



NOAA Technical Report NMFS Circular 424

Guide to the Leptocephali (Elopiformes, Anguilliformes, and Notacanthiformes)

David G. Smith

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ABSTRACT

Elopiform leptocephali have a large, forked caudal fin, and nonconfluent dorsal and anal fins. Anguilliform leptocephali have a small, rounded caudal fin confluent with the dorsal and anal fins and lack pelvic fins at all stages of development. In the Anguilliformes, larvae of the Macrocephenchelyidae, Myrocongridae, and the subfamily Simenchelyinae of the Synphobranchidae are unknown, and five distinctive kinds of leptocephali cannot be identified to family. Notacanthiform leptocephali are extremely elongate, have a single caudal filament rather than a true caudal fin, and have a short dorsal fin. Three kinds of notacanthiform larvae are known (*Tilurus*, *Tiluroopsis*, and *Leptocephalus giganteus*) that cannot yet be identified below the ordinal level.

INTRODUCTION

The current interest in ichthyoplankton has generated a need for reliable guides to the identification of the various groups. Among these are the leptocephali, the characteristic larval forms of the fishes of the orders Elopiformes, Anguilliformes, and Notacanthiformes. Leptocephali are collected with some frequency in tropical and subtropical oceanic waters, but their identification has always been a problem, largely because the literature is scattered and the taxonomy of the adults is uncertain. In recent years much progress has been made in our knowledge of eels and related groups, both larvae and adults, and the point has been reached where a comprehensive guide to the leptocephali is possible.

This guide differs from others in the series in that it is a guide primarily to families and genera rather than to species. Although many larvae remain unidentifiable to species, most can be readily identified to family and often to genus, and it is on this level that such a guide can be most useful. Therefore, the reader should bear in mind that this guide is not a final statement, but rather a point of beginning. It is an attempt to assemble in one place current knowledge relating to the identification of leptocephali.

CHARACTERISTICS OF LEPTOCEPHALI

Leptocephali have an elongate, highly compressed, nearly transparent body. A series of V- or W-shaped myomeres covers most of the lateral area of the body. A transparent area extends dorsally and ventrally from the myomeres. The head is small compared with the body. Rudiments of the dorsal, anal, and pectoral fins are present in all leptocephali. Pelvic fins are present in elopi-

form and notacanthiform larvae, and a caudal fin is present in elopiform and anguilliform larvae. The gut lies on the ventral margin. In all elopiform and notacanthiform larvae and some eel larvae it is a simple, straight tube. In many eel larvae, however, the gut has characteristic swellings, arches, or other modifications that can be useful taxonomic features. Pigmentation is present in the form of melanophores. The epidermis and myomeres are thin, and most of the interior of the body is filled with a mucinous material, medial to the myomeres. The notochord, the spinal nerve cord, and the dorsal aorta lie along the central axis of the body. The kidney is a linear structure lying along the top of the gut. A series of vertical blood vessels extend between the aorta and the gut and kidney. The posteriormost vertical blood vessel enters the posterior end of the kidney. Although heart and blood vessels are present and functional, no hemoglobin is formed until metamorphosis. The eyes and olfactory organs are well developed, and the portions of the brain associated with these functions are equally well developed. Strong, forwardly inclined, fanglike teeth are present in both upper and lower jaws. These are not homologous with the definitive teeth and disappear at metamorphosis.

Leptocephali grow larger before metamorphosing than most other larval fishes. Lengths of 50-100 mm are common, and some forms grow even larger. Certain notacanthiform larvae reach lengths of at least 1,800 mm (Nielsen and Larsen 1970).

Leptocephali commonly spend several months in the plankton. The larva of the European freshwater eel, *Anguilla anguilla*, is known to take about 3 yr from hatching to metamorphosis (Schmidt 1925). During this time, the leptocephalus undergoes a considerable increase in size without much change in basic structure. Then in a matter of a few days to 2 wk the leptocephalus transforms into a juvenile and takes up the habitat and way of life of the adult (Rasquin 1955; personal observation).

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IDENTIFICATION OF LEPTOCEPHALI

The Elopiformes and Notacanthiformes are both small groups and their larvae show relatively little variety in form. Elopiform larvae are identified primarily by the relative positions of the dorsal and anal fins, pigmentation, shape of the head, and number of myomeres. Several kinds of notacanthiform larvae can be distinguished, mainly by the shape of the head and eye, but they cannot yet be identified with known adults.

The Anguilliformes, the true eels, is a much larger and more diverse group, and shows much more variety in all characters. Important characters in identifying eel larvae are general body shape, length and form of the gut (long or short, a simple tube or with swellings or arches), form of the head and snout, form of the tail, pigmentation (distribution of melanophores), position of the vertical fins, position of the last vertical blood vessel, number of myomeres (total, predorsal, and preanal), and number of dorsal and anal fin rays. Families and genera, or groups of genera or groups of species, can be characterized by combinations of these features. At the species level, and occasionally above it, the number of myomeres is the most important character.

Of all the characters mentioned above, the only one universally carried through metamorphosis is the correspondence between the number of myomeres in the larva and the number of vertebrae in the adult. Because there are likely to be several eels in one area with similar vertebral counts, however, it is necessary to narrow the identification down to family or genus before attempting to match myomeres with vertebrae.

A few other characters are sometimes useful in linking larvae with adults. In some species, traces of larval pigmentation persist for a time in the juvenile. Eventually this disappears, but while it lasts it provides a good link. The position of the last vertical blood vessel in the larva is related, at least approximately, to the first caudal vertebra in the adult. The surest way to link a larva with an adult is to find metamorphosing specimens, which combine the characters of the adult with those of the larva.

METHODS

The leptocephali of the three orders are treated somewhat differently. The Elopiformes is a small and well-characterized group containing only two families. It is keyed out directly to genus. The eel larvae are treated mainly by family, with a few exceptions. The gulper eels comprise three families but are treated as a unit, the suborder Saccopharyngoidei. The Muraenesocidae is included with the related Congridae. The two subfamilies of the Synbranchidae are treated separately, as are the two genera of the Derichthyidae. The remaining 11 families are treated individually. Several distinctive but as yet unidentifiable larvae are treated separately at the end of the Anguilliformes section, but are not included in the key. Notacanthiform larvae cannot yet be identified beyond the ordinal level and are treated as a unit.

The key to Anguilliform leptocephali should be used with some caution. Some representatives of a group may not show very well some of the important characters of that group. Reference should always be made to the family account and the illustrations, and the keys should be considered only as auxiliary. The key includes only those forms belonging to a known family group.

Some rather vague terms are used in the descriptions. Because of the great variability of many characters shown in the larger groups, precision is impossible. Terms such as "moderate," "elongate," "pointed," "sharp," "blunt," etc. serve to indicate predominant trends and will be clarified by referring to accompanying illustrations and to actual specimens. Lateral pigment refers to pigment anywhere on the side of the body. Ventral pigment is that on the intestine or the ventral midline of the body posterior to the intestine.

The keys and descriptions have certain limitations. They do not apply to very young larvae or, in most cases, to metamorphosing specimens. Distinguishing characters develop with growth, and larvae less than about 10 mm become difficult to identify. At the other end of the growth scale, important characters are often lost at the onset of metamorphosis. Damaged or faded specimens will be difficult to identify because of the importance of such characters as pigmentation and position of fins. Occasionally even a specimen in good condition may not key out. The boundaries of some families are not clearly defined, and the larvae may show more variation than is now recognized. Several leptocephali are described in this paper that cannot be identified to family, and others may be found in the future.

Each family account begins with a description of the main characters of that family. A brief summary of the most important of these characters follows, along with a discussion of any problems or confusion that might arise in identifying those particular larvae. Where larvae of certain genera or species of that family are known, they are described. The species of each family or genus occurring in the western North Atlantic are listed, with the number of myomeres and vertebrae following each species name in parentheses. At the end of each account selected references are given. The literature cited is not intended to be complete, but it does give basic information as well as references to further sources. The reader is referred especially to Castle's (1969b) "An Index and Bibliography of Eel Larvae," which contains a wealth of information on literature and nomenclature, as well as listing all the species of eels whose larvae had been described up to the time of publication.

Representative examples of each group are illustrated. In addition to a whole view, enlarged views are shown of the head and other important characters. Original drawings were made from specimens chosen for their representative appearance and state of preservation. These specimens are identified in the figure captions by vessel and station number. Abbreviations and institutions where specimens are deposited are as follows: MBI = Marine Biomedical Institute, Galveston, Tex.; CI = *Columbus Iselin*, GS = *James M. Gillis*, P = *John Elliott*

KEY TO ORDERS OF LEPTOCEPHALI

- A1 Caudal fin large, forked Elopiformes (Figs. 1-4)
A2 Caudal fin small and rounded, or absent B
B1 Caudal fin small and rounded, continuous with dorsal and anal Anguilliformes (Figs. 5-53)
B2 Caudal fin absent, instead a single filament; dorsal fin short, located anteriorly Notacanthiformes (Fig. 54)

ELOPIFORMES (Figs. 1-4)

Large, forked caudal fin; short dorsal and anal fins not confluent with caudal fin; pectoral fins well developed; pelvic fins present but much smaller than pectorals in larvae nearing metamorphosis; gut a simple straight tube; pigmentation variable; 19 principal caudal rays.

Elopiform leptocephali do not vary widely in major characters. The main differences are in the position of the vertical fins, the shape of the head, and the number of myomeres. Four genera are recognized representing two families (three if the Megalopidae is recognized).

Key to Elopiform Leptocephali

- A1 Origin of anal fin well behind dorsal fin, by a distance exceeding the length of anal fin base; lateral pigment absent B (*Albulidae*)
A2 Origin of anal fin under dorsal fin or close behind it, by a distance not exceeding the length of anal fin base; lateral pigment present C (*Elopidae*)
B1 Distance between verticals from posterior edge of dorsal fin to anal fin origin about 2.5 times the length of dorsal fin base; snout short *Albula*
B2 Distance between verticals from posterior edge of dorsal fin to anal fin origin about 6-7 times the length of dorsal fin base; snout more prolonged *Pterothrissus*
C1 Origin of anal fin under middle of dorsal fin; head not depressed; fewer dorsal rays than anal rays *Megalops*
C2 Origin of anal fin under posterior end of dorsal fin or slightly behind; head depressed; more dorsal rays than anal rays *Elops*

Albulidae: Albula Linnaeus (Fig. 1)

Distance between posterior edge of dorsal fin and anal fin origin about 2.5 times the length of dorsal fin base; vent very far back, almost under hypural; head blunt, not depressed, with short snout; pigment confined to ventral margin of myomeres on each side, consisting of a row of small melanophores forming an interrupted line extending length of gut; maximum size before metamorphosis 60-70 mm standard length (SL).

At metamorphosis, the anal fin begins to move forward, but never as far relative to the dorsal fin as in *Elops* and *Megalops*.

Two species of *Albula* are currently recognized. *Albula vulpes* Linnaeus (number of myomeres-number of vertebrae: 68-74), is found around the world in tropical seas and *A. nemoptera* (Fowler) (77-80) is restricted to certain places in the tropical western Atlantic and eastern Pacific.

References: Alexander (1961), Eldred (1967a), Rivas and Warlen (1967).

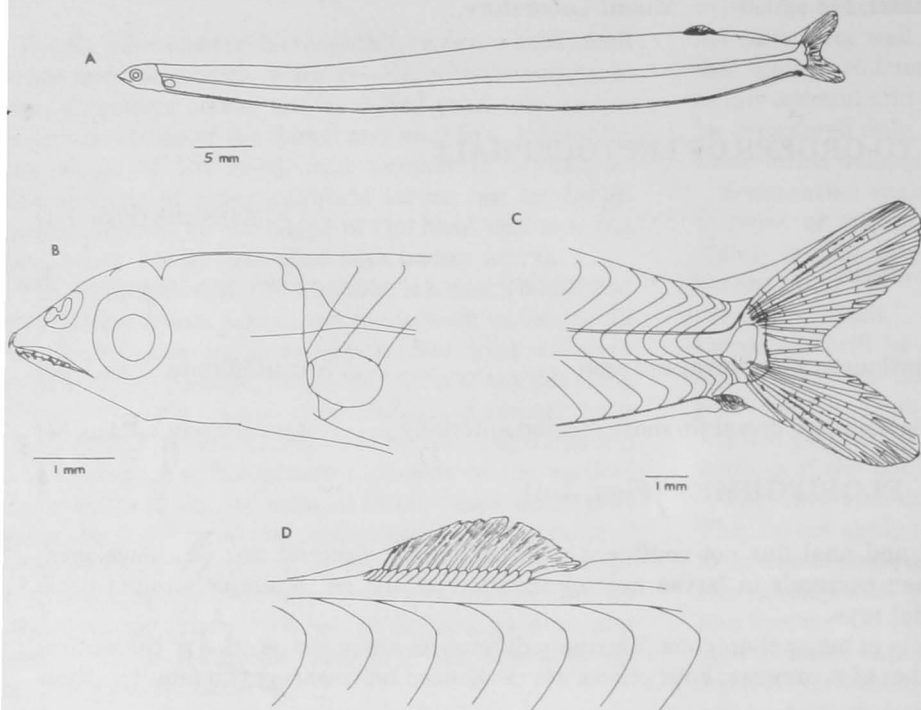


Figure 1.—Albulidae: *Albulula vulpes* Linnaeus, 61 mm SL, CI 90. A. Whole view. B. Head. C. Tail. D. Dorsal fin.

Albulidae: *Pterothrissus* Hilgendorf (Fig. 2)

Body elongate; distance between posterior end of dorsal fin and anal fin origin about 6-7 times the length of dorsal fin base, vent nearly under hypural; snout somewhat prolonged; a row of elongated melanophores along ventral margin of myomeres extending length of gut; maximum size at least 124 mm.

Larvae of *Pterothrissus* are collected much more infrequently than those of *Albulula*, and can be distinguished from them by the more elongate body, the longer snout, and the greater distance between the dorsal and anal fins.

Two species are known: *Pterothrissus bellocci* Cadenat (85-92) occurs off west Africa and *P. gissu* Hilgendorf is found off Japan. Larvae of the former species have been described; those of the latter have not.

References: Smith (1966), Richards (1969).

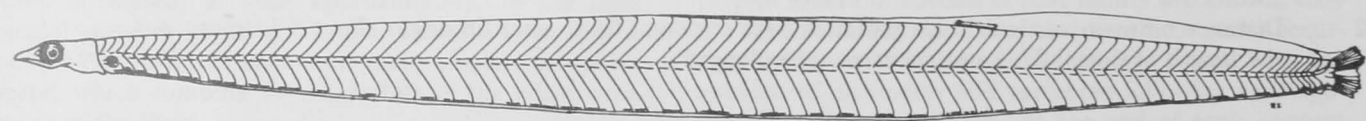


Figure 2.—Albulidae: *Pterothrissus bellocci* Cadenat, 123.9 mm SL, from Richards (1969).

Elopidae: *Megalops* Lacépède (Fig. 3)

Origin of anal fin under dorsal fin; head not markedly depressed; ventral pigment consisting of elongate melanophores on ventral margin of myomeres; lateral pigment consisting of small melanophores on myosepta below midlateral line; maximum size 20-30 mm.

The anal fin origin is distinctly farther forward relative to the dorsal fin in *Megalops* than in *Elops*, generally under the middle or anterior part of the dorsal fin. In *Elops* it is either behind the dorsal fin or under the posterior end. The head is not depressed in *Megalops* as it usually is in *Elops*. *Megalops* has fewer dorsal rays (9-16) than anal rays (16-25), whereas in *Elops* the dorsal rays are more numerous than the anal rays (20-25 vs. 14-17) (Wade 1962; Hildebrand 1963; Richards 1969). Very small larvae of *Megalops* have a distinct swelling in the posterior end of the gut; it becomes less obvious with growth. Larvae of *Megalops* are the smallest of the elopiform leptocephali.

There are two species of *Megalops*. *Megalops atlantica* Valenciennes (53-57), the tarpon, is found on both sides of the Atlantic. *Megalops cyprinoides* (Broussonet) (65-67), the oxeye, is found in the Indo-Pacific from east Africa to the Philippines and Australia.

References: Wade (1962), Eldred (1967b, 1972), Richards (1969).

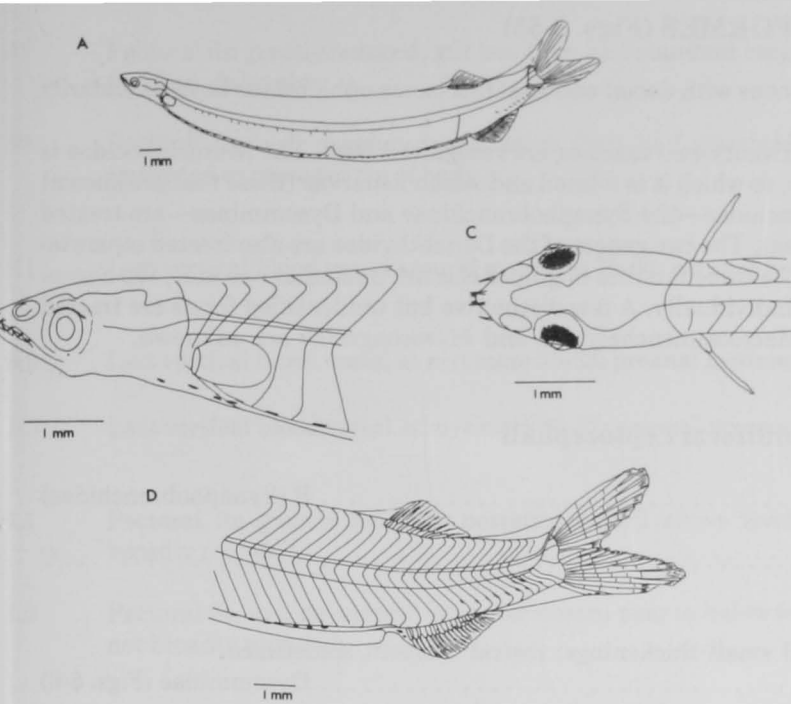


Figure 3.—Elopidae: *Megalops atlantica* Valenciennes, 21 mm SL, MBI 170. A. Whole view. B. Head, lateral view. C. Head, dorsal view. D. Tail.

Elopidae: *Elops* Linnaeus (Fig. 4)

Origin of anal fin slightly behind level of dorsal fin, by a distance not exceeding length of anal fin base; head depressed; ventral pigment consisting of elongate melanophores on ventral margin of myomeres extending length of gut; lateral pigment consisting of small melanophores just below midlateral line; a series of melanophores just above ventral flexure of myomeres between anal and caudal fins; maximum size 40-50 mm.

This genus is cosmopolitan and contains more species than the other elopiform genera, about seven. One species is found in the western Atlantic, *E. saurus* Linnaeus (73-80).

References: Gehringer (1959), Eldred and Lyons (1966), Richards (1969).

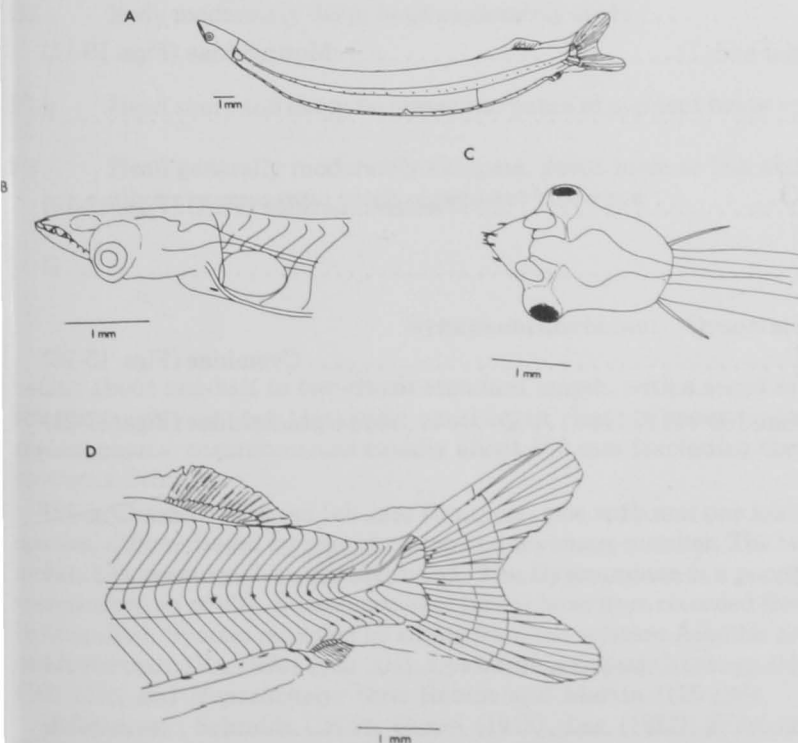


Figure 4.—Elopidae: *Elops saurus* Linnaeus, 20 mm SL, MBI 67. A. Whole view. B. Head, lateral view. C. Head, dorsal view. D. Tail.

Body variable; caudal fin small and rounded, continuous with dorsal and anal fins (some ophichthids have secondarily lost the caudal fin); pelvic fins always absent.

The great majority of leptocephali are eel larvae. Twenty-two families are recognized here. The Muraenesocidae is problematical; it is included here under the Congridae, to which it is related and which its larvae (those that are known) closely resemble. Two subfamilies of the Synaphobranchidae—the Synaphobranchinae and Dysommidae—are treated separately here because the larvae are markedly different. The two genera of the Derichthyidae are also treated separately to facilitate comparison with the Serrivomeridae. The three families of gulper eels are treated as one unit, the Saccopharyngoidei. The remaining 11 families are covered individually. A few distinctive but unidentified forms are treated separately at the end of the section. Larvae of the Macrocephenchelyidae and Myrocongridae are unknown.

Key to Anguilliform Leptocephali

- A1 Eye telescopic (Figs. 5-7) B (Synaphobranchidae)
- A2 Eye normal C
- B1 Intestinal pigment present; gut with several small thickenings; rostral filament sometimes present Dysommidae (Figs. 5-6)
- B2 Intestinal pigment absent; gut a simple straight tube; rostral filament absent Synaphobranchinae (Fig. 7)
- C1 Head deep with elongate hyomandibula; gut with a single pigmented thickening at posterior end Saccopharyngoidei (Figs. 8-9)
- C2 Head and jaw suspension normal D
- D1 Gut with one or more thickenings, loops, or arches E
- D2 Gut a simple straight tube without thickenings, loops, or arches H
- E1 Gut with a single thickening or arch at posterior end Moringuidae (Figs. 10-11)
- E2 Gut with two or more thickenings or arches F
- F1 Gut with two thickenings Nettastomatidae (Part) (Figs. 12-13)
- F2 Gut with three or more thickenings or arches G
- G1 Body very deep; myomeres about 80 Cyemidae (Figs. 15-16)
- G2 Body moderately elongate; myomeres more than 100 Ophichthidae (Figs. 17-21)
- H1 Melanophores absent Anguillidae (Fig. 22)
- H2 At least some melanophores present I
- I1 Intestinal pigment absent J
- I2 Intestinal pigment present L

J1	Pectoral fin greatly reduced; gut less than half standard length; dorsal and anal fin restricted to tip of caudal region	Muraenidae (in part: <i>Anarchias</i>) (Fig. 26)
J2	Pectoral fin well developed; gut more than half standard length; dorsal and anal fins not restricted to posterior tip of body	K
K1	Last vertical blood vessel around myomere 75-80; preanal myomeres more than 100	Derichthyidae: <i>Nessorhamphus</i> (Fig. 23)
K2	Last vertical blood vessel at myomere 59-63; preanal myomeres 76-83	Derichthyidae: <i>Derichthys</i> (Fig. 24)
K3	Last vertical blood vessel at myomere 30-37; preanal myomeres about 89-125	Serrivomeridae (Fig. 25)
L1	Pectoral fin greatly reduced; posterior nostril above level of middle of eye; tail generally broadly rounded	Muraenidae (Figs. 26-30)
L2	Pectoral fin well developed; posterior nostril near or below level of middle of eye; tail generally not broadly rounded	M
M1	Small but distinct deep-lying pigment spots along top of notochord; body elongate; ventral melanophores small, restricted to top of gut	Nemichthyidae (Figs. 31-32)
M2	Not as above	N
N1	Gut half standard length or less	O
N2	Gut greater than half standard length	P
O1	Body narrow and elongate; head elongate	Nettastomatidae (in part: <i>Facciolella</i>) (Fig. 14)
O2	Body moderately deep; head moderately short	Xenocoelidae (Figs. 33-34)
P1	Head short and deep; no crescentic patch of pigment below eye	Heterenchelyidae (Fig. 35)
P2	Head generally moderately elongate, snout more or less acute; those with short heads generally have crescentic patch of pigment below eye	Congridae (including Muraenesocidae) (Figs. 36-47)

Synphobranchidae: Dysommidae (Figs. 5-6)

Gut about one-half to two-thirds standard length, with a series of small thickenings; head variable, rostral filament sometimes present; eye telescopic; nasal organ closer to snout tip than to eye; ventral pigment a series of rather large melanophores; maximum size usually about 100 mm (excluding the rostral filament), up to 200 mm in *Leptocephalus rostratus* Schmidt.

These distinctive larvae fall into two types, one with and one without a rostral filament. Each type contains several species, differentiated by pigmentation and myomere number. The larva of only one species, *Dysomma brevirostre* (Facciola), has been conclusively identified. The Dysommidae is a poorly known group and many species probably remain undescribed as adults. Seven species of larvae have been recorded from the western Atlantic, but none has been positively identified. Species recorded as adults from the western Atlantic are *Dysomma anguillare* Barnard (119-130), *Dysomma brevirostre* (Facciola) (195-204), *Dysommia rugosa* Ginsburg (126-134), *Atractodenchelys phrix* Robins and Robins (169-173), and *Haptenchelys texis* Robins and Martin (126-128).

References: Schmidt (1909), Grassi (1913), Lea (1913), D'Ancona (1928, 1931), Blache et al. (1970), Robins and Robins (1970, 1976), Smith (1974), Keller (1976).

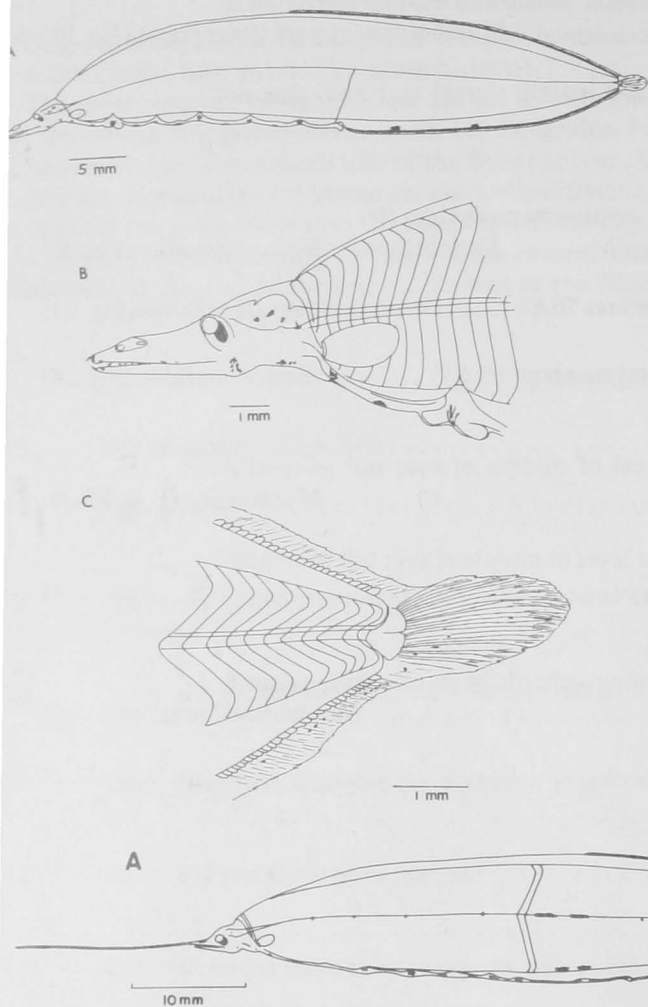


Figure 5.—Dysomminae, without rostral filament: 54 mm SL, MBI 47. A. Whole view. B. Head. C. Tail.

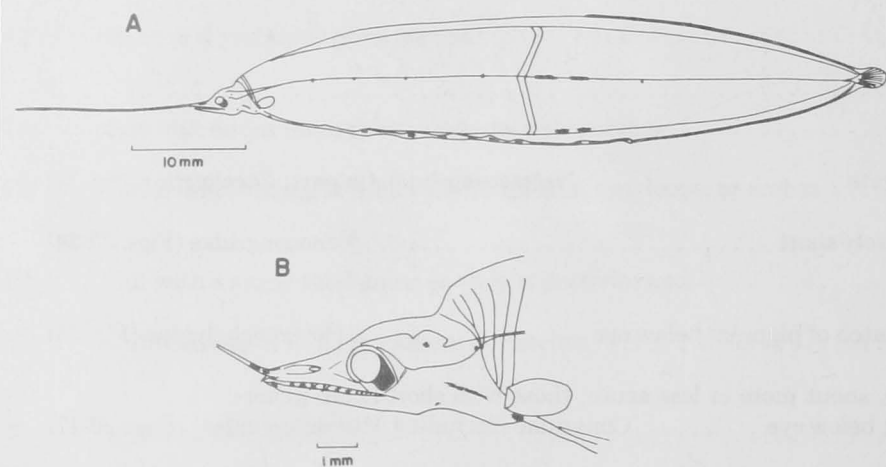


Figure 6.—Dysomminae, with rostral filament: *Leptocephalus proboscideus* Lea, 67 mm SL, from Smith (1974). A. Whole view. B. Head.

Synaphobranchidae: Synaphobranchinae (Fig. 7)

Gut without arches or thickenings, about three-fourths standard length; dorsal fin origin generally slightly anterior to level of vent; eye telescopic; central section of myomeres around spinal cord more opaque than dorsal and ventral parts, giving the effect of a broad white longitudinal stripe along the length of the body; no ventral pigment; lateral pigment generally conned to a few small melanophores near tail and on caudal fin; maximum size 130-170 mm.

Synaphobranchine larvae are easily recognized. The telescopic eye is found elsewhere among leptocephali only in the Dysomminae, and dysommines are easily distinguished by the prominent ventral pigmentation and the longer head. The broad white stripe formed by the opaque central section of the myomeres is found only in synaphobranchines.

The species of synaphobranchines show considerable overlap in vertebral numbers, making identification of larvae difficult. The following species occur in the western Atlantic: *Synaphobranchus affinis* Günther (128-139), *S. brevidorsalis* Günther (130-135), *S. oregoni* Castle (142-148), *S. kaupi* Johnson (146-150), *Histiobranchus infernalis* Gill (126-140), and *Ilyophis brunneus* Gilbert (144-151). The boundary between the Synaphobranchinae and the Dysomminae is not clear, and it is conceivable that some species considered to be synaphobranchines may have dysommime-type larvae and vice-versa.

References: Bruun (1937), Castle (1964a), Robins (1971).

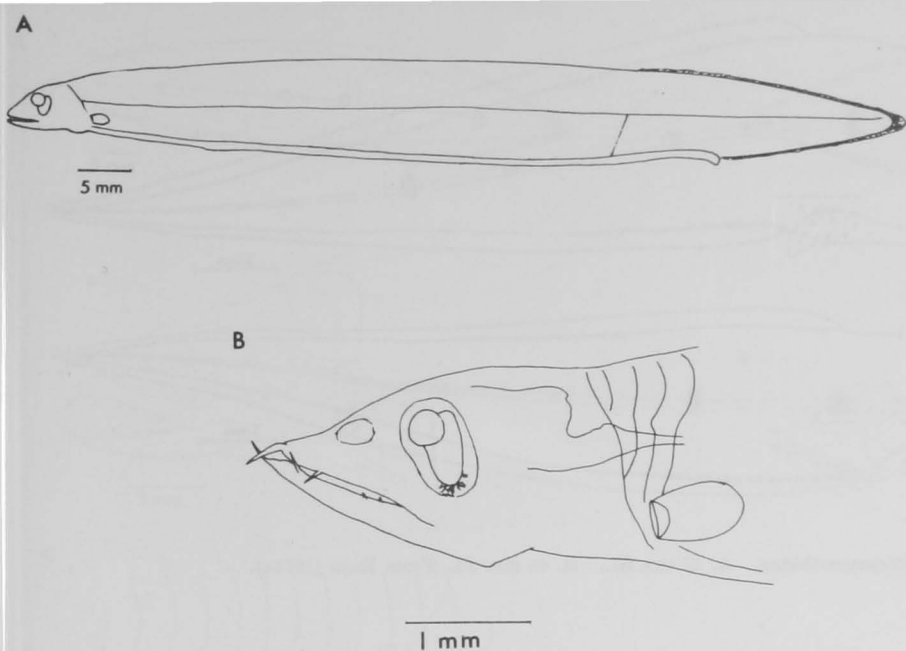


Figure 7.—Synaphobranchinae. A. Whole view, 84 mm SL, adapted from Bruun (1937). B. Head, 29 mm SL, Alb IV 73-2 stn. 70.

Synaphobranchidae: Simenchelyinae

Formerly treated as a family, this monotypic group was placed in the Synaphobranchidae by Robins and Robins (1976). One late metamorphic specimen of *Simenchelys parasiticus* Gill (121-125) was described by Raju and Rosenblatt (1971), but it was too far advanced to show any larval characters. No trace of pigment was present. Since all the other known larvae of the Synaphobranchidae have a telescopic eye, it is reasonable to expect that *Simenchelys* may show this character too.

Saccopharyngoidei (Figs. 8-9)

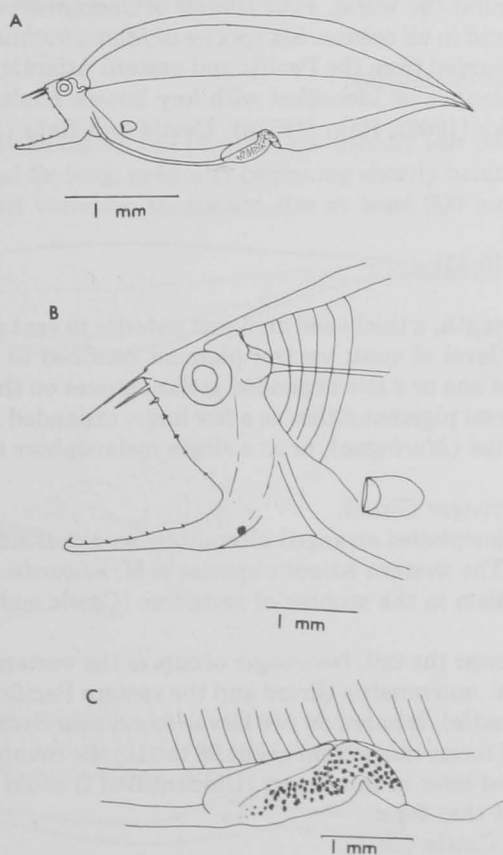


Figure 8.—Saccopharyngoidei, Eurypharyngidae: *Eurypharynx pelecanooides* Vaillant. A. Whole view, 19 mm SL, Alb IV 73-2 stn. 4. B. Head, 14 mm SL, Alb IV 73-2 stn. 19. C. Anal region, same.

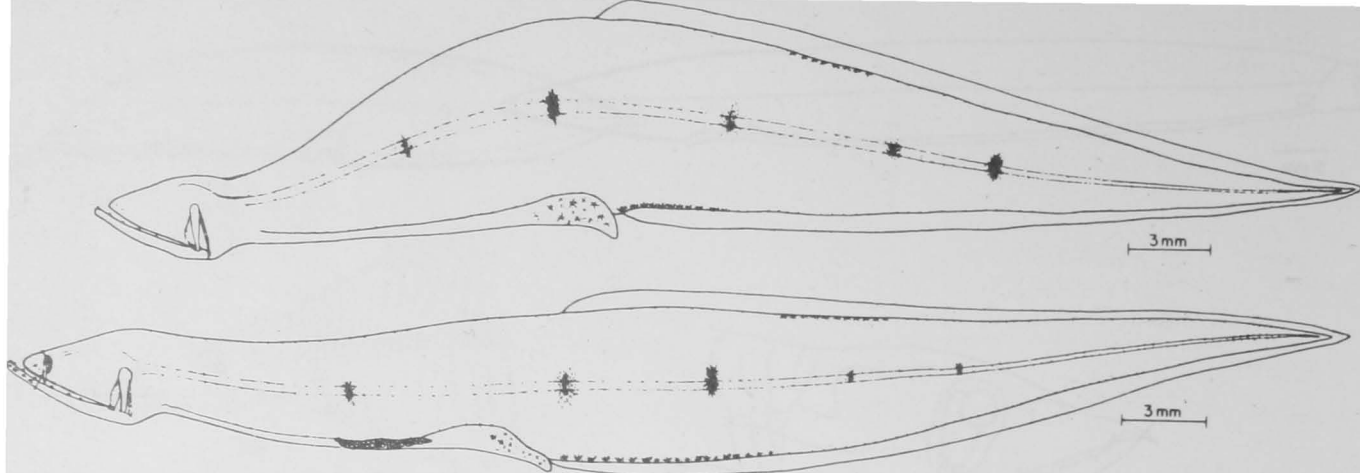


Figure 9.—Saccopharyngoidei, Monognathidae. A. 42 mm SL. B. 48 mm SL. From Raju (1974a).

Body short and deep; tail pointed; gut one-half to two-thirds standard length with a single pigmented thickening at posterior end; head short and deep with elongate hyomandibular element foreshadowing exaggerated jaw suspension of adults; ventral pigment confined to posterior thickening of gut; large lateral melanophores present in Monognathidae, absent in others; maximum size 30-40 mm.

The highly modified bathypelagic gulper eels of the families Eurypharyngidae, Saccopharyngidae, and Monognathidae are customarily placed in a separate suborder, the Saccopharyngoidei, to distinguish them from the rest of the eels, the Anguilloidei. Their larvae are typical eel leptocephali except for the modified jaw suspension. Monognathid larvae are distinguished by several large lateral melanophores (Fig. 9). Larvae of the Eurypharyngidae and Saccopharyngidae lack lateral pigment (Fig. 8). Based largely upon the difference in vertebral numbers, it seems that the larva described by Schmidt (1909) as *Leptocephalus latissimus* (170-250) belongs to *Saccopharynx* Mitchill (138-250), while *Leptocephalus pseudolatissimus* of Bertin (103-125) is the larva of *Eurypharynx* Vaillant (97-125). A single species of *Eurypharynx*, *E. pelecantoides* Vaillant, is currently recognized around the world. Four species of *Saccopharynx* were recognized in the most recent revision (Böhlke 1966); the genus is found in all oceans. Six species of *Monognathus* Bertin have been described, based on few specimens; the genus has been recorded from the Pacific and eastern Atlantic. Castle and Raju (1975) described a peculiar saccopharyngoid larva that cannot be identified with any known adult.

References: Schmidt (1909), Bertin (1938), Orton (1963), Böhlke (1966), Raju (1974a), Castle and Raju (1975).

Moringuidae (Figs. 10-11)

Body moderately deep; gut two-thirds to three-fourths standard length, a thickened arch just anterior to vent with one or a few large expanded melanophores; dorsal fin beginning near level of vent; ventral pigment confined to a single melanophore on the anterior ventral surface of gut (*Neoconger*) and one or a few expanded melanophores on the dorsal surface of the intestinal thickening (*Neoconger* and *Moringua*); lateral pigment either as a few large, expanded melanophores alternately on either side of the body along the midlateral line (*Moringua*), or as a single melanophore near tail (*Neoconger*); maximum size 60-70 mm.

Two genera of moringuids are known, *Moringua* Gray and *Neoconger* Girard.

Larvae of *Moringua* (Fig. 10) have several large midlateral melanophores arranged alternately on either side of the body. *Moringua* is found in the Indo-Pacific and western Atlantic. The western Atlantic species is *M. edwardsi* (Jordan and Bollman) (113-122). *Moringua edwardsi* shows sexual dimorphism in the number of vertebrae (Castle and Böhlke 1976), and this may be true of other species of the genus.

Larvae of *Neoconger* (Fig. 11) have only one lateral melanophore near the tail. *Neoconger* occurs in the western Atlantic, eastern Pacific, and Australia. The western Atlantic species is *N. mucronatus* Girard and the eastern Pacific form is *N. vermiformis* Gilbert. The Australian species, *N. tuberculatus* (Castle), is based on two larvae found near Sydney, but adults have not been collected. Total myomeres and vertebrae in all forms range from about 96 to 110; the counts for the three species overlap broadly. An unidentified leptocephalus treated later in this report (Unidentified I) could be confused with *Neoconger*. The differences are given in the account of that form.

References: Castle (1965d), Eldred (1967c, 1968a), Smith and Castle (1972).

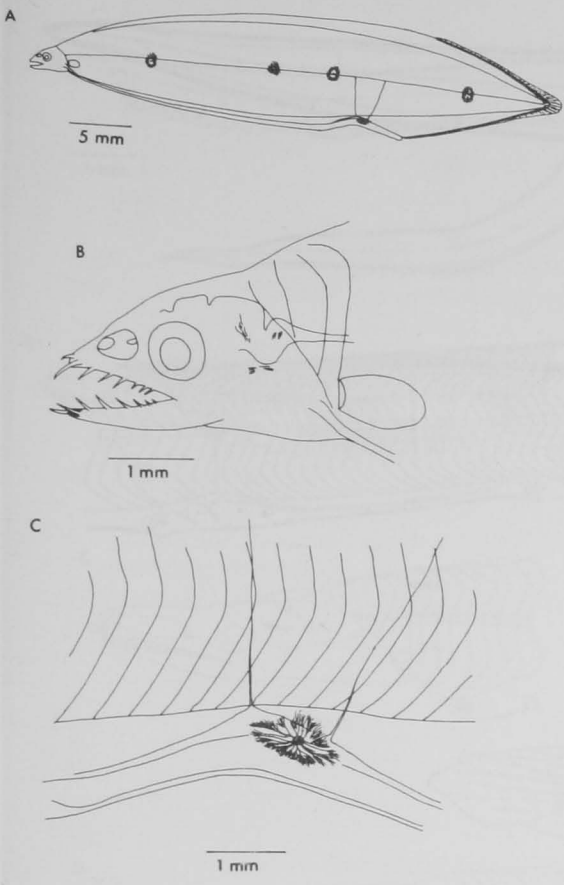


Figure 10.—Moringuidae: *Moringia edwardsi* (Jordan and Boliman), 43 mm SL, MBI 179. A. Whole view. B. Head. C. Anal region.

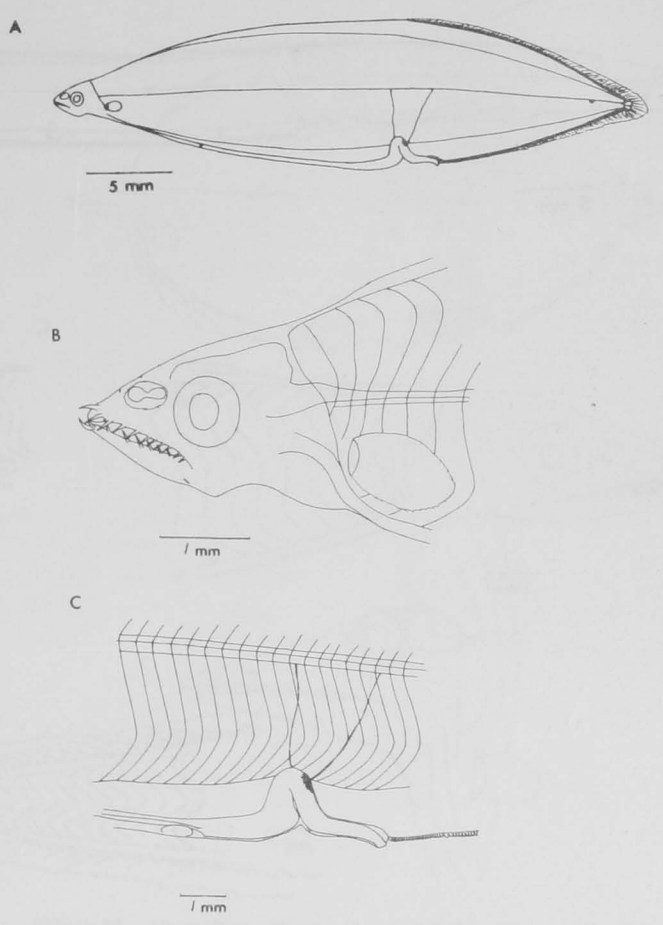


Figure 11.—Moringuidae: *Neoconger mucronatus* Girard, 33 mm SL, MBI 83. A. Whole view. B. Head. C. Anal region.

Nettastomatidae (Figs. 12-14)

Body deep to elongate; tail pointed; gut usually less than one-half standard length with two thickenings (except *Facolella*); dorsal fin long, generally beginning shortly behind head; head moderate to elongate; ventral pigment variable; lateral pigment variable; maximum size at least 200 mm.

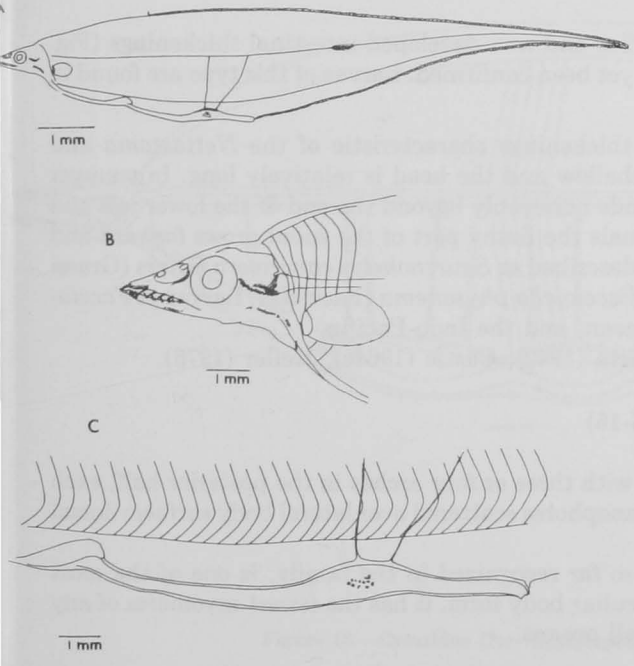


Figure 12.—Nettastomatidae: *Nettastoma-Metopomycter* group, 51 mm SL, MBI 214. A. Whole view. B. Head. C. Anal region.

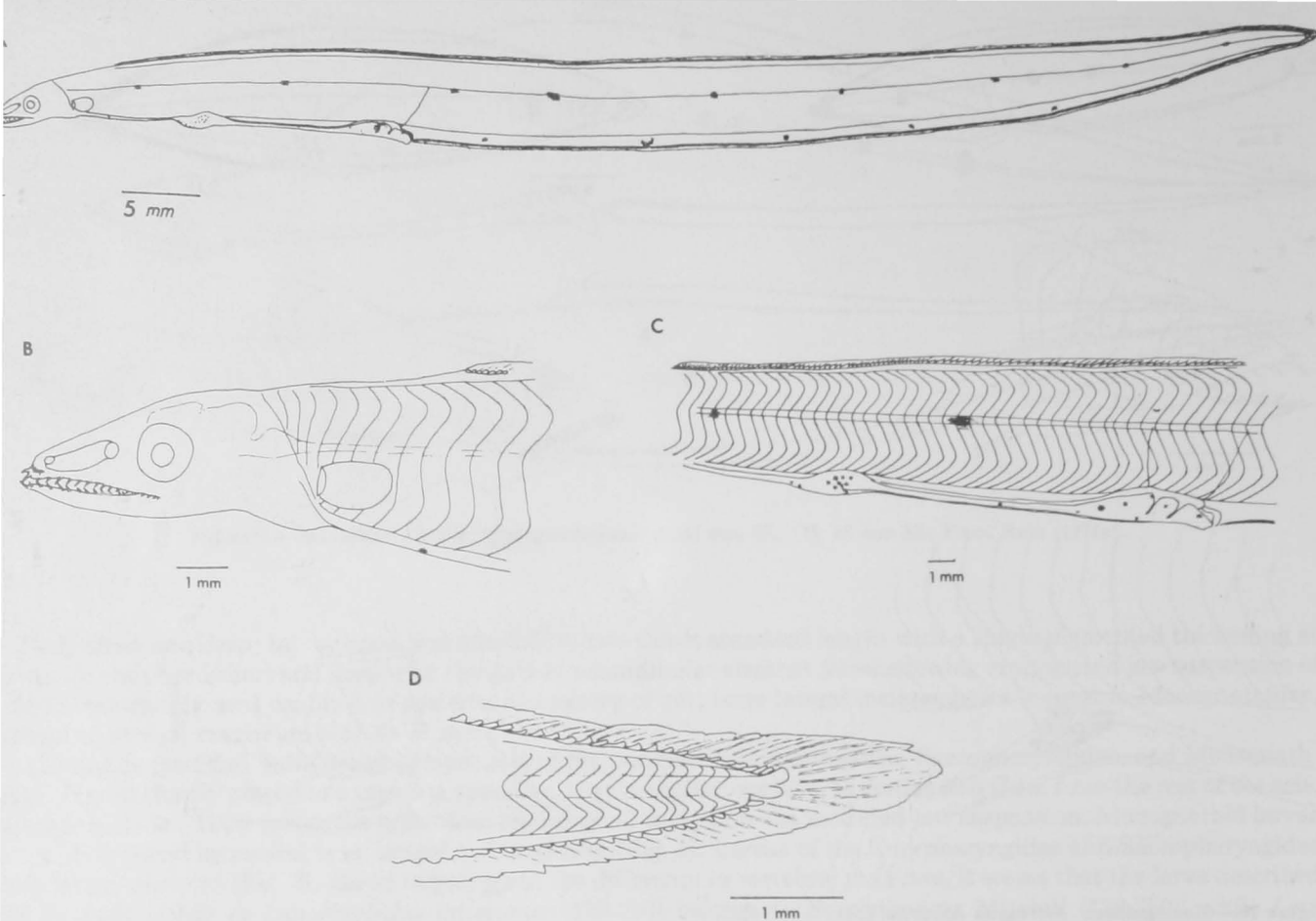


Figure 13.—*Nettastomatidae*: *Hoplunnis macrura* Ginsburg, 84 mm SL, MBI 202. A. Whole view. B. Head. C. Gut. D. Tail.

There are three basic types of nettastomatid larvae.

The larva of *Nettastoma melanurum* Rafinesque (190-207) is deep-bodied anteriorly, tapering sharply toward the tail, with a single deep-lying, horizontally elongate pigment spot on the notochord behind the vent. The intestinal thickenings are often reduced. Larvae of *Nettastoma* are found in the Mediterranean, the eastern and western Atlantic, and the Indo-Pacific. Similar larvae are known which have shallower bodies and different counts; these presumably belong to eels closely related to *Nettastoma* (Fig. 12).

Larvae of *Hoplunnis* Kaup have elongate, uniformly shallow bodies and well-developed intestinal thickenings (Fig. 13). *Saurechelys* Peters may have a similar larva, but this has not yet been confirmed. Larvae of this type are found in all oceans.

Larvae of *Facciolella* Whitley lack the well-defined intestinal thickenings characteristic of the *Nettastoma* and *Hoplunnis* groups (Fig. 14). The body is elongate and uniformly shallow and the head is relatively long. In younger specimens the rostral cartilage has an anterior projection that extends noticeably beyond the end of the lower jaw and bears the premaxillary teeth (Fig. 14D). In more advanced individuals the fleshy part of the snout grows forward and envelops the rostral projection (Fig. 14C). This larva was originally described as *Saurechelys cancrivora* Peters (Grassi 1913; Lea 1913; Sanzo 1938), a species that was long confused with *Facciolella physonema* (Facciola). Larvae of *Facciolella* occur on both sides of the Atlantic, including the Mediterranean, and the Indo-Pacific.

References: Grassi (1913), D'Ancona (1931), Sanzo (1938), Spartà (1942), Castle (1964c), Keller (1976).

Cyemidae (Figs. 15-16)

Body very short and deep; gut about two-thirds standard length with three or four arches in the posterior half, each with a melanophore at its peak; snout long and straight; several melanophores scattered over lateral body surface; dorsal fin origin near level of vent; maximum size 60-70 mm.

The larva of *Cyema atrum* Gunther (Fig. 15), the only species so far recognized in the family, is one of the most distinctive and easily recognized leptocephali. In addition to its peculiar body form, it has the fewest myomeres of any known eel larvae, around 80. The bathypelagic adult is found in all oceans.

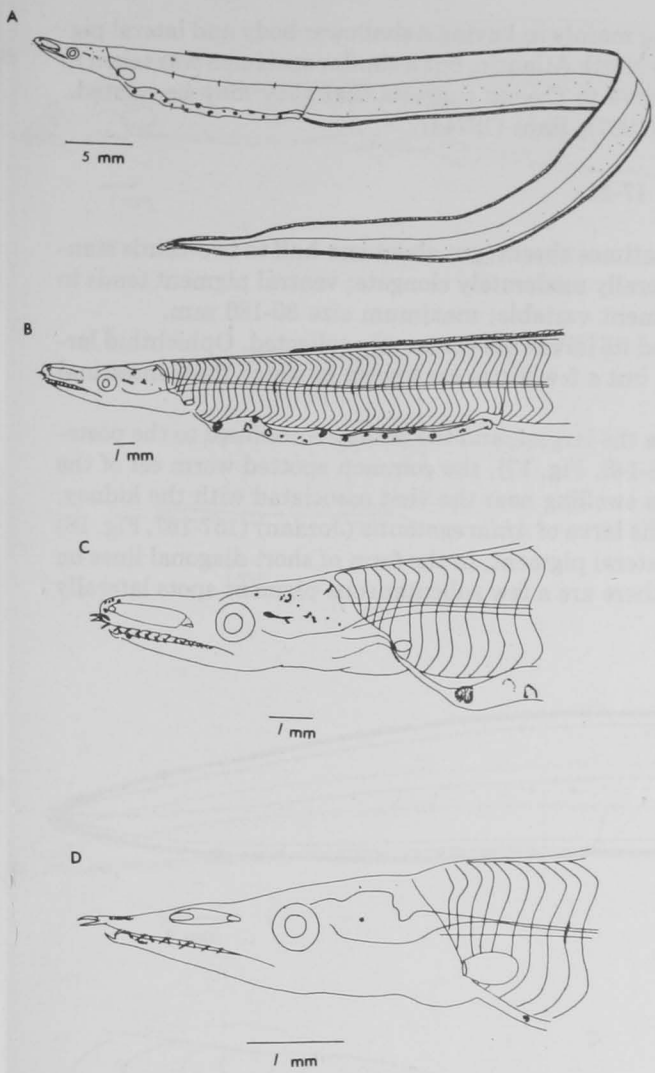


Figure 14.—*Nettastomatidae*: *Facciolella* sp. A. Whole view, 87 mm SL, MBI 200. B. Anterior body, same. C. Head, same. D. Head, 38 mm SL, MBI 195.

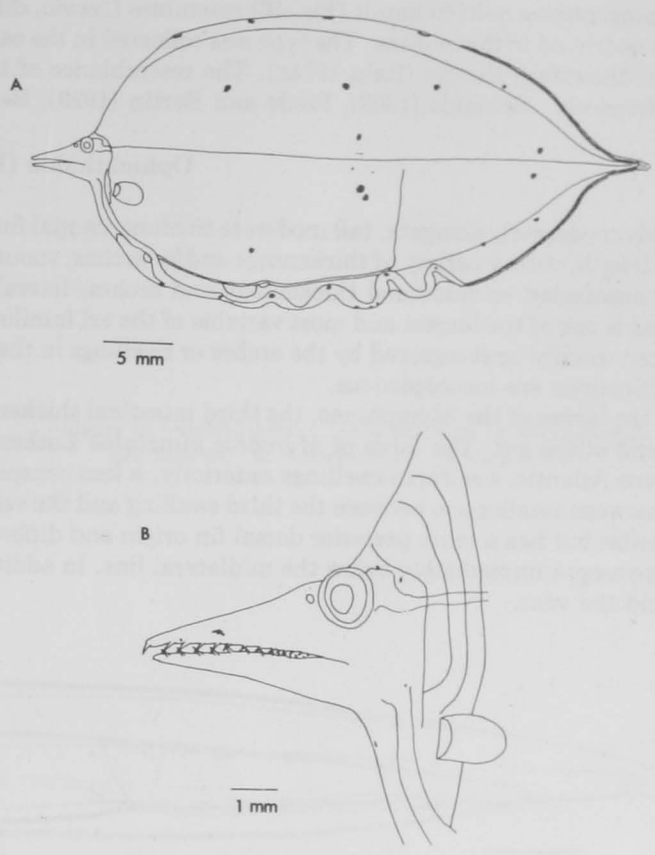


Figure 15.—*Cyemidae*: *Cyema atrum* Günther, 42 mm SL, GS 84. A. Whole view. B. Head.

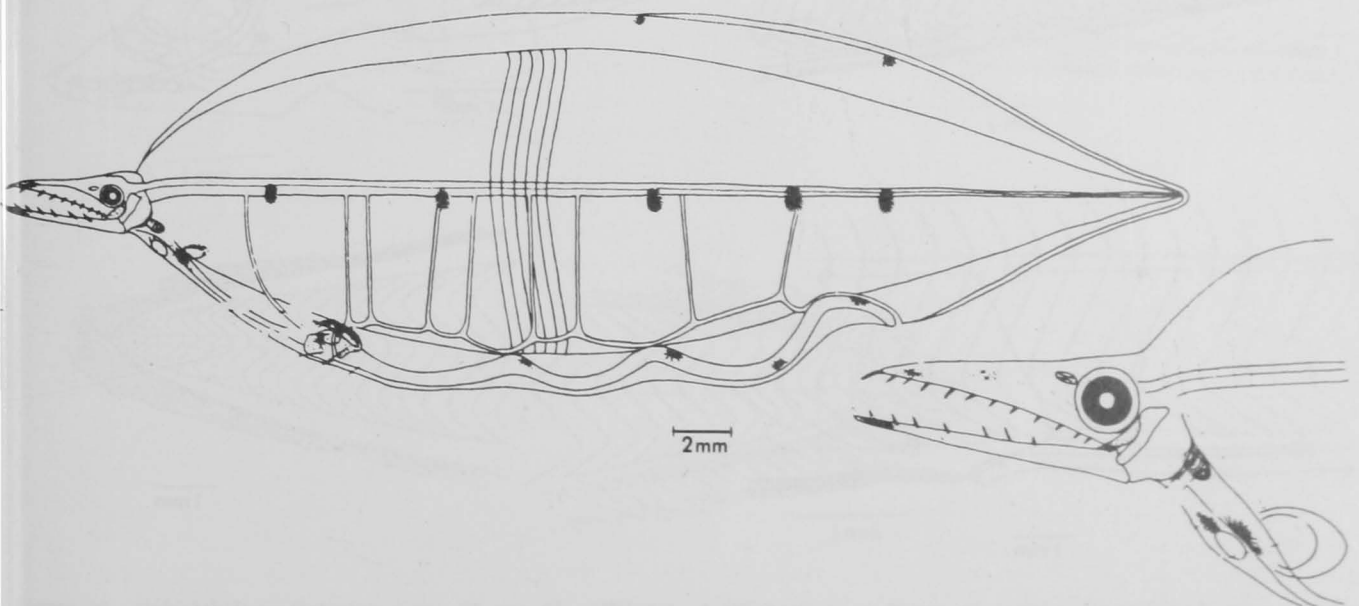


Figure 16.—*Cyemidae* (?): *Leptocephalus holti* Schmidt, 40 mm SL, from Raju (1974a).

Leptocephalus holti Schmidt (Fig. 16) resembles *Cyema*, differing mainly in having a shallower body and lateral pigment restricted to the midline. The type was collected in the eastern North Atlantic, but a similar specimen was taken in the southwestern Pacific (Raju 1974a). The resemblance of this larva to *Cyema* suggests that they may be related.

References: Schmidt (1909), Roule and Bertin (1929), Bertin (1937), Raju (1974a).

Ophichthidae (Figs. 17-21)

Body moderately elongate; tail moderate to blunt, caudal fin sometimes absent; gut about one-half to two-thirds standard length, with a variety of thickenings and/or arches; snout generally moderately elongate; ventral pigment tends to be concentrated on intestinal thickenings and arches; lateral pigment variable; maximum size 80-180 mm.

This is one of the largest and most variable of the eel families, and its larvae are commonly collected. Ophichthid larvae can usually be recognized by the arches or swellings in the gut, but a few forms are known in which these intestinal modifications are inconspicuous.

In the larvae of the Myrophinae, the third intestinal thickening is the largest, and the kidney is confined to the posterior end of the gut. The larva of *Myrophis punctatus* Lütken (138-148, Fig. 17), the common spotted worm eel of the western Atlantic, has three swellings anteriorly, a less conspicuous swelling near the vent associated with the kidney, and an even smaller one between the third swelling and the vent. The larva of *Ahlia egmontis* (Jordan) (157-167, Fig. 18) is similar but has a more posterior dorsal fin origin and different lateral pigment, in the form of short diagonal lines on the myosepta immediately below the midlateral line. In addition there are a few subcutaneous pigment spots laterally behind the vent.

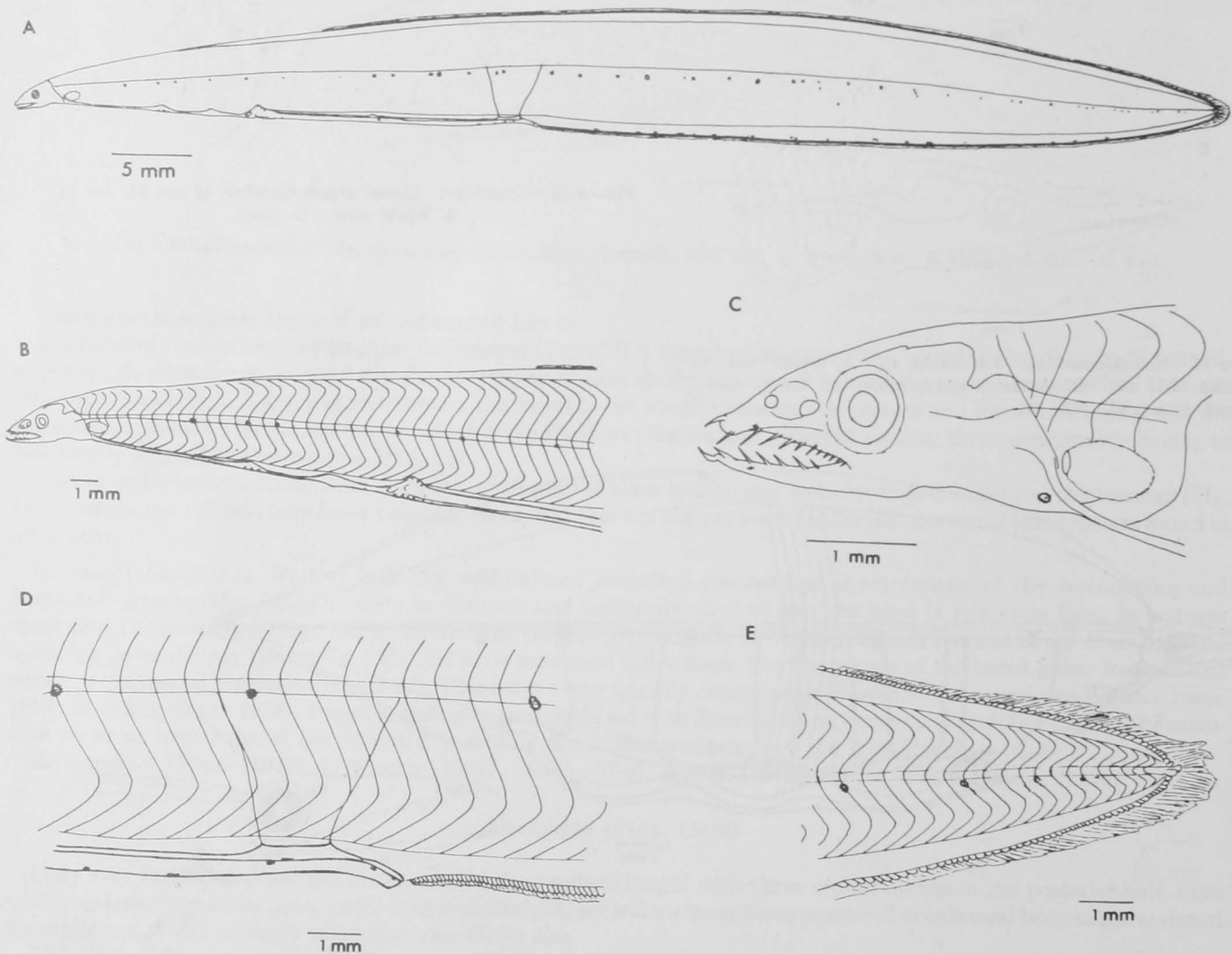


Figure 17.—Ophichthidae: *Myrophis punctatus* Lütken, 78 mm SL, MBI 198. A. Whole view. B. Anterior body. C. Head. D. Anal region. E. Tail.

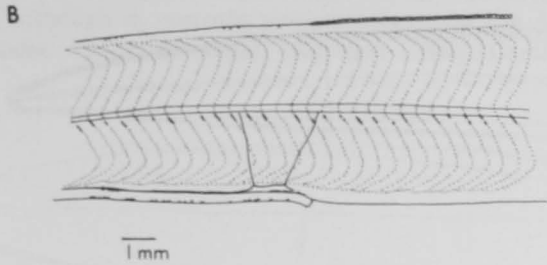
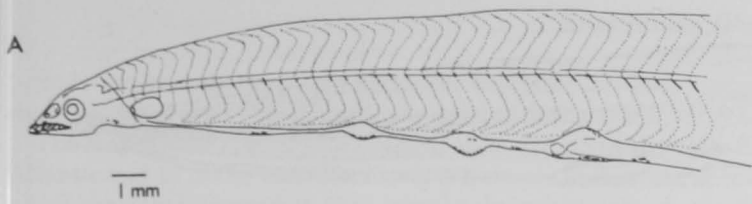


Figure 18.—Ophichthidae: *Ahlia egmontis* (Jordan), 82 mm SL, MBI 36. A. Anterior body. B. Anal region.

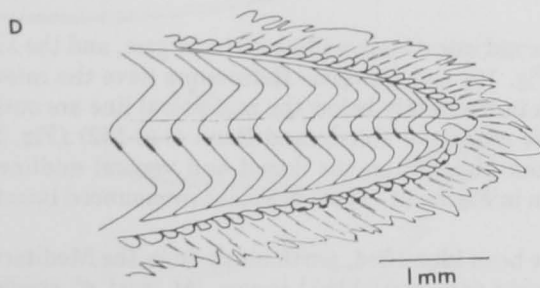
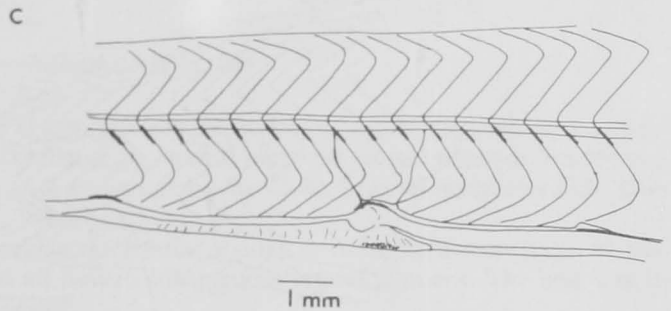
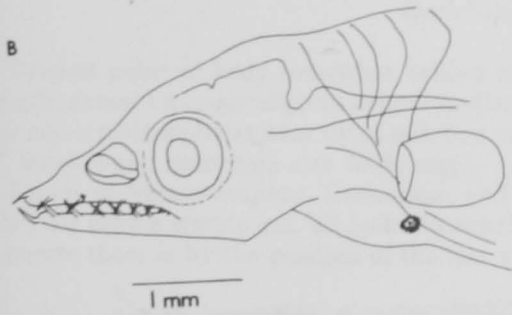
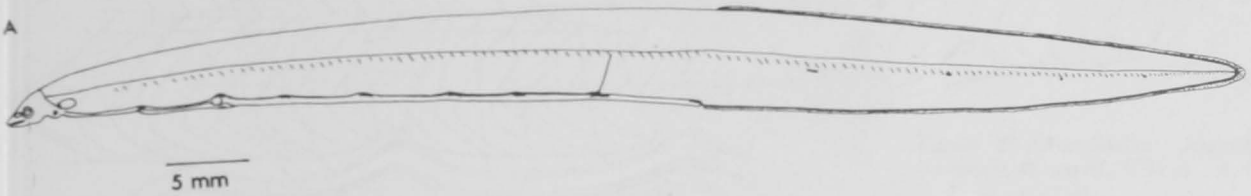


Figure 19.—Ophichthidae: *Ophichthus* sp., 77 mm SL, MBI 345. A. Whole view. B. Head. C. Anterior gut showing first two intestinal swellings with liver and gall bladder. D. Tail.

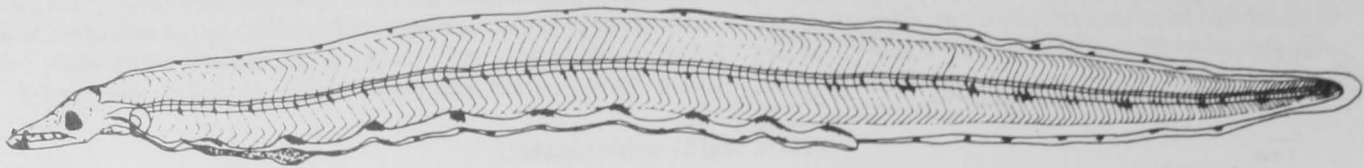


Figure 20.—Ophichthidae: *Pisodonophis cruentifer* Goode and Bean, 32 mm SL, from Richardson (1974).

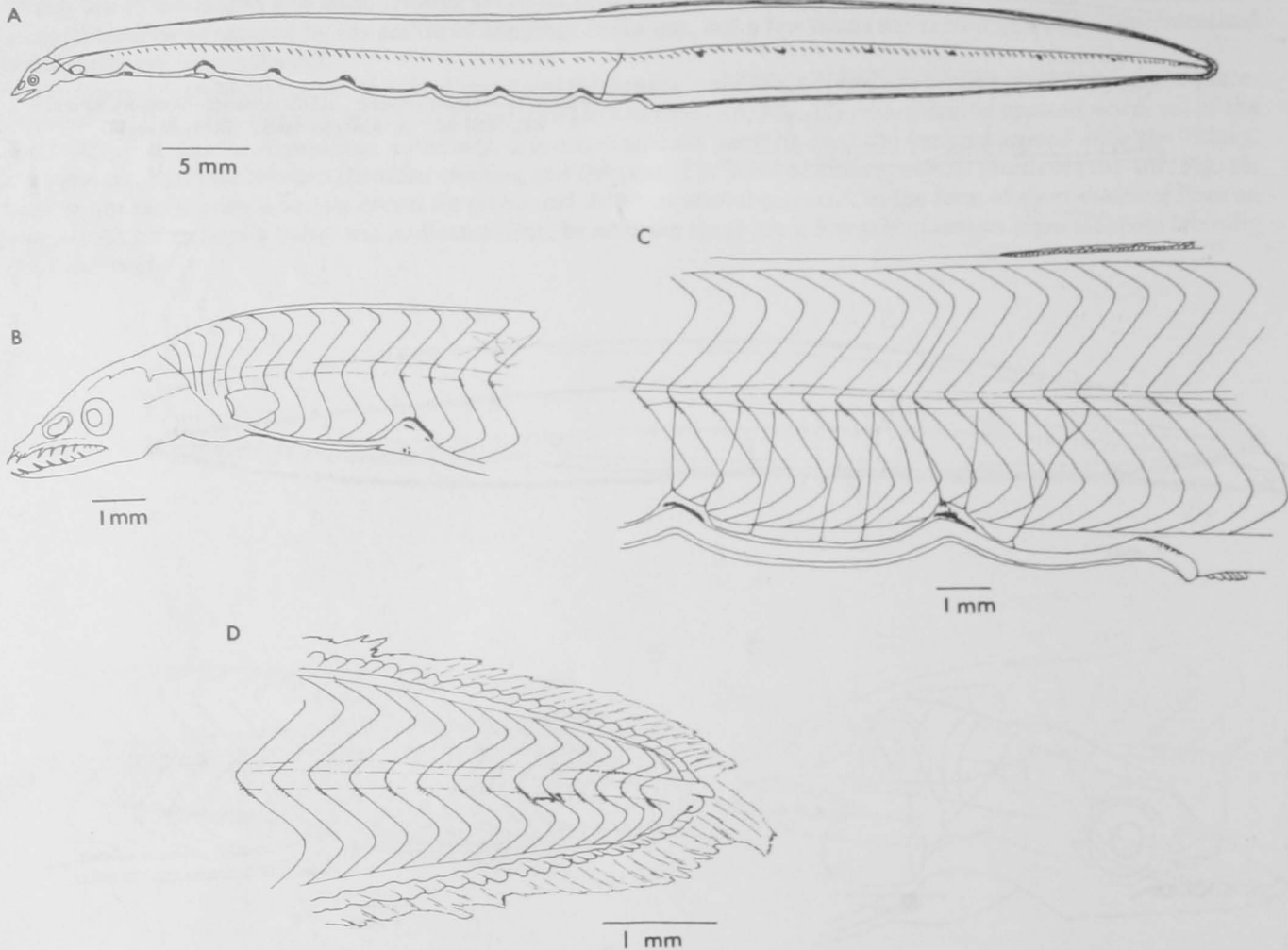


Figure 21.—Ophichthidae: unidentified, 72 mm SL, MBI 338. A. Whole view. B. Head. C. Anal region. D. Tail.

In larvae of the Ophichthinae, the second intestinal swelling is the largest, and the kidney extends some distance along the gut. Larvae of *Ophichthus* Ahl (Fig. 19) and *Dalophis* Rafinesque have the intestinal swellings reduced. Pigment varies, but in most cases the myosepta immediately below the midlateral line are outlined by short diagonal lines, as in *Ahlia* Jordan and Davis. *Pisodonophis cruentifer* Goode and Bean (146-152) (Fig. 20), from the east coast of North America, has nine intestinal arches and pigment on the dorsal and ventral midlines in addition to midlaterally. An unidentified ophichthine larva is shown in Figure 21. There are eight pronounced intestinal arches, each capped by black pigment.

Several other ophichthid larvae have been identified, particularly from the Mediterranean, but much work remains to be done. Blache (1977) dealt extensively with ophichthid larvae. At least 40 species of ophichthid eels exist in the western Atlantic. Larvae of *Myrophis punctatus*, *Ahlia egmontis*, *Pisodonophis cruentifer*, and *Pseudomyrophis nimius* Böhlke have been identified.

References: D'Acona (1931), Sparta (1937, 1938a, 1939a, 1940), Castle (1965c), Eldred (1966), Dean (1968) Richardson (1974), Blache (1977), Fahay and Obenchain (in press).

Anguillidae (Fig. 22)

Body moderately deep; gut a simple, straight tube about two-thirds standard length; dorsal fin origin slightly anterior to level of vent; head moderate with rather short snout; melanophores absent; maximum size 80 mm.

The Anguillidae contains 15 species, all in the genus *Anguilla* Shaw and all catadromous. Two species are found in the Atlantic and 13 in the Indo-Pacific. It is a closely knit group, species differing mainly meristically. Larvae of *Anguilla* are about the only leptocephali that completely lack melanophores. Castle (1965b) reported that the larvae of the muraenid genus *Anarchias*, at least the Australasian species, are also without melanophores, but these can be separated from *Anguilla* by the reduced fins and the shorter gut.

Larvae of both *Anguilla anguilla* (Linnaeus) (111-119) and *A. rostrata* (Lesueur) (104-111) are found in the western Atlantic, although *A. rostrata* predominates near the American coast.

References: Schmidt (1925), Jespersen (1942), Castle (1963), Smith (1968), Eldred (1968c).

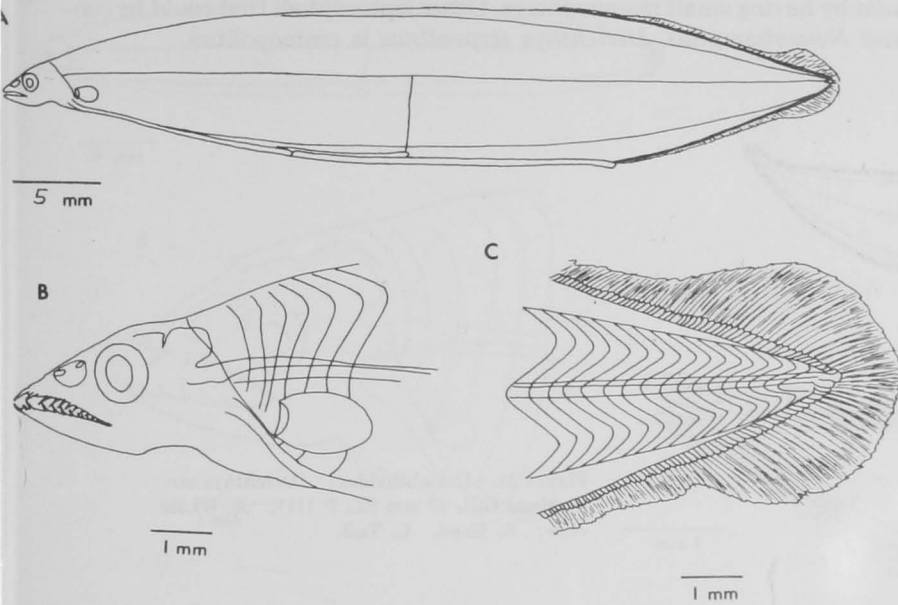


Figure 22.—Anguillidae: *Anguilla rostrata* (Lesueur), 48 mm SL, MBI 36. A. Whole view. B. Head. C. Tail.

Derichthyidae: *Nessorhamphus* (Fig. 23)

Deepest point of body somewhat behind midlength; tail sharp; gut simple and long, about nine-tenths standard length; dorsal fin origin slightly behind midlength; snout rather long; no ventral pigment; lateral pigment limited to a few small melanophores near tip of tail; last vertical blood vessel around myomere 75-80; preanal myomeres 118-121 in *N. ingolfianus*; maximum size 70-80 mm.

Larvae of *Nessorhamphus*, *Derichthys*, and the Serrivomeridae are similar enough to cause confusion (Figs. 23-25). They all have a simple gut, all lack intestinal pigment, and all have inconspicuous lateral pigment. The best way to separate them is by the position of the last vertical blood vessel.

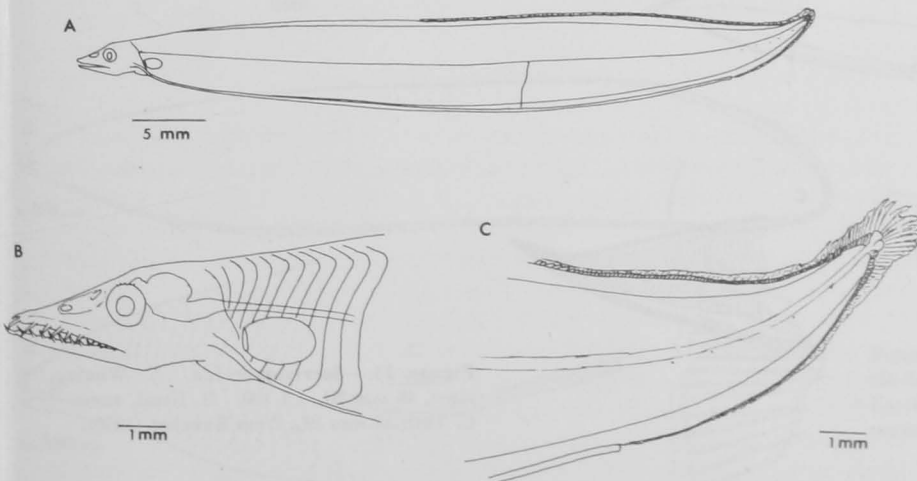


Figure 23.—Derichthyidae: *Nessorhamphus ingolfianus* (Schmidt), 51 mm SL, P 1111. A. Whole view. B. Head. C. Tail.

Nessorhamphus Schmidt was formerly placed in its own family, the Nessorhamphidae, but Robins and Robins (1971) transferred it to the Derichthyidae. The two recognized species are circumtropical, but *N. danae* Schmidt (135-145) is an equatorial species, found within 5°-10° of the Equator, whereas *N. ingolfianus* (Schmidt) (149-159) is found from about 10° to 30° both north and south of the Equator.

References: Schmidt (1930, 1931), Beebe (1935).

Derichthyidae: *Derichthys* (Fig. 24)

Gut simple, about three-fourths standard length; dorsal fin origin at about midbody; snout rather short with a rather flat or slightly concave dorsal profile; nasal organ moderately large; pigment restricted to a few small melanophores on myosepta midlaterally in postanal region; last vertical blood vessel at myomere 59-63; preanal myomeres 76-83; maximum size 50-60 mm.

Superficially, the larva of *Derichthys serpentinus* Gill (126-134), the only species in the genus, resembles *Anguilla*. In fact, it was first described under the name *Leptocephalus anguilloides* Schmidt. Aside from its more numerous myomeres, however, it differs from larval *Anguilla* by having small melanophores. Other leptocephali that could be confused with *Derichthys* are the serrivomerids and *Nessorhamphus*. *Derichthys serpentinus* is cosmopolitan.

Reference: Castle (1970b).

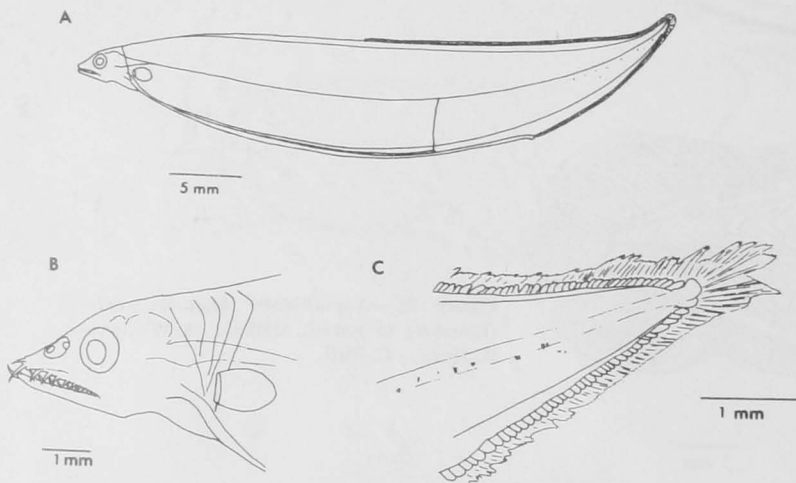


Figure 24.—Derichthyidae: *Derichthys serpentinus* Gill, 42 mm SL, P 1111. A. Whole view. B. Head. C. Tail.

Serrivomeridae (Fig. 25)

Tail sharp; gut simple, about two-thirds to three-fourths standard length; dorsal fin origin somewhat in front of level of vent; head moderate with sharp snout and concave dorsal profile; nasal organ small and close to eye; no intestinal pigment; lateral pigment absent or limited to small melanophores on myosepta along midline, sometimes restricted to postanal region; last vertical blood vessel at myomere 30-37; preanal myomeres ca. 89-125; maximum size 60 mm.

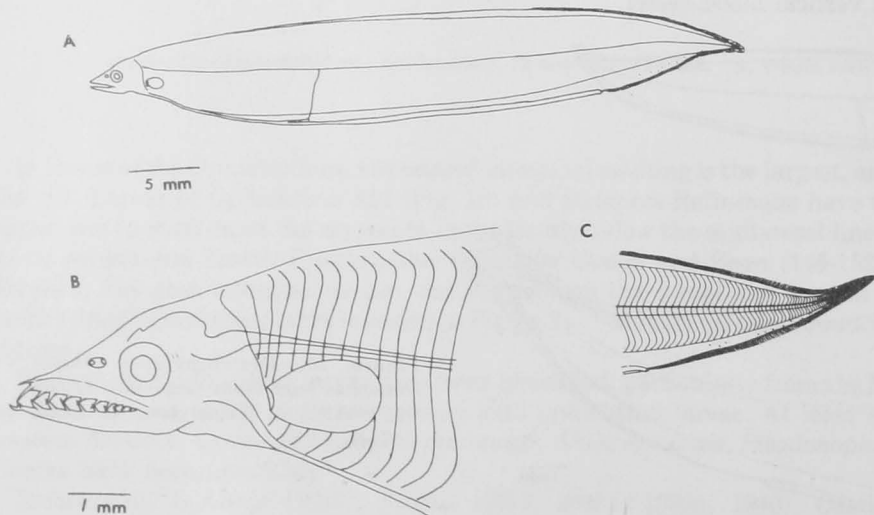


Figure 25.—Serrivomeridae. A. Whole view, 46 mm SL, CI 190. B. Head, same. C. Tail, 45 mm SL, from Bauchot (1959).

The serrivomerids are common midwater eels. Numerous species and at least three genera have been described, but the family needs critical study to confirm the validity of these nominal taxa. According to the literature, larvae of the following western Atlantic species have been described: *Platuronides acutus* Parr (153-158), *P. danae* Roule and Bertin (165-170), *Serrivomer beani* Gill and Ryder (154-165), *S. brevidentatus* Roule and Bertin (155-165), and *S. parabeani* Bertin (156-163).

References: Bauchot (1959), Beebe and Crane (1936, 1937a).

Muraenidae (Figs. 26-30)

Body moderate to moderately deep; tail broadly rounded; gut simple, about one-half to three-fourths standard length (longer in *Channomuraena*); dorsal fin variable, originating anywhere from shortly behind head to near tip of tail; head with short, blunt snout; posterior nostril near level of upper margin of eye; pectoral fin greatly reduced; pigment

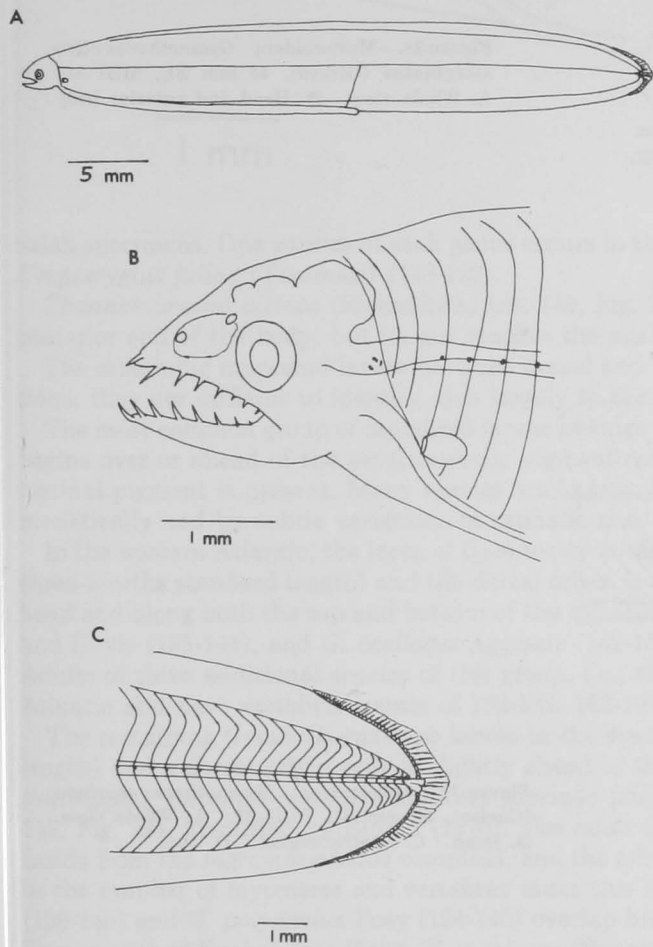


Figure 26.—Muraenidae: *Anarchias yoshiae* Kanazawa, 40 mm SL, MBI 30. A. Whole view. B. Head. C. Tail.

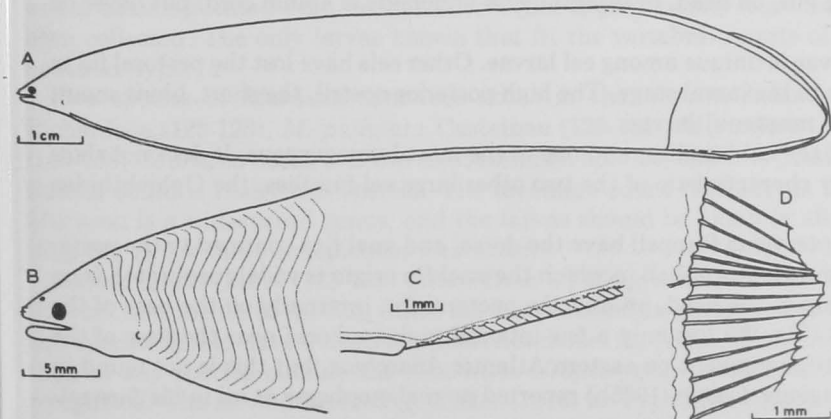


Figure 27.—Muraenidae: *Channomuraena vittata* (Richardson), 124 mm TL (metamorphosing), from Castle (1970a). A. Whole view. B. Head. C. Anal region. D. Tail.

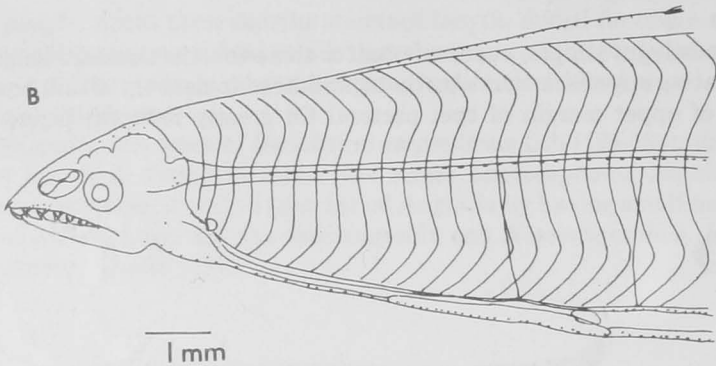
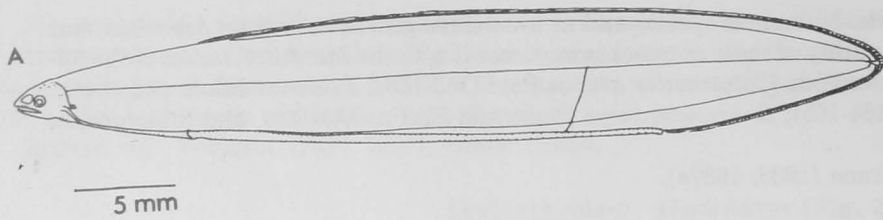


Figure 28.—Muraenidae: *Gymnothorax nigromarginatus* (Girard), 44 mm SL, MBI 345. A. Whole view. B. Head and anterior body.

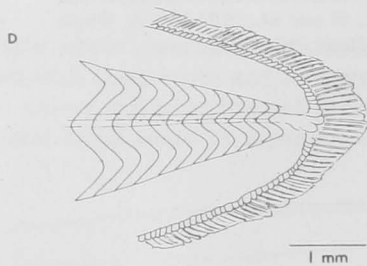
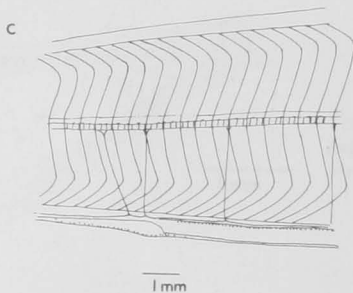
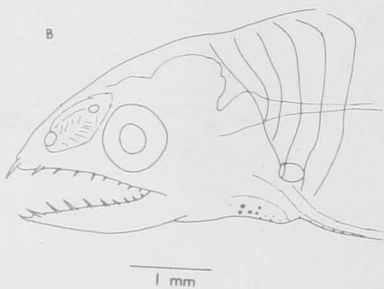
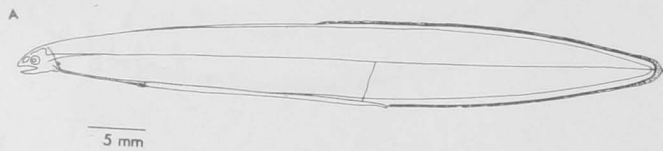


Figure 29.—Muraenidae: *Gymnothorax moringa* (Cuvier), 56 mm SL, MBI 36. A. Whole view. B. Head. C. Gastric region. D. Tail.

variable, may consist of small melanophores along gut, on head, or internally on underside of spinal cord, but never on lateral body surface; maximum size 60-70 mm.

The greatly reduced pectoral fin of muraenid larvae is unique among eel larvae. Other eels have lost the pectoral fin in the adult, but only the morays show this reduction in the larval stage. The high posterior nostril, the short, blunt snout, and the broadly rounded tail further characterize muraenid larvae.

This is one of the largest and most important of the eel families, and one of the most homogeneous. It does not show the great variation in larval and adult morphology characteristic of the two other large eel families, the Ophichthidae and Congridae.

Larvae of *Anarchias* Jordan and Starks and *Uropterygius* Rüppell have the dorsal and anal fins confined to the posterior extremity of the body (Fig. 26). These are the only leptocephali in which the anal fin origin is widely separated from the vent. *Uropterygius* has melanophores on the top of the head, around the pectoral fin, internally on the base of the brain, and on the underside of the gut. *Anarchias* (Fig. 26) has only a few internal melanophores near the base of the brain. Blache (1971) reported inconspicuous intestinal pigment on eastern Atlantic *Anarchias*, but this is not found in larvae from the western Atlantic or Australasian regions. Castle (1965b) reported no melanophores at all in his Austral-

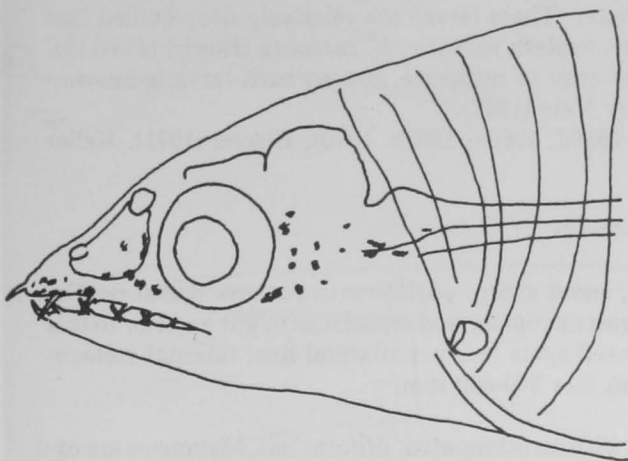


Figure 30.—Muraenidae: *Muraena miliaris* (Kaup) (?), 51 mm, MBI 340.

1 mm

asian specimens. One species of each genus occurs in the western Atlantic, *Anarchias yoshiae* Kanazawa (107-114) and *Uropterygius juliae* (Tommasi) (118-123).

Channomuraena vittata (Richardson) (ca. 149, Fig. 27) from the Atlantic also has the vertical fins restricted to the posterior end of the body, but its gut reaches the anal fin origin.

The remaining muraenid larvae have the dorsal and anal fin origins considerably farther forward. With a few exceptions, they are difficult to identify, due largely to the overlap in vertebral numbers of many species.

The most common group of muraenid larvae belongs to the *Gymnothorax* Bloch complex (Figs. 28-29). The dorsal fin begins over or ahead of the vent, cephalic pigment consists of small, discrete melanophores variably placed, and intestinal pigment is present. Many species are known, but few larvae have been identified with certainty. They differ meristically and by subtle variations in cephalic and ventral pigment.

In the western Atlantic, the larva of *Gymnothorax nigromarginatus* (Girard) (Fig. 28) has a relatively long gut (about three-fourths standard length) and the dorsal origin is well in front of the vent. Melanophores are present on top of the head and along both the top and bottom of the intestine. *Gymnothorax nigromarginatus* (137-145), *G. saxicola* Jordan and Davis (135-144), and *G. ocellatus* Aggassiz (142-150) are all closely related and their larvae are probably similar. Adults of three additional species of this group, i.e., those with serrated teeth, have been found in the western North Atlantic and have vertebral counts of 132-137, 162-167, and 163-174.

The remaining *Gymnothorax*-type larvae in the western Atlantic have a shorter gut (slightly over one-half standard length) and a dorsal origin over or slightly ahead of the vent. Several species exist but, with one probable exception, overlapping vertebral-myomere numbers preclude positive identification. The exception is *G. moringa* (Cuvier) (134-142, Fig. 29), identified by Eldred (1970). The adult is the most abundant western Atlantic species of *Gymnothorax* (aside from the *nigromarginatus* complex), and the relative abundance of the larva combined with the close agreement in the number of myomeres and vertebrae make this identification likely to be correct, although *G. funebris* Ranzani (139-145) and *G. polygonius* Poey (134-140) overlap broadly. The remaining species is *G. vicinus* Castelnau (129-136). Two species of *Enchelycore* Kaup, *E. nigricans* (Bonnaterre) (141-147) and *E. carynhroa* Böhlke and Böhlke (131-140), are found in the western Atlantic. If these also have a *Gymnothorax*-type larva, the problem of larval identification would be complicated even further. *Enchelycore*, particularly *nigricans*, is common enough that its larva should have been collected. The only larvae known that fit the vertebral counts of the two species of *Enchelycore* are of the *Gymnothorax* type.

Five species of *Muraena* Linnaeus occur in the western Atlantic: *M. miliaris* (Kaup) (118-126), *M. pavonina* Richardson (125-128), *M. punctata* Castelnau (128-132), *M. retifera* Goode and Bean (128-135), and *M. robusta* Osorio (153-156). *Muraena miliaris* is the most common species, and it is possible that the larva described by Eldred (1969a) as *Rabula acuta* is really this species. The myomere count (120-121) is too low for *R. acuta* but agrees with *M. miliaris*. *Muraena* is a widespread genus, and the larvae should be found in all oceans. The stripe of deep pigment on the head (Fig. 30) is the most conspicuous character.

Rabula acuta (Parr) (123-129) differs from all other western Atlantic morays in having the dorsal fin origin between the vent and the tip of the tail. Since the dorsal fin origin never seems to move backward at metamorphosis, the larvae of this species should have a relatively posterior dorsal fin origin, around the 74th-76th myomere. This is much farther back than in any species outside the *Anarchias-Uropterygius-Channomuraena* group, and should enable the larvae to be recognized. The larva described by Keller (1976) as Type I fits these conditions and may well be the true *R. acuta*. This species is probably not congeneric with the Indo-Pacific species that have been placed in *Rabula* Jordan and Davis.

Castle (1965b) tentatively identified three species of *Echidna* Forster. These larvae are relatively deep-bodied and lack ventral and lateral pigment. One species of *Echidna* occurs in the western Atlantic, *E. catenata* (Bloch) (114-119). The low number of myomeres should make the larva of this species easy to recognize, but no such larva is known.

The larva of *Thyrsoidea macrura* (Bleeker) has been identified by Nair (1947).

References: Nair (1947), Castle (1965b, 1970a), Eldred (1968b, 1968d, 1969a, 1969b, 1970), Blache (1971), Keller (1976).

Nemichthyidae (Figs. 31-32)

Body elongate, tail moderate or attenuated; gut long and simple; snout sharp, peglike with concave dorsal profile; nasal organ small; small melanophores along top of gut posterior to gastric region, and on bottom of gut anterior to this point; lateral pigment, when present, consisting of a few widely spaced spots below midlateral line; internal melanophores along top of spinal cord extending length of body; maximum size 300-400 mm.

Two major types of nemichthyid larvae exist.

Larvae of *Nemichthys* Richardson (Fig. 31) are extremely elongate with an attenuated, filiform tail. Myomeres are extremely numerous, well over 300, although they are difficult to count posteriorly. These larvae can reach 400 mm before metamorphosing. It has long seemed likely that more than one species of *Nemichthys* exist, as evidenced by Roule and Bertin's "Leptocephalus A" and "Leptocephalus B." Nielsen and Smith (in press) have recognized three species: *Nemichthys scolopaceus* Richardson, *N. curvirostris* (Strömman), and *N. larseni* Nielsen and Smith. Very small larvae of *N. scolopaceus* have two or three prominent pigment spots laterally below the midline (Fig. 31A). At this stage they can easily be confused with *Avocettina* (Fig. 32A). In *Nemichthys* these pigment spots are lower on the body than in

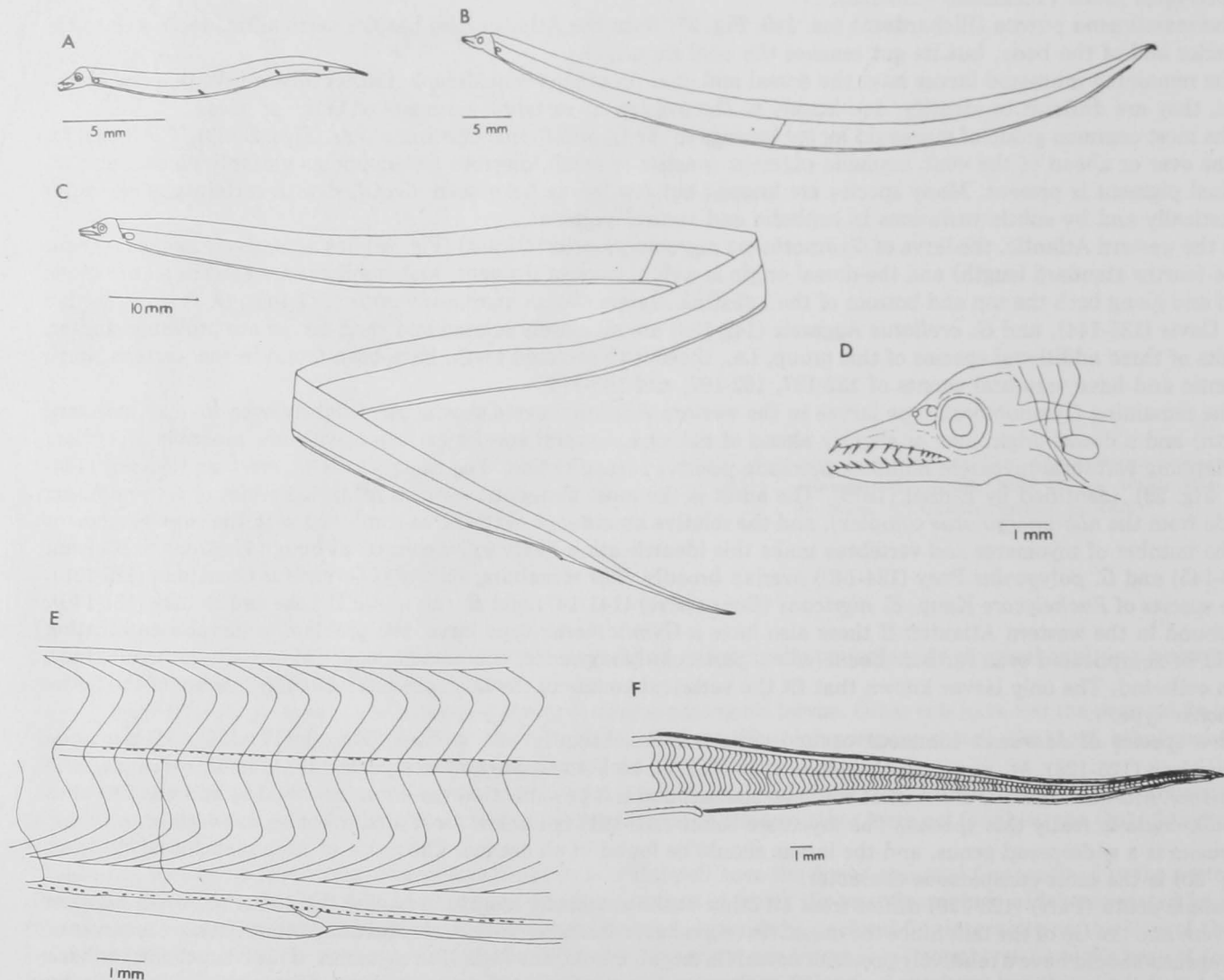


Figure 31.—Nemichthyidae: *Nemichthys scolopaceus* Richardson. A. Whole view, 15 mm SL, adapted from Roule and Bertin (1929). B. Whole view, 72 mm SL, MBI 163. C. Whole view, 182 mm SL, P 1392. D. Head. E. Gastric region. F. Tail.

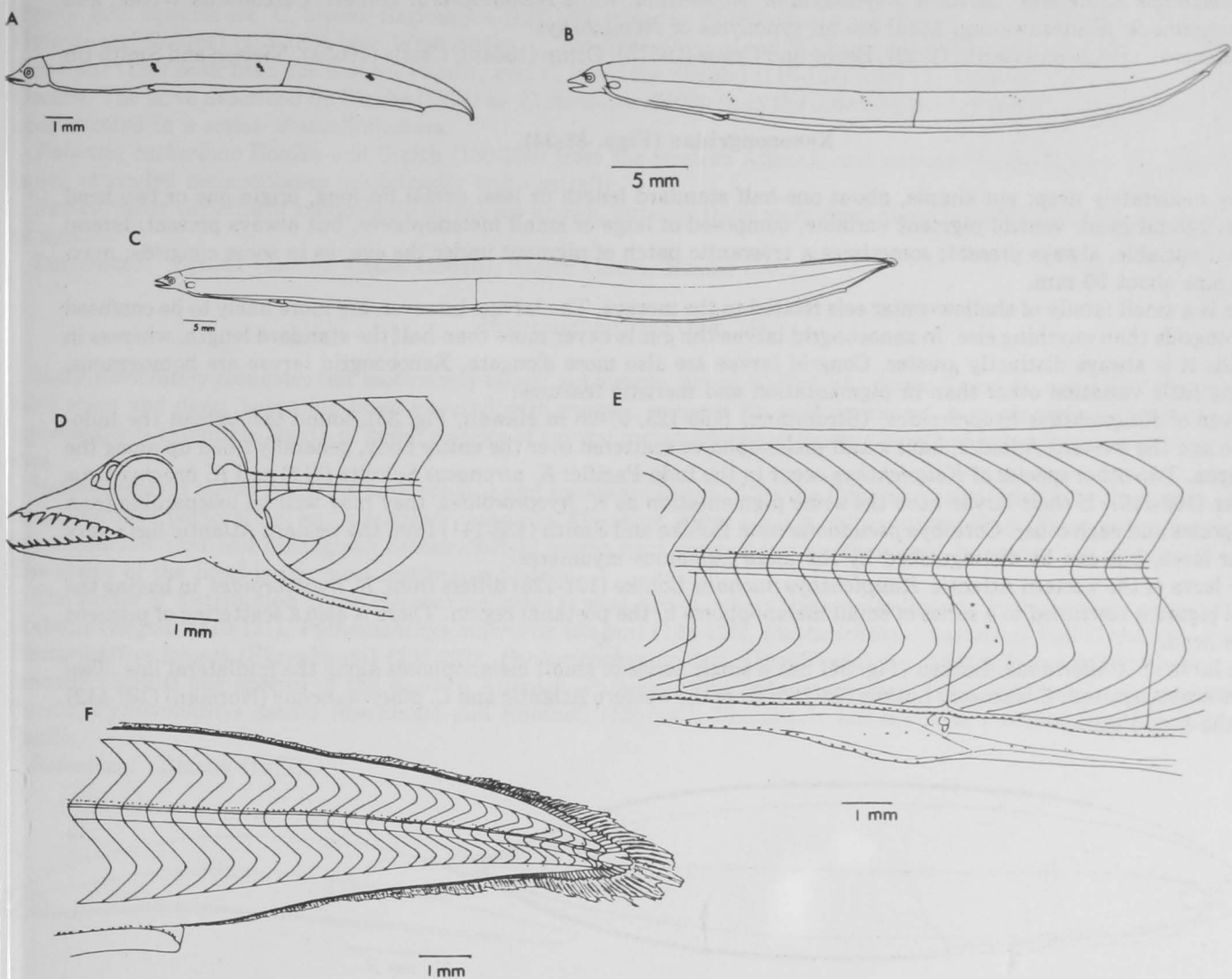


Figure 32.—Nemichthyidae: *Avocettina infans* (Günther). A. Whole view, 20 mm SL, MBI 197. B. Whole view, 45 mm SL, MBI 47. C. Whole view, 111 mm SL, MBI 216. D. Head. E. Gastric region. F. Tail.

Avocettina, but they move dorsally with growth and are unreliable as a diagnostic character. The surest way to distinguish *Nemichthys scolopaceus* from *Avocettina* at this stage is by the position of the liver and the last vertical blood vessel. In *Nemichthys* the posterior end of the liver is located around the 40th myomere and the last vertical blood vessel between the 80th and 100th myomere. In *Avocettina* these structures are at about the 30th and 70th-80th myomere, respectively. *Nemichthys scolopaceus* later develops an additional pigment spot anterior to the others, but with growth they all become inconspicuous and eventually disappear. Larvae of *Nemichthys curvirostris* ("Leptocephalus B" of Roule and Bertin) lack these pigment spots at all stages. At standard lengths greater than 100 mm, larvae of *N. curvirostris* have more preanal myomeres (ca. 300-320) than *N. scolopaceus* (ca. 250). Larvae of *N. larseni* are not known. *Nemichthys scolopaceus* is cosmopolitan, *N. curvirostris* is found in all oceans except the North Pacific, and *N. larseni* is restricted to the northeastern Pacific.

Larvae of *Avocettina* Jordan and Davis (= *Borodinula* Whitley) (Fig. 32) are less elongate and have a normal caudal structure. Three groups of lateral pigment spots are present. These are most prominent in young larvae and become less conspicuous with growth. Four species of *Avocettina* are now recognized: *A. infans* (Günther) (181-201) is found in all oceans north of about lat. 20°S, *A. acuticeps* (Regan) (198-216) and *A. paucipora* Nielsen and Smith (176-188) are found around the world in the Southern Hemisphere, and *A. bowersi* (Garman) (177-192) is restricted to the eastern tropical Pacific.

Larvae of *Labichthys* Gill and Ryder have not been described, but since the adults are similar to *Avocettina* the larvae are probably similar also. Two species of *Labichthys* exist. *Labichthys carinatus* Gill and Ryder (174-191) is found in all oceans north of about lat. 20°S, except the eastern Pacific, but is uncommon throughout. *Labichthys yanoi* (Mead and Rubinfoff) (178-190) occurs in the Southern Hemisphere south of about lat. 20°S and is common in high southern latitudes (lat. 50°-60°S).

Avocettinops Roule and Bertin is a synonym of *Avocettina*, while *Nematoprora* Gilbert, *Cercomitus* Weber, and *Paravocettinops* Kanazawa and Maul are all synonyms of *Nemichthys*.

References: Roule and Bertin (1929), Beebe and Crane (1937b), Orton (1964a), Castle (1965a), Nielsen and Smith (in press).

Xenocoegradae (Figs. 33-34)

Body moderately deep; gut simple, about one-half standard length or less; dorsal fin long, origin one or two head lengths behind head; ventral pigment variable, composed of large or small melanophores, but always present; lateral pigment variable, always present; sometimes a crescentic patch of pigment under the eye, as in some congridrids; maximum size about 90 mm.

This is a small family of shallow-water eels related to the morays. The larvae, however, are more likely to be confused with congridrids than anything else. In xenocoegradae larvae the gut is never more than half the standard length, whereas in congridrids it is always distinctly greater. Congridrid larvae are also more elongate. Xenocoegradae larvae are homogenous, showing little variation other than in pigmentation and meristic features.

Larvae of *Kaupichthys hyoprroides* (Strömman) (109-123, 97-98 in Hawaii, Fig. 33), found throughout the Indo-Pacific and the western Atlantic, have small melanophores scattered over the entire body, generally lined up along the myosepta. Two other species of *Kaupichthys* occur in the Indo-Pacific: *K. atronassus* Schultz (114) and *K. brachychirus* Schultz (108-116). If their larvae have the same pigmentation as *K. hyoprroides*, they may well be inseparable from that species and each other. *Catesbya pseudomuraena* Böhlke and Smith (136-141) from the western Atlantic has a very similar larva, but can be distinguished by the more numerous myomeres.

The larva of the western Atlantic *Kaupichthys nuchalis* Böhlke (121-125) differs from *K. hyoprroides* in having the lateral pigment restricted to a series of small melanophores in the postanal region. There is also a scattering of pigment on the head.

The larva of *Chilorhinus* Lütken (Fig. 34) has a single series of small melanophores along the midlateral line. Two species are recognized: *C. suenisoni* Lütken (98-105) from the western Atlantic and *C. platyrhynchus* (Norman) (107-112) from the Indo-Pacific.

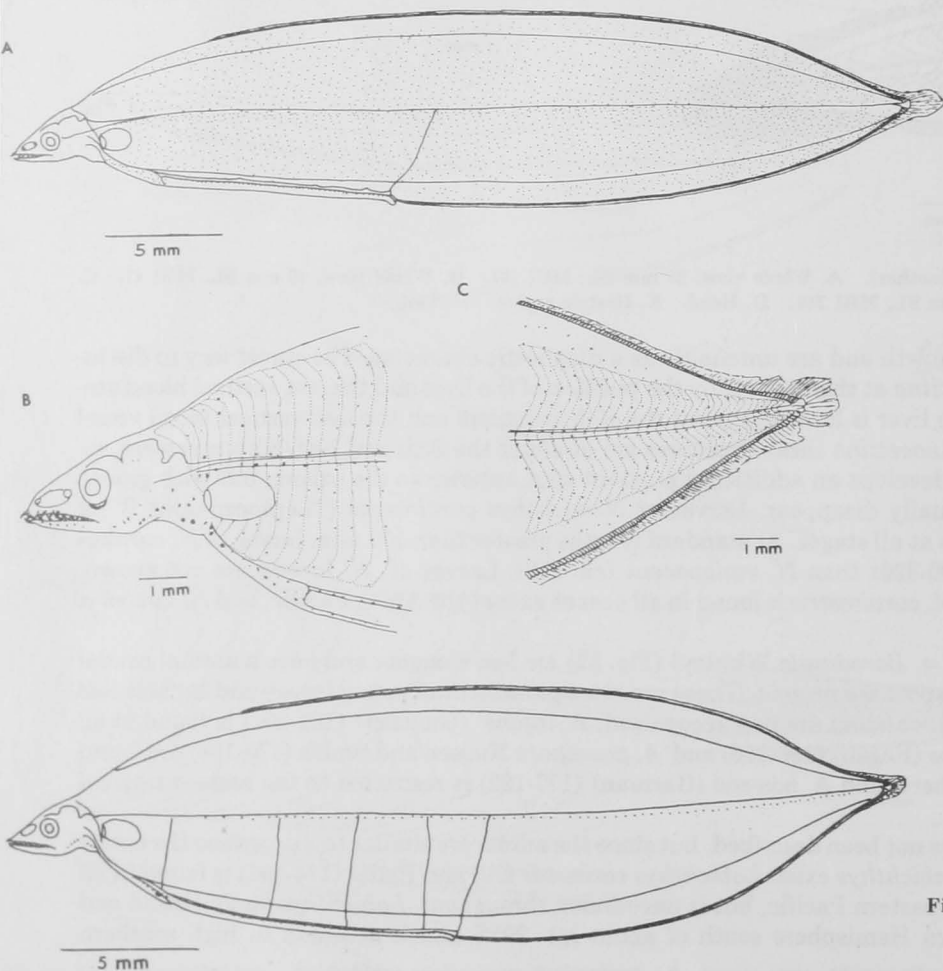


Figure 33.—Xenocoegradae: *Kaupichthys hyoprroides* (Strömman), 38 mm SL, MBI 26. A. Whole view. B. Head. C. Tail.

Figure 34.—Xenocoegradae: *Chilorhinus suenisoni* Lütken, 31 mm SL, P 1116.

Larvae of *Chlopsis* Rafinesque resemble those of *Chilorhinus*, but the midlateral melanophores are in an irregular double row. Species are *C. bicolor* Rafinesque (127-134) from the Mediterranean and the western Atlantic, *C. olokun* (Robins and Robins) (125-139) from West Africa, *C. bicollaris* (Myers and Wade) (138-145) and *C. apterus* (Beebe and Tee-Van) (136) both from the eastern Pacific, and *C. dentatus* (Seale) (116-124) from the Atlantic and western Indian Oceans. The larva described by Blache (1972) as *C. dentatus* differs from the others by having the lateral melanophores concentrated in a series of small clusters.

Robinsia catherinae Böhlke and Smith (130-136) from the western Atlantic and western Indian Oceans has several large, expanded melanophores midlaterally and ventrally.

Several other varieties of xenocongrid larvae are known, but only those mentioned above have been identified to genus or species.

References: Sparta (1939b), Orton (1964b), Smith (1969), Blache (1972).

Heterenchelyidae (Fig. 35)

Body moderately elongate; tail moderately blunt; gut simple, about 80-90% SL; dorsal fin origin around midlength; head short and deep, becoming blunt-snouted with growth; pectoral fin well developed; a single series of midlateral melanophores extending length of body; a series of ventral melanophores extending length of gut; maximum size 60-70 mm.

Heterenchelyid larvae resemble both congrid and muraenid larvae. Like the Congridae, they have lateral pigment, a well-developed pectoral fin, and a relatively long gut. The short, blunt head is quite muraenidlike. There are no simple key characters that will distinguish heterenchelyid larvae from congrid larvae; they must be recognized individually. The shape of the head is the most distinctive feature.

The center of distribution of the Heterenchelyidae is west Africa, where the species include *Pythonichthys microphthalmus* (Regan) (110-121), *Pythonichthys macrurus* (Regan) (124-136), *Panturichthys isognathus* Poll (149-162), and *Panturichthys longus* (Ehrenbaum) (209-227). *Panturichthys fowleri* (Ben Tuvia) (ca. 150) is found in the Mediterranean. There is one species in the western Atlantic, *Pythonichthys sanguineus* Poey (108), and one in the eastern Pacific, *Pythonichthys asodes* Rosenblatt and Rubinoff (126-135). The family has not been recorded from the Indo-Pacific.

Reference: Blache (1977).

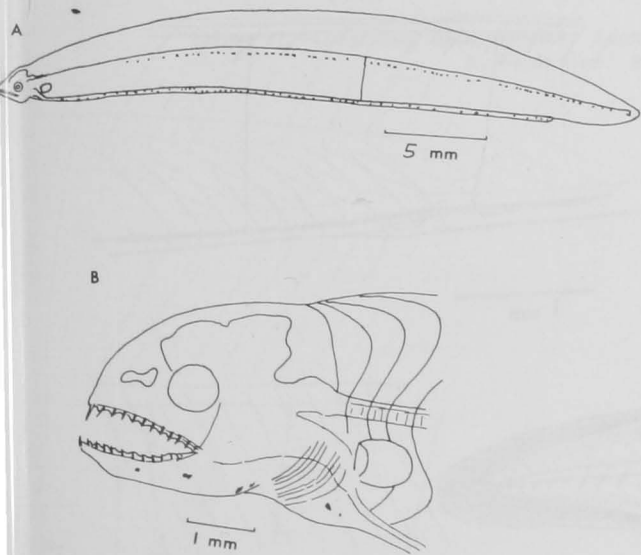


Figure 35.—Heterenchelyidae: *Pythonichthys microphthalmus* (Regan). A. Whole view, 34 mm SL. B. Head, 75 mm. After Blache (1977).

Congridae (including Muraenesocidae) (Figs. 36-47)

Body moderate to elongate; tail variable; gut simple, generally about three-fourths standard length or greater; dorsal fin variable, from very long to very short; ventral pigment variable but always present; lateral pigment variable, sometimes absent; maximum size variable, up to 200-300 mm in some species, most species probably reach close to 100 mm.

This is one of the largest of the eel families and without doubt the most difficult to characterize, because of the wide variation in almost all important characters. The best way to characterize this family is by elimination: of the eel larvae with a simple gut and ventral pigment, the Muraenidae, Nemichthyidae, Heterenchelyidae, and Xenocongridae can be distinguished by the features given in the accounts of those families. The remainder, presumably, are congrids.

Larvae of several genera and species groups are known.

Subfamily Bathymyrinae.—Larvae of *Ariosoma* Swainson (Fig. 36) have a very long gut and the dorsal fin origin near the posterior end of the body. The lateral pigment consists of minute melanophores outlining the myosepta immediately below the midline and forming a series of short diagonal lines from head to tail. The ventral pigment consists of small melanophores below the gut anteriorly, switching to the top of the gut behind the liver. A series of small melanophores lies on the dorsal midline from head to tail. Small specimens have larger, more widely spaced melanophores along the dorsal and ventral midlines (Fig. 36A), but these disappear with growth. Several ophichthids have similar lateral pigment, but they can be distinguished from *Ariosoma* by the shorter gut with its characteristic swellings or arches. The characteristic pigment of *Ariosoma* larvae is lost early in metamorphosis; such early metamorphic specimens are fairly common and can be confusing. Four species of *Ariosoma* are known from the western North Atlantic: *A. balearicum* (Delaroché) (120-137), *A. selenops* Reid (158-174), *A. analis* (Poey) (146-150), and *A. coquettei* Smith and Kanazawa (155-160).

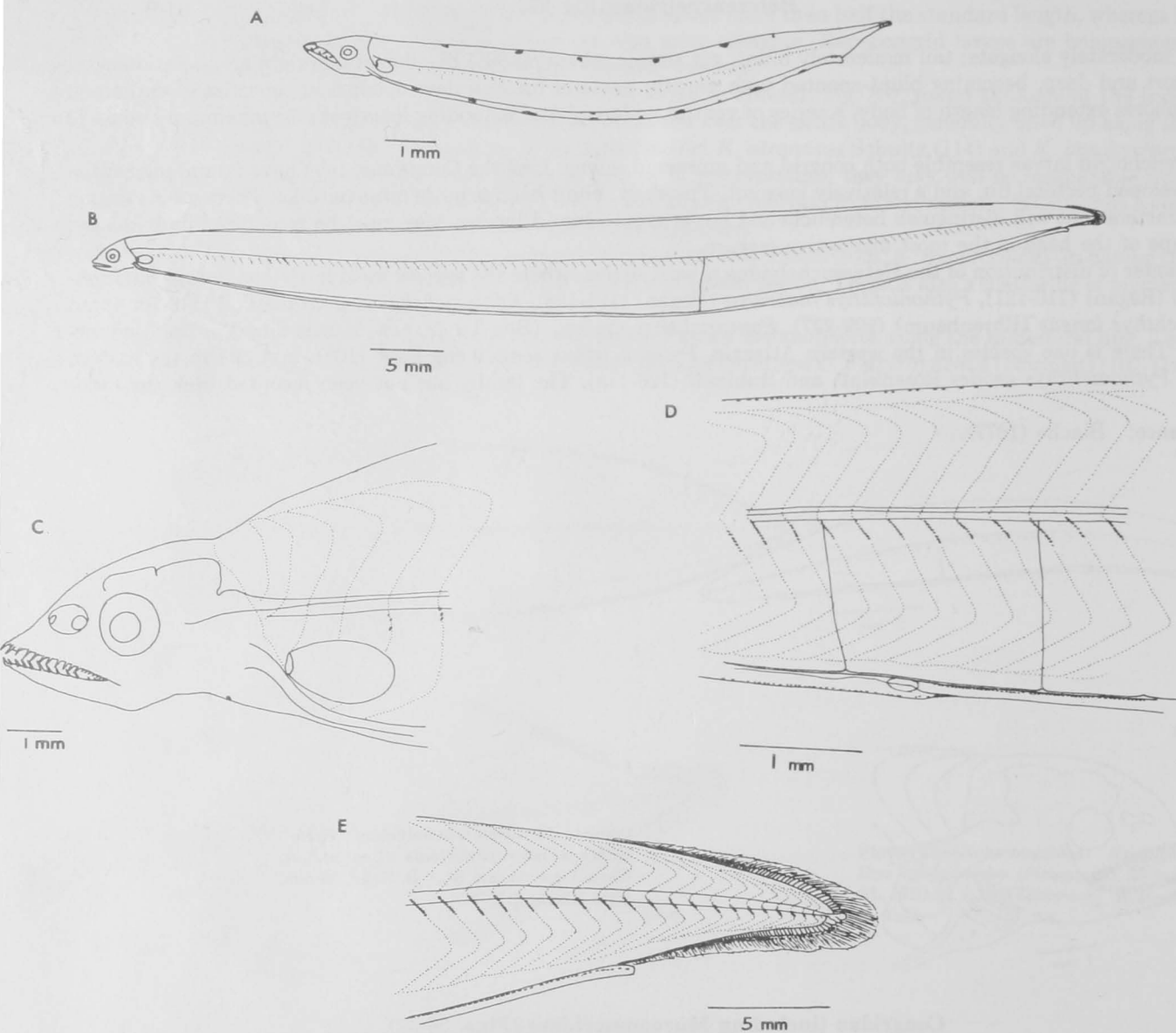


Figure 36.—Congridae, Bathymyrinae: *Ariosoma balearicum* (Delaroché). A. Whole view, 12 mm SL, MBI 57-B. B. Whole view, 69 mm SL, MBI 76. C. Head, 167 mm SL, MBI 203. D. Gastric region, same. E. Tail, same.

Some *Ariosoma* and *Ariosoma*-like larvae have the posterior end of the gut extending free of the body (Figs. 36-37). In *Ariosoma selenops* the free section is short, but in at least two other forms it can exceed the length of the body. The larva described as *Leptocephalus scalaris* Castle (Fig. 38) has additional pigment along the myosepta above and below the midlateral series and sometimes an oval patch of small melanophores midlaterally around the 50th myomere. The last vertical blood vessel is unusually far back, around the 90th-100th myomere. *Leptocephalus macrenteron* D'Ancona (Fig. 37) has only the midlateral series of melanophores outlining the myosepta, and the last vertical blood vessel is

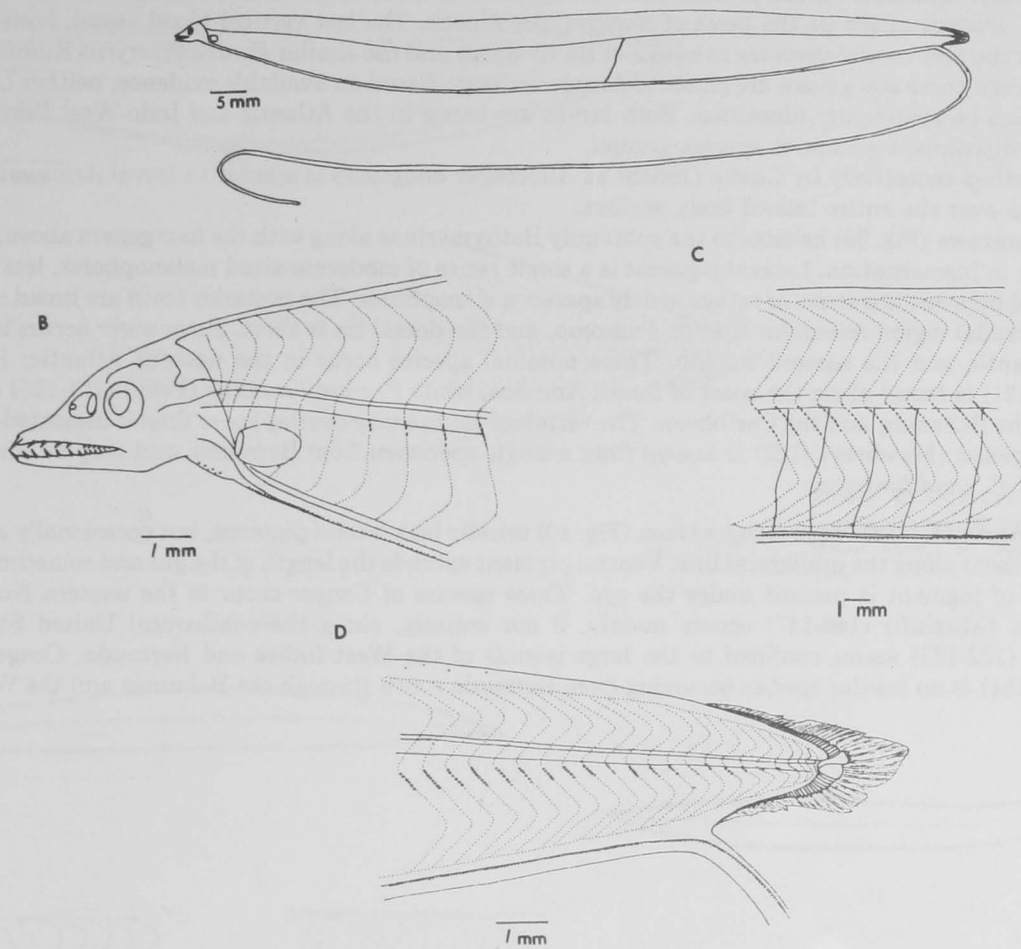


Figure 37.—Congridae, Bathymyrinae: *Leptocephalus macreteron* D'Ancona, 111 mm SL, MBI 242. A. Whole view. B. Head. C. Midbody. D. Tail.

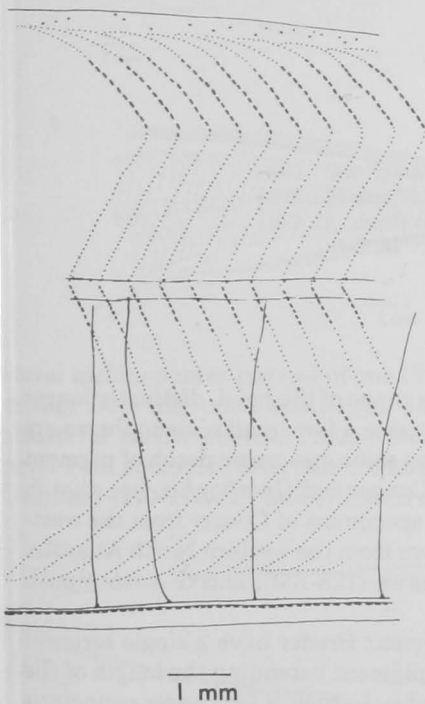


Figure 38.—Congridae, Bathymyrinae: *Leptocephalus scalaris* Castle, 69 mm SL, MBI 567. Midbody showing lateral pigment.

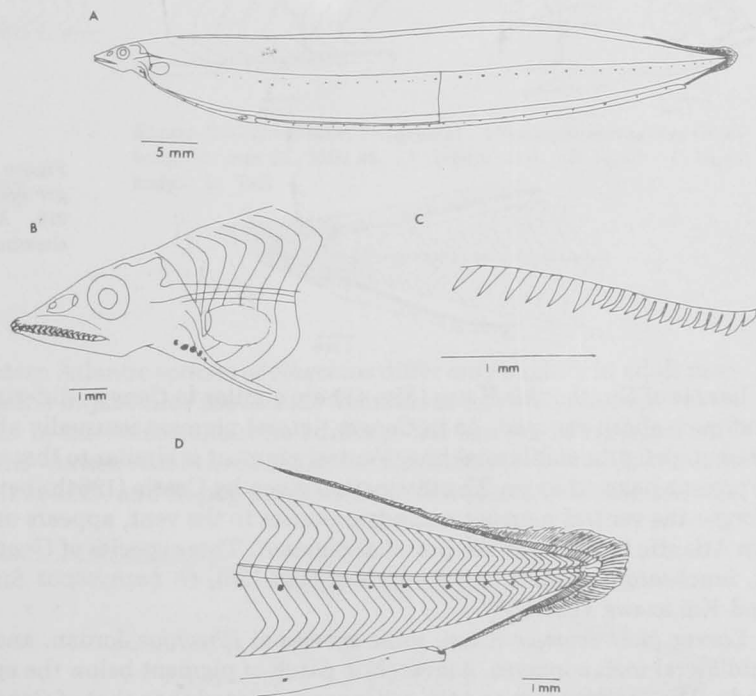


Figure 39.—Congridae, Bathymyrinae: *Paraconger caudilimbatus* (Poey). A. Whole view, 55 mm SL, MBI 47. B. Head, 59 mm SL, MBI 55. C. Upper teeth, same. D. Tail, same.

around the 70th-75th myomere. At the present time the identity of these larvae is uncertain, although Castle (1970a) suggested that *L. scalaris* might be the larva of *Bathymyrus* Alcock. The last vertical blood vessel, however, is much further back than the first caudal vertebra in adults of *Bathymyrus* and the similar *Parabathymyrus* Kamohara (around 70). In this character, these two genera are closer to *L. macreteron*. Based on available evidence, neither *L. scalaris* nor *L. macreteron* can be confidently identified. Both larvae are found in the Atlantic and Indo-West Pacific and must represent widely distributed genera or species groups.

The larva described tentatively by Castle (1964b) as *Alloconger anagoides* is similar to larval *Ariosoma* but has the pigment scattered over the entire lateral body surface.

Paraconger Kanazawa (Fig. 39) belongs to the subfamily Bathymyrinae along with the four genera above, but its larva differs from them in pigmentation. Lateral pigment is a single series of moderate-sized melanophores, less than one per myomere. Ventral pigment is a series of rather widely spaced melanophores. The posterior teeth are broad and bladelike (Fig. 39C). The caudal region resembles that of *Ariosoma*, and the dorsal fin is short. *Paraconger* occurs in the eastern and western Atlantic and the eastern Pacific. Three nominal species occur in the western Atlantic: *P. guianensis* Kanazawa (126-131) is found along the coast of South America, while *P. caudilimbatus* (Poey) (121-125) occurs in the Gulf of Mexico, the Bahamas, and the Caribbean. The vertebral counts may overlap more than is indicated above. *Paraconger harringtonensis* (Mowbray) (123) is known from a single specimen from Bermuda, and may be simply an aberrant specimen of *P. caudilimbatus*.

Subfamily Congrinae.—Larvae of *Conger* Oken (Fig. 40) usually lack lateral pigment, but occasionally a few melanophores may be present along the midlateral line. Ventral pigment extends the length of the gut and sometimes beyond. A crescentic patch of pigment is present under the eye. Three species of *Conger* occur in the western North Atlantic. *Conger oceanicus* (Mitchill) (140-147) occurs mainly, if not entirely, along the continental United States. *Conger esculentus* Poey (132-133) seems confined to the large islands of the West Indies and Bermuda. *Conger triporiceps* Kanazawa (156-161) is an insular species occurring from Bermuda south through the Bahamas and the West Indies to Brazil.

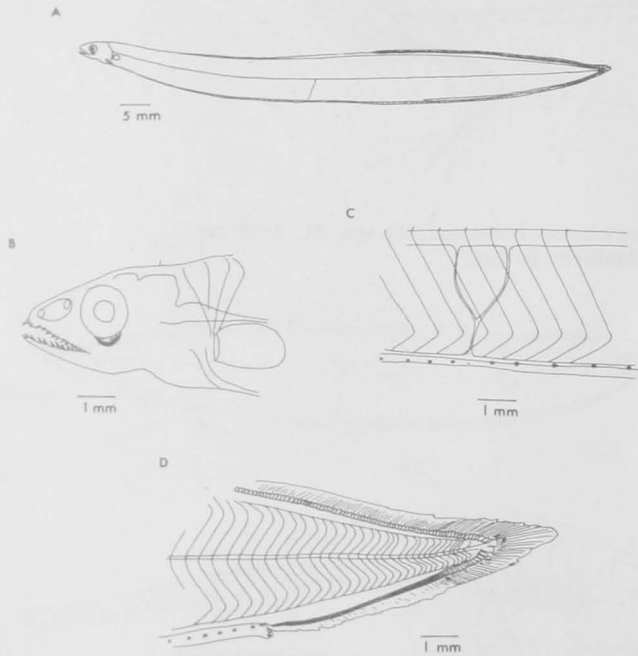


Figure 40.—Congridae, Congrinae: *Conger oceanicus* (Mitchill), 87 mm SL, MBI 210. A. Whole view. B. Head. C. Gut; showing ventral pigment. D. Tail.

Larvae of *Gnathophis* Kaup (Fig. 41) are similar to *Conger*, differing mainly in the shape of the head, distinctly longer and more sharp-snouted. As in *Conger*, lateral pigment is usually absent, but sometimes a few small melanophores are present along the midlateral line. Ventral pigment is similar to that of *Conger* and the same crescentic patch of pigment is present below the eye. The distinction given by Castle (1964b) between larvae of *Conger* and *Gnathophis*, i.e., that in *Conger* the ventral pigment extends posterior to the vent, appears unreliable. Most specimens of *Conger* from the western Atlantic fail to show the postanal pigment. Three species of *Gnathophis* are known from the western North Atlantic: *G. bracheatopos* Smith and Kanazawa (125-130), *G. bathytopos* Smith and Kanazawa (128-133), and *G. tritos* Smith and Kanazawa (136-138).

Larvae of *Uroconger* Kaup, some species of *Rhechias* Jordan, and *Pseudoxenomystax* Breder have a single series of midlateral melanophores, a crescentic patch of pigment below the eye, and ventral pigment extending the length of the body. The head is short and the tail is more pointed than that of *Conger* and *Gnathophis*. Larvae of *Uroconger syringinus* Ginsburg (Atlantic) (Fig. 42) and *U. lepturus* (Richardson) (Indo-Pacific) are recognized by their high myomere counts, above 200. Castle (1969a) showed that the larvae of at least some Indo-Pacific species of *Rhechias* have three rows of

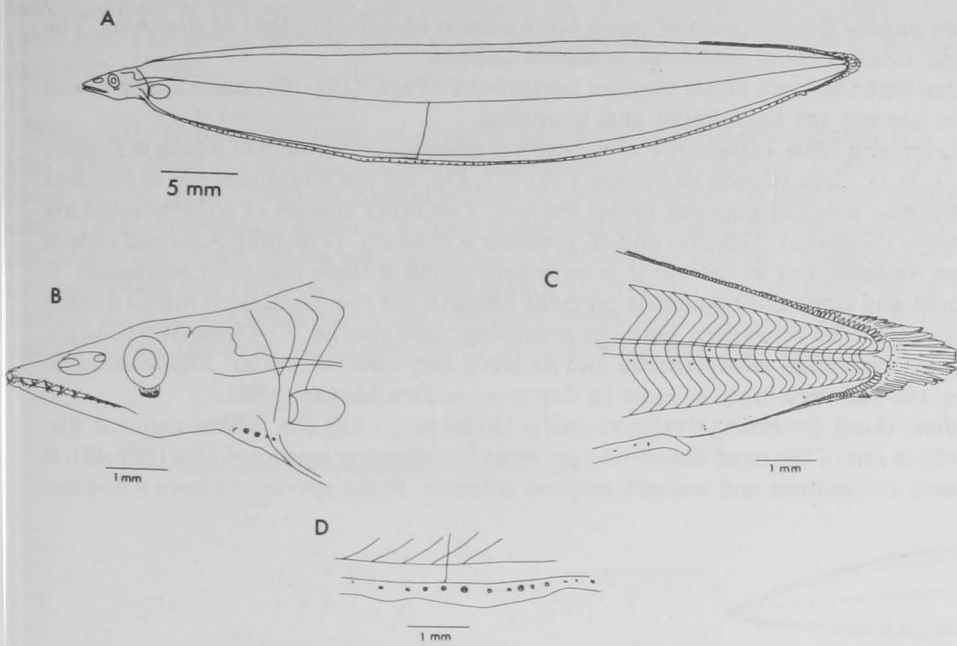


Figure 41.—Congridae, Congrinae: *Gnathophis* sp., 50 mm SL, P 809. A. Whole view. B. Head. C. Gut. D. Tail.

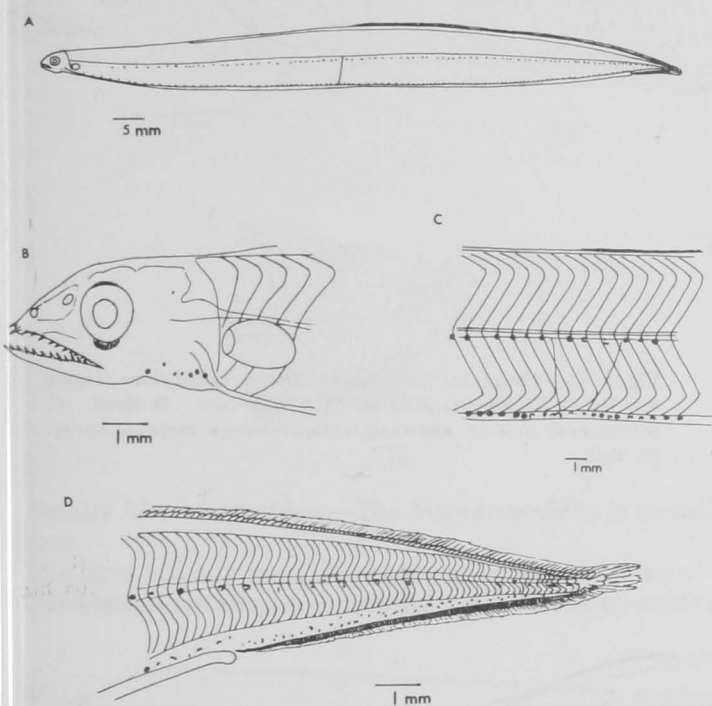


Figure 42.—Congridae, Congrinae: *Uroconger syringinus* Ginsburg, 101 mm SL, MBI 49. A. Whole view. B. Head. C. Mid-body. D. Tail.

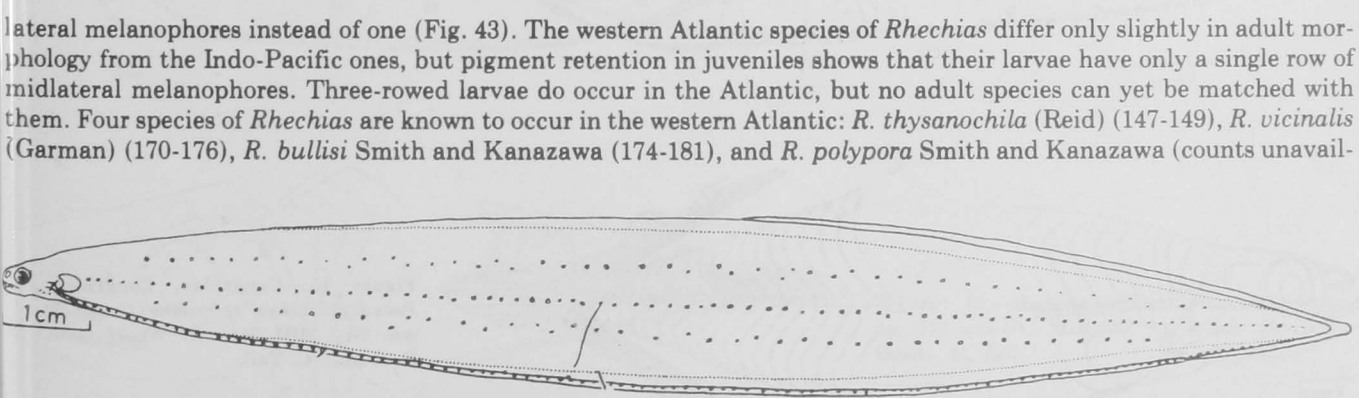


Figure 43.—Congridae, Congrinae: *Rhechias guttulata* (Günther), 123 mm TL, from Castle (1969a).

able). In addition the *Pseudoxenomystax dubius* Breder complex has a larva almost identical to that of *Rhechias*. The species composition is uncertain, but the total range of vertebral counts is 123-144.

Pigment retention in juveniles indicates that the larva of *Acromycter perturbator* (Parr) (157-168) has a single row of midlateral melanophores, but this larva has not yet been found and identified.

Larvae of *Hildebrandia* Jordan and Evermann have a single row of midlateral melanophores, each of which is slightly beneath the surface of the skin (Fig. 44C). In *H. flava* (Goode and Bean) (153-171, Fig. 44) the midlateral row of pigment is distinctly uneven and there is no crescentic patch of pigment under the eye. Two other species of *Hildebrandia* are known from the western Atlantic, *H. guppyi* (Norman) (173-178) and *H. gracilior* (Ginsburg) (176-182). A second type of *Hildebrandia* larva occurs in the western Atlantic, but at present it is uncertain which of these species it represents. It has a more even row of midlateral pigment and some inconspicuous pigment beneath the eye. *Ophisoma nitens* Jordan and Bollman from the eastern Pacific appears to be congeneric with the preceding three species. The Indo-West Pacific *Rhynchoconger* Jordan and Hubbs strongly resembles *Hildebrandia* and its larva may also be similar. *Rhynchoconger ectenurus* (Jordan and Richardson) has 155-159 vertebrae, at least in Japanese waters (Asano 1962).

The larva of *Pseudophichthys splendens* (Lea) (= *Promyllantor schmitti* Hildebrand) has the lateral pigment distributed over the entire surface of the body in one of the most distinctive patterns found in any leptocephalus (Fig. 45). It has 132-135 vertebrae and is found in both the eastern and western tropical Atlantic. Some specimens have a distinct

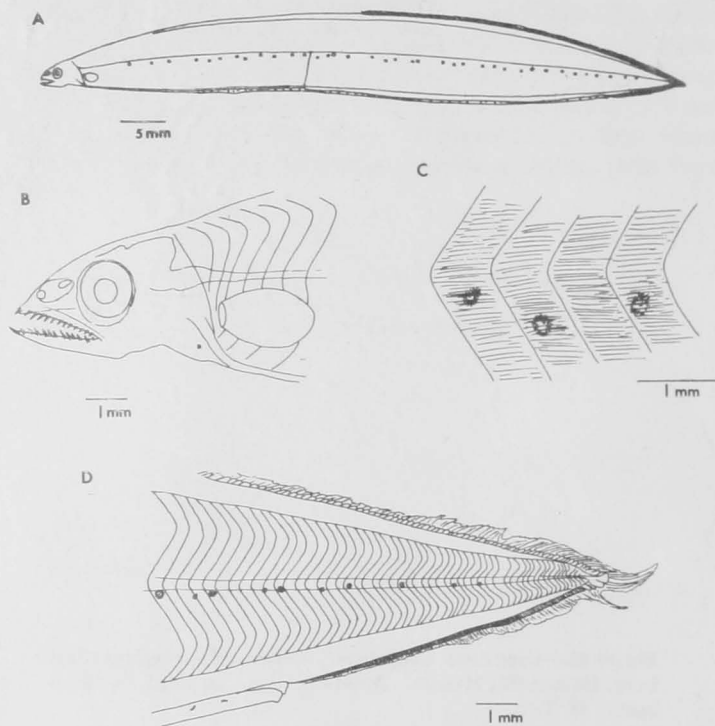


Figure 44.—Congridae, Congrinae: *Hildebrandia flava* (Goode and Bean), 73 mm SL, MBI 48. A. Whole view. B. Head. C. Midlateral region showing subcutaneous melanophores. D. Tail.

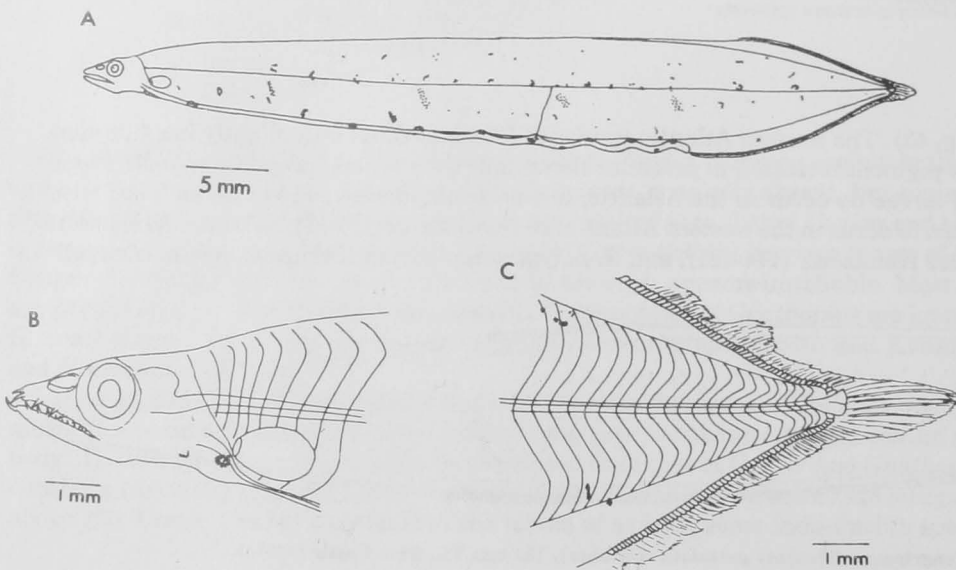


Figure 45.—Congridae, Congrinae: *Pseudophichthys splendens* (Lea), 50 mm SL, MBI 214. A. Whole view. B. Head. C. Tail.

looped pattern to the posterior part of the gut, an uncongridlike feature that could cause confusion when trying to key them out. The prominence of these loops varies individually, being quite obvious in some specimens and hardly apparent in others.

Subfamily Heterocongrinae.—Larvae of the garden eels, Heterocongrinae (Fig. 46), have shorter guts than most congrid larvae, about 67-75% SL. The dorsal fin begins at about the first quarter of the standard length. The tail is rather blunt, and in more advanced specimens the thickened tip can be seen developing which is used for burrowing by the adult. Lateral pigment is either in a single midlateral row or with additional melanophores along the myosepta below the midlateral line. Four genera are recognized: *Heteroconger* Bleeker, *Taenioconger* Herre, *Nystactichthys* Böhlke, and *Gorgasia* Meek and Hildebrand. *Gorgasia* stands apart from the other three, which are closely related to each other. One western Atlantic species is recognized, *Nystactichthys halis* (Böhlke), which has about 165 vertebrae. Myomere counts among larvae, however, vary from 140 to 167 and more than one species or subspecies may be present.

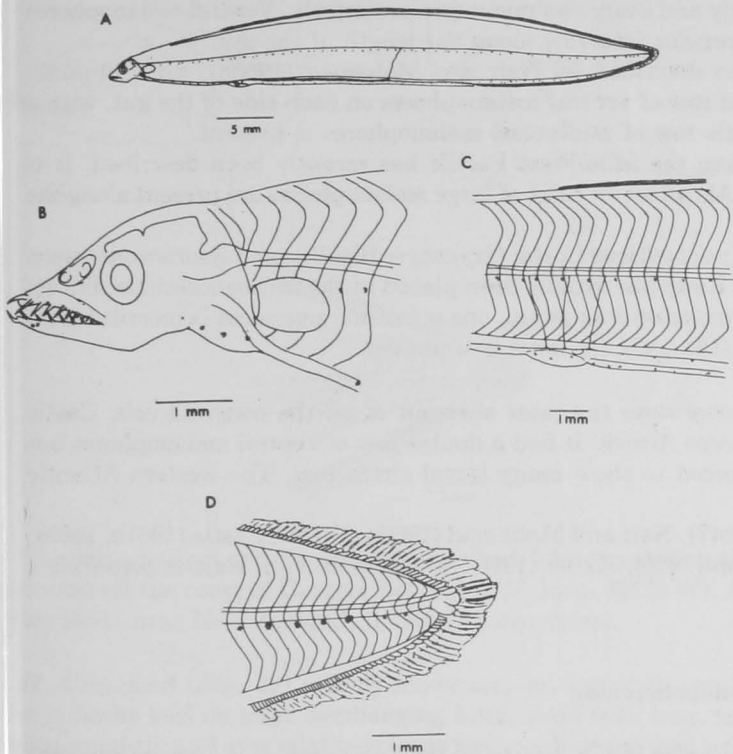


Figure 46.—Congridae, Heterocongrinae: *Nystactichthys halis* (Böhlke), 42 mm SL, MBI 55. A. Whole view. B. Head. C. Gastric region. D. Tail.

Family Muraenesocidae.—The Muraenesocidae is related to the Congridae, but its boundaries are not precisely known.

The larva of a species of *Paraxenomystax* Reid was described by Blache (1968) (Fig. 47). It has a series of large, expanded lateral melanophores distributed alternately on either side of the body. Ventral pigment is limited to a few large

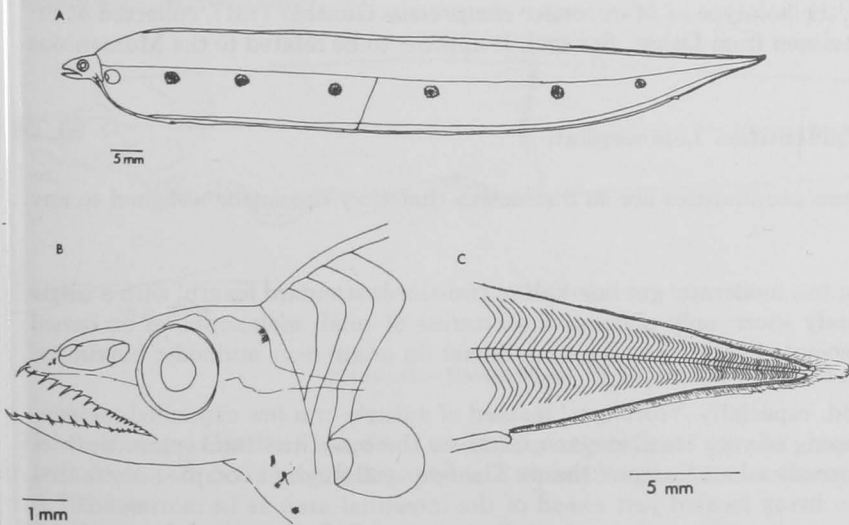


Figure 47.—Muraenesocidae: *Paraxenomystax* sp., 115 mm SL, MBI 330. A. Whole view. B. Head. C. Tail.

melanophores. The larvae can grow to well over 200 mm. The distinctions between this genus and the related *Xenomystax* Gilbert are not satisfactorily established, but species are found in all oceans. In the western Atlantic there is one described species, *P. bidentatus* Reid, and two or three undescribed species. Vertebral numbers range from 170 to about 215, with some north-to-south intraspecific variation.

The larvae of three species of *Muraenesox* McClelland and *Congresox* Gill have been described from India. The gut is shorter in these larvae than in *Paraxenomystax*, about two-thirds to three-fourths standard length.

Nair (1947) described a metamorphosing series of larvae of *Muraenesox cinereus* (Forsskal) (145-159). The body is moderate and the head is rather long with a characteristic convex dorsal profile above the nasal region. Ventral pigment is irregularly distributed the length of the gut. A single series of expanded melanophores is present midlaterally, one per myomere behind the 17th myomere, with three or four additional melanophores anterior to that point. The number of myomeres in Nair's specimen, 138, suggests that it might be *M. bagio* (Hamilton) (128-141) rather than *cinereus*.

Larvae of *Congresox talabonoides* (Bleeker) (132-145), as described by Nair and Mohamed (1960a), have a more elongate body and a shorter and more acute snout than the preceding. Midlateral melanophores are large and stellate and are distributed every three to four myomeres anteriorly and every two myomeres posteriorly. Ventral melanophores are clustered into a series of six to eight large spots at regular intervals along the length of the gut.

Larvae of *Congresox talabon* (Cantor) (143-149), also described by Nair and Mohamed (1960b), differ from *C. talabonoides* mainly in pigmentation. They have a paired row of ventral melanophores on each side of the gut, with a third row above the paired row on the right side. A single row of midlateral melanophores is present.

The larva of *Gavialiceps taeniola* Alcock (230-261) from the Indo-West Pacific has recently been described. It is elongate with a moderately long head and a pointed tail. About seven pairs of large melanophores are present along the length of the gut. Lateral pigment is absent.

Other genera assigned to the Muraenesocidae include *Cynoponticus* Costa, *Oxyconger* Bleeker, and *Sauromuraenesox* Alcock. Their larvae have not been described. *Hoplunnis* Kaup has usually been placed in the Muraenesocidae, but its larva is much more like a nettastomatid. Besides the *Paraxenomystax* group, one other muraenesocid is recorded from the western Atlantic, *Cynoponticus savanna* (Bancroft) (131-136); its larva is unknown.

Other Congridlike Eels.—*Coloconger* Alcock is in many ways the most aberrant of all the congrid eels. Castle (1969a) described a metamorphosing specimen of *C. raniceps* Alcock. It had a double row of ventral melanophores but lacked lateral pigment. The specimen was too far advanced to show many larval characters. The western Atlantic species, *C. meadi* Kanazawa, has 150-163 vertebrae.

References: D'Ancona (1928), Sparta (1938b), Nair (1947), Nair and Mohamed (1960a, 1960b), Castle (1964b, 1969a, 1977), Blache (1968), Raju (1974b), Castle and Williamson (1975), Keller (1976). In addition N. S. Raju is preparing a manuscript on eastern Pacific congrid larvae.

Macrocephenchelyidae

This monotypic family (*Macrocephenchelys brachialis* Fowler 182) is related to the Congridae. It is known from only two specimens, collected near Borneo, and its larva is unknown.

Reference: Robins and Robins (1971).

Myrocongridae

This monotypic family is known only from the holotype of *Myroconger compressus* Günther (131), collected at St. Helena in the South Atlantic, and a partial specimen from Dakar, Senegal. It appears to be related to the Muraenidae and Xencongridae. The larva is unknown.

Unidentified Leptocephali

Several kinds of leptocephali are known whose peculiarities are so distinctive that they cannot be assigned to any known family.

1. Unnamed (Fig. 48).—Body relatively deep; tail moderate; gut one-half to two-thirds standard length, with a single sharp arch at the posterior end; head moderately short; only pigment a scattering of small melanophores on dorsal aspect of intestinal arch, each melanophore associated with a small bump; dorsal fin origin near midbody; maximum size unknown, at least 63 mm.

Superficially this larva resembles a moringuid, especially *Neoconger*. Instead of a single or a few expanded melanophores, however, the present larva has a peppering of very small melanophores on the intestinal thickening. Each of these melanophores appears to be located on a small raised bump of tissue. The liver-gall bladder complex is situated anterior to the midpoint of the gut rather than being located just ahead of the intestinal arch as in moringuids.

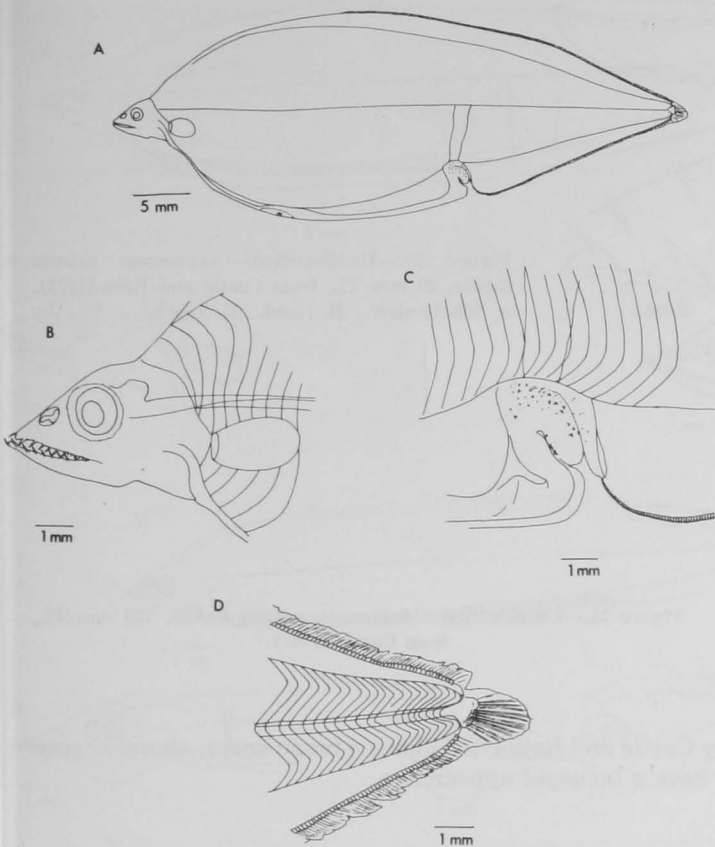


Figure 48.—Unidentified: I, 50 mm SL, USNS *Sands* 606-8-T3-C+D. A. Whole view. B. Head. C. Anal region. D. Tail.

This larva has not previously been described. The description above is based on a 50-mm specimen with 121 myomeres collected off the coast of Georgia (lat. 31°30'N, long. 75°25'W). Another specimen of 63 mm was collected by the *Dana* (Stn. 3651) near New Zealand; it had 132 myomeres.

II. Unnamed (Fig. 49).—Body moderate; gut less than one-half standard length, with irregular thickenings anteriorly; fleshy keel on nape overhanging head; head with long, pointed snout; nasal organ elongate, about midway between snout tip and eye; relatively large melanophores on gut; a few deep-lying pigment spots on spinal cord; maximum size unknown, at least 66 mm.

Weber (1913) mistakenly identified this larva as *Leptocephalus mirabilis* Brauer, a dysommine. The short, irregularly thickened gut and the fleshy keel on the nape are the most distinctive features of this larva. The form of the gut and the elongated body are somewhat reminiscent of the nettastomatid genus *Facciolella*, but this resemblance may or may not be significant. It has been collected from the Indo-Australian region and the western Atlantic.

Reference: Weber (1913).

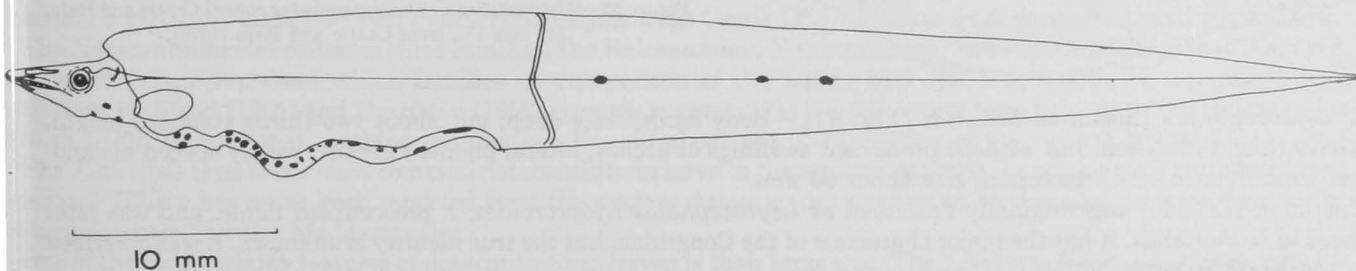


Figure 49.—Unidentified: II, 66 mm SL, USNS *Sands* 606-8-T3-C+D.

III. *Ascomana* Castle (Figs. 50-51).—Body elongate; gut long and simple; dorsal origin behind midlength; pectoral fin well developed; head long; lateral pigment absent; large ventral melanophores from throat to vent; maximum size at least 700 mm.

This is one of the largest of all leptocephali. It shows some muraenesocid features in the head, but its identity is unknown. Two species have been described, *A. eximia* Castle (153-159) from the Atlantic and *A. canina* Castle and Raju

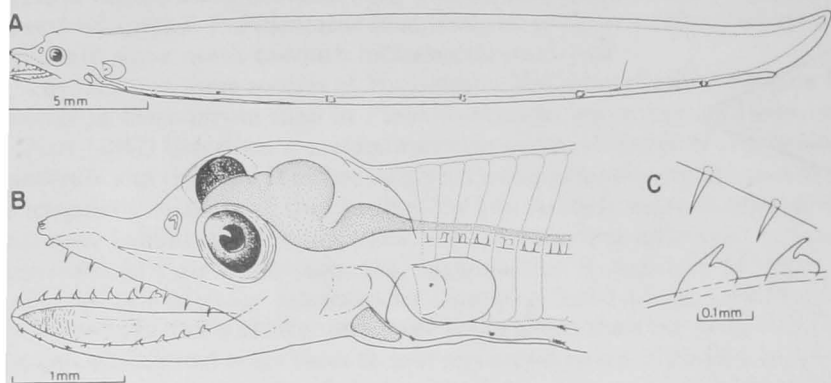


Figure 50.—Unidentified: *Ascomana eximia* Castle, 29 mm TL, from Castle and Raju (1975). A. Whole view. B. Head. C. Teeth.

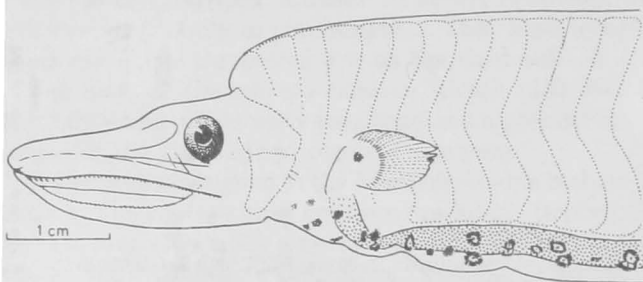


Figure 51.—Unidentified: *Ascomana eximia* Castle, 700 mm TL, from Castle (1967).

from the Indian Ocean. The smaller specimens described by Castle and Raju (1975) have a broad snout, shovel-shaped in dorsal profile, and the posterior teeth in the lower jaw have a bicuspid appearance.

References: Castle (1967), Castle and Raju (1975).

IV. *Thalassenchelys* Castle and Raju (Fig. 52).—Body very deep; tail very broadly rounded; head moderately short; gut about one-half standard length, without obvious thickenings or loops; dorsal origin at about midbody; pectoral fin well developed; pigment sparse or absent; maximum size 300 mm.

The large size and truncated tail make this one of the most distinctive of all leptocephali. Castle and Raju referred it to the Xenocoelidae, largely by a process of elimination, but this identification seems unlikely. It occurs in the Indo-Pacific and the eastern Pacific, but appears to be absent from the Atlantic.

References: Cohen (1959), Castle and Raju (1975).

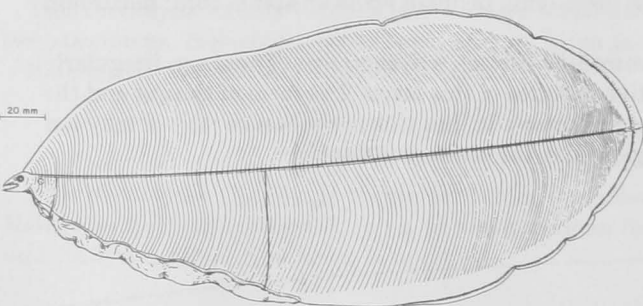


Figure 52.—Unidentified: *Thalassenchelys coheni* Castle and Raju, 246 mm TL, from Castle and Raju (1975).

V. *Leptocephalus thorianus* Schmidt (Fig. 53).—Body moderately deep; gut about two-thirds standard length, relatively thick throughout but without prominent swellings or arches; lateral pigment absent; widely spaced melanophores from liver to vent; maximum size about 90 mm.

This larva (133-143) was originally described as *Leptocephalus hyoproroides*, a preoccupied name, and was later changed to *L. thorianus*. It has the major characters of the Congridae, but the true identity is unknown. It was described from the North Atlantic.

A similar form occurs in the Indo-Pacific. It has heavier and more extensive pigment (Fig. 53C, D), but otherwise resembles *L. thorianus*.

Reference: Schmidt (1909).

NOTACANTHIFORMES (Fig. 54)

Body extremely elongate; tail without normal caudal fin, instead a postcaudal filament; short dorsal fin of about 10 rays located anteriorly around the 40th-50th myomere; small pelvic fins present on large specimens; pectoral fin mi-

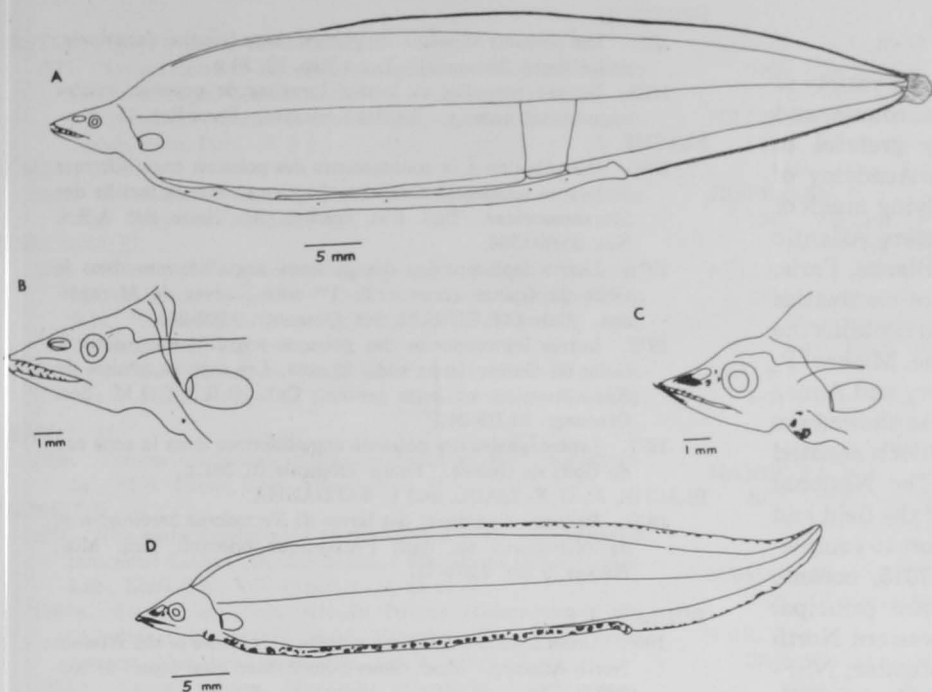


Figure 53.—Unidentified: *Leptocephalus thorianus* Schmidt. A. Whole view, 73 mm SL, Dana 4171 V (Atlantic). B. Head, same. C. Whole view, 59 mm SL, Dana 3917 VII (Western Pacific). D. Head, same.

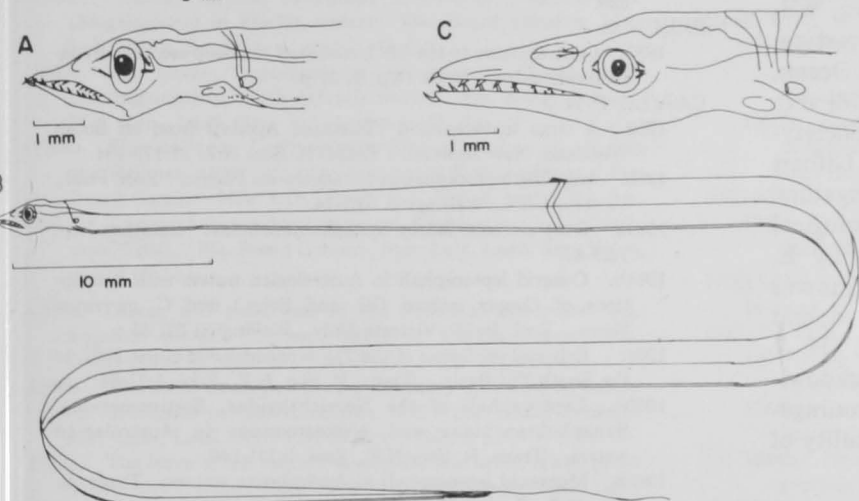


Figure 54.—Notacanthiformes. A. and B. *Tiluropsis*. C. *Leptocephalus giganteus* Castle.

ute; gut simple, extending almost entire length of body; ventral pigment variable; lateral pigment usually absent, but small melanophores may be present on myosepta just below midlateral line; myomeres broadly V-shaped, very numerous, 300 or more, maximum size at least 1,800 mm.

Three major types of notacanthiform larvae are known, distinguished mainly by the shape of the head and eye; *Tilurus* Kölliker has a moderately short head and a round eye; *Tiluropsis* Roule (Fig. 54A, B) has a moderately short head and a vertically elongated eye; *Leptocephalus giganteus* Castle (Fig. 54C) has an elongate head and a round eye.

The Notacanthiformes contains three families, the Halosauridae, Notacanthidae, and Lipogenyidae, but it is not certain which larvae represent which families. A comparison of the larvae with the descriptions of metamorphosing specimens by Mead (1965) and Harrisson (1966) strongly suggests that the *Tiluropsis* form belongs to the Halosauridae (Smith 1970). Beyond that, nothing positive can be said about the identification of the various larvae.

The *Tiluropsis* type is the most common notacanthiform larva in the western Atlantic. *Leptocephalus giganteus* is less common. *Tilurus* has never been reported from the western Atlantic, but appears to be the most common form in the eastern Atlantic and the Mediterranean.

One of the most striking features of notacanthiform larvae is their large size. The 1,800 mm *Dana* giant leptocephalus was shown by Nielson and Larsen (1970) to be *L. giganteus*.

The following species of notacanthiform fishes are found in the western North Atlantic. Halosauridae: *Halosaurus ovenii* Johnson, *H. guentheri* Goode and Bean, *Halosauropsis macrochir* (Günther), *Aldrovandia affinis* (Günther), *A. gracilis* Goode and Bean, *A. phalacra* (Vaillant), *A. rostrata* (Günther), and *A. oleosa* Sulak. Notacanthidae: *Polyacanthonotus africanus* (Gilchrist and von Bonde), *P. rissoanus* (DiFilippi and Verany), and *Notacanthus chemnitzii* Bloch. Lipogenyidae: *Lipogenys gilli* Goode and Bean. No information is available on vertebral numbers.

References: Castle (1959, 1967), Mead (1965), Harrisson (1966), Nielsen and Larsen (1970), Smith (1970), McDowell (1973).

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APPENDIX

Numbers of myomeres and vertebrae for species listed in this paper.

Albulidae	
<i>Albula vulpes</i>	68-74
<i>A. nemoptera</i>	77-80
Elopidae	
<i>Megalops atlantica</i>	53-57
<i>M. cyprinoides</i>	65-67
<i>Elops saurus</i>	73-80
Synphobranchidae: Dysommidae	
<i>Dysomma anguillare</i>	119-130
<i>D. brevirostre</i>	195-204
<i>Dysommina rugosa</i>	126-134
<i>Atractodenchelys phrix</i>	169-173
<i>Haptenchelys texis</i>	126-128
Synphobranchidae: Synphobranchinae	
<i>Synphobranchus affinis</i>	128-139
<i>S. brevidorsalis</i>	130-135
<i>S. oregoni</i>	142-148
<i>S. kaupi</i>	146-150
<i>Histiobranchus infernalis</i>	126-140
<i>Ilyophis brunneus</i>	144-151
Synphobranchidae: Simenchelyidae	
<i>Simenchelys parasiticus</i>	121-125
Saccopharyngoidei: Eurypharyngidae	
<i>Eurypharynx pelecyanoides</i>	97-125
Saccopharyngoidei: Saccopharyngidae	
<i>Saccopharynx</i> spp.	138-250
Moringuidae	
<i>Moringua edwardsi</i>	113-122
<i>Neoconger</i> spp.	96-110
Nettastomatidae	
<i>Nettastoma melanurum</i>	190-207
Cyemidae	
<i>Cyema atrum</i>	ca. 80
Ophichthidae	
<i>Myrophis punctatus</i>	138-148
<i>Ahlia egmontis</i>	157-167
<i>Pisodonophis cruentifer</i>	146-152
Anguillidae	
<i>Anguilla anguilla</i>	111-119
<i>A. rostrata</i>	104-111

erichthyidae	
<i>Nessorhamphus danae</i>	135-145
<i>N. ingolfianus</i>	149-159
<i>Derichthys serpentinus</i>	126-134
errivomeridae	
<i>Platuronides acutus</i>	153-158
<i>P. danae</i>	165-170
<i>Serrivomer beani</i>	154-165
<i>S. brevidentatus</i>	155-165
<i>S. parabeani</i>	156-163
Guraenidae	
<i>Anarchias yoshiae</i>	107-114
<i>Uropterygius juliae</i>	118-123
<i>Channomuraena vittata</i>	ca. 149
<i>Gymnothorax nigromarginatus</i>	137-145
<i>G. saxicola</i>	135-144
<i>G. ocellatus</i>	142-150
<i>G. sp.</i>	132-137
<i>G. sp.</i>	162-167
<i>G. sp.</i>	163-174
<i>G. moringa</i>	134-142
<i>G. funebris</i>	139-145
<i>G. polygonius</i>	134-140
<i>G. vicinus</i>	129-136
<i>Enchelycore nigricans</i>	141-147
<i>E. carychroa</i>	131-140
<i>Muraena miliaris</i>	118-126
<i>M. pavonina</i>	126-128
<i>M. punctata</i>	128-132
<i>M. retifera</i>	128-135
<i>M. robusta</i>	153-156
<i>Rabula acuta</i>	123-129
<i>Echidna catenata</i>	114-119
emichthyidae	
<i>Avocettina infans</i>	181-201
<i>A. acuticeps</i>	198-216
<i>A. paucipora</i>	175-188
<i>A. bowersi</i>	177-192
<i>Labichthys carinatus</i>	174-191
<i>L. yanoi</i>	178-190
<i>Nemichthys</i> spp.	more than 300
enocongridae	
<i>Kaupichthys hyoprорoides</i> (except Hawaii) ..	109-123
<i>K. hyoprорoides</i> (Hawaii)	97-98
<i>K. atronasmus</i>	114
<i>K. brachychirus</i>	108-116
<i>K. nuchalis</i>	121-125
<i>Catesbya pseudomuraena</i>	136-141
<i>Chilorhinus suenisoni</i>	98-105
<i>C. platyrhynchus</i>	107-112
<i>Chlopsis bicolor</i>	127-134
<i>C. olokun</i>	125-139
<i>C. bicollaris</i>	138-145
<i>C. apterus</i>	136
<i>C. dentatus</i>	116-124
<i>Robinsia catherinae</i>	130-136
Heterenchelyidae	
<i>Pythonichthys microphthalmus</i>	110-121
<i>P. macrurus</i>	124-136
<i>P. sanguineus</i>	108
<i>P. asodes</i>	126-135
<i>Panturichthys isognathus</i>	149-162
<i>P. longus</i>	209-227
<i>P. fowleri</i>	ca. 150
Congridae: Bathymyrinae	
<i>Ariosoma balearicum</i>	120-137
<i>A. selenops</i>	158-174
<i>A. analis</i>	146-150
<i>A. coquettei</i>	155-160
<i>Paraconger guianensis</i>	126-131
<i>P. caudilimbatus</i>	121-125
<i>Parabathymyrus oregoni</i>	149-152
Congridae: Congrinae	
<i>Conger oceanicus</i>	140-147
<i>C. esculentus</i>	132-133
<i>C. triporiceps</i>	156-161
<i>Gnathophis bracheatopos</i>	125-130
<i>G. bathytopos</i>	128-133
<i>G. tritos</i>	136-138
<i>Uroconger syringinus</i>	200-220
<i>U. lepturus</i>	200-220
<i>Rhechias thysanochila</i>	147-149
<i>R. vicinialis</i>	170-176
<i>R. bullisi</i>	174-181
<i>Pseudoxenomystax dubius</i> and related forms	123-144
<i>Acromycter perturbator</i>	157-168
<i>Hildebrandia flava</i>	153-171
<i>H. gracilior</i>	176-182
<i>H. guppyi</i>	173-178
<i>Rhynchoconger ectenurus</i>	155-159
<i>Pseudophichthys splendens</i>	132-135
Congridae: Heterocongrinae	
<i>Nystactichthys halis</i>	ca. 165
Muraenesocidae	
<i>Paraxenomystax</i> spp.	170-215
<i>Muraenesox cinereus</i>	145-159
<i>M. bagio</i>	128-141
<i>Congresox talabonoides</i>	132-145
<i>C. talabon</i>	143-149
<i>Cynoponticus savanna</i>	131-136
<i>Gavialiceps taeniola</i>	230-261
Other congrid-like eels	
<i>Coloconger meadi</i>	150-163
Macrocephenchelyidae	
<i>Macrocephenchelys brachialis</i>	182
Myrocongridae	
<i>Myroconger compressus</i>	131

ERRATA

NOAA Technical Report NMFS Circular 147: Guide to the Identification of General of the Fish Order Ophidiiformes With a Tentative Classification of the Order, by Daniel M. Cohen and Jorgen G. Nielsen.

Page 2, bottom of Table 1, blank spot, add: Aphyonidae