozawa 1986, 1988

EARLY LIFE HISTORY DESCRIPTION*

LARVAE:
Length at flexion: ~7.0–8.5 mm
Length at transformation: ~21.0 mm
Sequence of fin development: C_1, D & A, C_2, P_1, P_2

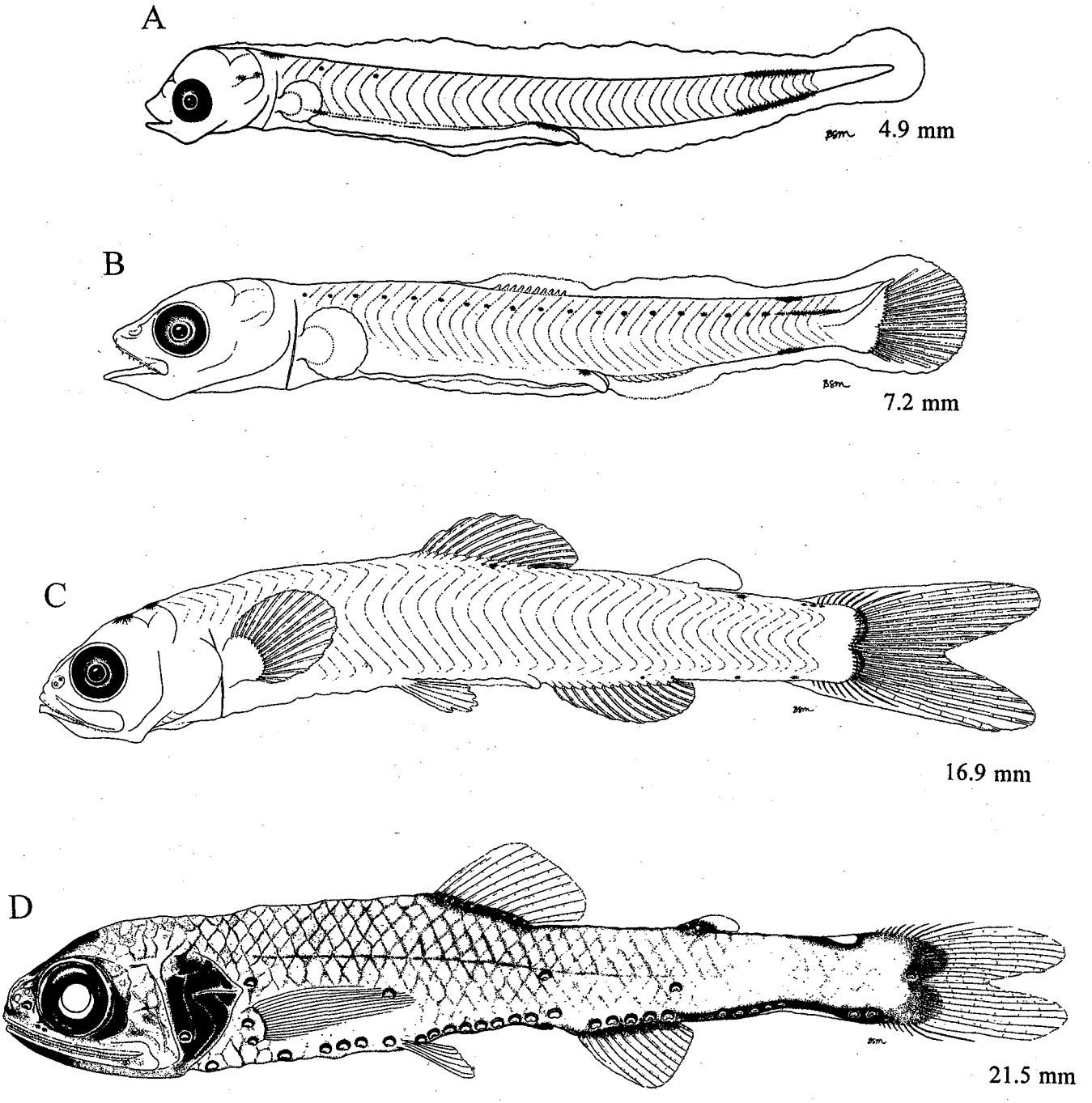
Pigmentation: *Preflexion*—By 4.9 mm, elongate opposing median blotches in future caudal peduncle region, 1 above terminal gut section, 1 above gas bladder, 1 at nape, 1 embedded in otic region, 1 or more embedded above anterior spinal column; by 6.1 mm, 1 in midline above cerebellum & 1 above medulla; by 6.8 mm, embedded series extends full length of spinal column. *Postflexion*—By ~10.0 mm, beginning of paired series on each side of D, median melanophore at A insertion, & series on hypural margin; in late postflexion stage, paired series extends from D origin to C & a paired ventral series present at A & posterior caudal peduncle.

Diagnostic features: High total vertebral count (39–41); slender body; gut relatively long, slender & straight; head relatively small; eyes round; distinct pigmentation, particularly in caudal peduncle region & embedded above spinal column.

ILLUSTRATIONS

A-D, from Moser & Ahlstrom (1996)

* Description based on Moser & Ahlstrom (1996)


A
4.9 mm
B
7.2 mm
C
16.9 mm
D
21.5 mm

LITERATURE CITED

Badcock, J. and T. M. H. Araujo. 1988. On the significance of variation in a warm water cosmopolitan species, nominally *Ceratoscopelus warmingii* (Pisces, Myctophidae). Bull. Mar. Sci. 42 (1):16–43.

——— and N. R. Merrett. 1976. Midwater fishes in the eastern North Atlantic. I. Vertical distribution and associated biology in 30° N, 23° W, with developmental notes on certain myctophids. Prog. Oceanogr. 7:3–58.

Bekker, V. E. 1983. Myctophidae of the world ocean. Nauka. Moscow. 248 pp. [in Russian].

Belyanina, T. N. 1982. Larvae of the midwater fishes in the western tropical Pacific Ocean and the seas of the Indo-Australian Archipelago. Tr. Inst. Okeanol. Akad. Nauk SSSR 118:5–42 [in Russian].

———.1986. Ichthyoplankton of some seamounts of the northwestern Indian Ocean with description of successive larval stages of development of *Triphoturus nigrescens* Brauer and three forms of *Diaphus* (Family Myctophidae). Tr. Inst. Okeanol. Akad. Nauk SSSR 116:73–84 [in Russian].

Berdar, A. and A. Cavaliere. 1979. Stadi larvali e postlarvali di mictofidi: *Hygophum hygomi* (Lütken). Mem. Biol. Mar. Oceanol. 9(6):167–173.

Butler, J. L. and E. H. Ahlstrom. 1976. Review of the deep-sea fish genus *Scopelengys* (Neoscopelidae) with a description of a new species, *Scopelengys clarkei*, from the central Pacific. Fish. Bull., U.S. 74:142–150.

Cavaliere, A. and A. Berdar 1976. Stadi larvali e postlarvali e mictofidi: *Lobianchia gemellarii* Cocco. Mem. Biol. Mar 6(5):175–182.

——— and ———. 1977. Stadi larvali e postlarvali e mictofidi: *Hygophum benoiti* (Cocco). Atti Soc. Peloritana, Sc. Fis. Mat. e Nat. (Messina). 23:141–149.

Clarke, T. A. 1973. Some aspects of the ecology of lanternfishes (Myctophidae) in the Pacific Ocean near Hawaii. Fish. Bull. 71 (2):401–434.

Dekhnik, T. V. and V. I. Sinukova. 1966. Distribution of pelagic fish eggs and larvae in the Mediterranean Sea. Part II. On the reproduction and ecology of larvae in Mediterranean Myctophidae, in studies on plankton of southern seas. Nauka, Moskow [in Russian; English transl. 55. U.S. Dep. Commer., Nat. Mar. Fish. Serv., Syst. Lab., Washington, D.C.].

Evseenko, S. A., H.-C. John, B. Klenz, and C. Zelck. 1998. Variability in larvae of genus *Loweina*, with descriptions of larval *Loweina interrupta* (Taaning, 1928) and *Loweina ?terminata* Bekker, 1964 (Teleostei, Myctophidae). Mitt. Hamb. Zool. Mus. Inst. 95:179–196.

Fahay, M. P. 1983. Guide to the early stages of marine fishes occurring in the western North Atlantic Ocean, Cape Hattaras to the southern Scotian Shelf. J. Northwest Atl. Fish. Sci. 4:1–423.

Fujii, E. 1984. Myctophidae. Pages 64–75 *in* H. Masuda, K. Amaoka, C. Araga, T. Uyeno, and T. Yoshino, eds. The fishes of the Japanese Archipelago. Tokai Univ. Press, Tokyo.

Gartner, J. V., Jr., T. L. Hopkins, R. C. Baird, and D. M. Milliken. 1987. The lanternfishes (Pisces: Myctophidae) of the eastern Gulf of Mexico. Fish. Bull., U.S. 85: 81–98.

Hulley, P. A. 1981. Results of the research cruises of FRV "Walter Herwig" to South America. LVIII. Family Myctophidae (Osteichthyes, Myctophiformes). Arch. Fischereiwiss. 31:1–300.

———. 1984a. Neoscopelidae. Pages 426–428 *in* P. J. P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese, eds. Fishes of the north-eastern Atlantic and the Mediterranean. I. UNESCO, Paris.

———. 1984b. Myctophidae. Pages 429–483 *in* P. J. P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, and E. Tortonese, eds. Fishes of the north-eastern Atlantic and the Mediterranean. I. UNESCO, Paris.

———. 1986. Myctophiformes. Pages 282–322 *in* M. M. Smith and P. C. Heemstra, eds. Smiths' sea fishes. Macmillan South Africa Ltd., Johannesburg.

———. 1994. Lanternfishes. Pages 127–128 *in* J. R. Paxton and W. N. Eschmeyer, eds. Encyclopedia of Fishes. Academic Press, San Diego.

Johnson, G. D. 1992. Monophyly of the euteleostean clades—Neoteleostei, Eurypterygii, and Ctenosquamata. Copeia 1992:8–25.

Matarese, A. C., A. W. Kendall, Jr., D. M. Blood, and B. M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. U.S. Dep. Commer., NOAA Tech. Rep. NMFS 80. 652 pp.

Miller, J. M., W. Watson, and J. M. Leis. 1979. An atlas of nearshore marine fish larvae of the Hawaiian Islands. Sea Grant Misc. Rep. UNIHI-SEAGRANT-MR-80-02. Univ. Hawaii Sea Grant College Program, Honolulu, Hawaii. 179 pp.

Moser, H. G. 1981. Morphological and functional aspects of marine fish larvae. Pages 89–131 *in* R. Lasker, ed. Marine fish larvae. Morphology, ecology, and relation to fisheries. Univ. Wash. Press, Seattle.

———. 1996. Neoscopelidae: Blackchins. Pages 383–385 *in* H. G. Moser, ed. The early stages of fishes in the Calfornia Current region. CalCOFI Atlas 33.

——— and E. H. Ahlstrom. 1970. Development of lanternfishes (family Myctophidae) in the California Current. Part I. Species with narrow-eyed larvae. Nat. Hist. Mus. Los Ang. Cty. Sci. Bull. 7. 145 pp.

——— and ———. 1972. Development of the lanternfish, *Scopelopsis multipunctatus* Brauer 1906, with a discussion of its phylogenetic position in the family Myctophidae and its role in a proposed mechanism for the evolution of photophore patterns in lanternfishes. Fish. Bull., U.S. 70:541–564.

——— and ———. 1974. Role of larval stages in systematic investigations of marine teleosts: the Myctophidae, a case study. Fish. Bull., U.S. 72:391–413.

——— and ———. 1996. Myctophidae: Lanternfishes. Pages 387–475 *in* H. G. Moser, ed. The early stages of fishes in the Calfornia Current region. CalCOFI Atlas 33.

———, ———, and J. R. Paxton. 1984. Myctophidae: development. Pages 218–239 *in* H. G. Moser, W. J. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall, Jr., and S. L. Richardson, eds. Ontogeny and systematics of fishes. Am. Soc. Ichthyol. Herpetol. Spec. Publ. 1.

——— and P. E. Smith. 1993. Larval fish assemblages of the California Current region and their horizontal and vertical distributions across a front. Bull. Mar. Sci. 53:645–691.

Nafpaktitis, B. G. 1977. Family Neoscopelidae. Pages 1–12 *in* R. H. Gibbs, Jr., ed. Fishes of the western North Atlantic. Mem. Sears Found. Mar. Res. 1. Pt. 7

———, R. H. Backus, J. E. Craddock, R. L. Haedrich, B. H. Robison, and C. Karnella. 1977. Family Myctophidae. Pages 13–299 *in* R. H. Gibbs, Jr., ed. Fishes of the western North Atlantic. Mem. Sears Found. Mar. Res. 1. Pt. 7.

Nelson, J. S. 1994. Fishes of the world, third edition. John Wiley and Sons, New York. 600 pp.

Okiyama, M. 1974. The larval taxonomy of the primitive myctophiform fishes. Pages 609–621 *in* J. H. S. Blaxter, ed. The early life history of fish. Springer-Verlag, New York.

———. 1984. Myctophiformes: development. Pages 206–218 *in* H. G. Moser, W. J. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall, Jr., and S. L. Richardson, eds. Ontogeny and systematics of fishes. Am. Soc. Ichthyol. Herpetol. Spec. Publ. 1.

———. 1988. Neoscopelidae. Pages 233–235 *in* M. Okiyama, ed. An atlas of the early stage fishes in Japan. Tokai Univ. Press, Tokyo [in Japanese].

Olivar, M. P. 1985. Ictioplancton del Atlantico sudoriental. Ph.D. Thesis. Univ. Barcelona. 710 p.

———. 1988. Planktonic stages of lanternfishes (Osteichthyes, Myctophidae) in the Benguela upwelling region. Inv. Pesq. 52(3):387–420.

——— and L. E. Beckley 1997. Larval development of *Lampanyctus* species (Pisces: Myctophidae) from the SW Indian Ocean, and species groups based on larval characters. Bull. Mar. Sci. 60(1):47–65.

——— and J. M. Fortuño. 1991. Guide to the ichthyoplankton of the southeast Atlantic (Benguela Current region). Sci. Mar. 55:1–383.

——— and I. Palomera. 1994. Ontogeny and distribution of *Hygophum benoiti* (Pisces, Myctophidae) of the north western Mediterranean. J. Plankton Res. 16(8):977–991.

———, H. G. Moser, and L. E. Beckley. 1999. Lanternfish larvae from the Agulhas Current (SW Indian Ocean) Sci. Mar. 63 (2):101–120.

Ozawa, T. 1986. Early life history of the family Myctophidae in the ocean off southern Japan. Pages 114–188 *in* T. Ozawa, ed. Studies on the oceanic ichthyoplankton in the western North Pacific. Kyushu Univ. Press, Fukuoka.

———. 1988. Myctophidae. Pages 194–233 *in* M.

Okiyama, ed. An atlas of the early stage fishes in Japan. Tokai Univ. Press, Tokyo [in Japanese].

Paxton, J. R., E. H. Ahlstrom, and H. G. Moser. 1984. Myctophidae: relationships. Pages 239–244 *in* H. G. Moser, W. J. Richards, D. M. Cohen, M. P. Fahay, A. W. Kendall, Jr., and S. L. Richardson, eds. Ontogeny and systematics of fishes. Am. Soc. Ichthyol. Herpetol. Spec. Publ. 1.

Pertseva-Ostroumova, T. A. 1964. Some morphological characteristics of myctophid larvae (Myctophidae, Pisces). Pages 76–93 *in* T. S. Rass, ed. Fishes of the Pacific and Indian Oceans. Tr. Inst. Okeanol. Akad. Nauk SSSR 73 [in Russian; English transl., Israel. Prog. Sci. Transl. 1411, Jerusalem].

———. 1974. New data on lanternfish larvae (Myctophidae, Pisces) with oval eyes from the Indian and Pacific Oceans. Tr. Inst. Okeanol. Akad. Nauk SSSR 96:77–142 [in Russian].

Richards, W. J. 1990. List of fishes of the western central Atlantic and the status of early life stage information. U.S. Dep. Commer. NOAA Tech. Mem. NMFS-SEFC-267, 87 pp.

———, M. F. McGowan, T. Leming, J. T. Lamkin, and S. Kelley. 1993. Larval fish assemblages at the loop current boundary in the Gulf of Mexico. Bull. Mar. Sci. 53 (2):475–537.

Rosen, D. E. 1973. Interrelationships of higher euteleostean fishes. Pages 397–513 *in* P. H. Greenwood, R. S. Miles, and C. Patterson, eds. Interrelationships of fishes. J. Linn. Soc. (Zool.), Suppl. 1.

Sanzo, L. 1918a. Contributo alla conoscenza dello svilluppo post-embrionale degli Scopelini Müller. Nota V. *M. benoiti* (Cocco). Mem. R. Com. Talassogr. Ital. 66:23–25 [in Italian].

———. 1918b. Contributo alla conoscenza dello svilluppo post-embrionale degli Scopelini Müller. Nota VI. *M. hygomi* (Lütken). Mem. R. Com. Talassogr. Ital. 66:27–31 [in Italian].

———. 1931. Uova e primi stadi larvali di *Myctophum gemellari* Cocco (= *Scopelus gemellari* C. e V.). Atti R. Acad. Naz. Lincei. 14:515–519 [in Italian].

———. 1939. Nuova contributo alla cononscenza dello svillupo de *Myctophum rissoi* (Cocco). Accad. Sci. Nat. Catania. Ser.6. 3:1–8.

Shiganova, T. A. 1974. Postembryonic development of *Hygophum benoiti* (Myctophidae, Pisces). J. Ichthyol. 14(5):746–754.

———. 1975a. Postembryonic development of *Hygophum macrochir* (Myctophidae, Pisces). J. Ichthyol. 15(3):429–437.

———. 1975b. Postembryonic development of *Notolychnus valdiviae* (Brauer, 1904)(Myctophidae, Osteichthyes) . Tr. Inst. Okeanol. Akad. Nauk SSSR 101:77–87 [in Russian].

———. 1977. Larvae and juveniles of the lanternfishes (Myctophidae, Pisces) of the Atlantic Ocean. Tr. Inst. Okeanol. Akad. Nauk SSSR 109:42–112 [in Russian].

Sparta, A. 1952. Contributo alla conoscenza dello sviluppo larvale di *Myctophum metopoclampum* Cocco. Boll. Pesca e Idriobiol. 7(1):5–10.

Stiassny, M. L. J. 1996. Basal ctenosquamate relationships and the interrelationships of the myctophiform (scopelomorph) fishes. Pages 405–426 *in* Stiassny, M. L. J., L. R. Parenti, and G. D. Johnson, eds. Interrelationships of fishes. Academic Press, New York.

Taaning, A. V. 1918. Mediterranean Scopelidae. Rep. Danish Oceanogr. Exped. 1908–1910. 2:1–154.

Tortonese, E. 1956. Iniomi. Pages 889–959 in Uova, larve e stadi giovanili di teleostei. Fauna flora Golfo Napoli. Monogr. 38.

Zahuranec, B. J. 2000. Zoogeography and systematics of the lanternfishes of the genus *Nannobrachium* (Myctophidae: Lampanyctini). Smithsonian Contrib. Zool. 407. 69 pp.

Zelck, C., H.-C. John, and M. P. Olivar. 1993. The larval development of *Symbolophorus rufinus* (Taaning, 1928). Mitt. Hamb. Zool. Mus. Inst. 90:313–320.

Zhudova, A. M. 1969. Materials on the study of the eggs and larvae of some species of fishes from the Gulf of Guinea and the adjacent waters of the open ocean. Trudy AtlantNIRO 22:135–163. [In Russian, English transl. W. L. Klawe, Inter-Amer. Trop. Tuna Comm., 1971].