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A Key for Identification of Ichthyoplankton from the Northwest Atlantic (Shelf waters north of the Cabot Strait)

by

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ABSTRACT

The key provides descriptions of eggs, larvae and fry of 58 fish species common for the Newfoundland Bank area, the Labrador shelf and the Davis Strait. The descriptions involve the following characteristic features: 1. Eggs: type of the clutch, egg capsule structure, perivitelline space width, structure of yolk, oil globule, blastodisc and embryo and pigmentation pattern. 2. Larvae: shape, morphosis stage, size, myomere number, body proportions, anus type, gut structure, head shape, teeth, fin structure and pigmentation pattern.

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I N T R O D U C T I O N

Early life histories of marine fishes have a key position in the studies of many aspects of their ecology and life cycles. The detection of areas and periods of spawning contributes greatly to the knowledge of population structure and the analysis of eggs and larvae distribution allows for obtaining migration patterns of fishes.

Problems concerning stock-recruitment relationship, year-class abundance fluctuations and impact of fishery are closely related to early life histories of marine fishes.

The foregoing has given impetus to studies of early life history of marine fishes and to extensive ichthyoplankton surveys during recent two decades, particularly in the North and North-west Atlantic, to the north of Nova Scotia and the Cabot Strait Investigations carried out by A.Dannevig (1919) in 1914-1918 were resumed in 1959 and special international ichthyoplankton surveys were initiated in the Flemish Cap Bank area in 1978, and, as a result, thousands of ichthyoplankton samples were obtained, which have not been totally sorted out.

Untill recently the only manuals for identification of the North Atlantic fish eggs and larvae were the monograph by E.Ehrenbaum: "Eier und Larven von Fischen" and by T.S.Rass: "Composition of ichthyofauna and taxonomic characters of eggs and larvae from the Barents Sea" (1949). The identification key drawn up by John B.Colton & Robert Marak (1969) assisted greatly in ichthyoplankton studies in the Georges Bank area. Identification of ichthyoplankton has been facilitated by F.S.Russell's monograph "The Eggs and Planktonic Stages of British Marine Fishes",

and by a 6 - volume edition of "Development of fishes of the Mid-Atlantic Bight" by Jones, Martin, Hardy, Johnson, Fritzsche & Drewry, concerning eggs, larvae and fry from warm temperate waters of the West Atlantic , chiefly off the USA coast.

The identification of ichthyoplankton from the Great Newfoundland Bank, Labrador shelf and Davis Strait still presents difficulties and this work is an attempt to alleviate this problem.

The key provides descriptions of eggs, larvae and fry of 58 species occurring frequently in ichthyoplankton samples taken in shelf and slope waters in the northern part of the Northwest Atlantic. Fishes which spawn in the coastal areas or inhabit oceanic depths are practically excluded. Eggs, larvae and fry are described based chiefly on literature data and the corresponding references are given. The aim of the author was to present a simple key for the identification to be easily carried out by the staff responsible for the analysis of ichthyoplankton samples. The descriptions are to be considered as detailed annotations to figures rather than as data on the development of eggs, larvae and fry. The key is far from perfect due to the incomplete list of species and inadequate information on some stages. However, the necessity of accelerating the analysis of extensive ichthyoplankton material collected during Soviet and international surveys in the northernmost Northwest Atlantic has forced the author to present this tentative paper and any critisism will be highly appreciated and acknowledged with gratitude.

SOME NOTES ON THE DEVELOPMENTAL STAGES AND TERMINOLOGY

The key conforms with the developmental stages proposed by Prof. T.S.Rass (1946, 1949) on the basis of morphological and taxonomic characters inherent in definite periods of development. Phases and stages are recognized as two major developmental categories (Fig.1). Phases embrace two distinctive periods of ontogeny, splitting into stages. A total of 5 phases are recognized: 1) egg; 2) prelarva; 3) larva; 4) larva-fry and 5) fry. The egg phase covers the period of embryo-development, the prelarval phase is characterized by the presence of the yolk sac; the larval phase lasts from the time of the yolk sac absorption till the end of metamorphosis. During the larva-fry stage the larval shape of the body is lost, the body is opaque, fin rays are differentiated and scales are developing. In the fry the features of adults are acquired and the phase ends at maturity.

Developmental phases are subdivided into stages. A total of 4 stages are distinguished during the egg stage (after T.S.Rass). (Fig.2). Stage I (non-fertilized eggs are frequently referred to this Stage): from fertilization to the beginning of the embryonic shield formation; Stage II: from the embryonic rod formation till the separation of the postanal part from the yolk sac surface; Stage III: from the definition of the caudal region till the time when the embryo body embraces the entire periphery of the yolk; Stage IV: from the time when the embryo embraces the yolk till the emergence. At this stage the eyes are pigmented in many species and a specific pigmentation pattern is recorded in each species.

During the larval phase two stages are recorded: early larva with the protopterigium and no rays in the fins and the stage of late or advanced larva which lasts from the time of ray formation in unpaired fins till the end of metamorphosis. In some fishes this phase may be accompanied by a greater number of stages.

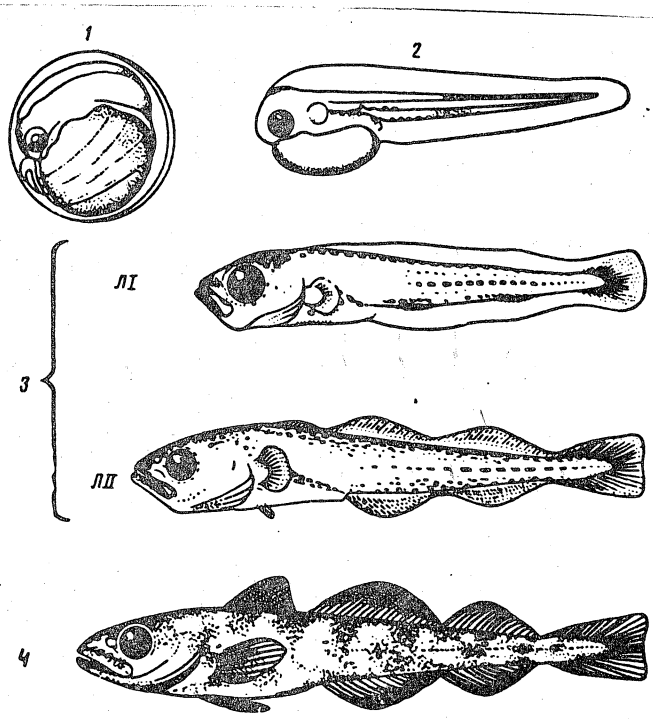


Fig. 1. Developmental phases of cod.
1 - egg; 2 - prelarva ; 3 - larvae; LI - early larva, LII - late larva, 4 - fry.
(Rass,Kazanova,1966)

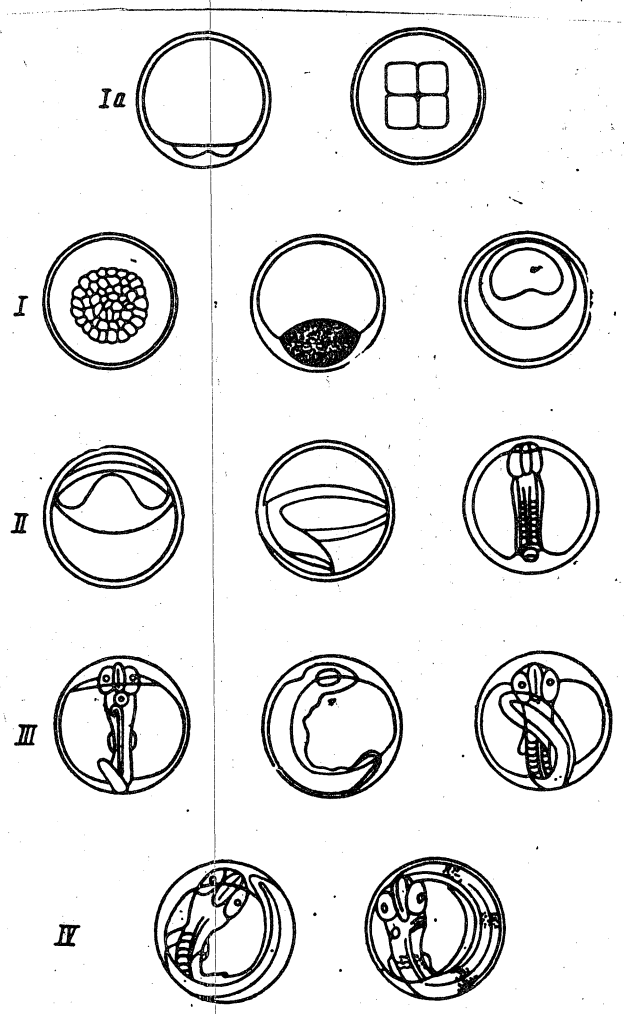


Fig. 2. Stages of embryo development in cod
I - cleavage and overgrowth; Ia - initial cleavage (2 - 8 blastomeres);
II - embryonic shield formation;
III - early embryo;
IV - advanced embryo.
(Rass, Kazanova, 1966)

Terms used follow those of Mansueti & Hardy (1967) (except for the developmental stages) and are defined as follows:

Total Length: Straight-line distance from the tip of the snout to the tip of the caudal fin (or of protopterigium in prelarvae).

Standard Length: Straight-line distance from the tip of the snout to the tip of urostyle or notochord (or to the end of the hypural plate in advanced stages).

Head Length: Distance from the tip of the snout to the most posterior part of the auditory vesicle or of opercular membranes, following operculum formation.

Preanal Length: Distance from the tip of the snout to the posterior margin of the anus.

Egg Diameter: In spherical eggs, the greatest diameter of the egg capsule; in elliptical eggs two measurements are given: Major and Minor axes.

Yolk Diameter: Greatest diameter of the yolk prior to embryo formation.

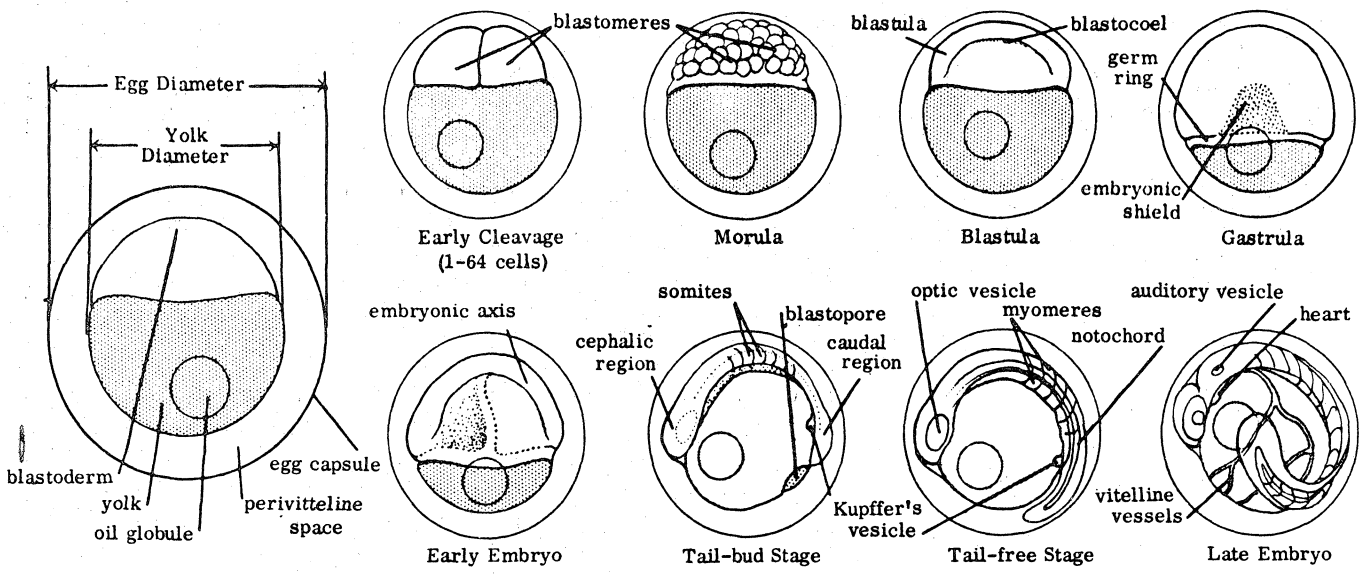
Oil Globule Diameter: Greatest diameter of oil globue.

Width of Perivitelline Space: Distance between egg capsule and yolk, expressed as the ratio of width of perivitelline space to radius of egg capsule.

Preanal Myomeres: The number of myomeres between the most anterior myoseptum and a vertical line drawn from posterior margin of anus.

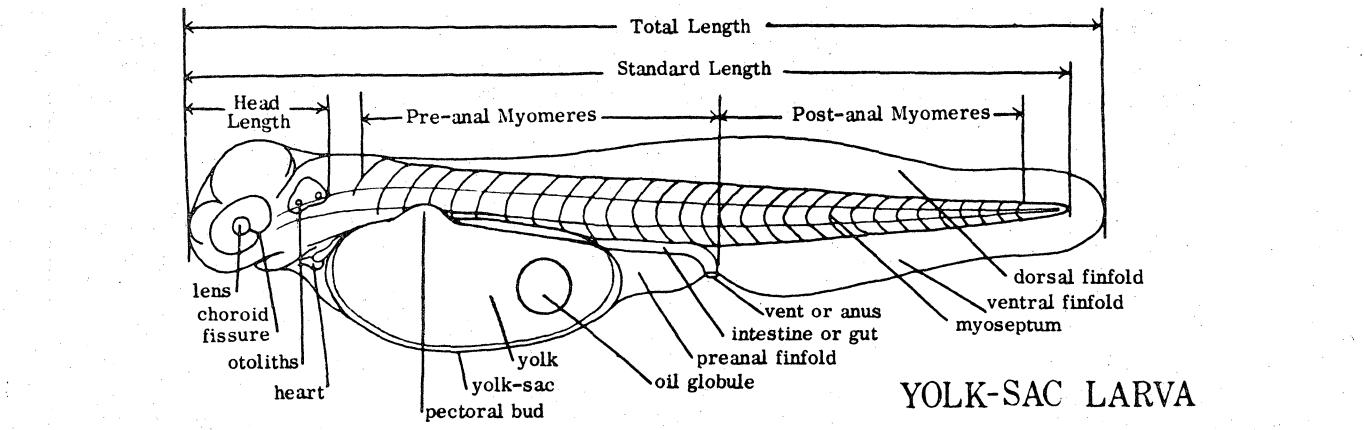
Postanal Myomeres: The number of myomeres between a vertical line drawn from posterior margin of anus and the most posterior myoseptum. Last myoseptums in prelarvae and early larvae are frequently obscured, resulting in a low count.

Other terms employed in descriptions of eggs, larvae and fry are given in Fig.3.

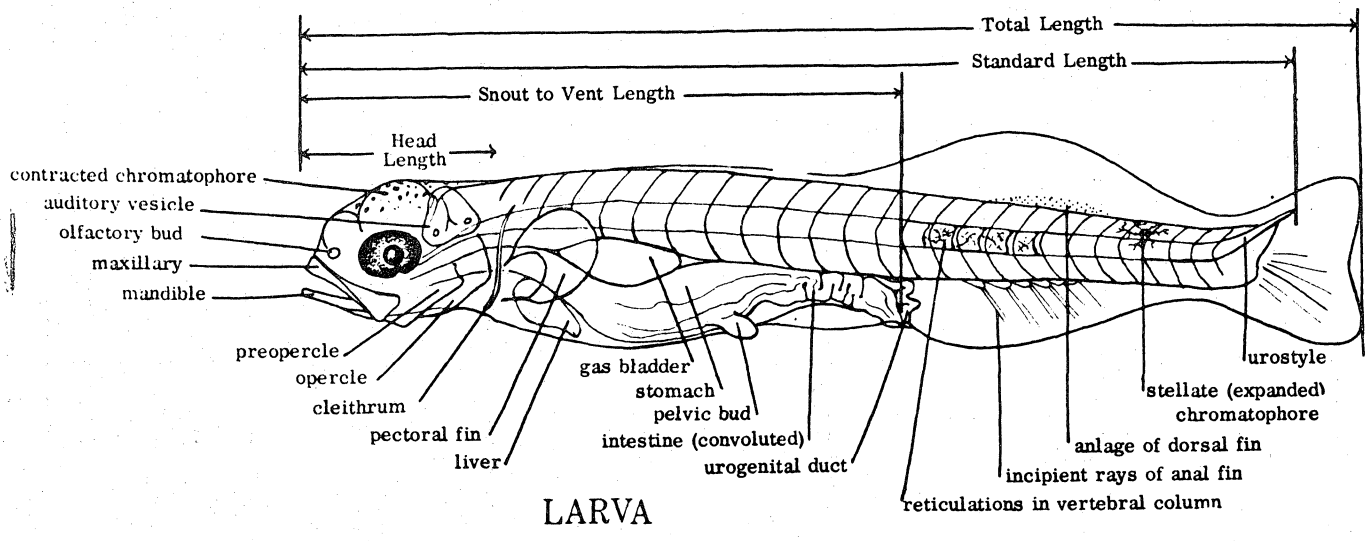


EGG STRUCTURE

EGG DEVELOPMENT



YOLK-SAC LARVA



LARVA

Fig.3.Morphology and development of egg and larval stages of typical teleost(Mansueti & Hardy,1967).Yolk-sac larva identical to prelarva,

LADYFISH ELOPS SAURUS LINNE, 1766

Spawning . . . unknown.

Eggs undescribed, probably pelagic.

Prelarvae undescribed.

Larvae. The development is represented by two periods of length increase (Stages I and III) interspaced by a period of length decrease (Stage II).

Larvae I. The size is 5.3-38.3 mm (sometimes 45.0 mm) TL. The body is ribbon-like, long and deep. The body depth is 11-14 % of the length. The total myomere number is 74-83 (preanal -70) the gut is straight, the anus is in the posterior 1/9th of the body; the head is slightly deeper than the body. Four sharp long teeth are in a single row on each side of the jaw, the anterior two are the longest. Incipent rays are in C and D. The dorsal finfold is originated immediately behind the head; the preanal finfold from anus to point 1/3 distance to the head. Pigmentation; the body is translucent; 16 melanophores are along the dorsum of the digestive tract. Eyes are melanin-and guanin-pigmented.

At 11.5 - 24.0 mm TL the body is deeper than the head; the head is still triangular. The myomer number is 74-83 (65-72 are preanal). Incipent gas bladder and the kidney are evident near the 35-36th myomere and near 52-53 myomere.
6 teeth are at each side of the upper and lower jaw; at 40-45 mm TL the number of teeth increases. The dorsal finfold is reduced in the anterior part of the body. Incipent rays are in the caudal fin.

The hypuralia number is 4- 7. Pigmentation: At 24 mm TL the melanophore number increases up to 43; at 11.5 mm 8 melanophores are developed along the lateral line and their number increases to 30 at 24 mm TL.

At 30.0-46.7 mm TL 21-24 incipient rays are in the dorsal, 13-15 in the anal and 1+19+1 in the caudal fin.

Larvae II. During this period TL decreases from 40.0-45.0 down to 18.0-20.0 mm. 22-25 rays in the dorsal, 13-16 in the anal, and 1+19+1 - 2+19+2 in the caudal and 4 in the ventral fin. The total myomere number is 83-72, 77-60 are preanal and 66-48 are predorsal. The gas bladder a is at myomere 39-28, the kidney is at myomere 55-47. The leptocephalid appearance is lost, the head is no longer triangular. The anteanal distance constitutes 93.4-81.7% and the head depth 7.1-15.1% of the body length. The eye diameter is 1.2-3.9% of SL. At 34.0 mm SL the incipient ventral fin is at myomere 36, the gas bladder is extended to the vertebral column at 30.0 mm SL.

Pigmentation: the melanophores increase in number and size; the melanin pigment is evident on the dorsal side of the gas bladder.

Larvae III. (pre-juveniles). 18.0-30.0 mm SL. The finfold is partially retained in the caudal pedancle at 25-35 mm. The body is thicker, the finfold occupies a considerable portion of the body cavity, the kidney is between myomeres 48 and 54 at 25 mm SL. The leptocephalid pigmentation is lost and silvery pigment appears on the body at 32 mm.

Range: from the Gulf of Maine to Brazil.

Reference: Gehringer 1959; Hildebrand, 1963; Mansueti & Hardy, 1967.

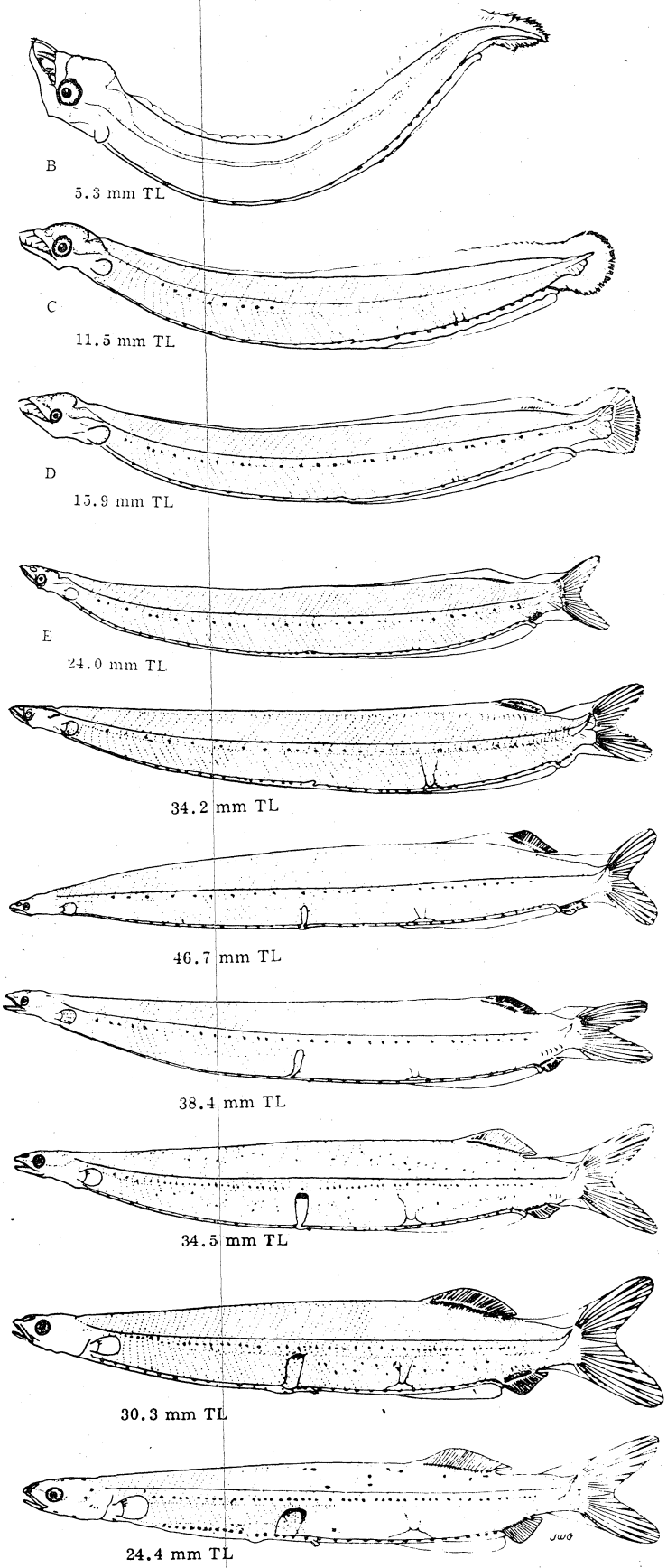


Fig. 4. Elops saurus
A-F - larvae I, TL, mm: A-5.3; B-11.5; C-15.9;
D-24.0; E-34.2; F-46.7.
G-J - larvae II; G -38.4; H - 34.5; I - 30.3;
J - 24.0.
(Gehringer, 1959)

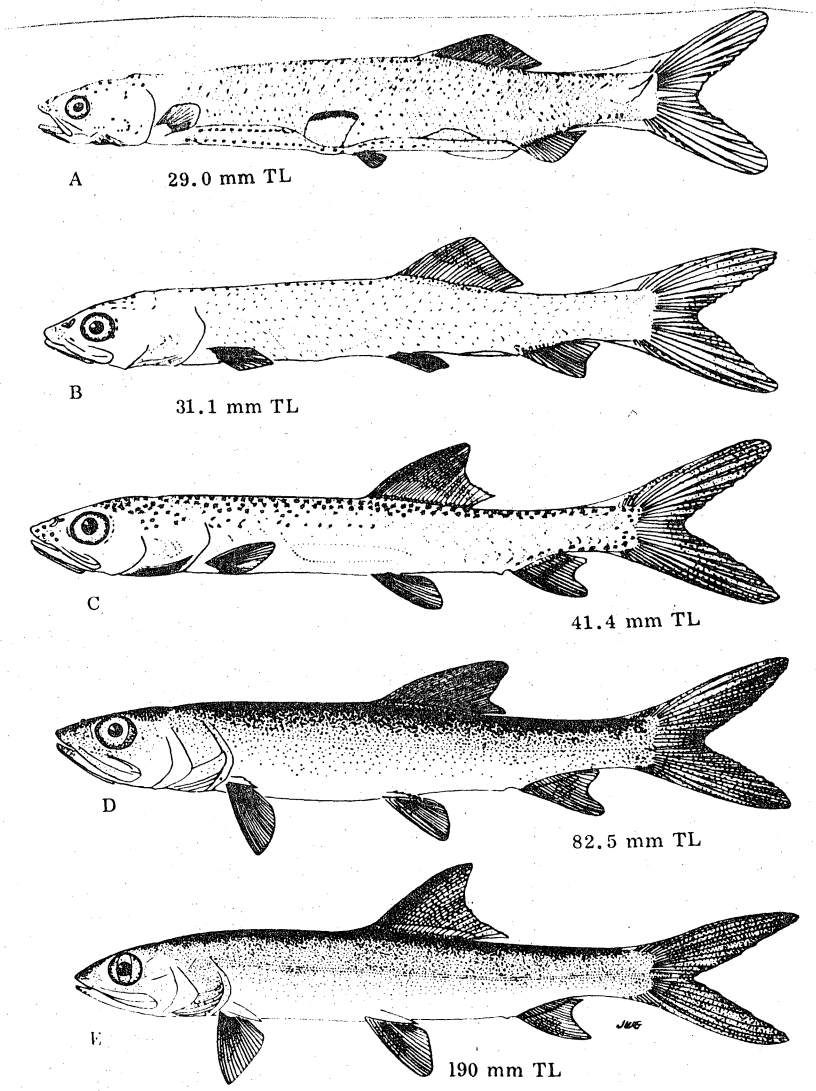


Fig. 5. Elops saurus
A, B - larvae III (larva -fry), TL, mm:
A - 29.0; B - 31.1;
C-E - fry, TL, mm: C-41; D-82.5; E-190.0.
(Gehringer, 1959)

TARPON MEGALOPS ATLANTICA VALENCIENNES, 1846

Eggs undescribed.

Prelarvae undescribed.

Larvae. Larval development is divided into 3 stages: Stage I, a period of initial length increase ending with a fully formed leptocephalus; Stage II, a period of marked shrinkage during which the larvae loses its leptocephalous form; Stage III, a second period of length increase which terminates with the onset of the juvenile stage.

Larvae I are 9.4-27.9 mm TL. The body is a ribbon-like, leptocephalous in shape. The myotome number is 54-57; 40-43 are preanal. The gut is straight and is along the ventral tips of myotomes; the anus is in the posterior 1/6th of the body, the gas bladder is still lacking; the head length is 8.2% of TL. The head is triangular in the dorsal aspect and is wider than the body. The mouth is large and oblique; the lower jaw is protruding; teeth: 1+7 in the upper and 1+6 in the lower jaw. Larvae are transparent, eyes are pigmented with black melanophores. At 11.7 mm the depth of the head is decreased, the body depth is 5.1-8.5% of TL in the pectoral fin region. Incipient kidney is visible above the posterior part of the gut. 8 incipient rays are in the dorsal fin at myomere 41-45 and incipient hypurals are in the caudal fin. A few melanophores are scattered above the posterior part of the gut.

The ribbon-like shape is gradually disappearing at 17.1 mm SL; the gas bladder is developing at myomere 20; the jaws are equal.

At 21.3-23.0 mm the ribbon-like shape is completely lost; the body is leptocephalous, thicker but laterally compressed. Incipient ventral fin is at myomere 23-25, 12 rays are in the dorsal fin and 20 rays are in the anal fin; remnants of the protopterigium are evident. The gas bladder appears as a cylindrical sac, the kidney is extending to myomere 24. Melanophores are evident above the anterior part of the gut; 5 pigment stripes are an the caudal pedancle below the lateral line.

The leptocephalous shape is disappearing at 24.0-27.9 mm. The dorsal fin originates above myomere 42, the anal fin -below myomere 44, the ventral - at myomere 23. 12 rays are in the dorsal and 20 are in the anal fin. The kidney is at myomere 35-45 and is separated from the gut. Pigmentation: 1 stellate melanophore is on the ventral side of the head anteriorly to the heart, another one is above the heart and 3-4 melanophores are behind the heart; a row of elongated melanophores is along the dorsal side of the gut up to the region separating the gut and the kidney; 4 melanophores are on the kidney and 4-5 melanin dashes are on the caudal pedancle.

Larvae II. 27.3-13.0 mm SL. 12-13 rays are in the dorsal and 20-22 in the anal fin. The myomere number is 55-57, 43-38 are preanal. At 27.3-25.0 mm SL the body length is decreased considerably; the snout is no longer convex; the cranial bones are visible; the heart is distinctive; the egg-shaped gas bladder is in the myotome 23-24 region.

Pigmentation: 2 melanophores are on the dorsal side of the gas bladder; 5 pigment dashes are on the ventral side of the caudal pedancle; hypurals and pectorals are pigmented and a

series of melanophores on the dorsal side of the gut.

At 22.8-13.0 mm SL the body depth at pectoral is 6.8-9.5% of SL, the head length is 9.2-26.9%, the preanal length is 83.7-71.5% and the predorsal length is 79.3-69.2% of the body length. The mouth is now subsuperior; jaws are well developed at 15-13 mm. The dorsal fin originates above myomere 39-36 and the anal fin is below myomere 41-38. The dorsal and anal fins are increased in height and length. The caudal fin is with a few branched rays. At 20.0 mm SL blood circulation is evident, gas bladder is increased and at 17.0 mm SL it is located in the 20-21-st myomere region. Pigmentation: a series of melanophores is along the dorsal surface of the intestine and along the lateral line, a few melanophores are on the kidney and on the anal, dorsal and caudal fins, 1 melanophore is below pectorals. Several melanophores are on the head over the brain and on the dorsal surface.

Larvae III. 12.6-25.0 SL. The body is clupeoid, 38-41 myomers are preanal and 37-39 are predorsal. Preanal length is 70.2-78.6% and predorsal 61.8-76.0% of SL. The maximum body depth at pectorals is 9.9-17.0% of SL. At 13.7 mm SL the gas bladder is enlarged anteriorly, extending to myomere 12. The head length is 20.7-28.6%. The mouth is oblique, the lower jaw extends to the point in vertical alignment with the pupil. Teeth: 0+6 in the upper and 0+8 in the lower jaw. 12-17 rays are in the dorsal and 19-25 in the anal fin. The anal fin is deeper than the dorsal one. Pigmentation: at 13.8 mm melanophores are on the head, on the snout, on the opercle, over brain and in area below the midline. Pigment is also on the caudal fin base, in the anterior dorsal and posterior anal rays, on the dorsal surface of the gas

bladder and the gut and in the region separating the gut and the kidney. At 15.9 mm melanophores outline myomeres and are developed on the body above the midline.

Juveniles are over 25 mm SL. 14-18 rays are in the dorsal and 24-28 in the anal fin. The body is torpedo-like, scales are first evident at 30-34 mm SL. Pigmentation: the body is no longer transparent at length over 25 mm, pigment is mostly above the lateral line, the gular plates are heavily pigmented; opercles are silvery; pigment is on the tip of the mandible, on the snout, and occiput. Juveniles become darker dorsally with age.

Range: from Nova Scotia to Brazil and from the West Africa to Congo.

References: Eldred, 1967, 1972; Harrington, 1958; Hildebrand, 1939; Mercado, 1971; Mercado & Giardeli, 1978; Swangon, 1946; Tagatz, 1973; Wade, 1962; Mansueti, 1967; Mansueti & Hardy 1978.

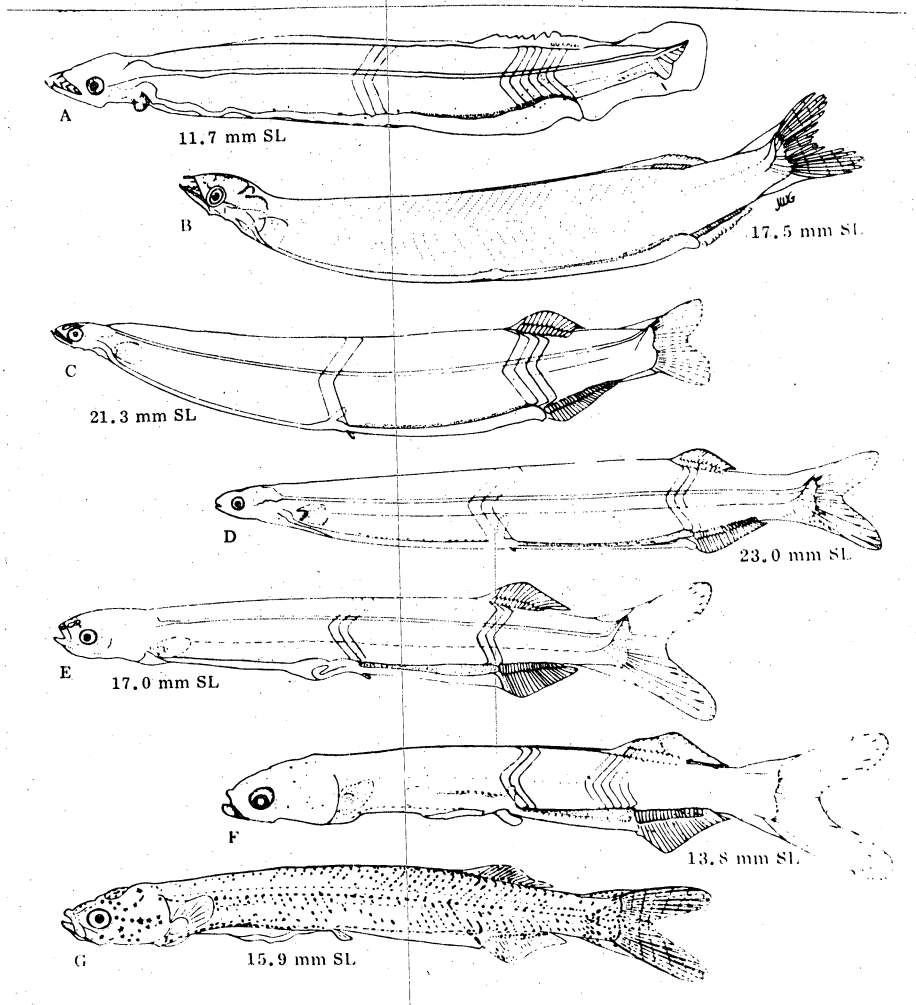


Fig. 6 Megalops atlantica
A-C - larvae I, leptocephalid, SL, mm:
A - 11.7; B - 17.5; C - 21.3;
D, E - larvae II 23.0; 17.0 mm
F, G - larvae III 13.8; 15.9 mm
(A,CF - Wade, 1962; B- Gehringer, 1959;
G - Harrington, 1958;(After Mansuetti & Hardy, 1967)

BONEFISH ALBULA VULPIS (Linné, 1758)

Spawning location is unknown, probably at sea.

Eggs. Fertilized eggs are 1.3 x 1.4 mm with a single oil globule.

Prelarvae are unknown.

Larvae. The larval development is accompanied by two periods of the length increase (Stages I and II) interspaced by a period of length decrease.

Larvae I. The size ranges from 7.8 to 87.0 mm SL. At 7.8 mm the total number of myomeres is 73 (preanal myomeres - 72), the anus is at the base of the caudal fin, the head is narrow, the snout is conical, the upper jaw with 2 protuberant incisors and 3 smaller teeth. The depth is the greatest at the 30th myomere; the origin of the dorsal finfold at about the 30th myomere; developing rays are in the caudal fin, the gut is straight. Pigmentation: about 20 dark brown spots are present along the dorsal edge of the gut.

At 17.8 mm teeth are reduced in size, both jaws are equal, the urostyle is turned upward , the gas bladder is present at myomere 32, although not indicated in the illustration. Incipient rays appear in the dorsal fin at 20.0-23.3 mm SL and in the anal fin at 26-28 mm. The gas bladder is at myomere 30 and incipient ventral fin is at myomere 33. At 33.5 mm teeth become smaller (1+12 in the upper and 1+5 in the lower jaw).

At 43.5 TL the dorsal origin is above myomere 50. Dorsal ray count is complete, rays are present in all fins except for the ventral. Pigmentation: a series of red-brown dashes run along the dorsal side of the gut and several melanophores are

at the base of the caudal fin.

At 43-87 the ray number is 10-16 in the dorsal, 4-7 in the anal and 10/9-11/11 in the caudal fin. The total myomere number is 65-73 (preanal- 62-72, predorsal - 40-61).

Larvae II. The size is from 65 to 20.0 mm TL. The ray number is 14-19 in the dorsal, 7-9 in the anal and 11/11 in the caudal fin. The myomere number is 67-75 (preanal - 70-55, predorsal - 55-29). Proportions expressed as percent SL are as follows: predorsal length - 80.99-55.44%, preanal length - 96.46-82.46%, the head length - 5.49-19.30%.

By 31.6 mm SL the body is deeper, much thicker and more fish-like than in the previous stage. The head is bullet -shaped and becoming proportionately larger as the stage progresses; teeth are minute. Remnants of the finfold are present at 37.1 mm SL The dorsal fin migrates forward from the 50-56th to the 29th myomere and the anal fin-from the 65-70th to the 57th myomere. Pigmentation: Dusky blotches mixed with yellow are becoming silver as the stage progresses. Between P and V there are two rows of melanophores along the intestinal tract and a vertical series of melanophores at the caudal fin base. At 46.0-41.0 mm SL melanophores are on the anal, caudal and dorsal fins and two melanophores near pectorals. At 39.0 SL mm the head is pigmented. By 28.0 mm SL no pigment is visible and three days after capture the body becomes non transparent.

Larvae III. The size is 20-36 mm. By 28.5 mm 12 rays are in the pectoral and 8 in the ventral fin. At 28.0 mm the body depth at the dorsal origin is 6.5 times in SL and the eye dia-

meter is 5.05 times in the head length. The dorsal origin is equidistant between the base of the caudal fin and the tip of the snout. Scales is first evident at 35 mm. Pigmentation: at 25 mm SL the body is still transparent, melanophores are along, above and below the lateral line and five dark spo ts are over the back. At 28 mm two dark lines along sides; some pigment is at the base of the anal fin and ventrally on the caudal peduncle.

Fry. At 51.2 mm proportions as percent of SL are: the head length is 31.3%, predorsal length is 57.60%, preanal is 82.68%; the head is bullet-shaped, the snout is conical, the mouth is inferior, teeth are quite small. Pigmentation: 12 cross-bands on the back extending to the lateral line; the pigment is developed on the snout, above the eye on D and C.

Range. Adults are common in all warm seas, in the West Atlantic, possibly from the Bay of Fundy to Rio de Janeiro.

Hildebrand, 1963; Gill, 1907; Alexander, 1961; Shen Shen Chien, 1964; Hollister, 1936; Eldred 1967; Uchida, 1958; Richards, 1969.

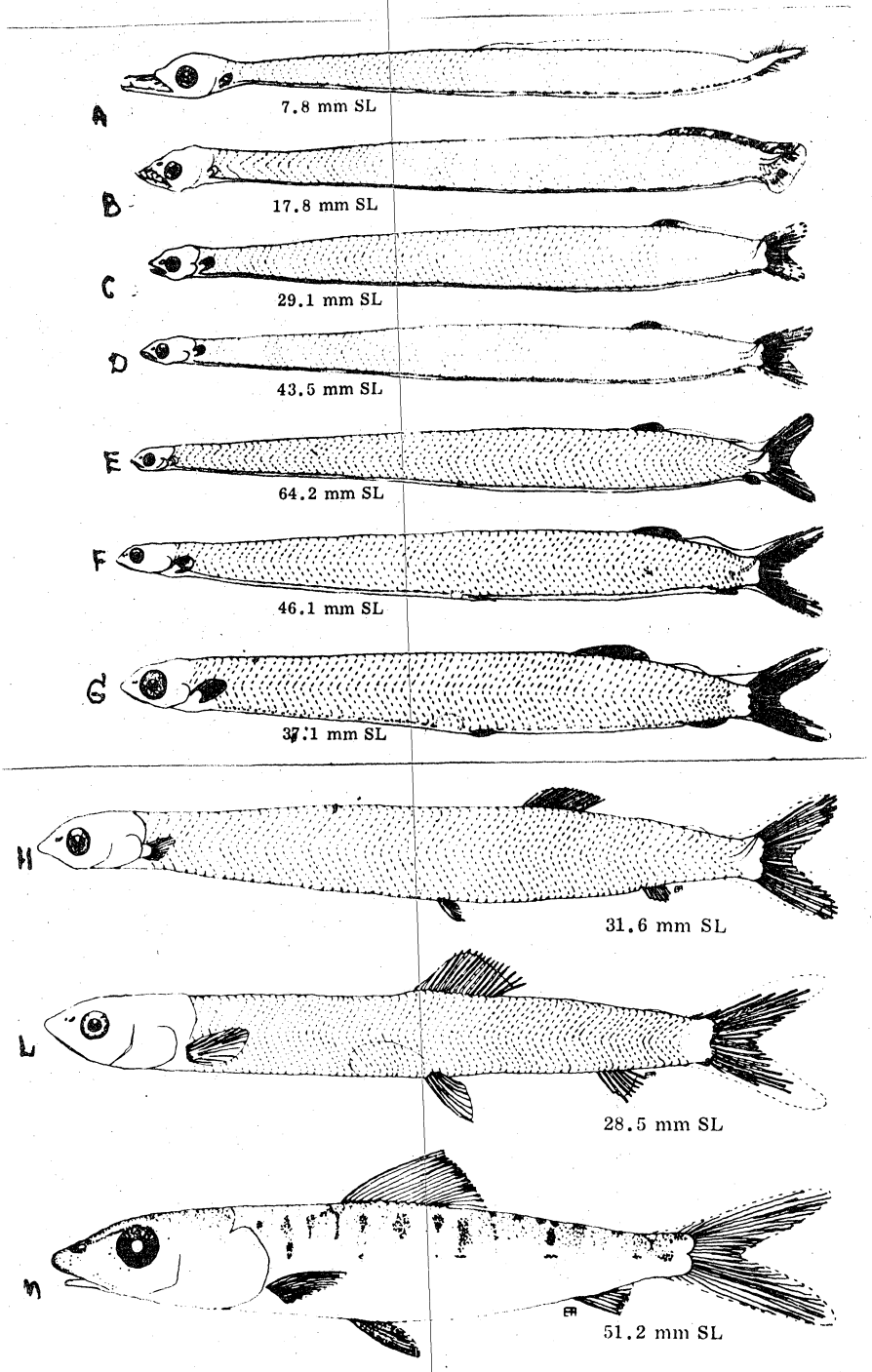


Fig. 7. Albula vulpes

A - E - larvae I (leptocephalid), SL, mm:
A-7.8; B-17.8; C-29.1; D-43.5; E-64.2
F - L - larvae II, mm: F - 46.1; G - 37.1;
H - 31.6; L -28.5;
M - fry, 51.2 mm
(Alexander, 1961, after Mansuet i & Hardy, 1967)

HERRING Clupea harengus harengus Linnè, 1758.

Eggs are demersal, sticky and are deposited on the bottom, where the substratum consists of gravel, broken shell or on algae to which the eggs adhere. All the eggs are practically spherical, though may be of slightly irregular form. The diameter varies between 0.9 and 2.0 mm. The outer egg membrane is thin, transparent, with the remains of chorion, a sticky, jelly mass. The perivitelline space constitutes 15-19% of the egg diameter.

The periods of embryodevelopment (from fertilization to hatching) are given below.

Temperature, average, C°	Days	
0	50	Seliverstov 1972; Williamson, 2 1910
3.5	49	Meyer, 1878
6.8	17-20	Kotthaus, 1939
7.0	15-19	Kotthaus, 1939; Braum, 1973
7.8	15	Meyer, 1878
10.7	10-12	Kotthaus, 1939
12.3	7-9	Kotthaus, 1939
15	7	Blaxter, 1969

Prelarvae are 5.5-12.0 mm long and hatched when the length of 5.5-9.0 mm is reached. The body is elongated, thread-like and of the typical clupeid form. The postanal portion of the body is very short with the anus far back, near the tail, and the preanal part forming 80% of the body length. The yolk sac is ovoidal;

the yolk is granulated and is fully absorbed at a length of about 10 mm. Pigmentation appears during embryodevelopment and is arranged in a row of melanophores on the dorsal surface of the gut. 1-3 days after hatching the second row of melanophores develops along the ventral side of the gut to the anus with a large melanophore above. Thus there is the lower lateral row of melanophores in the anterior and the ventral row in the caudal part of the body. Both rows are paired.

Larvae are 10.0-48.0 mm long and have the typical clupeid form. The rays appear in D at lengths of 10.0-12.0 mm. The morphological changes during the larval development can be summarized as follows:

11-12 mm - first appearance of rays in the dorsal fin
17 mm - notochord begins to turn up
18 mm - rudiments of rays in the anal fin appear
21 mm - notochord completely turned up
22 mm - first appearance of pelvic fins
28 mm - dorsal fin with complete number of ray rudiments
30-35 mm - anal fin with complete number of ray rudiments air bladder becoming noticeable
41-45 mm - scales appearing in the beginning of the fry phase
48-50 mm - metamorphosis

Ref.: Kryzhanovskij, 1956; Rass, 1949; Ehrenbaum, 1905-1909; Russel, 1976

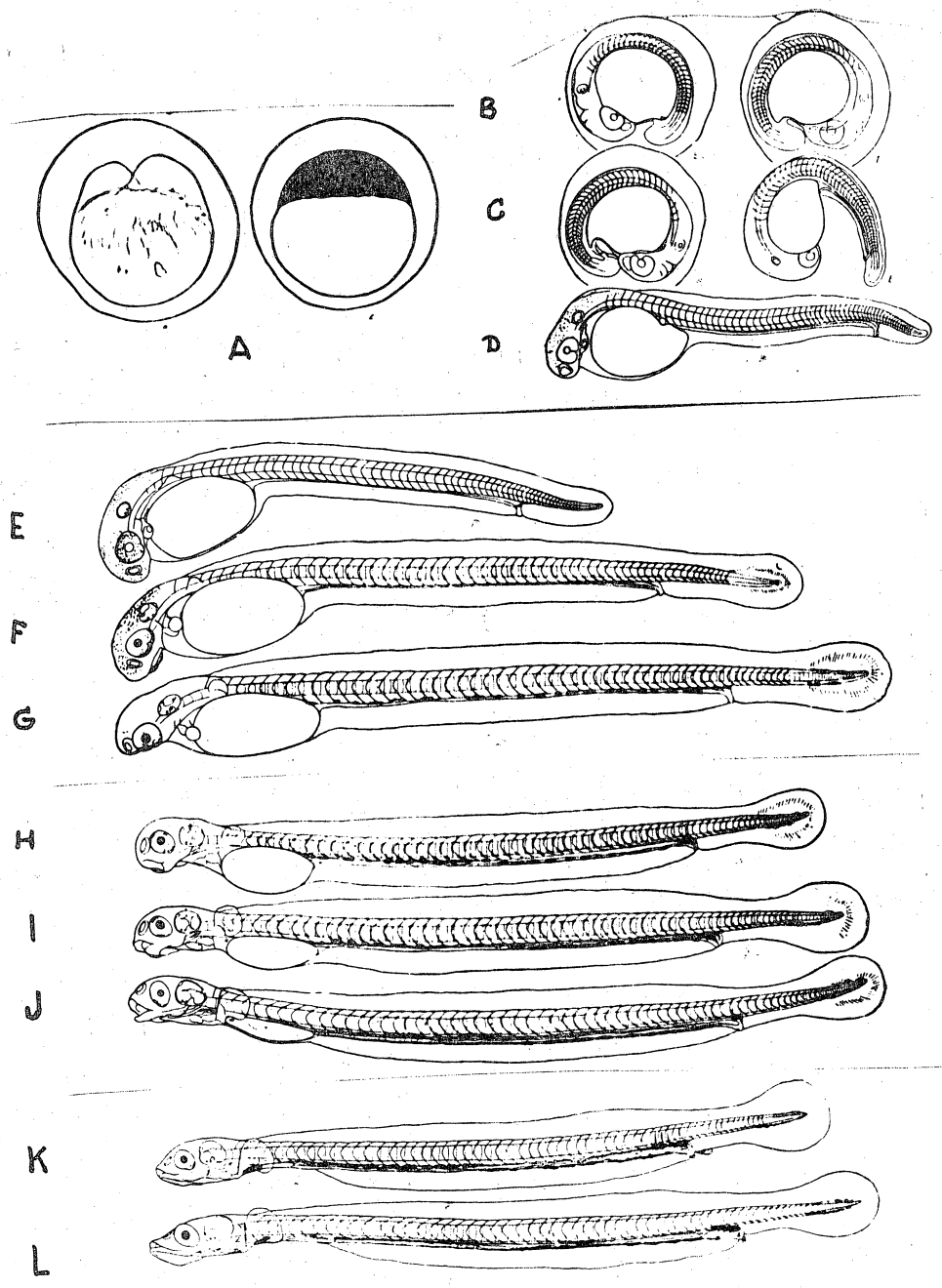


Fig.8 Clupea harengus L.

A - early stages of embryodevelopment;B - D - releasing the tail from the yolk surface;E,F -the embryos artifitially released from the egg membrane,4.92 and 6.25 mm TL;G - prelarvae 6.62 mm,6 hour after hatching;H - J - prelarvae 7.48,7.98,8.22mm;K,L - larvae 7.32 and 7.95 mm ,11 days after fertilization; development at 18°C (Kryzhanovsky,1956).

ATLANTIC MENHADEN BREVOORTIA TYRRANUS (LATROBE, 1802)

Spawning occurs chiefly at sea, closer to shore.

Eggs are buoyant, spherical, transparent, 1.3-1.95 (1.61 in the average) mm in diameter. The yolk is slightly segmented, yellow, 0.9-1.2 mm in diameter, a single small oil globule 0.11-0.17 mm in diameter, the oil globule diameter is 11 times in the egg diameter. The egg capsule is thin, horny; the perivitelline space is 1/2 of the egg diameter in large specimens. The embryonic axis is formed before the closure of the blastopore. At the 22-24th somite stage the tail is attached to the yolk sac surface, the Kupffer's vesicle is conspicuous, the blastopore is closed, the eyes are forming and the otoliths are present. Advanced embryos are slender with dorsolateral melanophores from the snout to the tip of the tail. Just prior to hatching the anus is in the posterior 1/10 of the body. The incubation lasts 42-54 hours at 15-20°.

Prelarvae are 2.4-4.5 mm long. Hatching length is about 2.4 mm. At 3.3 mm TL 35 preanal myomeres are present. The head is attached to the yolk. The yolk mass is large, ovoid. The anus is in the posterior 1/8 of the body length. At 4.5 mm the head is less deflected, 1/2 of the yolk sac is absorbed, the anus is in the 1/5 of the body. In newly hatched the incipient mid--lateral line is formed as nerve endings.

Pigmentation. The eye is unpigmented, small melanophores are along the entire dorsal surface and at the finfold base and few are scattered through the dorsal and ventral finfolds. A series of small melanophores along the ventral surface of the

caudal region. At 4.5 mm TL the finfold is lacking pigment.

Larvae I are 5.0-30.0 mm long. The body is clupeoid in shape, the anus is in the posterior 1/4 or 1/5th of the body. The myomere number is 45-50, 37-40 are preanal, and 8-10 are postanal. The body depth is 30 times in the total length. The gut is straight. At 8.3 mm TL incipient rays are in the caudal and anal fins.

Pigmentation at 5.0 mm a series of melanophores is along the dorsal and ventral surfaces of the gut up to the mid-point of the body and ventrally in the caudal region; few melanophores are scattered dorsally in the caudal region and near the caudal fin. At 5.7 mm TL melanophores are no longer evident dorsally except near the tip of the tail and a series of melanophores is present along the digestive tract.

Larvae II are 10.7-28.7 mm long. The body is clupeoid in shape; the anus is in the posterior 1/4-1/5 of the body. The myomere number is 48 , 35 are preanal. The gut is convoluted only in the gas bladder region. The gas bladder is first evident at 11.0 mm TL. The tail fin is forked at 16.6 mm. The finfold between the dorsal and caudal fins is reduced at 17.0 mm, the anal part is retained untill 28.7 mm TL. The urostyle is directed upward at 10.7 mm TL. At 20.0 mm TL small teeth are evident on the edge of the upper jaw.

Pigmentation: by the end of the stage additional melanophores are over the gas bladder, on the opercle and at the bases of caudal, anal and dorsal fins, below pectorals and a series of melanophores at the lateral line level.

Range: From Nova Scotia to Florida.

References: Colton & Marak, 1969; Bigelow & Schroeder, 1953; Hildebrand, 1963; Reintjes, 1968, 1969; Richards, 1959; Kuntz & Redcliffe, 1917; Kyshean & Lodge, 1974; Pepper, 1974; Weatland, 1956; Mansueti & Hardy, 1967.

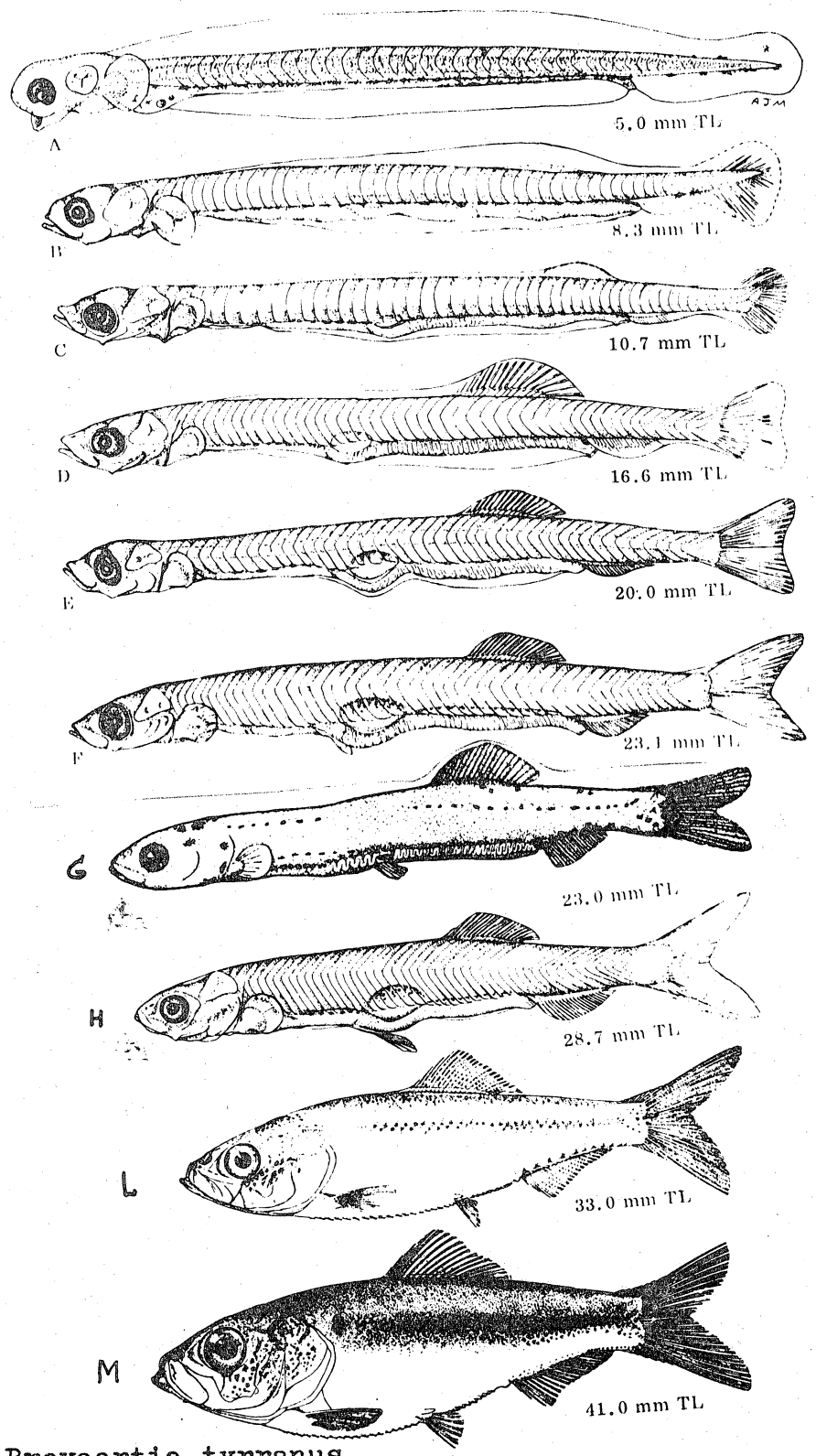


Fig.9. Brevoortia tyrranus

A-F - larvae, TL, mm: A - 5.0; B-8.3; C-10.7;
D-16.6; E-20.0; F- 23.1;
G-H - larva-fry, mm: 23.0; 28.7;
LM - fry, mm: 33.0; 41.0.
(A,F,H - Mansuet i & Hardy, 1967;
G,L,M - Kuntz & Radcliffe, 1917; after Mansuet i & Hardy, 1967)

SILVER ANCHOVY. ENGRAULIS EURYSTOLE (Swain & Meek, 1885)

Spawning is probably at sea.

Eggs are pelagic, transparent, elliptical, the major axis is 1.02-1.25 mm, the minor is 0.50-0.80 mm. The yolk is segmented into large granules. No oil globule. The perivitelline space is narrow, the embryo is along the major axis, the head is deflected downward over the yolk. Advanced embryo is free of pigment. The chord is thick and its structure is heterogeneous.

Prelarvae: 3.0-3.4 mm TL. The body is elongated and clupeoid in shape. 8 hours after hatching the head is no longer deflected over the yolk. The yolk sac is long, tapering to the point at a mid-point. Half of the yolk sac is absorbed during the first day after hatching. The gut is straight at hatching. The anus is in the posterior 1/4th of the body. The dorsal side of the finfold is just behind the ear capsules. The edge of the finfold is almost straight at hatching and becomes concave in the caudal pedancle region during the first day after hatching. The preanal part of the finfold is extended to the mid-point of the yolk. By the end of the first day after hatching incipient rays are in the pectoral and caudal fins. The structure of the incipient chord is heterogeneous and reticulated. Pigmentation: during 8 hours after hatching a row of melanophores over the posterior gut extending beyond the yolk; pigment is present in the ventral finfold. Melanophores are increased considerably in size during the first day after hatching.

Larvae: 5.2 mm TL (from one specimen described). The body is clupeoid in shape and deeper anteriorly. The mouth is terminal, the upper jaw extends beyond the point in vertical alignment with the pupil. The opercle is distinctly visible. Dorsal, anal, caudal and pectoral fins are with incipient rays. Pectorals are rounded, pelvies are lacking. The dorsal surface of the finfold is reduced, incipient rays in the dorsal fin are forked. The preanal part of the finfold extends to the distal edge of pectorals and terminates below the origin of the dorsal part of the finfold. The chord is thick and the posterior part of the gut is looped. Pigmentation: the body is almost lacking pigment with remnants of melanophores.

Range: from the USA coast off Massachusettes to the Northern Carolina.

References: Kuntz & Radliffe, 1917; Hilderbrand, 1963; Hubbs, 1953; Radcliffe, 1914.

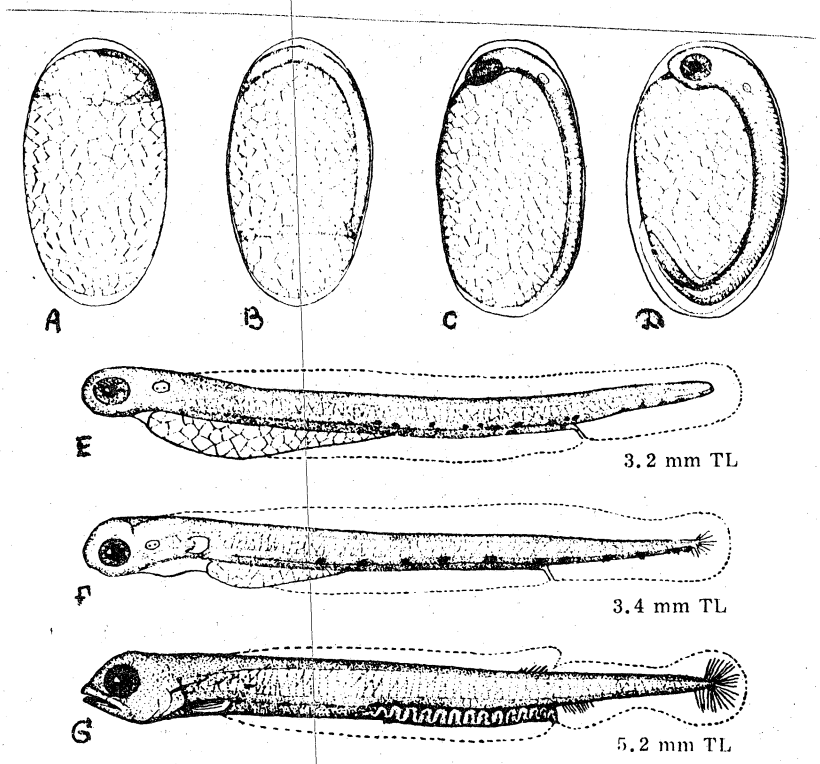


Fig.10. Engraulis eurystole

A-D eggs at II(A,B) and III(C,D) stages

E - prelarva 3.2 mm TL ; F - prelarva 3.4 mm TL

G - larva 5.2 mm long

(Kuntz a. Radcliffe,1917)

BAY ANCHOVY. ANCHOA MITCHILLI (VALENCIENNES, 1948)

Eggs are single, transparent, pelagic, slightly oval, rarely spherical in shape. The major axis is 0.65-1.24 mm long, the minor 0.64-1.12 mm long. The yolk is segmented into large granulas; the envelope is smooth, the perivitelline space is very narrow. Eggs are becoming demersal with advancing development. The incubation period lasts 24 hours at 27.2-27.8°.

Prelarvae. The length at hatching is 1.8-2.7 mm, the body is clupeoidlike, elongated and flattened. The preanal distance is 2.02 mm at 2.75 TL and 2.51 mm at 3.70 mm TL. The head is deflected downward over the yolk. The yolk is pear-shaped tapering to a point at half-length. More than 1/2 of the yolk is absorbed 12 hours after hatching. Incipient rays are first evident in the caudal fin at 3.7 mm TL. Pigmentation is lacking initially. Several melanophores are present on the lower edge of the caudal pedancle between the anus and the caudal fin.

Larvae. Specimens described 2.7-15.0 mm TL. The body is clupeoid-shaped, elongated, the mouth is terminal and apparently functional at 2.7 mm. The finfold somewhat constricted in the caudal region at 29 mm TL. The relative depth of the finfold is decreased by 3.0-4.0 mm TL. The posterior region of the gut is convoluted at 5.0 mm. Incipient pectoral fins are evident at 5.0 mm TL. Some specimens are with full caudal count at 7.0-8.0 mm TL. The caudal fin is slightly forked at 10.0 mm TL. The ventrals appear at 15.0 mm TL but apparently without rays. The urostyle is turned upward at 7.5 mm.

Pigmentation. A double row of melanophores is along the venter at 3.5 mm TL. Few melanophores at the bases of pectoral and caudal fins.

Larvae-fry and fry. The length is over 15.0 mm. The body depth is 12 times in the body length at 16.0 mm TL; the depth increases with advancing development and is 9 times in the body length at 20.0 mm TL and 5.5 times at 25.0 mm TL. Projected snout is developed and the posterior convolutions of the gut are no longer visible externally at 20.0-25.0 mm. The anal origin is slightly behind the dorsal origin.

Pigmentation. Individuals may remain quite transparent untill mature. At TL 19.5 mm a series of melanophores between the operculum and the ventral fins; a similar series from the origin of the anal to the caudal base; a mid-lateral row of melanophores on the posterior 2/3rds of the body; scattered melanophores are on the dorso-lateral surface; a dark blotch between the eyes on the top of the head; the caudal fin is heavily pigmented. A row of melanophores is along the anal base and continuing to the caudal fin, few melanophores are on the head.

Range: From the Gulf of Maine in the north to Yucatan, (Mexico) in the south.

References: Kuntz, 1914; Hardy & Mansueti, 1967, Simmons E.G., 1957.

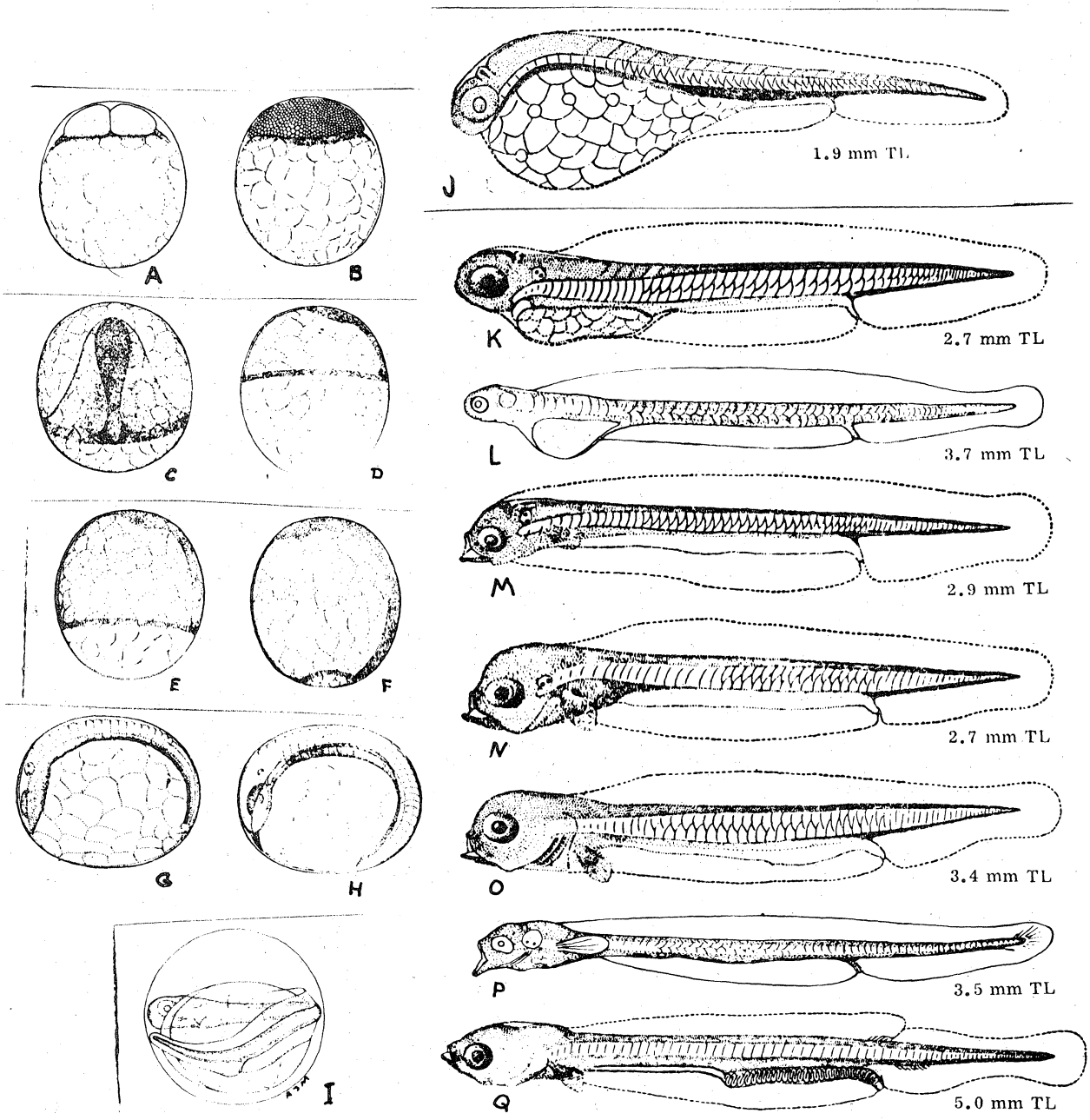


Fig.11. Anchoa mitchilli

A-I- Egg development;

J-L - prelarvae, TL, mm: J -1.9; K - 2.7 (12 hours after hatching); L - 3.7; M-Q - larvae, TL, mm: M- 2.9 (36 hours); N - 2.7 (3 days); O-3.4; P-3.5. Q - 5.0.

(A-H, K, M-O, Q - Kuntz, 1914; D, L, P - Mansueti & Hardy, 1967).

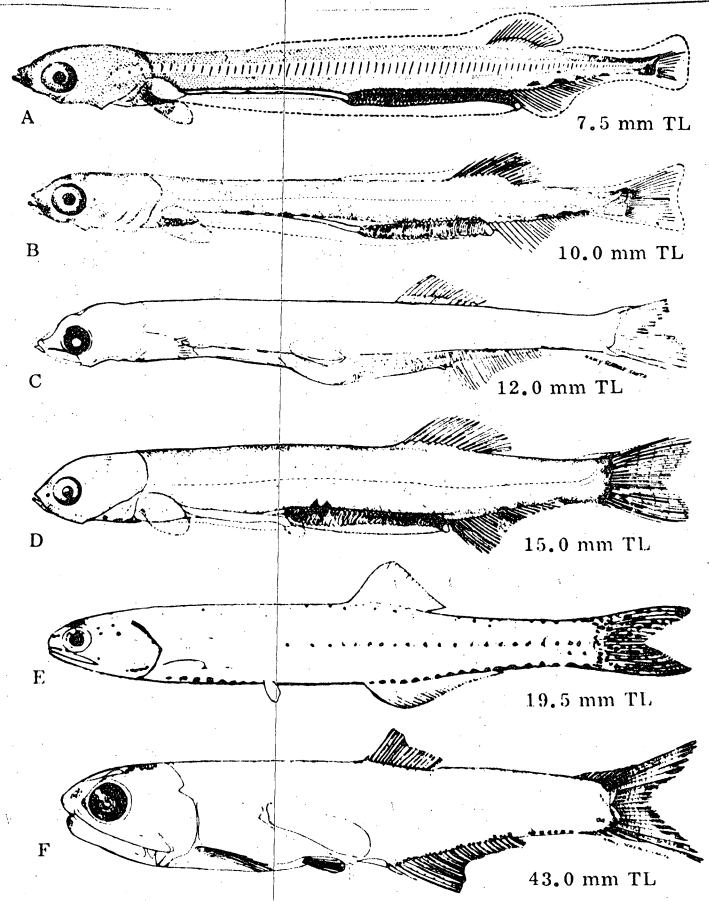


Fig.12. Anchoa mitchilli

A-D - larvae, TL, mm: A-7.5; B-10.0; C-12.0 (intestine bulged below expanded gas bladder); D-15.0 (incipient pelvic fin)

E-fry, 19.5 mm; F-fry, 43.0 mm (gas bladder visible)

(A,B,D - Kuntz, 1914; CF - Mansuet i & Hardy, 1967; E - Fowler, 1945).

STRIPED ANCHOVY ANCHOA HEPSETUS (LINNE 1758)

Eggs are buoyant, transparent, elliptical. Major axis is 1.20-1.66 and ... minor is 0.70-0.94 mm long. The envelope is smooth, the perivitelline space is small, the yolk is segmented into large cells; no oil globules.

Prelarvae are 3.6-4.5 mm TL, clupeoid in shape, long, slender, thread-like. The head is somewhat decurved; the dorsal outline is slightly convex . The yolk sac is elongate, tapering to a point posteriorly. The anus is in the posterior 1/4th of the body. The body is transparent, without any melanophores.

Larvae are 5.0-13.0 mm TL, long, clupeoid-shaped. At 10 mm TL the body is slightly deeper. The mouth is oblique, the upper jaw is extending to the eye at 5.0 mm TL and is beyond it at 10.0 mm. The gut is almost straight, but with striated appearance. The finfold depth in the caudal pedancle region is decreased at 5.6 mm TL. At 10.0 mm TL the notochord is oblique posteriorly. Pigmentation: five very small melanophores on the middle of the chest and along the venter from the anus to the caudal fin.

Range: from Nova Scotia in the north to Uruguay in the south.

References: Hildebrand & Cable, 1930; Hildebrand, 1963; &Hardy
Bigelow & Schroeder, 1953; Mansuet i, 1967.

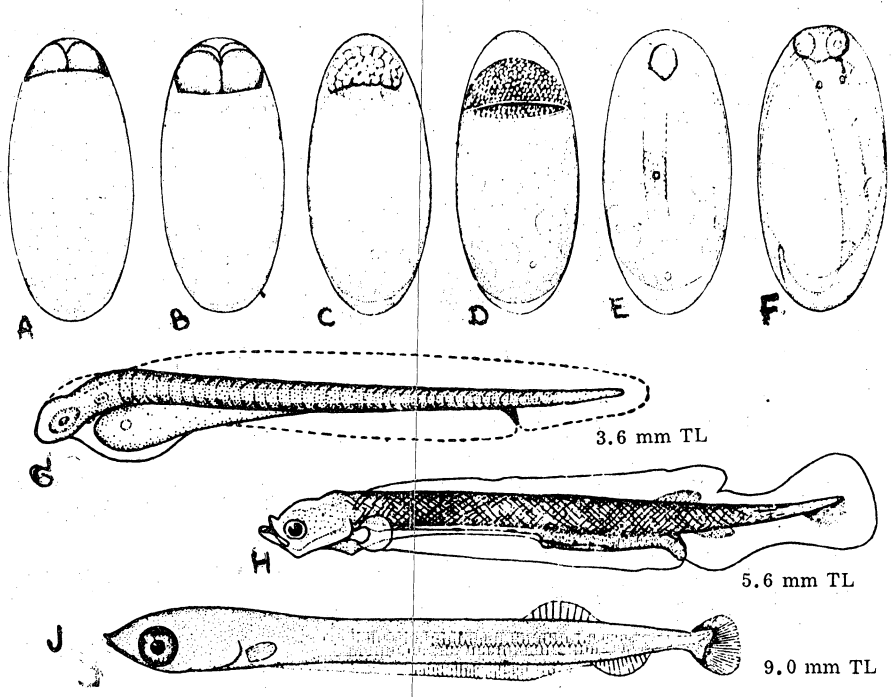


Fig.13. Striped anchovy Anchoa hepsetus

A-F - eggs at various stages; G - prelarva 3.6 mm TL
H -larva 5.6 mm TL ; J - larva 9.0 mm TL

(Hildebrand & Cable,1930)

CAPELIN, Mallotus villosus villosus (Müller, 1776)

Eggs are demersal, attached to sandy, pebble or rocky grounds; the diameter is 1.045-1.160 mm. The eggs are light-grey with a shade of yellow or orange due to the presence of carotinoid pigment. The egg membrane is tough and consists of 2 layers with the micropyle at the animal pole. A sticky jelly membrane is especially pronounced at the vegetation pole, where it forms a thick layer covering 1/3 of the egg surface and tinging it dark-grey. The yolk contains about 70 oil globules, each 0.5-0.1 mm in diameter. The perivitelline space constitutes 1/5 of the egg diameter. The blastodisc height is 0.2-0.3 mm at Stage I and about 0.3 mm in the end of Stage II. The embryo is free of pigment up to the end of Stage III, when the melanin pigment becomes notable in the eye rudiments. The pigmentation is scattered throughout Stage IV, then the melanophore rows appear along the dorsal and the ventral sides of the gut.

Prelarvae are 4.8 - 10.0 mm long, and hatched when the length of 4.8-7.5 mm is reached on the 20th - 22nd day at the temperature of 7.2°C. The newly hatched prelarvae of capelin are transparent and definitely clupeid in appearance. The number of preanal myotomes is 48-51, the height of the dorsal part of the fin fold is 0.05-0.15 mm, that of the ventral is 0.05-0.10 mm. The pectoral fins are 0.2-0.3 mm high and a little in front of the yolk sac which is 0.45-0.95 mm long. The yolk sac is rounded and is extended backwards, with the oil globule diameter of 0.10-0.20 mm. The pigment is dark-brown and consists of double low lateral row of melanophores and single ventral and subcaudal

rows. The low ventral row runs from the head to the anus and consists of 9-12 pigment cells. The ventral row consisting of 13-19 melanophores continues from the yolk sac to the anus. The subcaudal row is on the ventral sides of myotomes and contains 3-6 cells. Stellate pigment cells are well dispersed over the ventral surface of the yolk sac and disappear with its absorption. Prelarval and larval capelin have complete lower lateral and ventral rows in contrast to herring, in which the lower lateral row is developed in the anterior and ventral in the posterior part of the body. Ref: Rass, 1949; Pozdnyakov, 1960; Fridgeirsson, 1976.

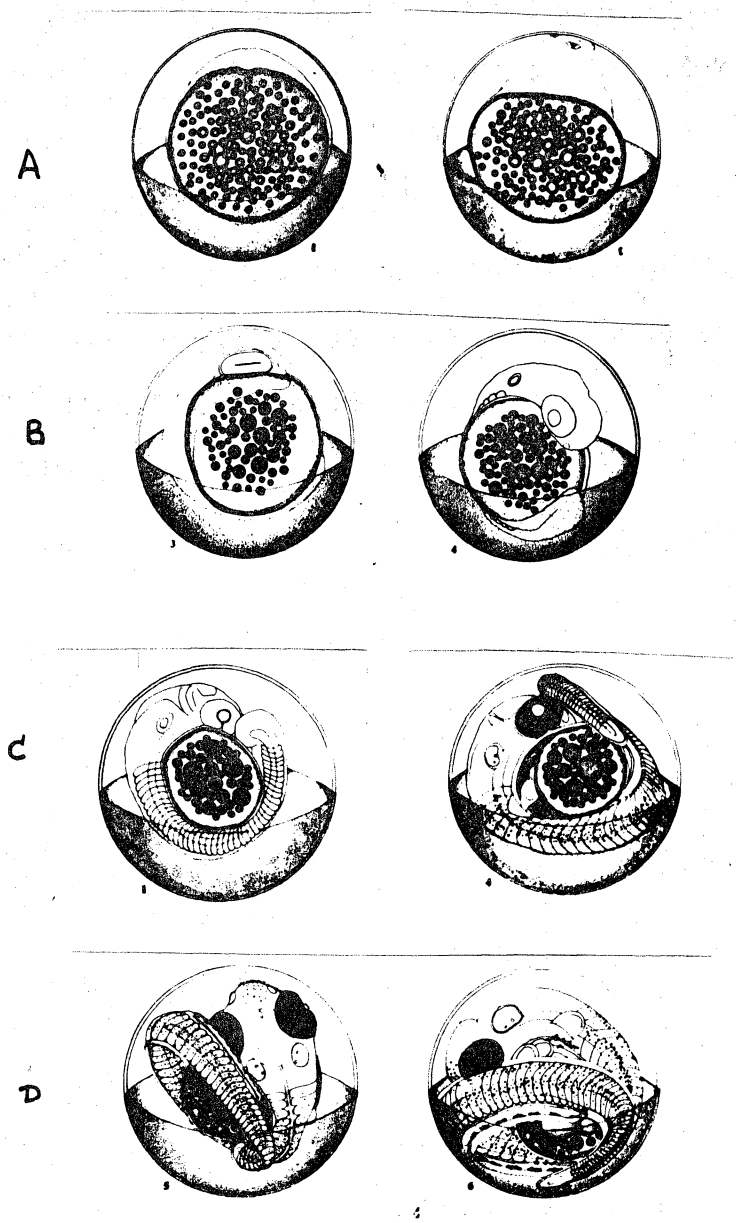


Fig. 14. Mallotus villosus villosus
Egg stages: A-I; B-II; C-III, D-IV;
(Friedgeirsson, 1976)

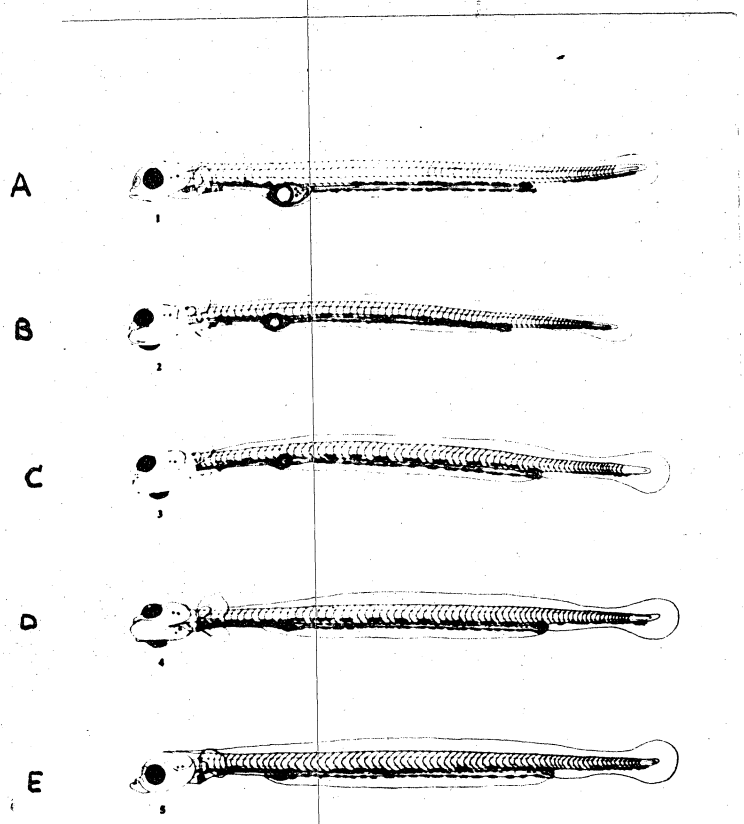


Fig. 15. Mallotus v.villosus
Prelarvae, mm: A,B - 7.2; C - 7.6; D - 7.7;
E - larva , 7.7 mm.
(Friedgeirsson, 1976)

VINCIGUERRIA NIMBARIA (Jordan & Williams, 1895)

Eggs are single, spherical, 0.64-0.72 mm in diameter; no oil globule. Egg capsule is double, the inner one is but slightly visible. The yolk is mot fully segmented with granules of different sizes. The perivitelline space is 1/7th of the egg diameter. The embryo is thin and does not embrace half of the yolk by the time of the blastopore closure; myomeres are lacking. In advanced embryo two dorsolateral rows of melanophores are apparent to be a distinguishing character.

At later stages a total of 40 myomeres are present in the embryo body; the gut length is about 0.7 of the body length, the yolk is an elongated cline in a backward position along the gut, which is characteristic of more advanced developmental stages of stomatid fishes. Two rows of pigment dashes on the head run from between the eyes to the occiput and two dorsolateral rows are present on the body up to the end of the chord where several ventral melanophores are apparent.

By the time of hatching the tail is beyond the head, the finfold is wide in the caudal region and narrow in the trunk.

Prelarvae are undescribed.

Larvae. Reported larvae are 7.3 mm, 14.3 mm and 15 mm long. At 7.3 mm the body is slender, elongated, the caudal division is rather short and is more than three times in the trunk length. The anal fin origin is posterior to the vertical line through the centre of the dorsal fin. Eyes are elliptical and stalked.

Pigmentation: A single caudal melanophore on the ventral edge of the caudal peduncle, two or more black dots in the anal fin origin and a narrow row of pigment cells at the junction of body and isthmus. At the stage close to metamorphosis (14.3 mm) incipient photophores are apparent and the gut is double looped, with a pigment cell; the caudal division is about 2.75 in the trunk length. The caudal melanophore is visible on the ventral side of the caudal peduncle margin; a pigment dash in the caudal fin ray base is more heavily pigmented dorsally. Three large pigment cells are usually at the anal fin base, the shoulder girdle region near the clavicle is pigmented. During metamorphosis (which occurs at 13-16 mm) at 15 mm the caudal region is 2-2.5 times in the trunk length, the anal fin is posteriorly to the vertical line through the dorsal fin centre. Photophores are: OA-20-22 the last one is over the 6-8th VAV, VAV 9-11; the caudal melanophore is present ventrally or lacking.

Ahlstrom & Counts, 1958; Jespersen & Tåning, 1926; Sanzo, 1931; Grey, 1964.

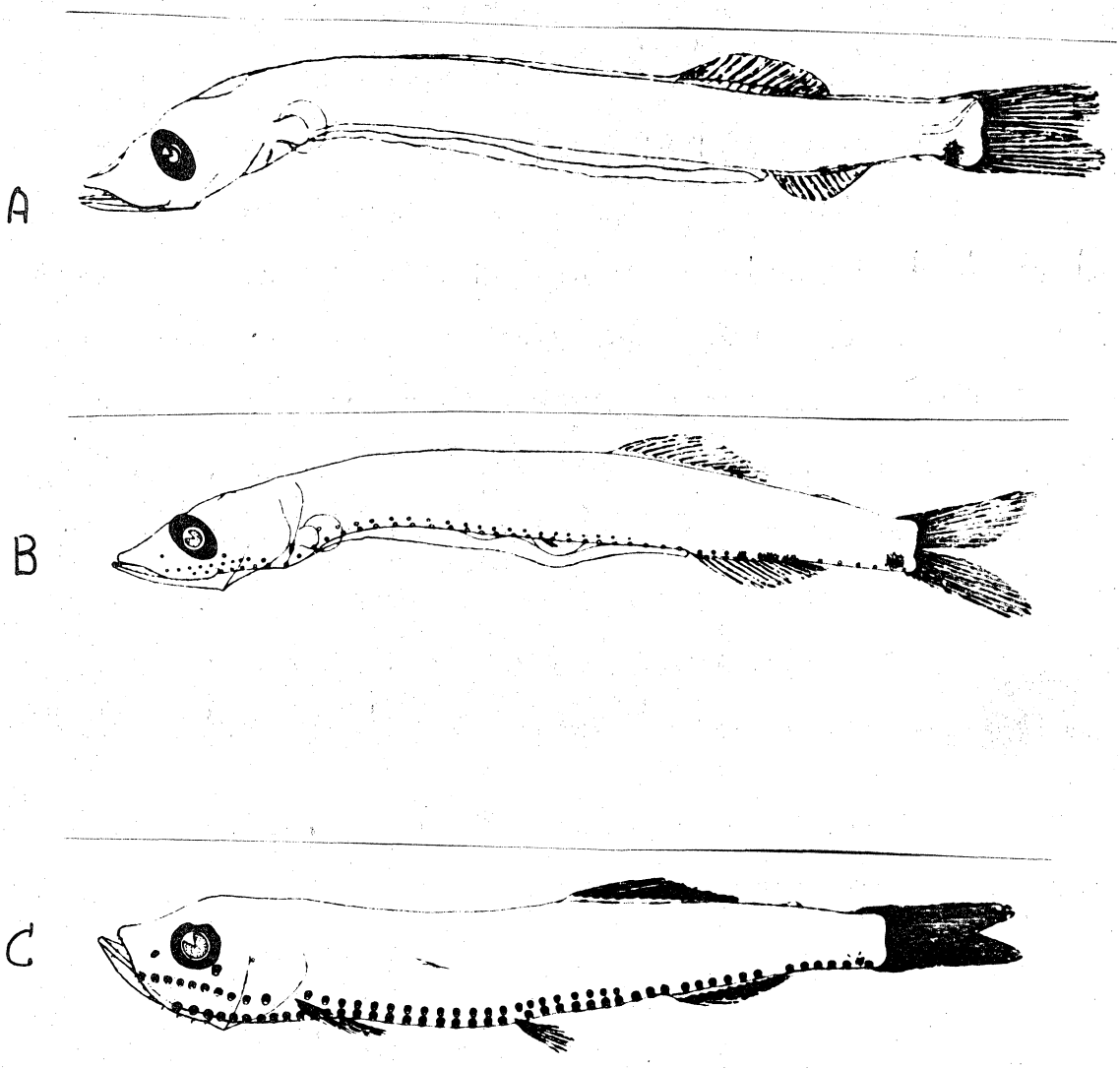


Fig.16. Vinciguerria nimbaria
A - larva 7.3 mm SL; B - larva 14.3 mm SL;
C - metamorphosis, 15 mm SL.
(Jespersen & Tåning, 1926)

VINCIGUERRIA POWERIAE (COCCO), 1838

Eggs are single, spherical, 0.7-0.85 mm in diameter, a single oil globule 0.17-0.19 mm in diameter, the egg capsule is single, the yolk is granulated irregularly, the perivitelline space is below 1/10 (8-9%) of the egg diameter. In advanced embryos a total of 39-40 myomeres are present.

Prelarvae undescribed.

Larvae. Specimens of 9.16, 11.3 and 20 mm long are described. The body is elongated, stomiatoid-shaped. At 9.16 mm the body is uniformly slender, the snout is elongate and flattened, the eyes are elliptical and pedunculate. The finfold is narrower in the caudal peduncle region; the caudal fin is rounded. Incipient rays are in the caudal, anal and dorsal fins; the dorsal fin rays are not isolated. Pectorals are small, membranous. The gut is almost straight posteriorly with an oval and pink organ. The pigment is lacking. At 11.3 mm the caudal division is more than 3 times in the trunk length, and about 3 times at later stages. The anal fin origin is below the 4th or 5th ray of the dorsal fin. Ventrals are absent, the eyes are elliptical. A single melanophore is at the end of the caudal peduncle on the midline. An incipient photophore is visible above the anal papilla. The place of the future ventrals is devoid of the inner pigment. At 20 mm (close to metamorphosis) the preanal length is 72.4-77.5% SL, the eyes are elliptical. The anal fin origin is below the 10-11-th dorsal ray. Incipient non-pigmented photophores are present. The pigmentation pattern is identical to that at the previous stage.

During metamorphosis (at 14-23 mm) the length is reduced

the eye is rounded at 22.9-17.7 mm; the anal fin origin is below the end of the dorsal fin; the adipose is developing. The preanal length is 64.3-67.8% SL, the caudal division is 30-32% SL i.e. 2-2.1 times in the preanal length. The photophores are now pigmented. The posterior OPB are somewhat larger than the anterior ones, the upper OP is absent, the lower OP are small and equal in size or the posterior one is larger; BP8, IV 23, VAV 9-10, AC 5+6.

Pigmentation: several small pigment cells are on the top of the head; in some specimens pigment is present in the anterior part of the abdominal cavity; the remnants of the caudal melanophore are visible.

Ahlstrom & Counts, 1958;
Jespersen & Taning, 1926; Sanzo, 1931, Grey, 1964.

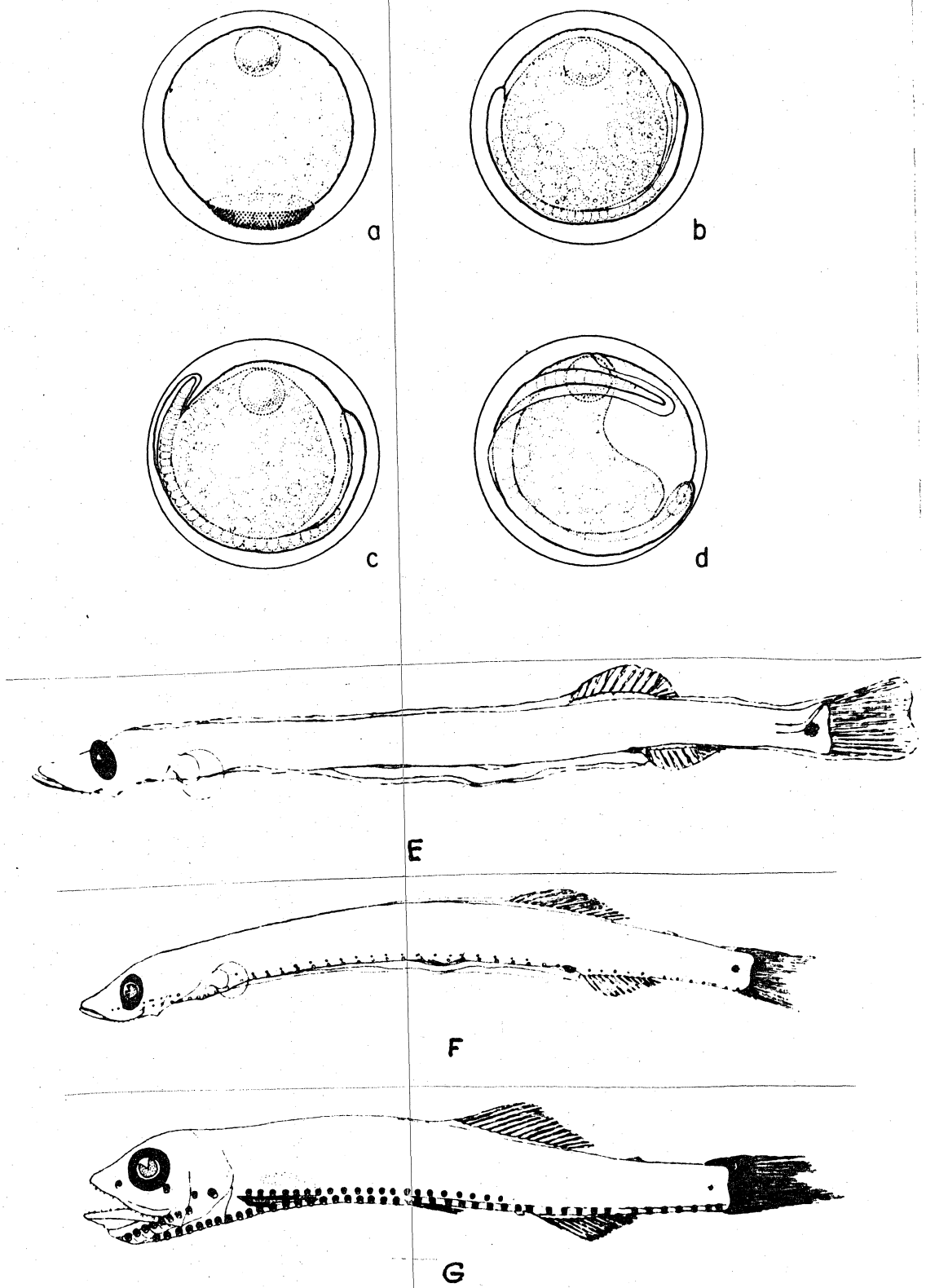


Fig.17. Vinciguerria poweriae

A-D - eggs, 0.7-0.85 mm in diameter; oil globule 0.17-0.19 mm
E - larva 11.3 mm SL; F - larva 20 mm SL; G - metamorphosis at 17.7 mm SL.

(A-D - Ahlstrom & Counts, 1958; E-G - Jespersen & Taning, 1926)

VINCIGUERRIA ATTENUATA (COCCO), 1838

Eggs are single, spherical, 0.84-0.92 mm, a single oil globule 0.18-0.195 mm.

Prelarvae undescribed.

Larvae. Specimens 9.2, 11.3 and 18.3 mm are described. The body is elongate, the anus is in the posterion third of the body. At 9.2 mm the pectorals are present, the finfold is narrow in the trunk and widened in the place of the future dorsal and anal fins. The preanal length is more than 3 times as much as the post-anal length. The eyes are elliptical, the incipient gas bladder is visible in the mid-part of the body. Larvae are transparent and nonpigmented.

At 9.7 mm SL the postanal length is less than 3 times in the preanal length. Rays are in the dorsal, anal and caudal fin. The anal fin is anteriorly to or below the mid-point of the dorsal fin. The eyes are oval and pigmented. The pigment concentration is in the gas bladder region. A single large melanophore is at the mid-point of the end of caudal peduncle. At 18.3 mm (close to metamorphosis) the preanal length is 64.2-70.8% of SL and twice as large as the postanal length which is 25-29.2% of SL. The anal fin origin is below the 7th ray of the dorsal fin.

During metamorphosis which takes place at 12.5-20.0 mm the preanal length is 59.3-70.0% of SL. The postanal length is 32.2-38.4% of SL, i.e. 1.6-2 times in the preanal length. The anal fin origin is below the middle of the dorsal fin. Photophores are pigmented AO 17-19 or less, the last one is over the 3rd-5th VAV, VAV 7-9. The caudal melanophore is at the mid-point of the caudal peduncle end. The abdominal pigment is visible.

Ahlstrom & Counts, 1958; Jespersen & Tåning, 1926; Sanzo, 1931; Grey, 1964.

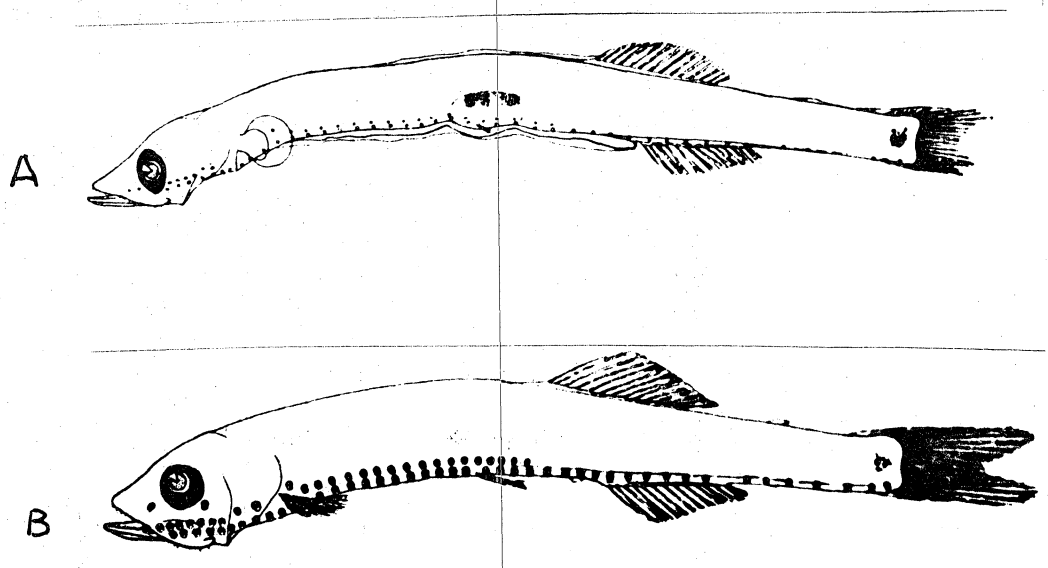


Fig.18.Vinciguerria attenuata

A - postlarval stage, 18.3 mm SL;

B - metamorphosis stage, 18,5 mm SL.

(Jespersen& & Tåning,1926)

ICHTHYOCOCCUS OVATUS (COCCO, 1838)

Eggs are pelagic, spherical, transparent 0.80 mm in diameter with a single oil globule 0.24 mm in diameter. The egg membrane is smooth and tinted orange in the reflected light. The yolk is but indistinctly segmented. The perivitelline space is very narrow. The embryo development lasts two days. Eggs are fully free of pigment. After the blastopore closure the head region is slowly and the caudal is rapidly differentiated.

Prelarvae are 2.2 - ? mm long. The yolk sac is very large, its length is only 2.5 times in the body length. The anus is in the posterior one fourth of the body; the preanal length is about 80% of TL. 32 myomers are preanal and 6 are postanal. The anus opens at the finfold margin. The oil globule (0.24 mm in diameter) is closer to the caudal region of the yolk sac. The body, the yolk sac and the oil globule are unpigmented.

Larvae. The minimum length of a described specimen is 10.8 mm and the maximum is 28.2 mm. In early larvae the body is slender, elongated and cylindrical. The head length is 1/6th of the total body length. The anus is in the posterior one third of the body. Preanal myomers are 26, postanal are 13. The preanal length is 68-70% of TL. The snout is long and flattened dorsoventrally, the elliptical eyes are at half the distance between the tip of the snout and the head end. Pectoral fins are fan-like, the lower rays are longer; incipicent rays are in the caudal fin. The gut is straight and drooping beyond the anus and the protopterigium.

Pigmentation. One melanophore is on each myomere, forming a lateral row of pigment. Melanophores are present on the rounded parts of the pectoral and caudal fins, at the anus, on the isthmus, jaws and snout; the region behind the eye is slightly pigmented.

Rays are first apparent in the caudal fin. At 11.04 mm rays are complete in the caudal fin. Incipient rays are evident in the dorsal fin and the protopterigium is separated in the place of the future adipose and anal fins. At 14.48 mm long and short rays are complete in the caudal fin, 8 rays are in the dorsal fin and 8-9 rays are in the caudal fin. The lower rays in the pectoral fin are elongated and incipient ventral fin is at the dorsal fin origin. At TL 21.36 mm the adipose fin is distinct, the anal rays are complete (15), the length of the lower rays in the pectoral fin is 2/3 rds of the predorsal length. The greatest larval length is 28.2 mm when 12 rays are in the dorsal fin, the dorsal fin length exceeds its depth. The ventral rays in the pectoral fin are beyond half-length of the dorsal fin. Pelvic fins are small with incipient rays. The lateral pigment row is now a wide band consisting of small dashes running from the centre to the ventral margin of each myomere. This stage seems to be accompanied by length decrease and by the metamorphosis. At 15.0 mm SL the distance between the dorsal and adipose fins increases, the ventral rays in the pectoral fins are reduced to reach half the predorsal length. A part of the gut is still drooping outside the body.

The metamorphosis probably starts at 14-13 mm SL when the body remains elongated and now a small part of the gut only is outside the body. The eyes are oval and shifted somewhat upward and backward. The pectorals are in the ventral position, and lacking long rays. Photophores are first apparent.

Sanzo, 1931; Jespersen & Tåning, 1926.

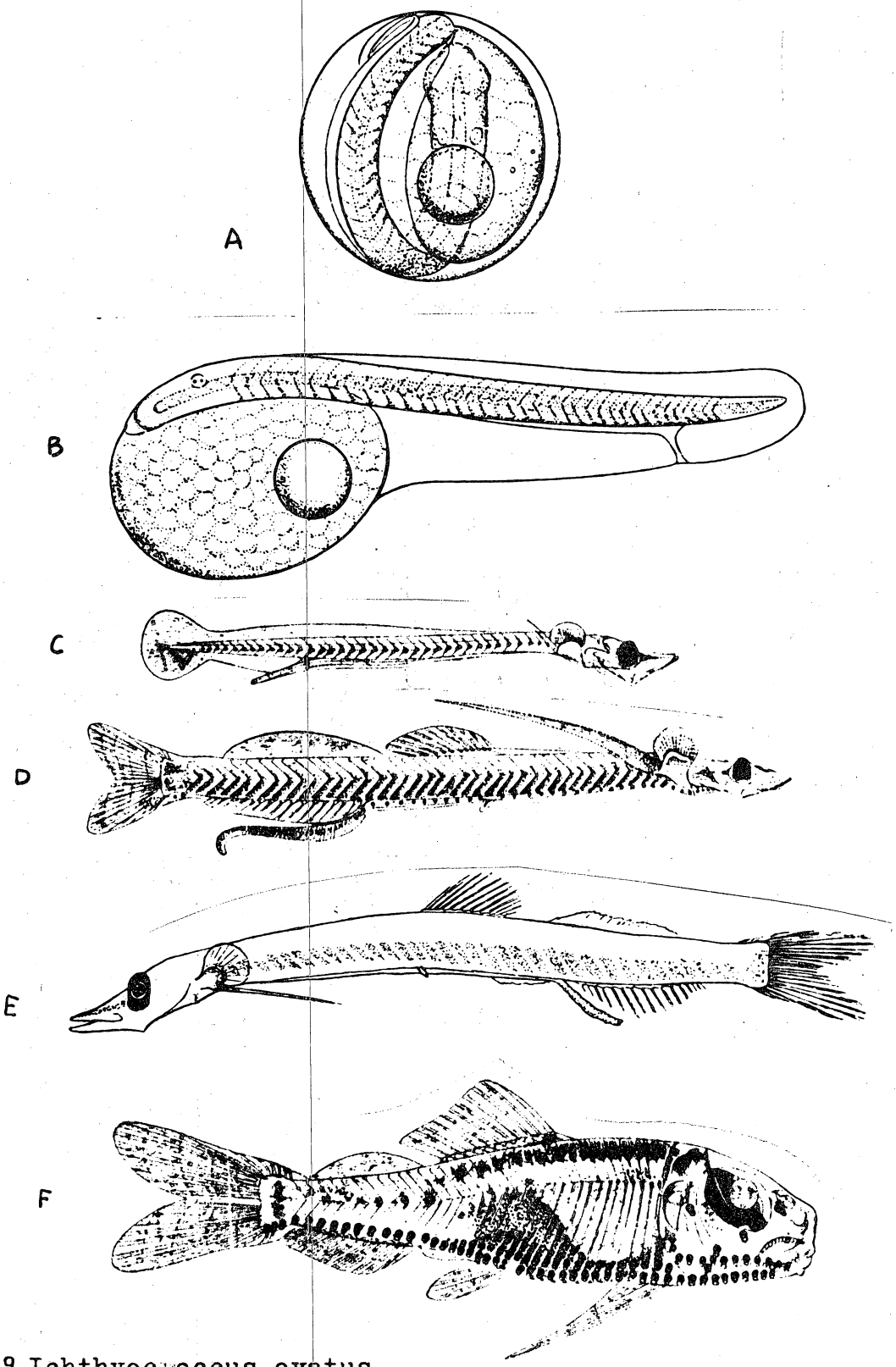


Fig.19. Ichthyococcus ovatus

A-egg II, 0.80 mm in diameter, oil globule 0.24 mm;
B-prelarva 2.2 mm (alive)
C-larva 10.8 mm TL; D-E - larvae, 28.20 TL, 15.0 SL,
F-larva -fry 15.2 mm SL.
(A-D, F Sanzo, 1931; E- Jespersen & Tåning, 1926)

CYCLOTHONE BRAUERI JESPERSEN AND TÄNING, 1926.

Larvae are 4.8-13.7 mm long. At a length of 4.8 mm the body is elongated, slender, the intestine is slightly curved, the air-bladder is in the anterior part of the body, the anus opens at the remnants of protopterigium, the head is about 8 times in the total length; rudimentary jaws are developed, pectoral fins and rays in C, A, D, V are developed, rays in P are lacking. Pigment is arranged in three groups in the foregut, midgut and hindgut with melanophores on the dorsal side of the air-bladder. The caudal pigment consists of 11 large melanophores at the same intervals one from another and there is heavy pigment visible in the lower part of the caudal peduncle. In larvae 10.5 mm long jaws are developed and fins are rayed. 5 melanophores are present between the pectoral fin base and the air-bladder. Pigmentation pattern in the caudal region and in the gut is not changed at a length of 10.5 mm and remains the same in larvae 13.7 mm long. . . Jespersen & Täning, 1926. .

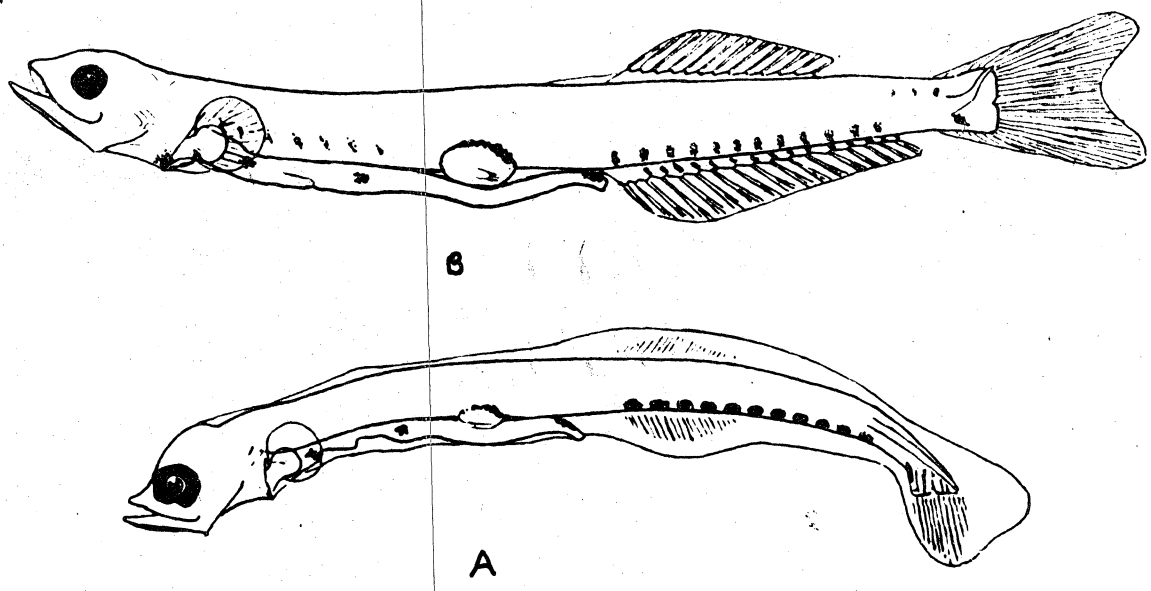


Fig.20.Cyclothone braueri
A- larva 4.8 mm; B - larvae 13.7 mm.
(Jespersen & Taning, 1926)

MAUROLICUS MUELLERI (GMELIN, 1788).

Eggs are pelagic, spherical, transparent, with a thick, jelly-like capsule forming a typical cellular surface of concave hexagonal cells. The egg diameter is 1.29-2.02 mm with the capsule and 0.87-1.20 mm when free of the capsule (sometimes it may be the yolk diameter). A single oil globule 0.22-0.28 mm in diameter is present. The perivitelline space is narrow, the yolk is segmented. The embryonic axis, the yolk and the oil globule are lacking pigment.

Prelarvae are 3.0 mm TL

Hatching occurs at about 3.0 mm. Prelarvae are poorly developed; the yolk sac is large, (47% of TL) and extended beyond the head. The anus is somewhat posteriorly and opens on the finfold margin. The distal oil globule is on the ventral side of the yolk sac, a bit behind its centre. The finfold is wide, ear and nose capsules are visible. The mouth is not fully developed, the intestine is straight.

The pigment is lacking.

Larvae are 3.92 mm TL - 10.3 mm SL.

At TL 3.92 mm the body is moderately long, the finfold, the anus is somewhat posteriorly to the middle of the body. The myomere number is 32-33. The preanal length is 53% TL, the head length is 18% TL. The eyes are elliptical, vertical, pigmented. The mouth is developed, the snout is short. The oil globule remnant and a small rounded pectoral fin are present. The intestine is almost straight with a small thickening in the middle part and it is slightly curved downward in the anal part.

At 5.4 mm TL - 5.9 mm SL the early larval body shape and morphological characters are retained. Preanal myomers are 13, postanal are 19. Anlage gas bladder is present and the caudal fin is with incipient rays. The pigment is lacking. At 6.4 mm SL incipient rays are in the anal fin and at 6.9-7.5 mm SL photophores may appear. When larvae are of 6,0-10,0 mm SL at the caudal and anal fin bases there are a few melanophores which disappear in advanced larvae. At 7.5 mm SL the body depth is increased considerably to form 16-17% SL; anlage pelvics appear and incipient rays are evident in the dorsal and pectoral fins. At 10.3 mm all fins except for pectorals are completely rayed but the protopterigium remnant is retained.

Larvae-fry are 10.0 mm - 13.0 mm long. Fin rays are complete, the photophores are not fully developed; the adipose fin is considerably longer than in fry and adults.

Sanzo, 1931; Grey, 1964; Okiyama, 1971; Robertson, 1976; Jespersen & Tåning, 1926; Ahlstrom, 1974.

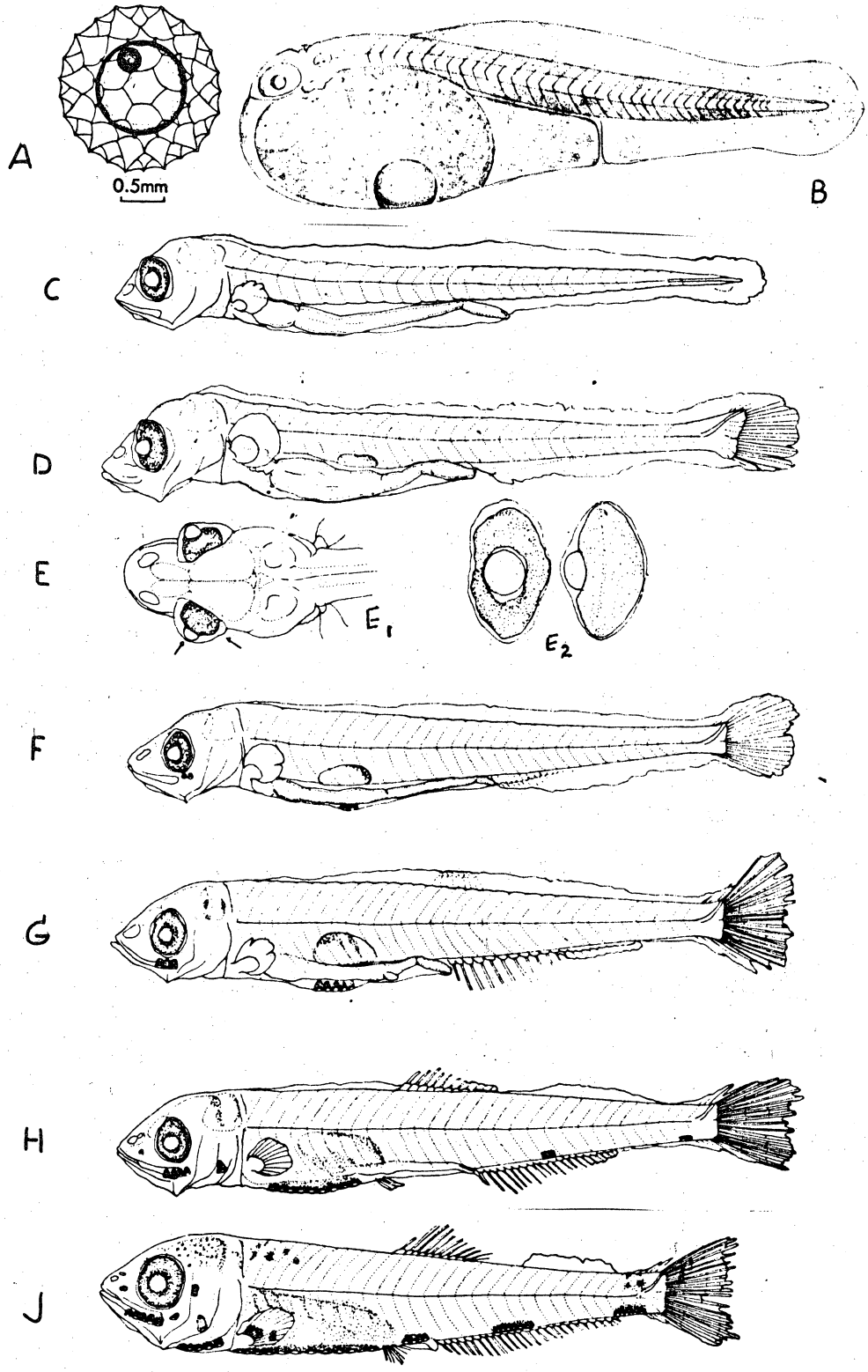


Fig.21. Maurolicus muelliri

A - egg; B - prelarva 3.0 mm TL (alive)
C - larva 3.9 mm SL; DE - larva 5.9 mm TL;
(E_1 - head; E_2 - eyes;/ F - larva 6.9 mm;
G - 7.5 mm SL; H - 10.3 mm SL; J - larva-fry 13.0 mm SL
(A -Robertson, 1976; B - Sanzo, 1931; C-J - Okiyama, 1971)

ARGYROPELECUS HEMIGYMNUS COCCO, 1829

Eggs are pelagic, spherical, transparent, 0.92-1.04 mm in diameter with a single large oil globule 0.26-0.28 mm in diameter. The egg capsule is smooth, double, the perivitelline space is narrow. The yolk is clearly segmented. Pigment is lacking even in advanced embryos.

Prelarvae are 2.5-3.5 mm TL. The length at hatching is about 2.5 mm. The yolk sac is egg-shaped, 40-42% of TL and not less than 1/4th is projected over the head. The anus is in the posterior half of the body and opens on the finfold margin. The preanal length is 55% of TL. Prelarvae are poorly developed; no incipient rays in the fins, the head region is but slightly differentiated, rudimentary eyes are lacking pigment. The ventral oil globule is in the middle of the yolk sac. The total myomere number is near 30; 13 are preanal. At 3.5 mm TL the mouth is not opened, nose and ear capsules are present, the crystalline lens is present in the eye rudiments. The yolk sac length is decreased down to 25% of TL. The preanal length is 50%. 13 myomeras are preanal and 24-25 are postanal. The body, the yolk sac and the oil globule are devoid of pigment.

Larvae are 4.68 mm TL - 10.92 mm TL - 7.84 mm TL - 11.2 mm TL. In unformed larvae 4.68 mm long the yolk is fully absorbed, the body is moderately long and compressed, 24 myomeras are postanal and 12-13 are preanal; jaws are formed, eyes are elliptical, the upper edge of the eye is more rounded than the lower one. The finfold is broad. The caudal fin is

with the definitive number of long rays. At 7.5 mm TL the urostyle is developed. At 9.0 mm TL the eyes are fully pigmented; incipient rays first appear in the dorsal and anal fins at 10.0-11.0 mm TL when 5-7 upper rays are present in the pectoral fin; the preanal length is about 50% SL, which is the highest length during larval development, followed by the period of length decrease. The photophores are first apparent. At 7.84 mm TL the body shape is similar to that of fry and adults.

Sanzo, 1931; Jespersen & Tåning, 1926; Ahlstrom, 1974.

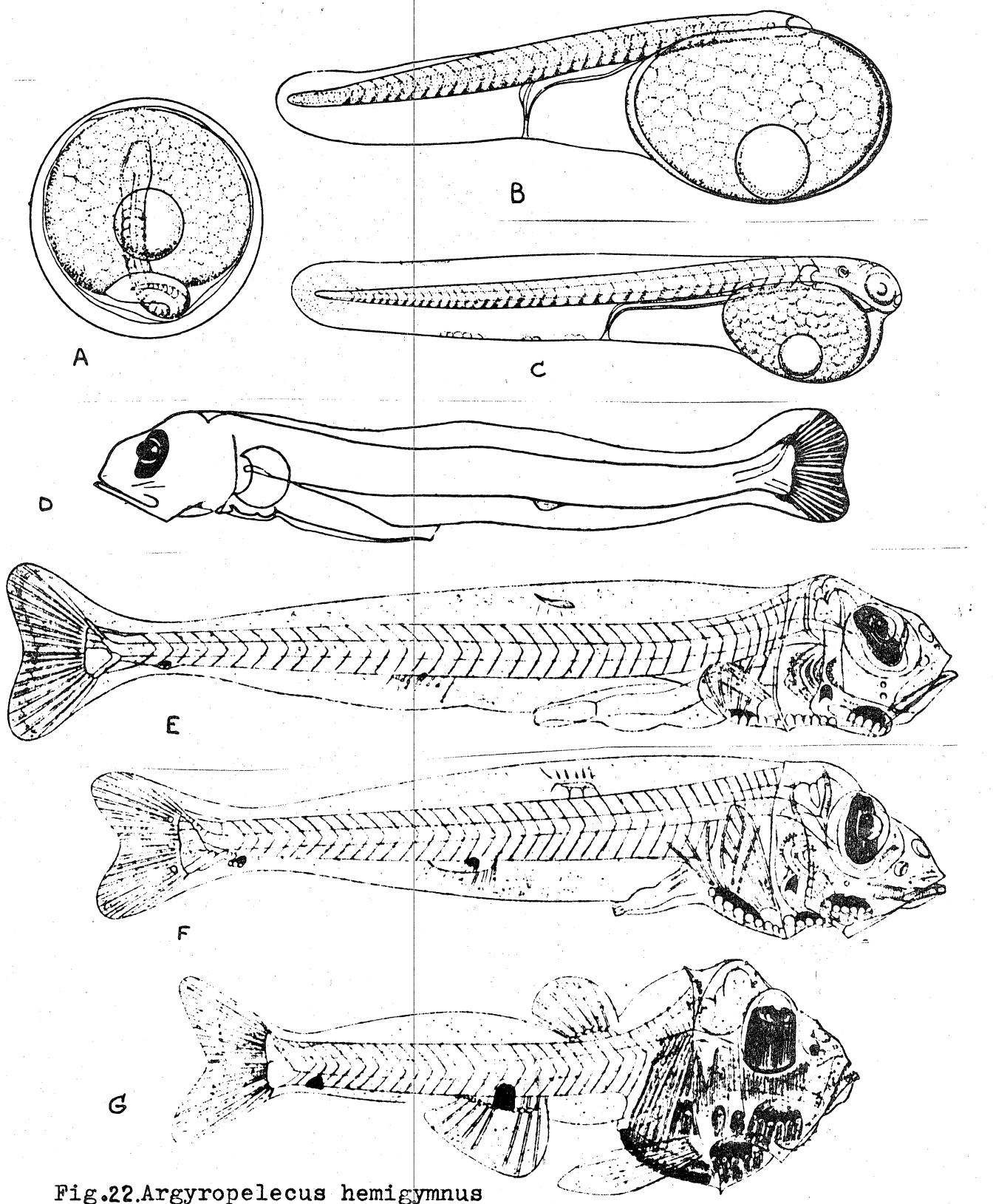


Fig.22.Argyropelecus hemigymnus
A - egg III, B, C - prelarvae, 2.5 and 3.5 mm TL;
D-F - larvae, 9.0 mm SL; 10.92 and 9.92 mm TL, G - larva--fry 7.92 mm TL.
(A-C, E-G - Sanzo, 1931; D - Jespersen & Tåning, 1926)

CHAULIODES SLOANEI BLOCH ET SCHNEIDER ,1801

Eggs are pelagic, spherical, transparent, 2.24-2.52 mm in diameter; the oil globule is about 1.40 mm; the perivitelline space is large. The egg capsule is simple; the yolk is segmented, no oil globule. At Stage III the yolk is oval rather than rounded and is streched along the ventral embryonic axis before hatching. The myomere number is 57-58 which corresponds to the vertebrae number in adults.

Prelarvae are 7.20 - 7.40 mm TL.

Hatching takes place at 7.20 mm, the morphosis rate being insignificant. It looks like a free embryo rather than a prelarva . The body is elongated, slender and transparent. The preanal length is 86.2% and the maximum depth is 11,7% TL. The finfold is not deep and is broad in the preanal region. A large yolk sac is between the vertical across the posterior eye edge and at 1 mm before the anus. The eyes are rounded,unpigmented, the mouth is not opened; the gut is straight,the posterior end being projected at an obtuse angle to the body axis. Incipient pectorals are present, pigment cells are evident in the caudal fin. The length of fixed larvae is decreased down to 6.50 mm.

Larvae. The postembryonic development is accompanied by 3 periods:

1. length increase (8.0-35.2 mm SL); 2. metamorphosis and length reduction from 38.3 to 24.6 mm SL; 3.larva -fry growth up to over 25.0 mm.

At 8.0 mm SL the body is considerably elongated, the depth is only 4.2%, the preanal length is 92% SL. The eyes are large and oval, the maximum diameter is 65%, the minimum is 40% of the head length. The myomere number is 56. The pectorals are small, membranous, the finfold is low and widened posteriorly. Jaws are with small teeth. The posterior end of the intestine is not conjoined with the trunk; the urostyle is straight, the pigment is lacking.

At 13.7 mm SL the head is at an angle to the body axis and rays are developing in the caudal fin. At 18.0 mm the snout length is 31% of the head length. The finfold is sharply elevated in the site of the future adipose fin; the ventral part of the finfold is streched up to segment 10. The caudal fin is developed, the urostyle is turned upward, hypurals and 20 fin rays are evident, the caudal fin is equally bladed, slightly forked.

At 22.8 mm SL incipient pelvics are first apparent at myomere 23 and incipient dorsal fin at myomere 14; the body depth is only 2.6%, and the head length is only 8.8% of the body length. The preanal length is 97.1% of SL. The tip of the gut is not conjoined giving space for the future anal fin. In larvae 24.4 mm long pterygiophores are evident in the anal fin, the posterior ones being developed first. At 35.2 mm fins are formed; 12 rays are in the anal, 6 in the dorsal, 7 in the pelvic and 11 in the pectoral fins, the pectoral rays are still developing; the anterior ray in the dorsal fin is longer; the posterior division of the gut is drooping below the anal fin origin. The period of larval growth is over, in individual larvae ventral unpigmented photophores are present.

At 32.0 mm the body is shortened the ventral and lateral rows of photophores are evident, photophores are scattered on the head and a row of photophores is apparent along the branchiostegal membrane. The ventral photophores are pigmented, the lateral row is absent. The preanal length is reduced down to 90% SL, the tip of the gut is adjoined to the trunk, jaws are elongated.

Larvae-fry at 24.6 mm, resembles an adult fish; the body is shortened by 30% in the average. Both adipose fins are developed, a single stick-like barbel with a few photophores is in the low jaw angle. The preanal length is 85%. The body is by 10% deeper. The eye is rounded, the head is broad, the jaws are with large teeth. Pigmentation. A few melanophores are on the top of the head, on the trunk and on the mid-line along the myocepts and on the peritoneum.

Sanzo, 1931; Belyanina, 1977; Ege, 1918; Morrow, 1964; Parin & Novikova, 1974.

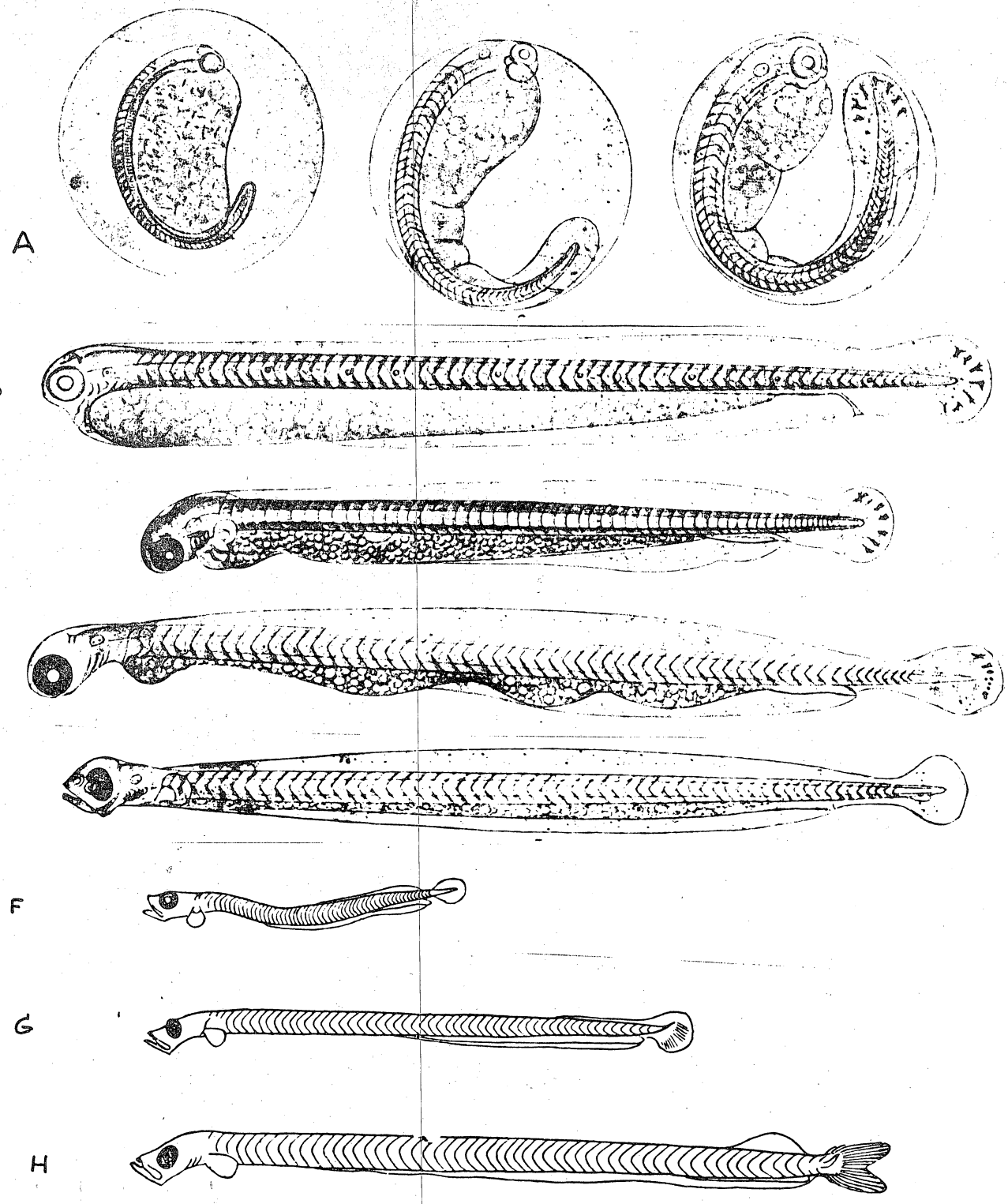


Fig. 23. Chauliodes sloanei

A - eggs III 2.24 mm in diameter; B - prelarva at 7.20 mm TL. (alive); C - prelarva at 5.72 mm TL (13th day of incubation); D - prelarva at 7.40 mm TL; E - larva at 8.72 mm TL; F, G, H - larvae at 8.0, 13.7 and 18.0 mm. (A - E - Sanzo, 1931; F - H - Belyanina, 1977).

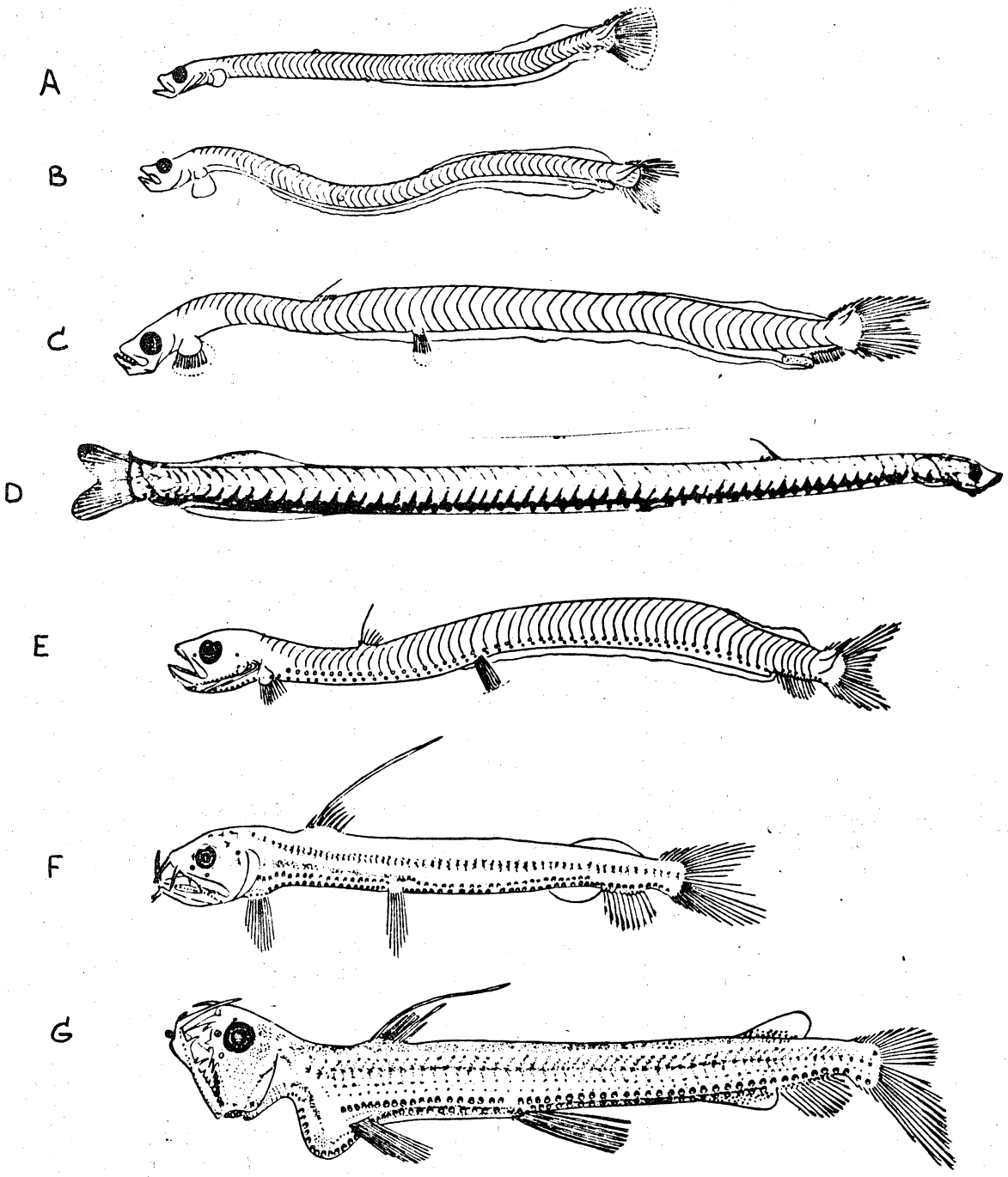


Fig. 24. Chauliodes sloanei
A - C - larvae at 22.8 , 24.2 and 35.2 mm SL;
D - E - larvae at 41.63 mm TL and 32.0 mm SL during metamorphosis;
F - larvae - fry at 24.6 mm SL during late metamorphosis;
G - juvenile at 32.6 mm SL.
(A-C, E-G - Belyanina, 1977; D - Sanzo, 1931).

STOMIAS BOA FEROX REINHARDT, 1842

Eggs undescribed.

Prelarvae undescribed.

Larvae are 10.0-48,0 mm TL. The larval development is accompanied by the period of length increment and of length reduction. At 10.0-15.6 mm the body is very elongate, stomatoid, laterally compressed and with a completely posterior anus. The preanal length is 88-94%, the depth is 6.5-5.6%, the head length is 13-14% SL at 15.6 mm the head is at an angle to the body axis. The eyes are oval; the maximum eye diameter is 28-15%, the minimum 16-8% of the head length. The total myomere number is 78 of which 64 are preanal and 14 are postanal. The intestine is straight, the posterior end is not adnated. A relatively deep finfold stretches dorsally and is deeply concave at the boundary between the dorsal and the caudal part of the finfold. The ventral part of the protoperigium is similarly fulvate. Incipient pterigiophores are evident somewhat anteriorly to the concave region in the dorsal and anal fins(At 15.6 mm 12 are in the dorsal and 15 are in the anal fin). The caudal part of the finfold is rounded. The pectoral fin is small, and low-inserted, fan-like, membranous, limb-based. Incipient hypurals are in the caudal part of the protopterigium.

Pigmentation. A row of melanophores is along the lower edges of myomeres over the gut and a dorsal row of small melanophores spaced at intervals. Small dot-like melanophores are present in the caudal part of the protopterigium harolding the site of the future anal fin. At 15.6 mm melanophores are evident

at the site of the future dorsal fin, on the anal part of the gut and on the anterior intestine. Several melanophores are on the isthmus and on the mandible.

At 20.0 mm TL the caudal fin is developed, with 19 definitive long rays; the lower blade of the caudal fin is larger than the upper; the eyes are small, oval; melanophores are apparent on the head.

At 30.4 mm the preanal length is 92% SL and the head length is 9.0% SL. The body depth at pectorals is 5.3% SL. The eyes are small, oval, the maximum diameter is 16% and the minimum is 12% of the head length. Incipient pelvics are evident at 2/3 rds of the body length from the head. Photophores are apparent between the gut and the lower ends of the myomeres: 43 are anteriorly and 11 posteriorly to the pelvic fins on each myomere; photophores are unpigmented. The protopterigium is still deep and anterior to the dorsal fin.

At the maximum length of 48.0 mm the body is still elongate, the dorsal part of the protopterigium is present; photophores are increased in number up to 48 anteriorly and up to 14 posteriorly to the pelvics. 9 photophores are apparent at the anal fin base and 2 are present behind the fin.

At 41.5 mm the body is shortened. The preanal length is 90%, the head length is 11% and the body depth is 7% of the standard length. The finfold is still relatively deep anteriorly to the dorsal fin; the head is broader, the dorsal and anal fins are conjoined with the caudal fin by the protopterigium remnants. A single lateral row of unpigmented photophores is

apparent, the ventral photophores are pigmented dorsally.

Larva-fry are 32.3 mm long and over. The body proportions are changed. The preanal length is reduced down to 86% of SL, the body depth is increased up to [illegible]7.5%; the head length is 10%. The body is semi-transparent, the eyes are small, rounded; the eye diameter does not exceed 19% of the head length. A well-developed barbel is with three terminal appendages. The finfold remnants persist on the dorsal side of the body. The pelvics are well-developed, with 5 rays, and the same ray number is in the pectoral fins. Photophores are unpigmented.

Range: at and over great depths beyond and off the shelf.

Sanzo, 1931; Ege, 1918; Morrow, 1964.

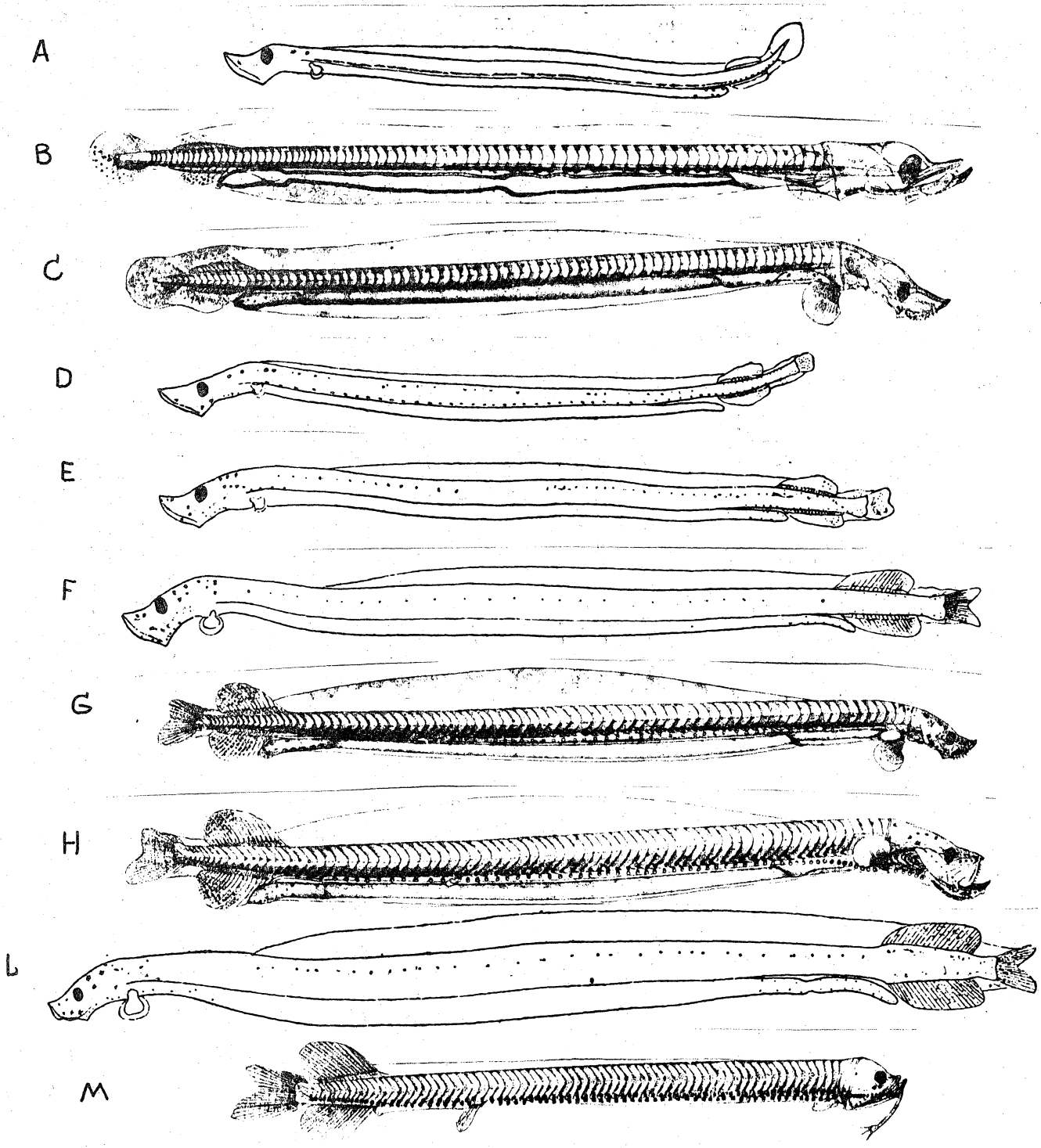


Fig. 25. Stomias boa ferox

A-E - Yearly larvae: A - at 10.0 mm SL; B - at 10.44 mm TL; C - at 15.6 mm TL; D - at 17.0 mm SL; E - at 22.0 mm SL; F-L - fully formed larvae: F - at 30.0 mm SL, G - at 30.4 mm TL; H - at 41.5 mm TL, L - at 44.0 mm SL; M - larva - fry at 32.3 mm SL.

(A,D-E, L - Ege, 1918; B, C, G, H, M - Sanzo, 1931)

ATLANTIC ARGENTINE, ARGENTINA SILUS (ASCANIUS, 1755)

Eggs are pelagic or bathypelagic, spherical, 30-3.5 mm in diameter, the perivitelline space constitutes 1/8-1/10 of the egg diameter, yolk is segmented with the granule diameter below 0.1 mm and a single oil globule 0.95-1.16 mm in diameter and incidental small oil globules. A large oil globule is ovoid and either colourless or slightly redfish and turns yellow after fixation in formalin. The membrane is thin and transparent with occasional small furrows on the surface. The width of the embryo body in the region behind the head constitutes 1/8-1/10 of the egg diameter at Stage III-IV. Embryos and the yolk sac surface are unpigmented, the mouth remains undeveloped even at later stages of embryodevelopment.

Prelarvae are 6.0-17.0 mm long and hatched at 6.0-9.0 mm. The prelarva is elongate, of clupeoid shape, with a very

large yolk sac. There are 47 preanal and 20 postanal segments. The preanal portion forms 75% of the body. The anus opens at the fin fold margin. The yolk sac is ovoid with the height constituting 1/3 of the body length and the length forming half the length of prelarvae. A large oil globule is in the medio-ventral part of the yolk sac, the diameter making up 1/5-1/7 of the body length. The yolk sac is sometimes reduced during hatching and may be smaller in some specimens at similar stages. The pigment appears at the lower margins of myomeres in the anus region when the prelarvae have reached the length of 8.0 mm. The second aggregation of melanophores develops near the last caudal myomeres when the prelarvae are 8.5 mm long and the third one is present half-way between the posterior edge of the yolk sac and anus along the upper surface of the gut at the prelarvae length of 10.0-11.0 mm. By then the mouth opens and at a length of 12 mm, jaws are developed and black pigment is appearing in the eye. The fourth group of melanophores forms pigmentation above the medium part of the yolk sac at a length of 16.5 mm and two small aggregations are added above the gut at equal intervals between the original groups. The eye is fully pigmented. Weak rays are forming in the caudal fin. Yolk sac is almost wholly absorbed.

Larvae are 19-55 mm long. 8 groups of melanophores are notable at a length of 19 mm, and at 22 mm the notochord is bent upwards. Rudimentary rays in the caudal, dorsal and anal fins can be seen when the larvae are 28 mm long.

There are 11 rays in the anal and 13 in the caudal fin at a length of 39 mm. The remnants of the fin fold still remain at a length of 50 mm and the ventral fins are present below the dorsal fin base. (Schmidt, 1906).

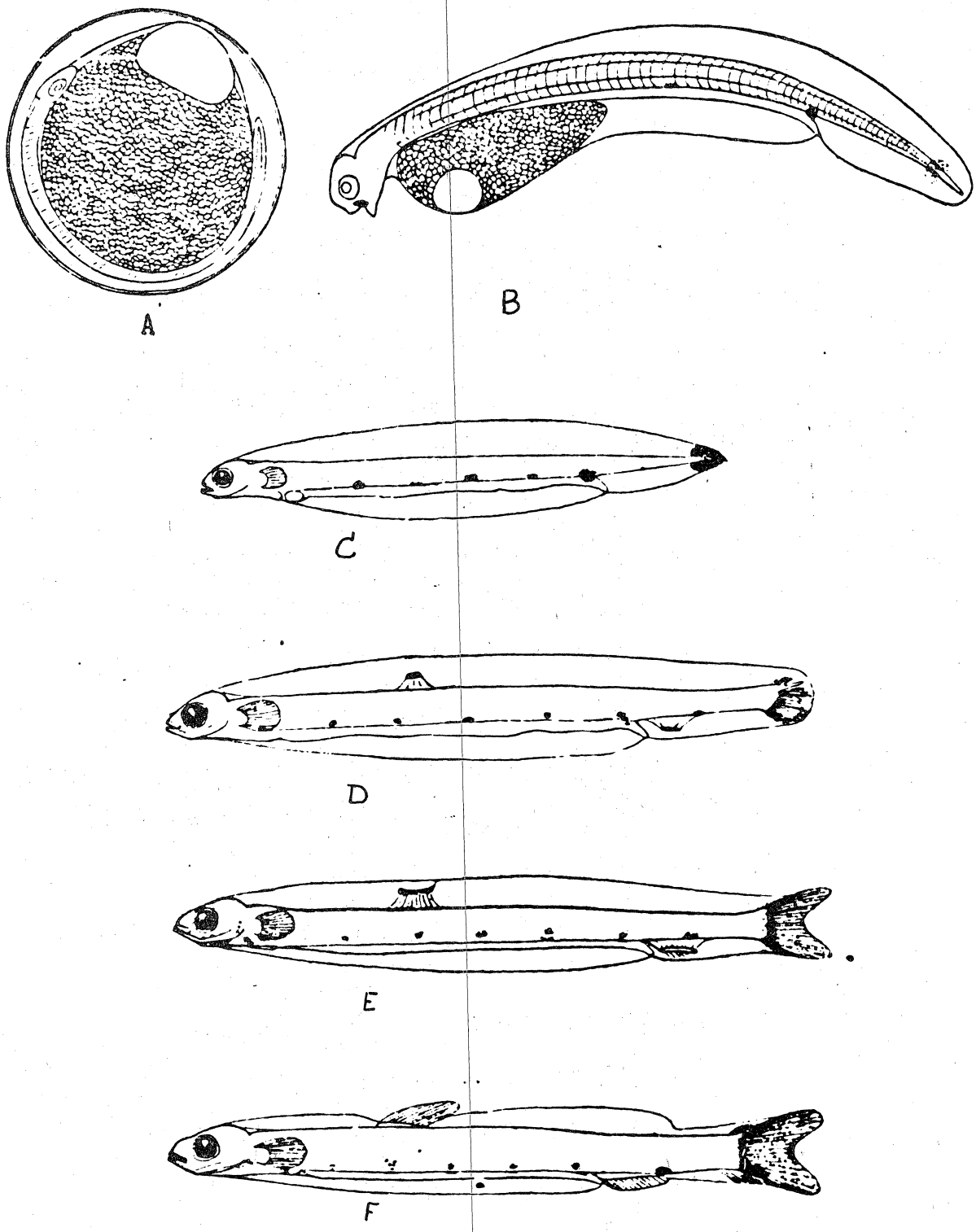


Fig.26. Argentina silus

A - egg; B - prelarva at 12 mm; C, D, E, F - larvae at 17.0, 28.0, 35.5 and 45.0 mm.

(Schmidt, 1906)

NANSENIA GROENLANDICA (Reinhardt, 1839)

Eggs undescribed. Prelarvae undescribed.

Larvae are 6.0-18.0 TL.

The body is elongated, the preanal length is 80-70% of the body length; the anus is in the posterior one third of the body. The total myomere number is 47, the preanal are 29. The intestine is well developed; at 7.5 mm the middle part is thickened and equals half the body depth minus the finfold. The freely drooping part of the gut is absent (or removed when the larvae are caught). The head length is 25-22% of the total body length. The head is rounded and becomes more rounded with growth. The mouth is small, the posterior edge of the upper jaw does not reach the middle of the eye. Eyes are oblong and inclined forward to the longitudinal axis. The pectorals are large, fan-like. The urostyle is almost straight. Incipient rays are in the caudal and dorsal fins at myomeres 15-20. The dorsal anlage is in the protopterigium and is not conjoined with the body.

Pigmentation. The head is devoid of pigment and the eyes are pigmented. A few large melanophores are below the pectoral fin in the anterior part of the intestine, on the gut thickening and anteriorly to it. The most typical are 2-3 large lateral melanophores above the lateral line in the middle part of the body at myomere 15-21, where internal pigment is present between the gut and the lower edges of myomeres. Two caudal ventral melanophores are evident behind the anus, one dorsal melanophore is present anteriorly to the anus and one is over the gut. A characteristic large melanophore in the caudal fin

base is gradually transformed into a small concentration of pigment to be retained during larval development.

At 10.0 mm the urostyle is turned upward and the eyes are less oblong. Incipient pelvics are apparent; pectorals are with 12-14 rays. Pigmentation pattern remains the same as in earlier larvae.

At 13. 25 mm TL the body is cylindrical; rays are in the dorsal, caudal, anal and pelvic fins. The protopterigium is the deepest in the region of the future adipose fin. Pigment is present on the snout and behind the eye, the caudal pigmentation pattern is retained, though the pigment is now less intensive. Three large lateral melanophores are clearly visible and in the middle part of the body where many secondary melanophores are also present. The internal ventral pigmentation is more distinctly pronounced.

At 18 mm the protopterigium remnants are still evident, the body is even more cylindrical; the eyes are of irregular rounded shape. The caudal fin is concave. The ventral finfold is present between the pelvics and the anus. The dorsal finfold is the continuation of the adipose fin anteriorly and posteriorly to the dorsal fin. 11 rays are in the dorsal, 11 in the anal and 15 in the pectoral fin. The [illegible] lateral parallel rows of melanophores along the myomeres is the characteristic feature of the species. The caudal devision is, however, devoid of the secondary pigment and retains the pigmentation pattern of the earlier stages, though the pigment has become less pronounced.

The larvae-fry are 20.5-27.0 mm long. At 20.5 mm the protopterigium remnants are no longer evident. The body is slender, the adipose fin is present but the larval characters are retained, such as the caudal pigmentation pattern and large branched lateral melanophores. The traces of early larval pigmentation are evident at 27 mm when the caudal division is not completely black.

Range: the North Atlantic beyond the shelf, over depths exceeding 1000 m. The spawning takes place in spring.

Schmidt, 1918; Cohen, 1964.

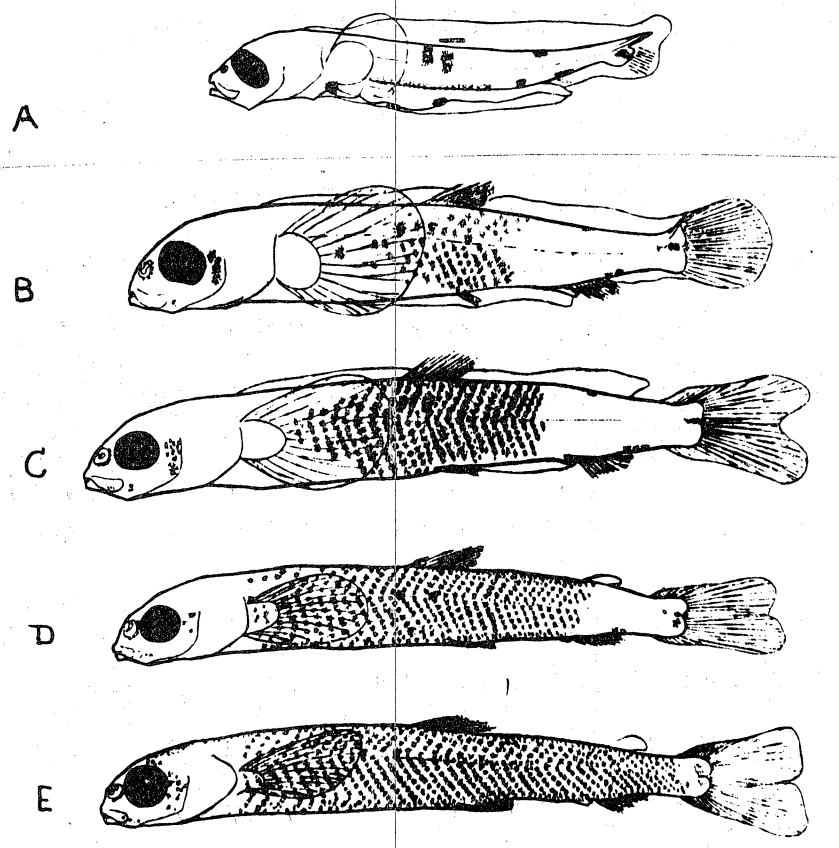


Fig.27. Nansenia groenlandica

A, B, C - larvae at 7.5, 13.25 and 18.0 mm TL;
D, E - larvae-fry at 20.5 and 27.0 mm TL.

(Schmidt, 1918)

NOTOLEPIS RISSOI KROVERI (Bonoparte,184o)

Eggs unknown.

Larvae are 9.5-45.0 mm long and of the sudid type. At the length of 9.5 mm protopterigium and pectoral fins are present, unpaired fins are lacking, the preanal portion constitutes 32.5-33.7% of the body length. Larvae are transparent with single pigment spot in the peritoneal region above the mid-point of the dorsal side of the gut. A and C are developing at lengths of 13.0-18.0 mm and by then rudimentary fin rays appear. The peritoneal pigmentation becomes more intensive. At a length of 20.5 mm rays in A and rudimentary D appear. There are two peritoneal aggregations of pigment and two stellate melanophores over the last rays in A. In larvae 45 mm long the preanal region forms 60% of the total length and the number of peritoneal pigment spots reaches 12, as compared to 3-at 23, 4 - at 28 and 6-7 spots at 38 mm. The snout is elongate at early stages and becomes of the typical adult form at the larval length of 18-20 mm.

Ege, 1931 .

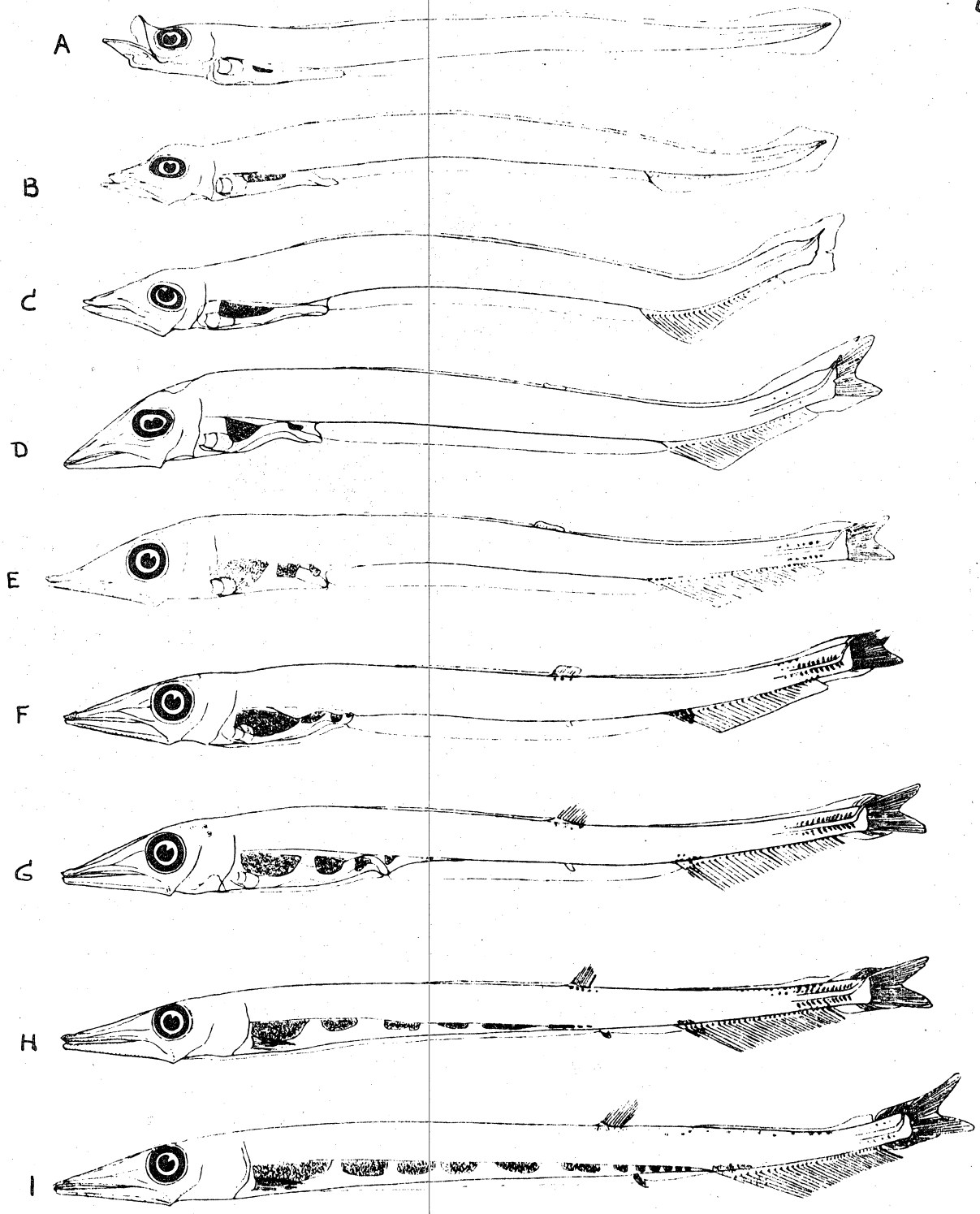


Fig.28 Notolepis rissoi

A-G - larvae, SL, mm: A - 9.5, B - 13.0, C - 18.0, D - 20.5, E - 23.0, F - 28.0, G - 30.0, H, I - larvae-fry: H - 38.0; I - 45.0 mm.

(Ege, 1931)

PROTOMYCTOPHUM ARCTICUM (Lütken, 1891)

Eggs undescribed. Prelarvae undescribed.

Larvae. Reported length is 7.5-15.0 mm. Larvae are large, the eyes are crescentshaped, oblique, the lens is not shifted upward. The cone-like adnexa is lacking, the body is slender, poorly pigmented. The snout is long and pointed, 28 - 33% of the head length. The intestine is short, the anus and the anal fin origin are widely spaced. In advanced larvae the intestine is longer and no space is evident. The posterior edge of the upper jaw is widened. The anus is in the anterior half of the body. The preanal length is 40-43% of the body length and up to 50% and over in advanced larvae. The anal fin origin is beneath the dorsal one and is significantly longer. At 13.0-14.0 mm rays are in the anal and at 16-17 mm in the dorsal fin.

The body is unpigmented except for a few ventral melanophores. The body melanophores-13-14 and the caudal - 27-28. 11-15 rays are in the dorsal and 18-23 in the anal fin. At about 10 mm photophores are apparent. Sometimes ventral melanophores are present in the caudal row.

Täning, 1918; Pertseva-Ostroumova, 1964, Ahlstrom, 1974.

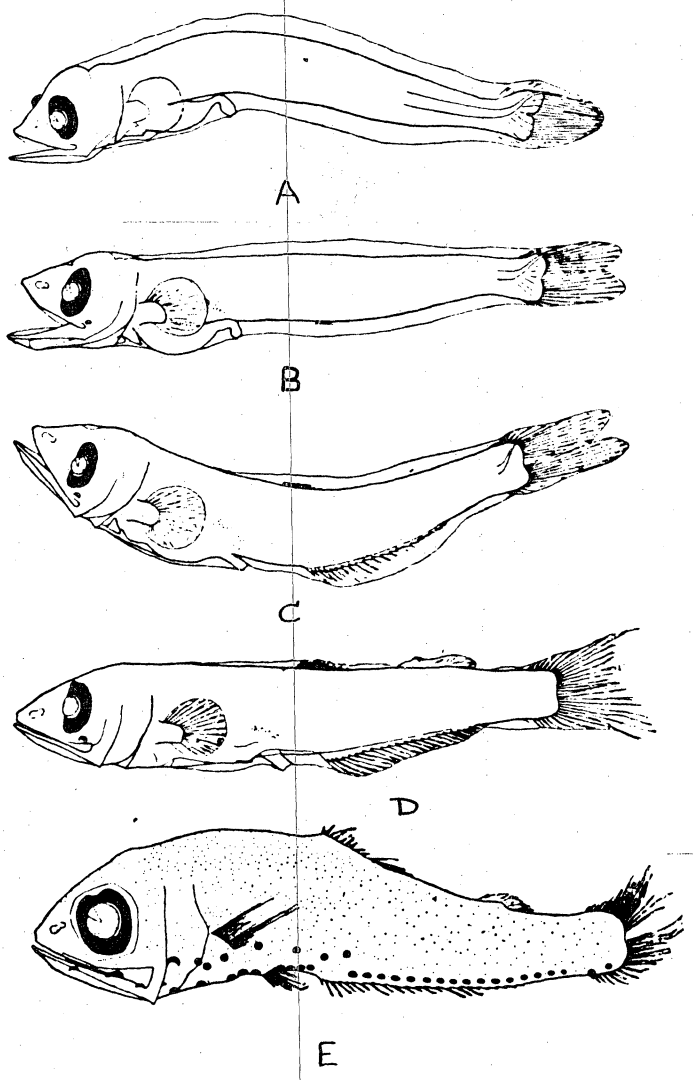


Fig.29. Protomyctophum arcticum

Larvae: A - at 7.5 mm; B - at 10.3 mm; C - at 12.5 mm;
D - at 14.0 mm.
Fry: E - at 15.0 mm.
(Tåning, 1918)

HYGOPHIUM HYGOMI (Lütken, 1892)

Eggs undescribed. Larvae undescribed. Larvae are 3.8-9.0 mm long. The body is slender, the eyes are oval with a small cone-like concentration of the choroid tissue ventrally. The dorsal sinus is developing. The intestine is a thick tube with a bulge in the middle. The preanal length is 52-63% SL at 4.0-5.0 mm, 55-63% SL at 5.0-8.0 mm and 65-59% SL at 9.0-17.0 mm. The body depth increases gradually from 13-15% at 4.0-7.0 mm to 23-32% at 8.0-17.0 mm. The head length is 29-33% SL in early larvae and 26-31% SL in advanced larvae. Rays are first apparent at 7.0-8.0 mm in the anal fin and at 11.0 mm in the dorsal fin; rays are complete in the dorsal fin at 12.0-13.0 mm. Incipient pelvic fins are present by the begining of the metamorphosis at 15.0 mm.

Pigmentation. Two ventral rows of parallel dashes are present between the isthmus and the shoulder girdle origin. The pigment appears in early larvae and disappear during the metamorphosis. At 3.8 mm a large stellar melanophore is present on the ventral side posteriorly to the anus over the middle part of the future anal fin and is retained till the metamorphosis. In larvae 5.0 mm long one melanophore is apparent over the middle part of the intestine and is also retained till the metamorphosis.

Shiganova, 1977; Taning, 1918; Moser & Ahlstrom, 1970.

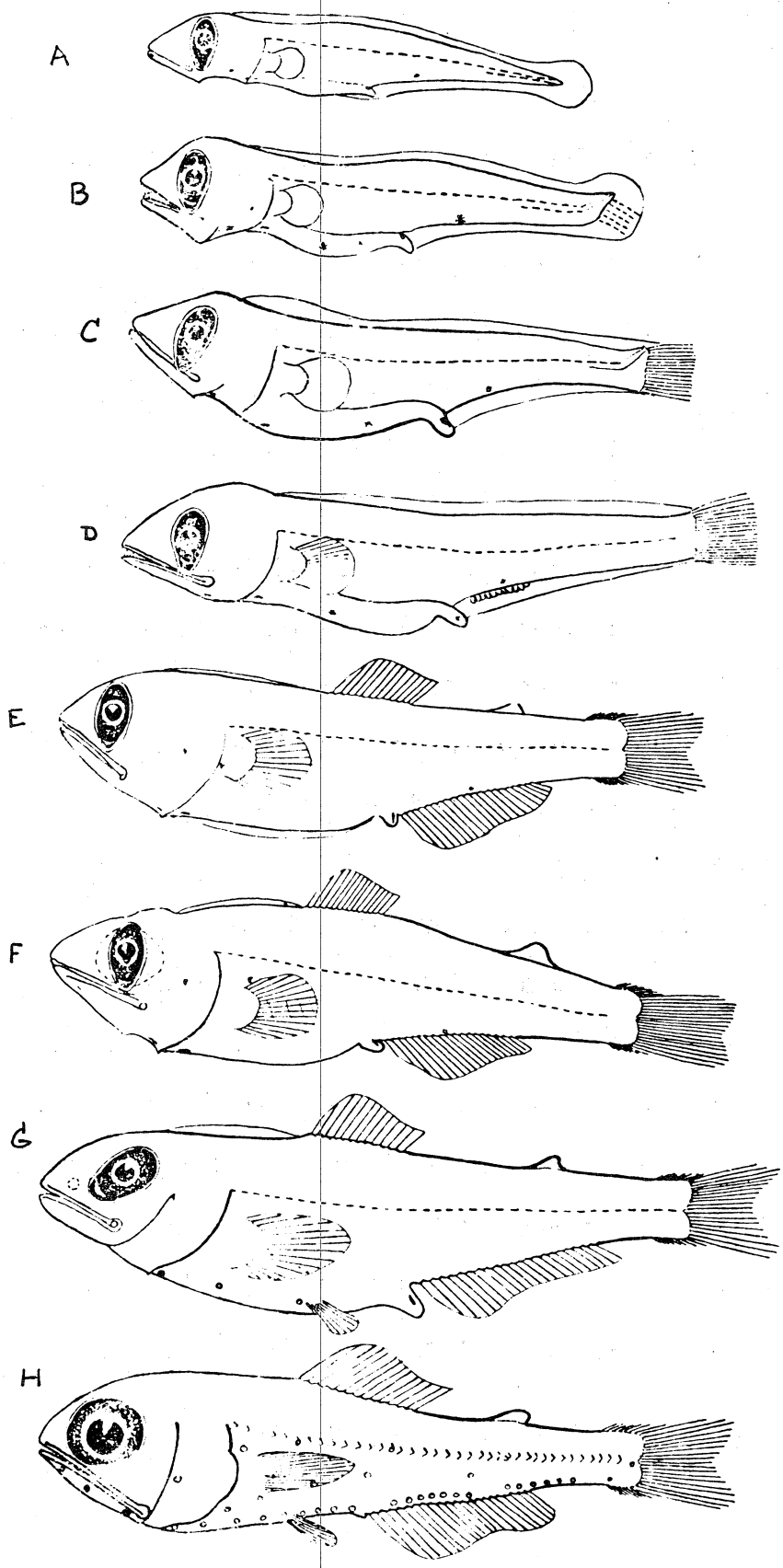


Fig.30. Hygophum hygomi

A - D - larvae, SL, mm: A - 3.8; B - 5.4; C - 6.4; D - 7.1.

E - G - larvae-fry; mm: E - 9.8; F - 12.4, G - 16.4; H - 18.5.

(Shiganova, 1977)

BENTHOSEMA GLACIALE (Reinhardt, 1837)

Eggs undescribed. Larvae undescribed.

Larvae are 5.0-13.0 mm long. The body is deep; the intestine is moderately short, the eyes are oval with an arched concentration of choroid tissue on the ventral side. The body depth at the pectoral fin origin is 21-22% of SL in unfinned larvae and 27-29% of SL in advanced larvae. The body length is 25-28%. The gut is retort-like with drooping anus. The preanal length is 53-57% at 8-10 mm SL and 49-54% SL at 10-13 mm. At 7.0-8.2 mm rays are differentiated in the pectoral, dorsal and anal fins. At 12-13 mm pelvics are developing. The adipose fin is apparent at about 7.0 mm.

Pigmentation. In early larvae pair melanophores are on the isthmus and are becoming large and distinct with growth. One ventral melanophore is present posteriorly to the anus beneath the last body vertebrae. At 7 mm the pigment is on the anal papilla and absent at 11.0 mm. At 10.0-11.0 mm one melanophore is on the operculum, at 8-9 mm large melanophores are beneath the pectoral fin and disappear by the end of the metamorphosis, which takes place at 13.2-15.0 mm.

Holt, 1898; Taning, 1918; Shiganova, 1977.

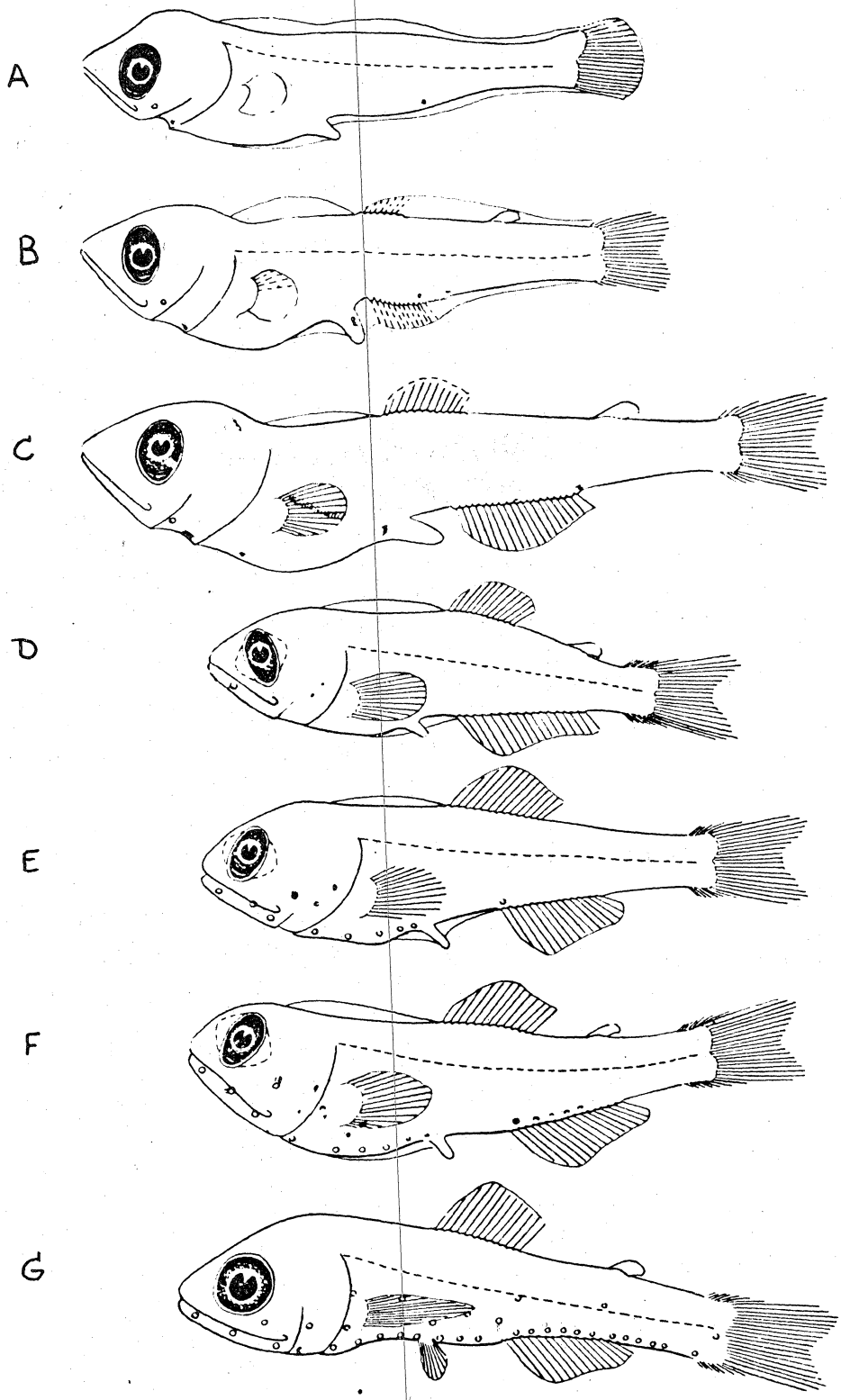


Fig.31. Benthosema glaciale

A - F - larvae, SL, mm : A - 6.2; B - 7.2, C - 8.3; D - 9.4; E - 10.5 ; F - 10.8; G - fry at 12 mm.

(Shiganova, 1977)

DIOGENICHTHYS ATLANTICUS (TANING, 1918)

Eggs undescribed.

Prelarvae undescribed.

Larvae: 3.5-12.8 mm SL. The body is elongated; at 7-8 mm the anus is near the middle of the body; the preanal length is 56.9-61% of SL. At 4.0-5.0 mm the maximum preanal length is 63.5%. The eye is elliptical, the eye length is 33-40% of the head length. The gut is long and is slightly expanded anteriorly. The head is large: 30-35% in the Atlantic individuals and 21-28% in the Pacific specimens. The head length decreases with growth.

The most distinctive feature is a chin barbel, which is first evident at 4-5 mm, when rays are apparent in the caudal fin. At 5-6 mm rays are developing and at 8 mm they are fully formed in the pectorals. Incipient rays are in the dorsal fin at SL slightly exceeding 7 mm and at 8.2-8.5 mm the rays are well-developed. Incipient adipose is visible at 7 mm, pelvics are developing at SL over 12 mm.

Pigmentation: In the smallest larvae 5-7 melanophores are behind the opercle below the pectoral fin but with age only 1 distinct melanophore is retained. A row of melanophores is on the lateral surface of the gut which is gradually submerging into the body tissue, becomes paler and disappeares completely by the beginning of metamorphosis.

A significant diagnostic character is the row of melanophores originating over the anus and extending to the middle of the caudal peduncle and submerging with growth into the body tissue to become paler. After the urostyle is turned upward a large melanophore appears in the caudal fin base.

References: Täning , 1918, 1928; Pertseva-Ostroumova, 1964, Moser & Ahlstrom, 1970; Shiganova 1977.

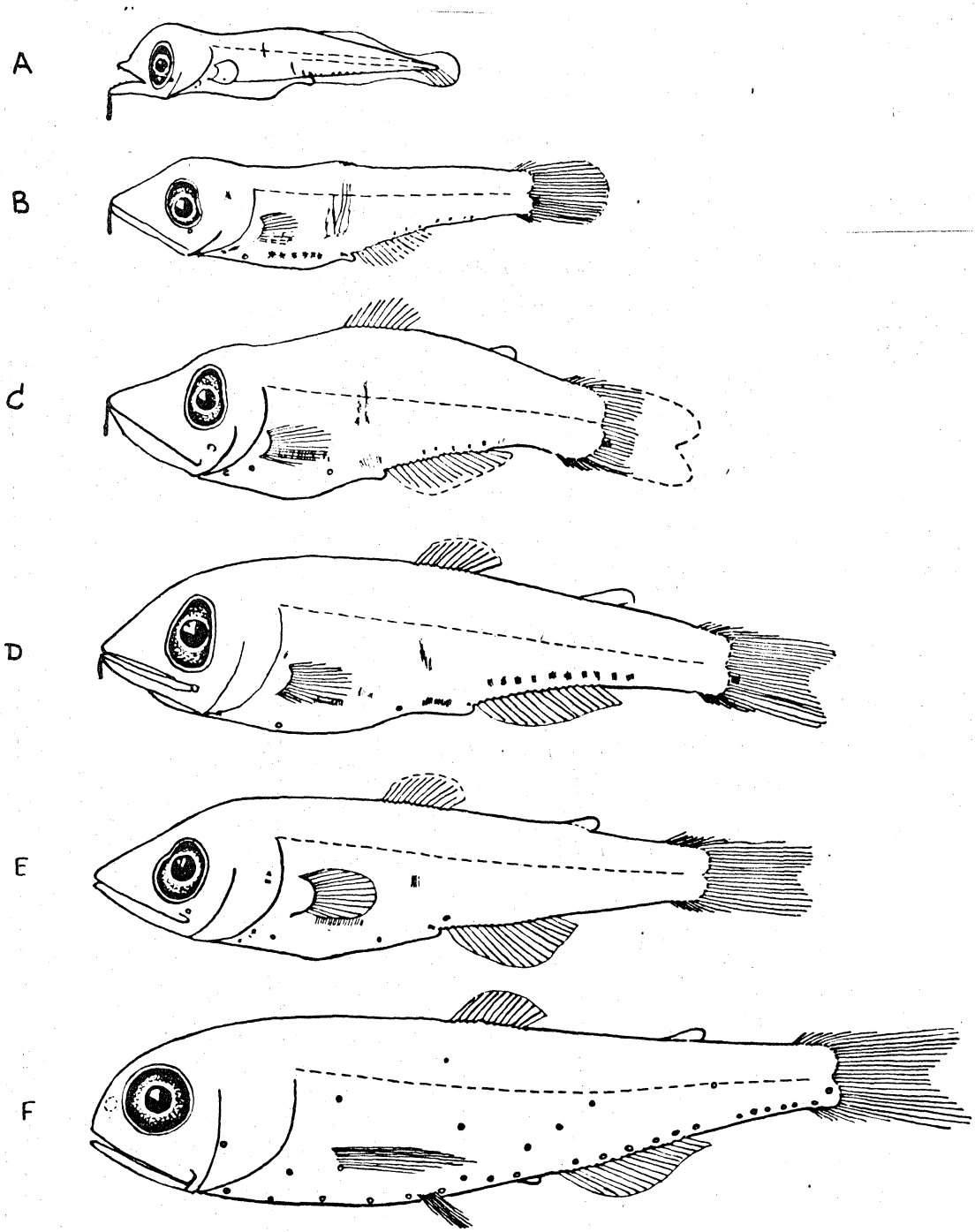


Fig. 32. Diogenichthys atlanticus
A, B - larvae at 4.5 and 6.1 mm SL;
C, D - larvae-fry at 7.5 and 10.3 mm SL;
E, F - fry at 11.9 and 12.8 mm SL

(Shiganova, 1977)

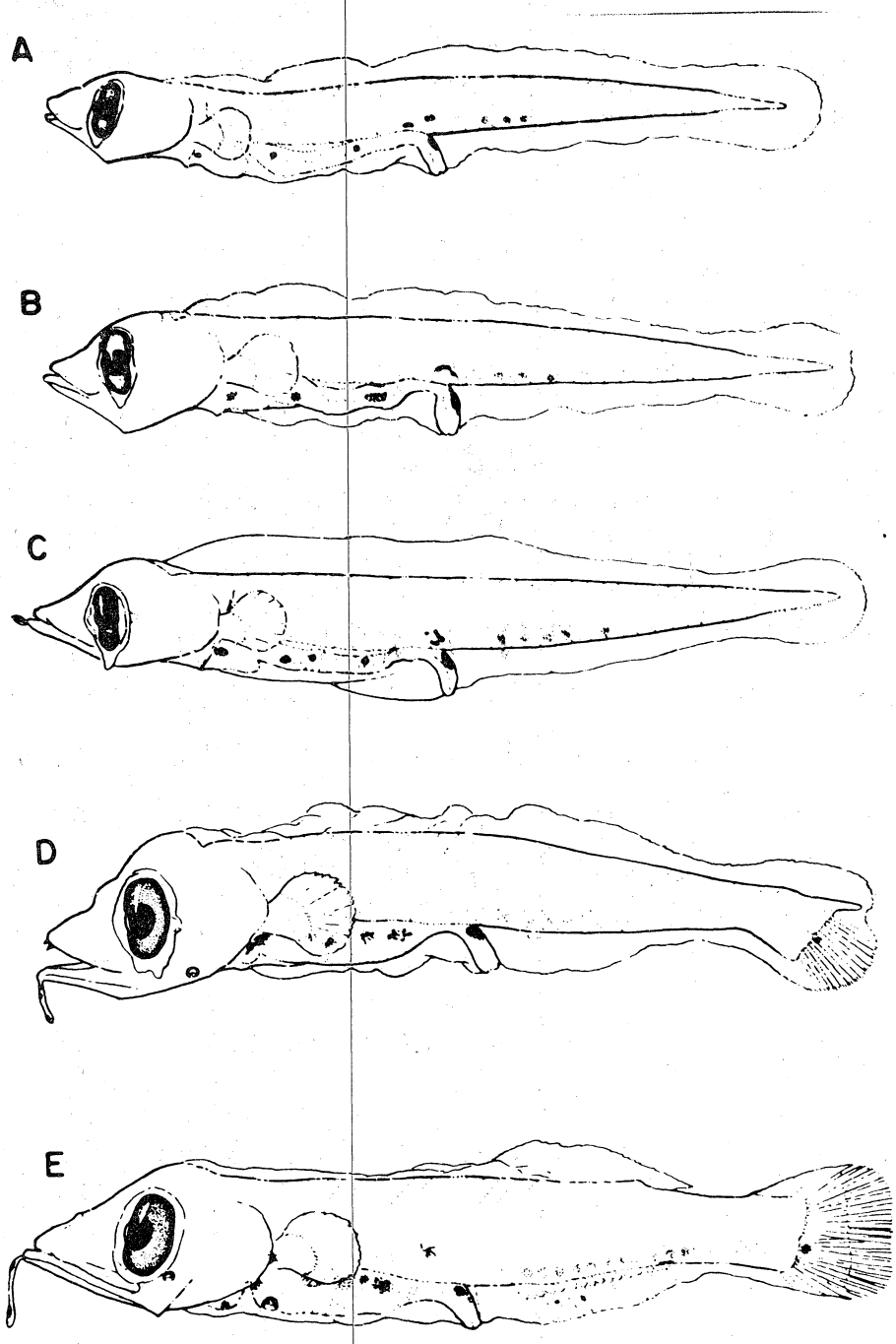


Fig. 33 Diogenichthys atlanticus

Larvae: A - at 3.6 mm; B - at 4.3 mm; C - at 5.1 mm; D - at 6.0 mm; E - at 7.2 mm.

(Moser & Ahlstrom, 1970)

FRESH-WATER EEL ANGUILLA ROSTRATA (LESUER, 1817)

Eggs. Putative ripe unfertilized eggs are 0.59-1.25 mm (1.06 mm in the average) in diameter. Eggs are transparent, slightly elliptical, with a few relatively large oil globules.

Prelarvae are 6.0-9.0 mm long.

Larvae. The larval development is accompained by two leptocephalid stages and two elver stages.

Leptocephalid. Stage I: 10.5-69.0 mm TL; the body is elogated, leaf-shaped, compressed laterally. The myomere number is 104-111 (63+41-47), at 10.5 mm and 102-110 (64-71+38-46) at 18-58 mm. The preanal length is 70-74%, the body depth is % at 10.5 mm and 6.6-6.2% of TL at 40-50 mm. Teeth are long, sharp and thin initially and become shorter with growth. The tooth formula is $\frac{I + 3}{I + 3}$ at 10.5 mm. $\frac{I + 4}{I + 3}$ at 14.5 mm, $\frac{I + 5}{I + 4}$ at 15.75 mm, $\frac{I + 6}{I+5-6}$ at 22 mm, $\frac{I + I + VII + 27}{I + VII + 2}$ at 43.9 mm and $\frac{I + I + VII + 8}{I + VII + 4}$ at 50 mm. At 44 mm TL rays first appear in the dorsal and anal fins. The dorsal fin origin is at myomere 61 at 50 mm TL.

Pigmentation: at 10.5 - 14.25 mm a few stellate melanophores are at the caudal end of the protopterigium; at 15.75 mm TL 8 melanophores are on the caudal surface of the finfold; at 44-50 mm TL the caudal fin is free of pigment and the eye is completely pigmented.

Leptocephalid. Stage II: 71-58 mm TL. At 59.5 mm the total myomere number is 105 (68+37), 60 are predorsal, and 37 are postanal. The preanal length is 39 mm, the postanal length is 18.0

mm, the head length is 5.0 mm, the horizontal eye diameter is 0.9 mm, and the snout length is 1.6 mm. The body depth is 2.5 mm behind the head and 3.6 mm at the pectoral base; the maximum body depth is 11.0 mm.

At 71.0-58.0 mm the body is leptocephalous; at 64-65 mm the body shows a gradual decrease. By the end of the stage the head is rounded though in the beginning of the stage the head shape is similar to that in leptocephalid at Stage I. Teeth count is $\frac{I + V + 8}{I + VI + 3}$ on each side at 59.5 mm; at 57-58 mm they disappear. Rays in the caudal fin are: 1 + 4 + 2 + 2. Pigmentation is probably lacking.

Elvers: 60-48 mm TL at Stage I and 48-65 mm at Stage II. The myomere number is 103-109, 35-37 are preanal, 68-72 are postanal and 26-29 are predorsal. 7-10 myomeres are between the dorsal and anal origins; 16 rays are in the pectoral fin and 203-258 in the dorsal, anal and caudal fins. The preanal length is 38-29.5% and the predorsal length is 26.1-31.8%; the head length is 11.1-11.5%; the maximum body depth is 4.1-4.8%. The body becomes of rounded shape, typical of adults. The mandible projects beyond the maxillary. At 52 mm the dorsal origin is 4.5 mm before the anus.

Pigmentation: a few thin melanophores are on the dorsal surface of the snout and behind the head; a few small melanophores are in the caudal region and a row of large melanophores is along the notochord between the pectoral and caudal fins.

References: Bigelow & Schroeder, 1953; Egles, 1968; Edel, 1975; Eldred, 1968; 1971; Harden & Jones, 1968; Eigerman & Marsh, 1902; Jeffries, 1960; Jensen, 1937; Mc Lane, 1955; Ranoy, 1959; Schmidt, 1916; 1925; Smith, 1907; Smith & Saunders, 1955; Vladykov, 1955; Mansueti & HARDY 1967.

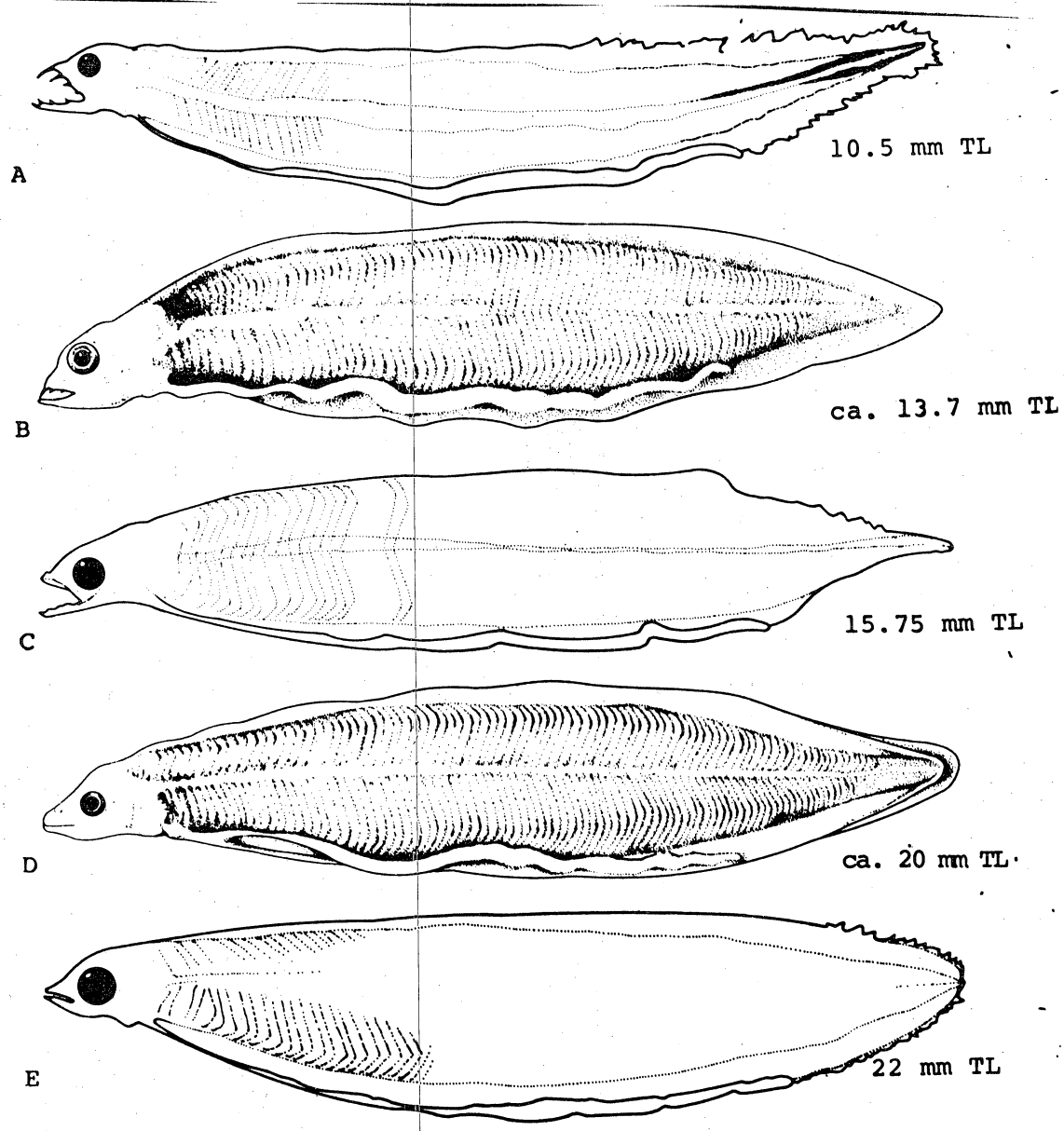


Fig.34 Anguilla rostrata

A - leptocephalid I at 10.5 mm;
B - leptocephalid II at 13.7 mm (teeth are shortened, gut is curved);
C - at 15.75 mm TL; D - at 20 mm TL; E - at 22 mm TL.
(A,C,E - Schmidt, 1916; B,D - Vladykov, 1955; cited after Hardy, 1978)

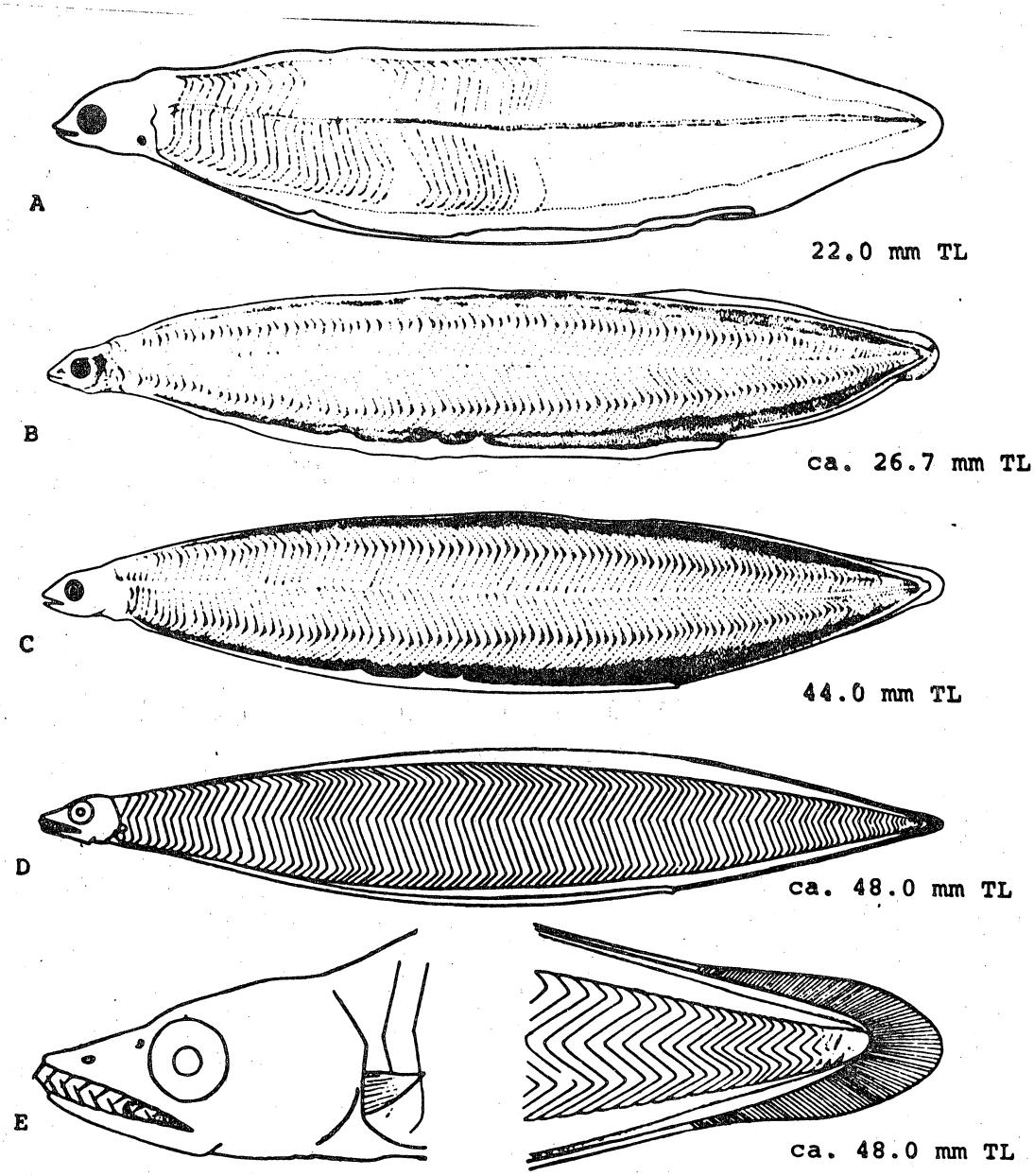


Fig. 35. Anguilla rostrata

A - leptocephalid I at 22.0 mm TL;
B - leptocephalid I at 26.7 mm TL;
C - leptocephalid I at 44.0 mm TL;
D - leptocephalid I at 48.0 mm TL

(A,C - Schmidt, 1916; B - Vladykov, 1955;
D,E - Eigenmann & Kennedy, 1901; cited after Hardy, 1978)

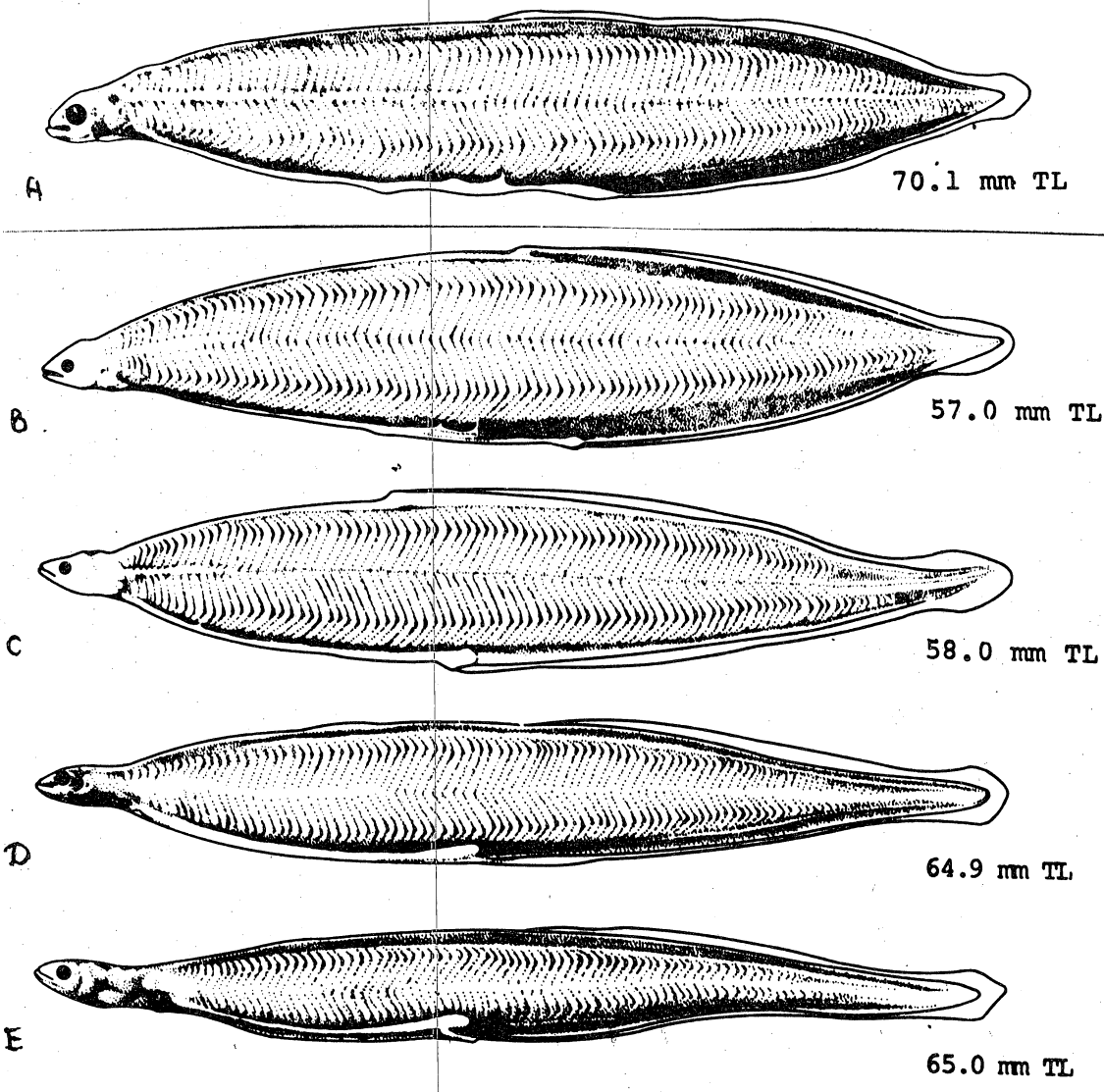


Fig. 36. Anguilla rostrata

A - leptocephalid II at 70.1 mm TL (the gut is shortened considerably);
B - leptocephalid II at 57.0 TL;
C - leptocephalid II at 58.0 mm TL;
D - leptocephalid II at 64.9 mm TL (the body is increased in length);
E - leptocephalid II at 65 mm TL.

(A,D,E - Vladykov, 1955, B,C - Schmidt, 1916, AFTER HARDY, 1978)

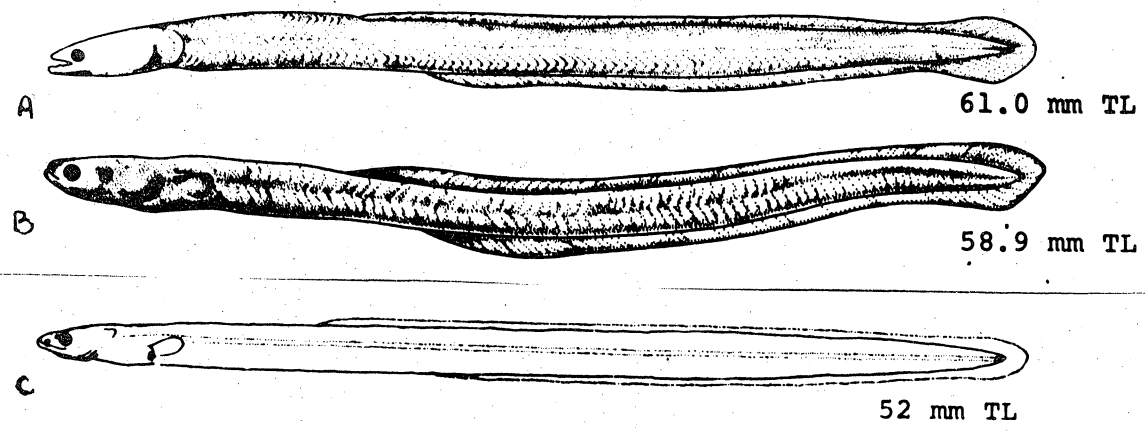


Fig. 37 Anguilla rostrata

A - elver I at 61.0 mm TL ; B - elver I at 58.9 mm TL;
C - elver I at 52 mm TL.

(A - Schmidt, 1916; B - Eldred, 1968; Ege, 1939; cited after Hardy, 1978).

CONGER OCEANICUS (MITCHILL, 1818)

Eggs undescribed.

Prelarvae undescribed.

Larvae are leptocephalous. The body is compressed. The length is up to 160 mm. Specimens described (75-98 mm long) are probably advanced when the length has already decreased.

The total myomere number is 140-151, 74 are preanal, 72 are postanal; 52 myomeres are between the origin of the anal and dorsal fins at 96.5 mm TL. The head length is 4.6 mm, the eye length is 1.7 mm, the body depth is 6.6 mm; the eyes are oval, the pectoral fin is formed. The gut is straight, tubular, the anus is in the posterior half of the body; the pectoral fin is well-developed; the head is somewhat elongate , the snout is pointed.

Pigmentation; At 93 mm TL a crescent concentration of melanophores is beneath the eye. Alive leptocephals are fully transparent. In fixed specimens at 96.5 mm TL a row of about 85 pigment dots is visible along the mid-lateral line; about 100 small melanophores are along the ventral surface of the body below and on the gut. Numerous black dots are in the anal and dorsal bases. In advanced individuals 75 mm long the outer edges of the fins are pigmented.

References: Bigelow & Schroeder, 1953; Costello, 1946; Briggs, 1958; Fowler, 1952; Jackson, 1953; Jordan & Davis, 1892; Hardy, 1978; Hanser, 1975; Leim & Scott, 1966; Lippson & Moran, 1974; Smith, 1979.

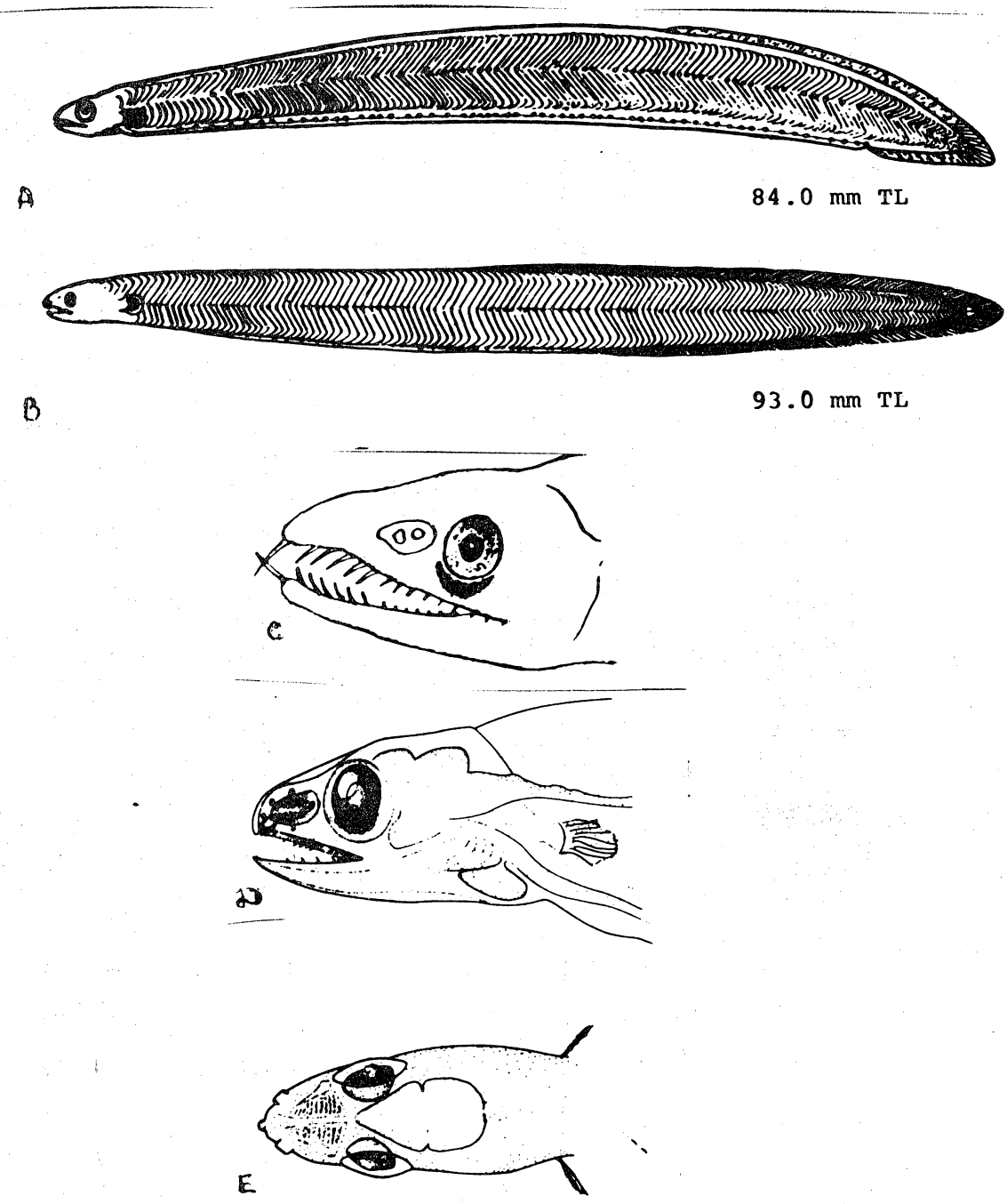


Fig. 38. Conger oceanicus

A.- leptocephalid 84.0 mm TL,
B - leptocephalid 93.0 mm TL,
C - head of B
D, E - head of transforming leptocephalid 93.5 mm TL,
(dorsal and lateral aspects).

(A - Bigelow & Schroeder, 1953; B, C - Lippson & Moran, 1974; D, E - Hardy, 1978; cited after Hardy, 1978).

ATLANTIC NEEDLEFISH SRONGYLURA MARINA (WALBAUM, 1792)

Eggs. A compact mass of eggs is attached to algae. Egg are 3.5-3.6 mm in diameter; transparent; the membrane is with thread-like swellings of different length, but not exceeding the egg diameter. The perivitelline space is very narrow, the yolk is almost in contact with the membrane; no oil globules; incubation period is unknown; the finfold is formed 163 hours after hatching.

Prelarvae are 9.2.-14.4 mm at hatching. The yolk sac is large and oval; the head is not deflected on the yolk. The lower jaw becomes thicker by the end of the stage; the finfold is small and is not developed anteriorly to the dorsal fin and is present between the dorsal and caudal and between the anal and caudal fins. Incipient rays are in the dorsal, caudal and anal fins. The urostyle is turned upward by the end of the stage. The mouth is opened. Pigmentation: a wide dark band is over the lateral line between the head and the anus, the yolk sac is pigmented.

Larvae: 25.5-48.2 mm TL. The body is arrow-like, the anus is in the posterior 1/3rd of the body. Jaws are equal in the beginning of the stage, the lower jaw becomes considerably longer with development. The remnants of the preanal part of the finfold are retained up to 37.0 mm TL. Ventrals are evident at 30.0 mm TL. Pigmentation: at 25.3 mm large melanophores are anteriorly on the ventral surfaces of the sides; melanophores are on the head and on the body; a distinct row of melanophores is along the dorsal midline. At 30.0-37.0 mm large melanophores are on the body and on the head and their concentration is denser below the midline. At 48.2 mm the melanophores become numerous.

Fry. The minimum reported length is 45.0 mm. The caudal peduncle is deeper than in adults. At 44.5 mm the length of the upper jaw is 60% of the lower.

Pigmentation: dark above, light ventrally; a distinct dark band along the lateral line between the eye and the caudal fin base becomes lighter in the posterior part of the body.

Range: from the Gulf of Maine to the central Florida; the Gulf of Mexico and off Rio de Janeiro. Spawning occurs in the coastal waters, bays and estuaries; probably in river mouths.

References: Arnold et al. 1960; Bean, 1893; Berry & Rivas, 1962; Delsman, 1924; Forster, 1974; Fowler, 1945; Hardy, 1978; Hildebrand & Schroeder, 1928; Ryder, 1882; Smith, 1907; Tracy, 1910.

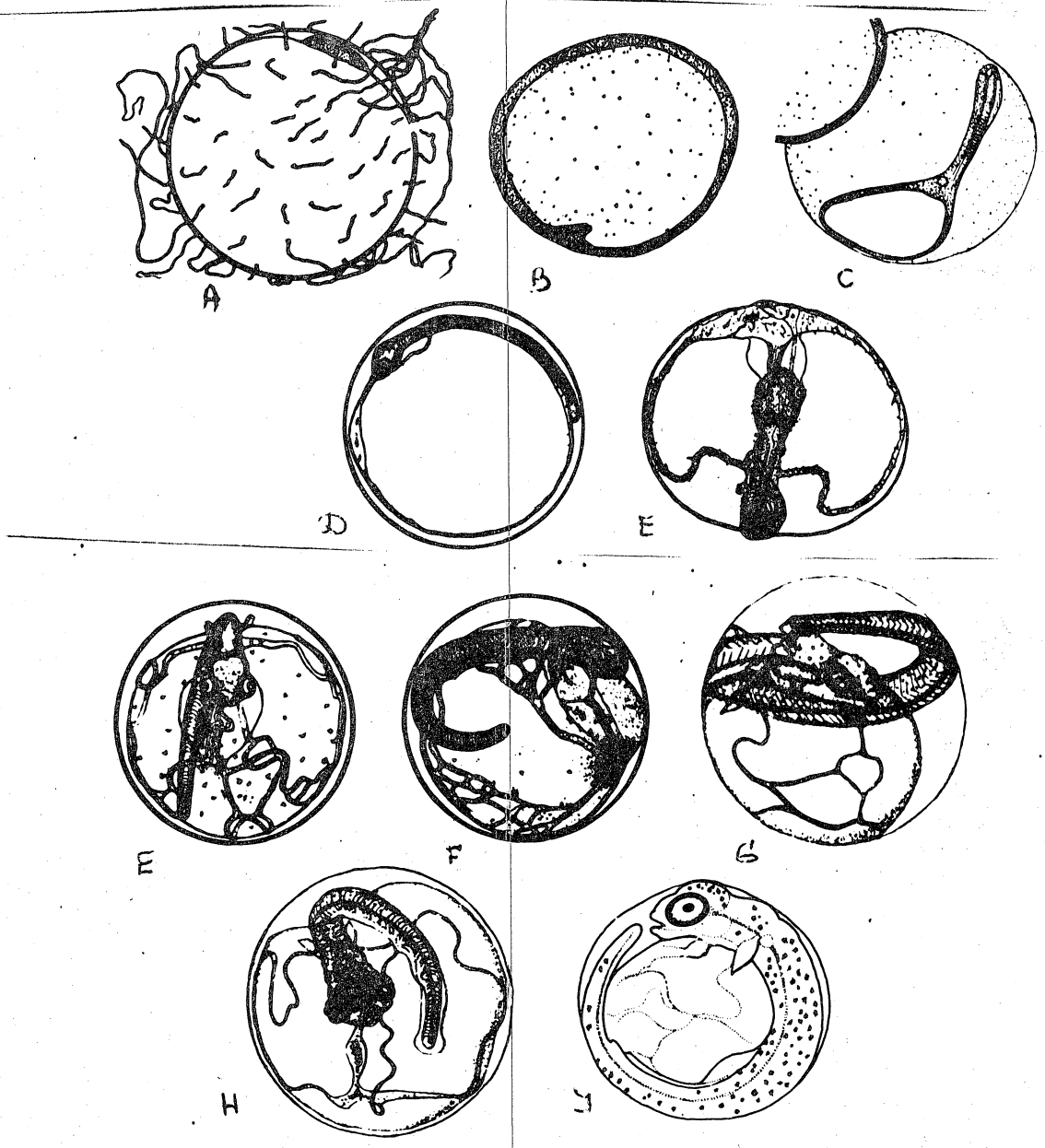


Fig. 39 Strongylura marina

Embryonic stages: I - A,B; II - C,D, III - E-G; IV-H-J.

(A-G -Ryder, 1882; H-J - Hardy, 1978)

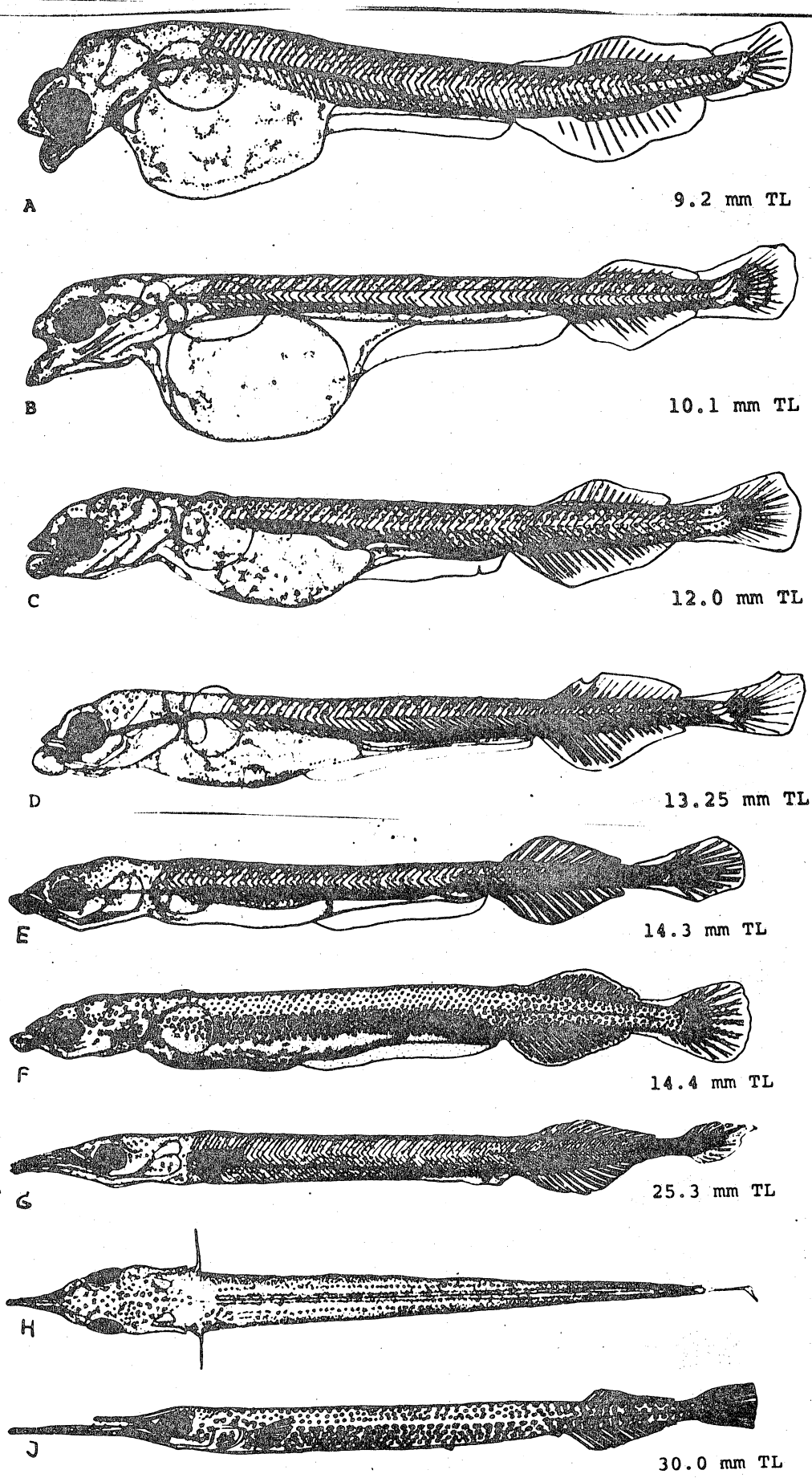


Fig. 40. Strongylura marina

A-E - prelarvae; F- J- larvae
(Hardy, 1978)

ATLANTIC SAURY SCOMBERESOX SAURUS (WALBAUM, 1792)

Eggs are spherical, semi-transparent, the membrane is pale due to microfibres distributed evenly or in concentrations on the membrane surface. The perivitelline space is 6.6-6.5% and 10-13% of the egg diameter at early and late stages respectively. The yolk is segmented. Eggs are 2.15-2.76 mm in diameter. The yolk sac is 2.12 mm in the average. At Stage I the blastodisc depth is 0.75 mm. At Stage II the yolk is not completely overgrown with cellular material, the embryo embraces 1/4th of the peripherial of the yolk. Eye bubbles are distinct. The head is 0.35 mm wide in the eye bubble region, the body width is 0.1 mm; pigment is lacking. When embryo occupies 1/3rd of the yolk sac, the eyes are formed, pigment cells are in two rows on the embryonic shield and on the yolk sac surface around the embryo.

By the end of Stage II incipient pectorals are evident and the width of the head is 0.57 mm and of the body-0.12 mm.

At Stage II eyes are elliptical, the embryo embraces 2/3 rds of the yolk, the caudal region is separated from the yolk sac surface; two lateral rows of melanophores are present; 1.02 mm by the end of the Stage; the width of the head is 1.02 mm and of the body-0.37 mm. The caudal fin with incipient rays. The head and the dorsal side are brightly pigmented.

At Stage IV the caudal fin is extended beyond the head, the mouth is evident; incipient rays are in the caudal fin, mesenchina is thickened in the anal fin region; the eyes are pigmented; the yolk diameter is less than at Stage III. The yolk is pigmented.

Prelarvae are probably 6.0-9.5 mm long. The specimen described is the yolk sac larva 8.5 mm long; larvae without the yolk sac 6.0 mm long are reported. The maximum length of prelarvae is 8.0-9.5 mm. The yolk sac is oval, the snout is blunt, the mouth is well-developed, the low jaw is not extended beyond the upper. The pectoral and caudal fins are with incipient rays, the dorsal finfold is extended 1/3 of the distance between the snout tip and the anus.

Pigmentation: larvae are blue except for fins, the dorsal surface is heavily pigmented.

Larvae are 6.0-26.0 mm long. The body is elongated but rounded, slightly compressed from sides; the yolk sac is completely absorved at 6.4 mm. The eyes are large, convex, oval, heavily pigmented. The snout is short, the mouth is *superior*, the lower jaw extends beyond the upper. The preanal length is 67.0-70.0% and the head length is 24.6-27.5% of TL. The dorsal and ventral finfold *margin* is present. Pectorals are large, rounded and lacking rays. 3 rays are in the anal and 13 in the caudal fin. The body is brown, the dorsal surface and the head are heavily pigmented, a few large melanophores are on the sides of the head, on the jaws on the occiput and on the caudal base.

At 9.5 mm the preanal length is 67.0-71.0% and the head length is 24.6-27.5% of TL. At 10.7 mm the body is elongated, the snout is short, the eyes are large. The finfold is retained completely on the ventral side and partially on the dorsal side. The caudal fin with up to 16 rays; [illegible] 4 rays are the pectoral, 12 in the anal and 3 in the dorsal fin. Small incipient additional fins *are* on the ventral side.

Pigmentation: additional concentration of melanophores is in the dorsal fin base. At 11.5 mm the dorsal finfold is reduced, the caudal fin is straight, the pectoral fin is enlarged with a definite ray number. The anal part of the protopterigium is reduced at 14.0 mm and ventral fins are evident.

At 16.3 mm caudal rays are longer, the additional rays grow in number. 7 rays are in the pectoral, 12 in the anal and 8 in the dorsal fin. The caudal fin base is heavily pigmented. At 20.5 -21.5 mm jaws are elongated anteriorly and become narrower with the lower jaw being considerably longer. Small teeth are evident, eyes are rounded and less. The caudal fin is with 21 axis ray and 4 rays on each side; 11-13 rays are in the pectoral, 11 in the dorsal and 6 in the ventral fin. Small additional fins are on the dorsal surface of the caudal peduncle. The upper rays in the pectoral ray are much longer than the others. The protopterigium is retained on the ventral surface.

At 24.8 mm the body shape is fry-like, but the jaws are still short, the protopteregium is reduced, fin rays are formed. The anterior rays in the dorsal, anal and ventral fins are elongated, the caudal fin becomes forked. Teeth are distinct. The caudal, dorsal and anal bases are heavily pigmented. Pectorals and ventrals are transparent.

Spawning takes place in the open ocean 32-64 km off the shore.

Range: from Cape Verde to Norway in the East Atlantic and from the Bermudes to Newfoundland and Iceland in the West Atlantic.

References: Ahlstrom, 1972; D'Ancona, 1930, 1931; Gilchrist, 1905; Hartman, 1970; Nesterov & Shiganova, 1976; Nichols & Breder, 1927; Kolliker, 1958; Orton, 1964; Poll, 1947; Sanzo, 1940; Zilanov & Bogdanov, 1969.

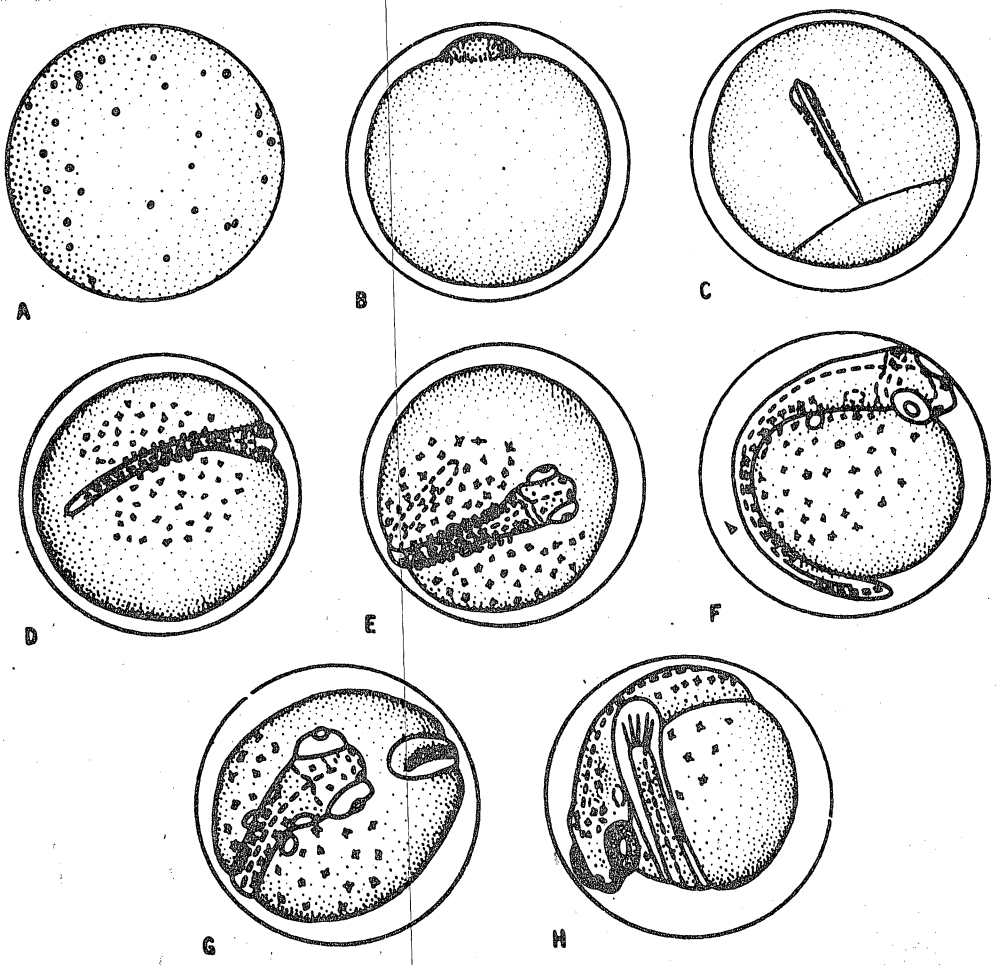


Fig.4 I. Scombresox saurus

A - ovarial eggs; B - Stage I - epithelial blastula;
C - Stage III - embryo, embracing 1/4th of the yolk;
D, E - embryo-development at Stage III; F-H - Stage IV.
(Nesterov & Shiganova, 1976)

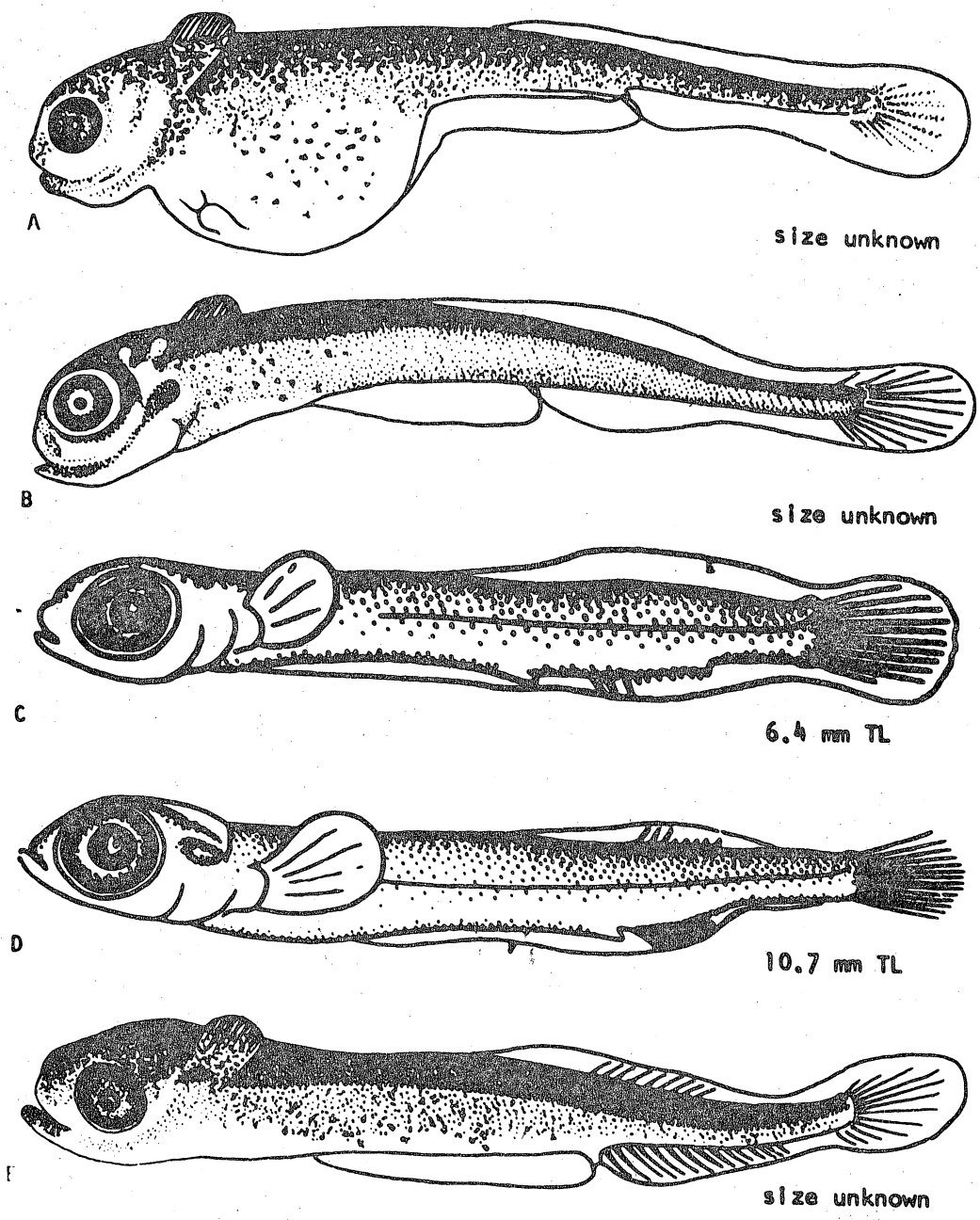


Fig.42. Scombresox saurus

A,B - prelarva and larva (size unknown);

C,D,E - larvae at different lengths

(E - size unknown);

(A,B,E -Gilchrist,1904;C,D - Nesterov & Shiganova,1976)

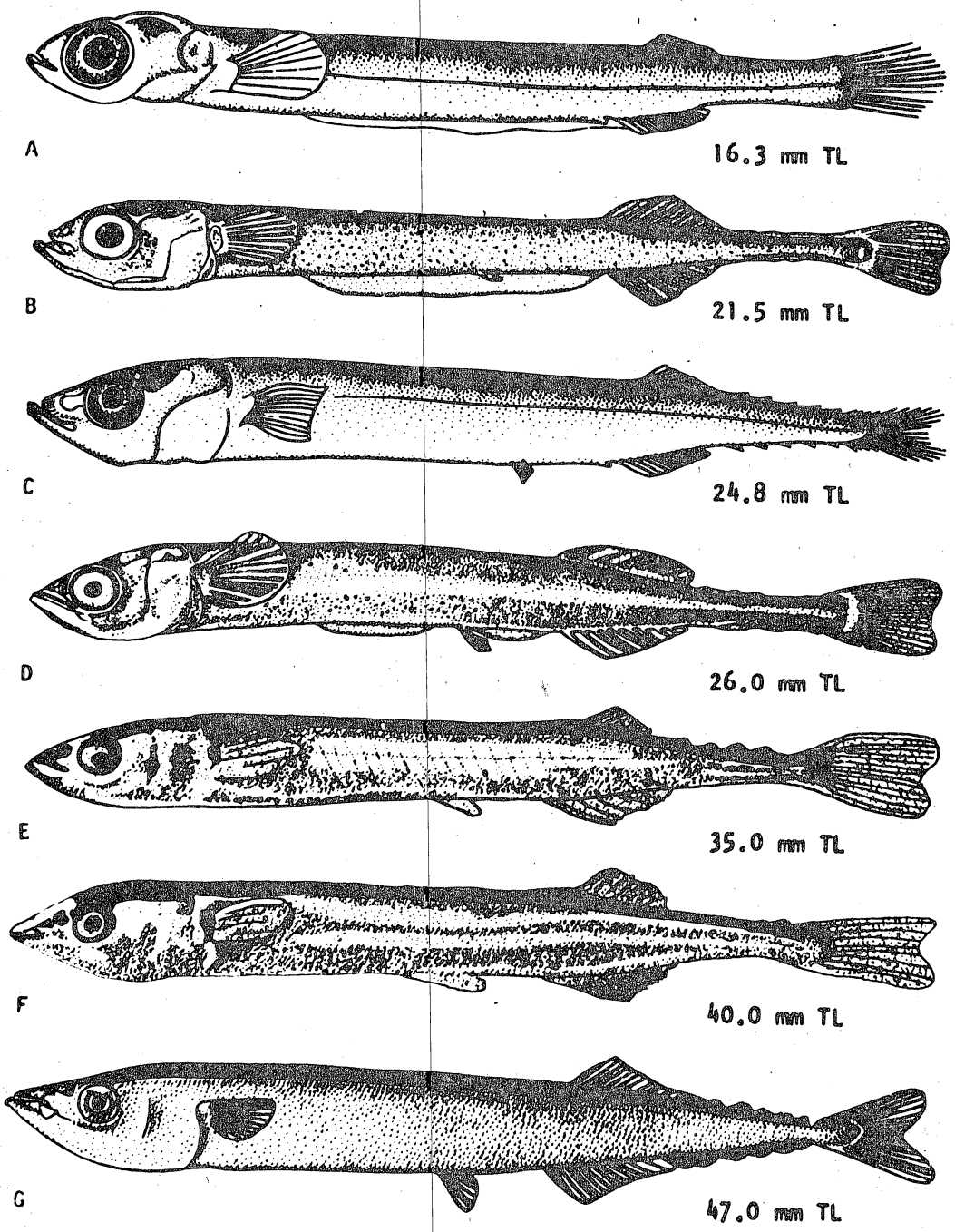


Fig.43. Scombresox saurus

A,B,C,D - larvae at different lengths;
E,F - larvae-fry (?); G - fry 47 mm TL.
(A,C,G -Nesterov & Shiganova,1976;
B,D-F -D'Ancona ,1931)

CUSK, BROSME BROSME(Ascanius,1772).

Eggs are pelagic, spherical, 1.16-1.58 mm in diameter. The membrane is plain and transparent, the perivitelline space is narrow, single oil globule, 0.23-0.32 mm in diameter, yolk unsegmented. At Stage III, when the embryo is half way round the yolk, with the tail just free, very small melonophores are scattered over the embryo. Before hatching pigmentation cells become larger and there are aggregations of melanophores in the postanal portion of the body, especially at the end of the tail, extending onto the fin fold.

Prelarvae are 3.9-5.0 mm long, sudid-like with the anus in the anterior part of the body on the fin fold. Spotty melanophores are noticeable in the eyes with single melanophore in the occipital region; large melanophores are above the gut and on the dorsal part of the body and there are three postanal rows of pigment cells with the posterior one at the tip of the urostyle. Yolk sac is almost wholly absorbed at a length of 5.0 mm, the eye is pigmented, rudimentary mouth is developed and open, the anus is on the lateral side of the embryonic fin.

Larvae are 5.5-37.5 mm long. There are three separated rudimentary rays in the ventral fins with tips pigmented at the larval length of 6.84 mm. The postanal pigmentation is shown by three rows of pigment cells which are still present at a length of 12.5 mm when caudal and pectoral fins are furnished with rays. The tip of the lower jaw and of the snout are pigmented. Larvae 21 mm long have elongated rays in the ventral fins which are significantly reduced at a length of 54 mm. A short barbel is detectable in a specimen 37.5 mm long.

Russel 1975 Schmidt 1905

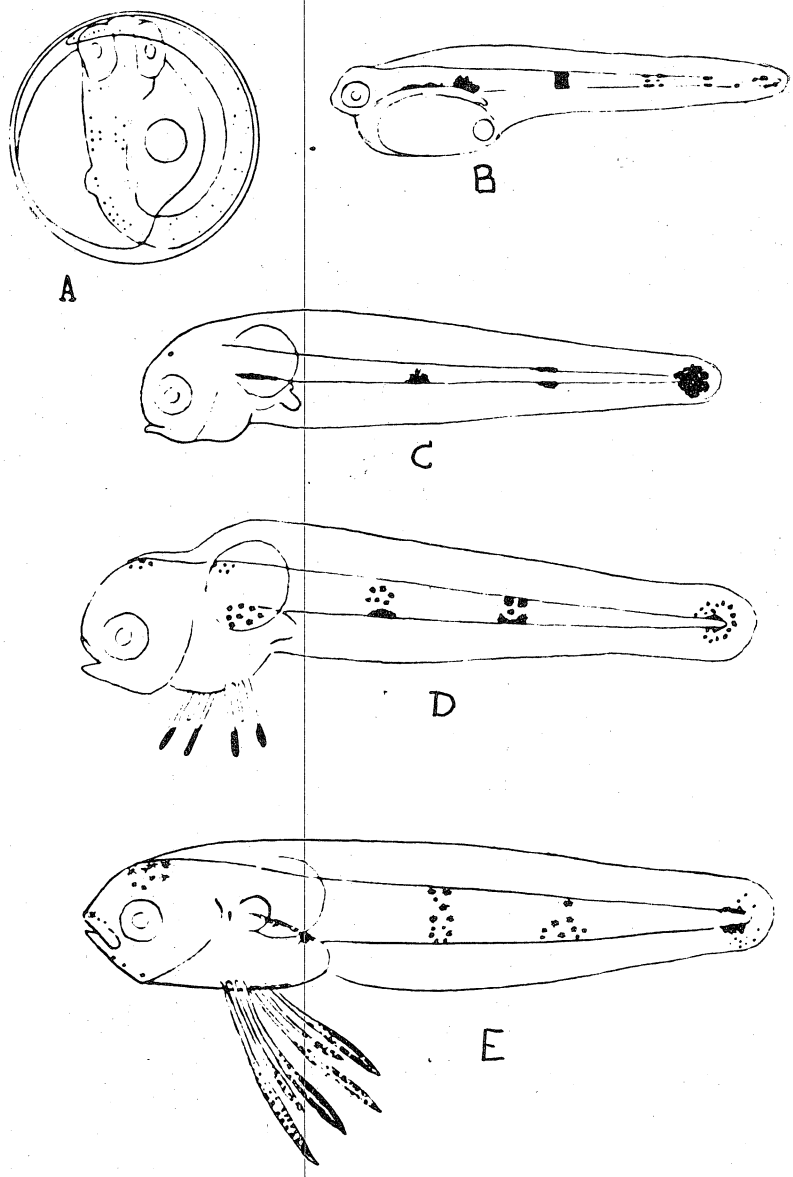


Fig.44Brosme brosme

A - egg 1.1 mm in diameter (McIntosh, 1892); B - prelarva at 4.1 mm (McIntosh, 1892); C, D, E - larvae at 5.0; 6.8 and 10.5 mm (Schmidt, 1905).

FOURBEARD ROCKLING, RHINONEMUS CIMBRIUS (LINNE, 1766)

Eggs are pelagic, spherical, 0.66-0.98 mm in diameter, the membrane is smooth, yolk unsegmented, single oil globule, 0.14-0.25 mm in diameter. At very early stages has several small oil globules which later coalesced to one. Pigmentation appears in the embryo body and on the oil globule at Stage II. At Stage IV, when embryo has almost completely surrounded the yolk, the eyes are still not wholly pigmented. There are three diffuse stripes of pigment in the preanal part of the body, a distinct row of melanophores in the mid-point of the caudal region and single or several subcaudal melanophores. The pigmented oil globule is in the posterior part of the yolk sac.

Prelarvae are 2.0-3.5 mm long and hatched at a length of about 2 mm. The body is of the gadoid type with a large yolk sac and the preanal portion forming about half of the body length.

Anus is of the cod type and opens on one side of protopterigium. The eyes are not fully pigmented. Melanophores are present on the head, embryonic fin and arranged in the typical row half way along the postanal region with several ventral melanophores in the end of notochord. Eyes are wholly pigmented at a length of 2.75 mm when the yolk sac is nearly absorbed. The preanal region of the body is free of pigment.

Larvae are 3.65-17.5 mm long. The development of V is advanced. Four jointed rays with a black membrane are far beyond the anus. The remnants of the postanal pigment row are visible; the subcaudal pigment is lacking.

Developing rays are noticeable in the unpaired fins, at a length of 5.3 mm, the pigmentation pattern remaining the same. The peritoneal pigmentation becomes heavier at lengths over 9 mm when it is present on the head and on the dorsal side of the preanal region. Fins are fully rayed at a length of 17.5 mm.

Rass, 1949 ; Ehrenbaum, 1905-1909 .

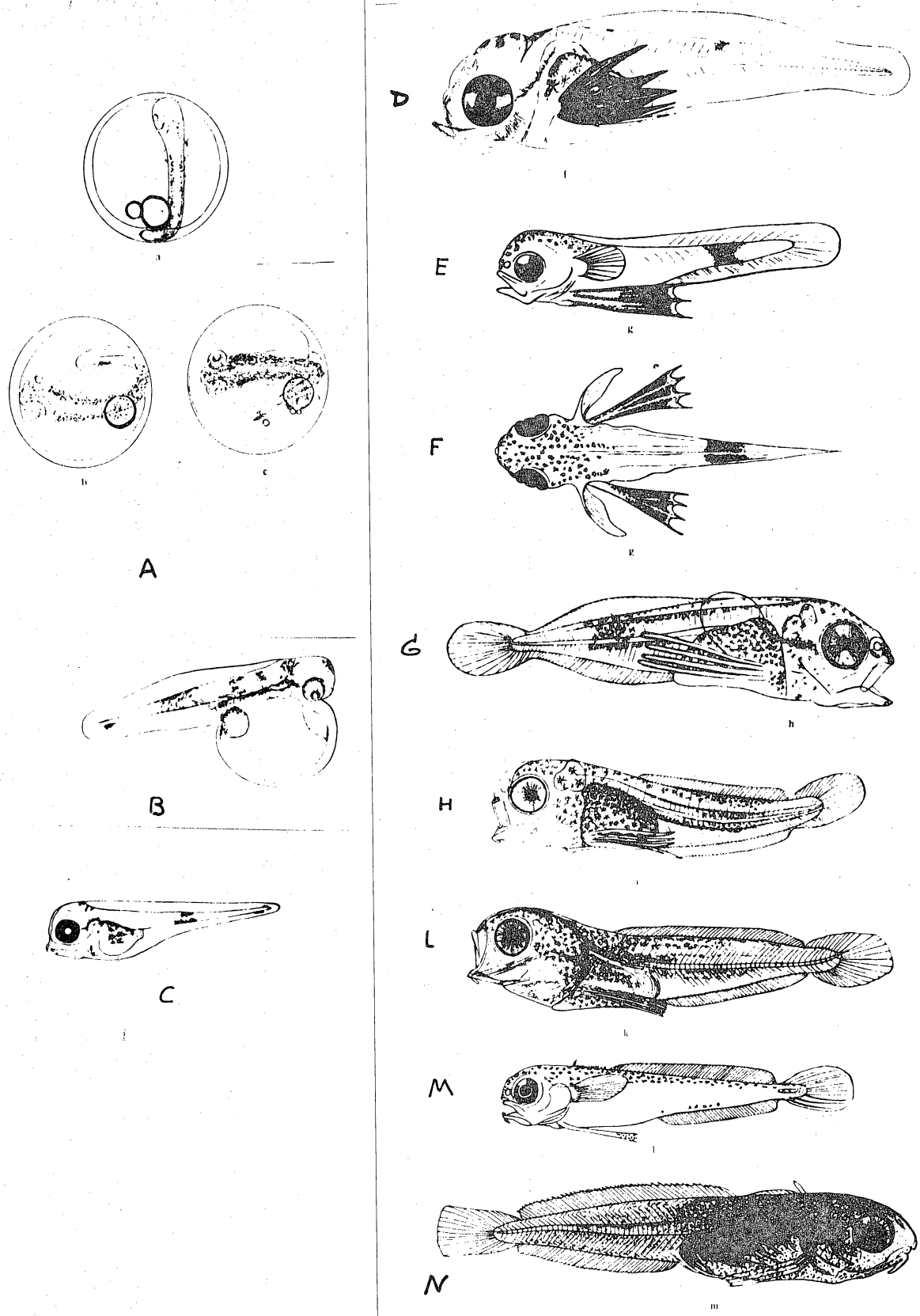


Fig.45.Rhinonemus cimbrius

A - eggs; B - prelarva at 2.15 mm; C, D, E, F - larvae at 2.75, 3.65 and 5.30 mm; G, H, L, M, N - larvae and larvae-fry at 9.0; 10.0; 13.8, 17.5 and 22.0 mm.

(Ehrenbaum, 1905-1909).

RED HAKE UROPHYCIS CHUSS (WALBAUM 1792)

Eggs are pelagic, spherical, 0.72-0.76 mm in diameter. The membrane is thin, transparent and smooth; yolk unsegmented and has a group of 30 oil globules on the vegetative pole at a very early stage which are later coalesced to one, 0.15-0.17 mm in diameter, that is always below one fourths of the egg diameter

Prelarvae are 2.1-2.2 mm long, yolk sac is ovoid, with anus on one side of the fin fold and the preanal area amounting to 40-50% of the body length. Oil globule is in the posterior third of the yolk sac. There is a single pigment cell in the mezencephalon and two caudal groups of melanophores on the ventral and dorsal sides, one above the other.

Larvae are 6.9-9.0 mm long; D begins a little in front of A and V stretch to beyond the anus. Strong pigmentation is present in the mid-point of the caudal region with another aggregation of peritoneal melanophores. Fry are 40 mm long, the body is elongated, V overlap the anus. The pigment is more or less uniformly distributed; the body is light silver on the ventral and greenish-blue on the dorsal side. It differs from related species in size and the number of oil globules during early Stage I and in the diameter of oil globule, pigmentation pattern of embryos and larvae at later stages and in the number and length of fin rays in fry. Ref.: Bigelov and Schroeder, 1953; Miller and Marak, 1959.

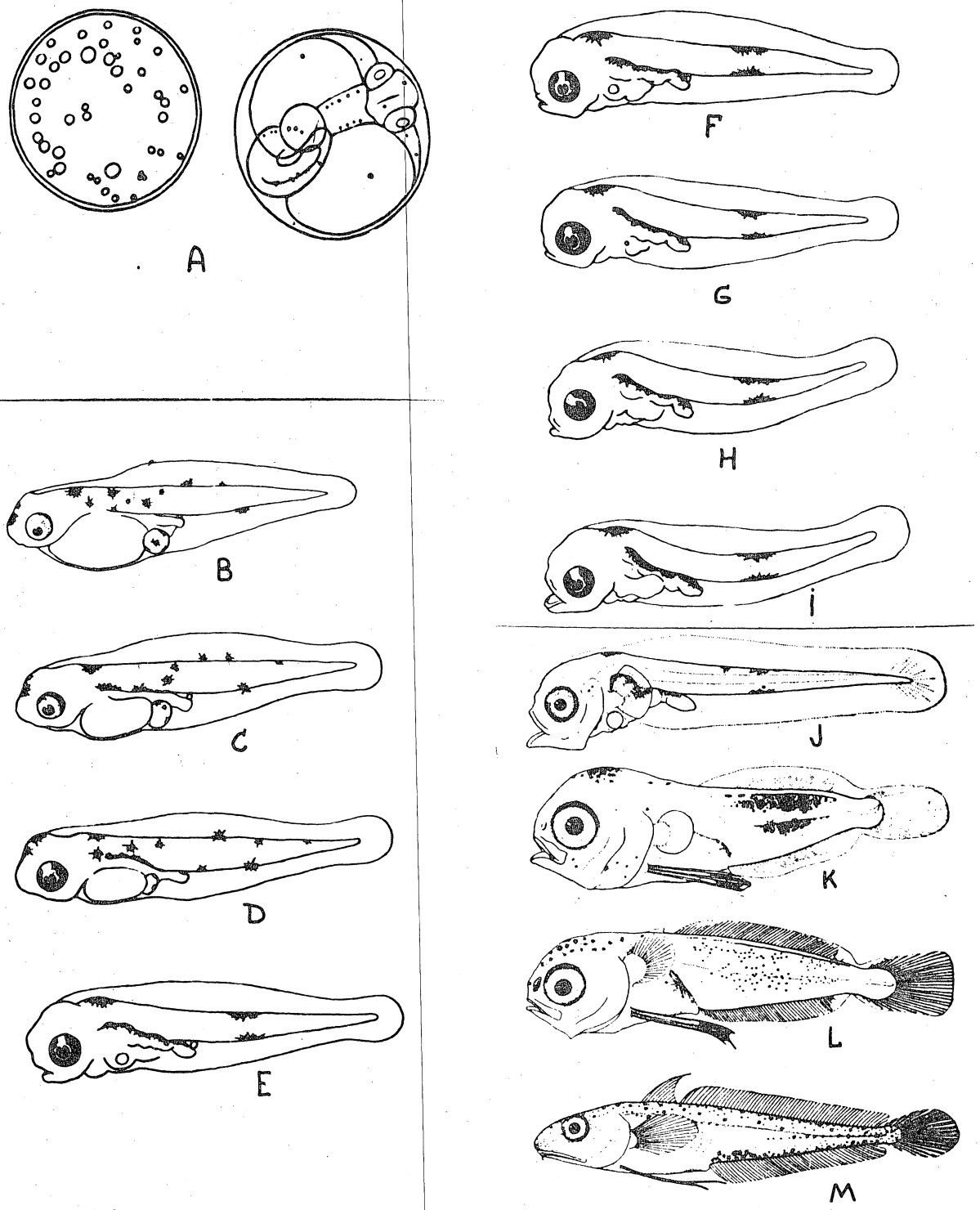


Fig.46.Urophycis chuss

A - eggs; B,C,D,E - prelarvae at 2.1 - 2.2 mm; F,G,H,I,J,K - larvae at 2.2 mm (Miller & Marak, 1959); L,M - larvae at 6.2 and 9.0 mm;
N - fry at 40.0 mm (Bigelow & Schroeder, 1953).

SPOTTED HAKE UROPHYCIS REGIUS (WALBAUM, 1792).

E g g s are pelagic, spherical, 0.75-0.80 mm in diameter. The membrane is thin, transparent and smooth, yolk unsegmented and contains 8-30 oil globules during early Stage I, which are concentrated at the vegetative pole of the egg and by the end of Stage I have coalesced to one, 0.20-0.25 mm in diameter, which always exceeds one fourths of egg diameter. At later stages yolk is pigmented.

Prelarvae are 1.50 - 2.20 mm long, yolk sac is ovoid with anus on one side of the fin fold and the preanal region equaling 40-60% and the body height 15-35% of the total length. Oil globule is in the posterior part of the yolk sac. There is a single large pigment cell on the tip of the snout, a large melanophore above mesencephalon, 4-7 small pigment cells on the yolk sac and several melanophores in the trunk and tail regions. The number of myomeres is 40-42.

Larvae are 2.12-2.30 mm long and over. The preanal portion forms 38-45% of the total length. Traces of caudal fin rays are apparent. There are one or two large melanophores at the tip of the snout, 2-3 coalesced caudal melanophores at the 26th-28th myomere and weaker ventral pigmentation at the 27th-30th myomere.

It is easily separable from related species by the size and number of oil globules at early Stage I and by oil globule size and pigmentation pattern in embryos, prelarvae and larvae.

Serebryakov, 1978.

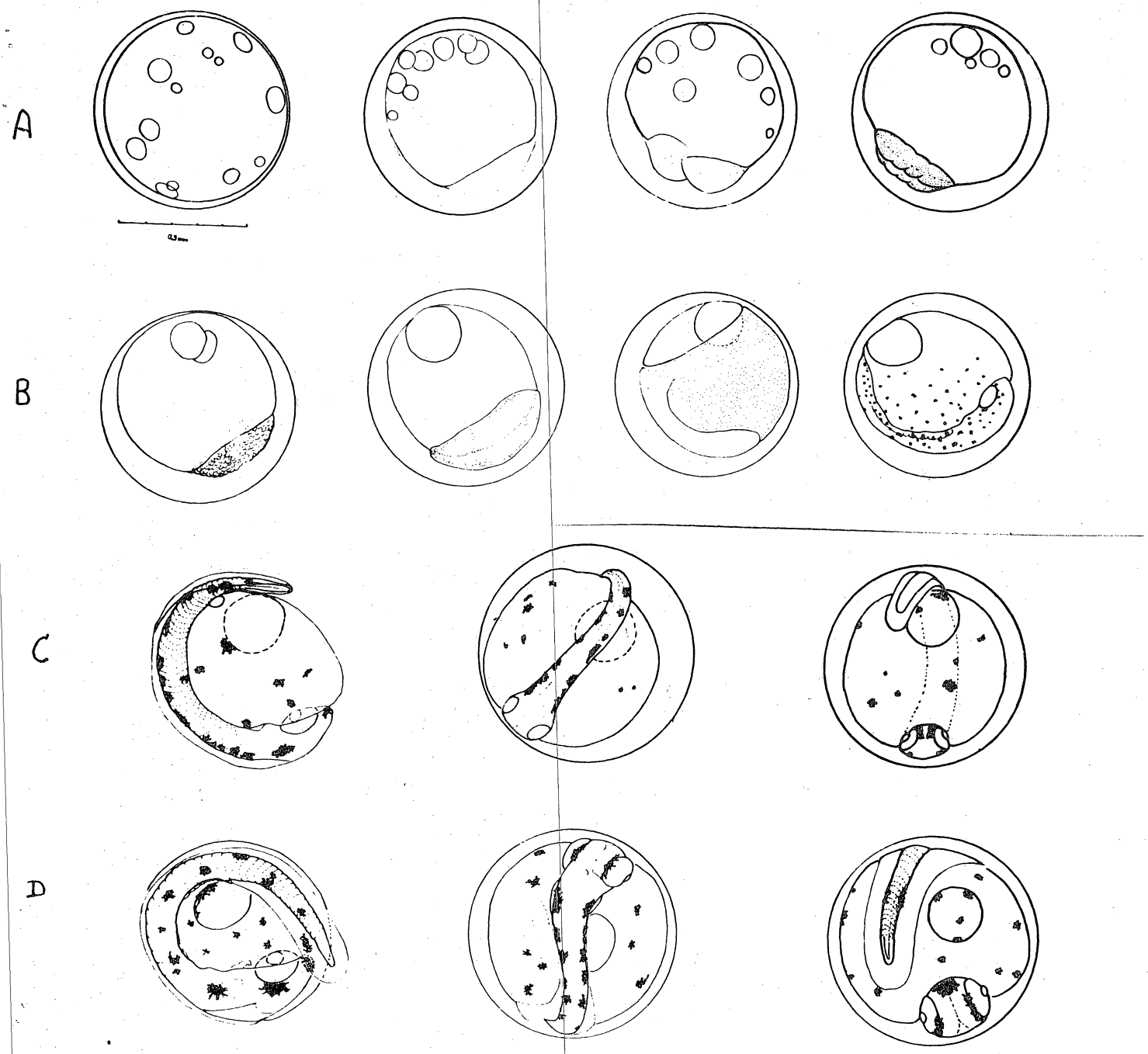


Fig.47. Urophycis regius
Eggs at I(A), II (B), III (C), IV (D) stages.
(Serebryakov, 1978)

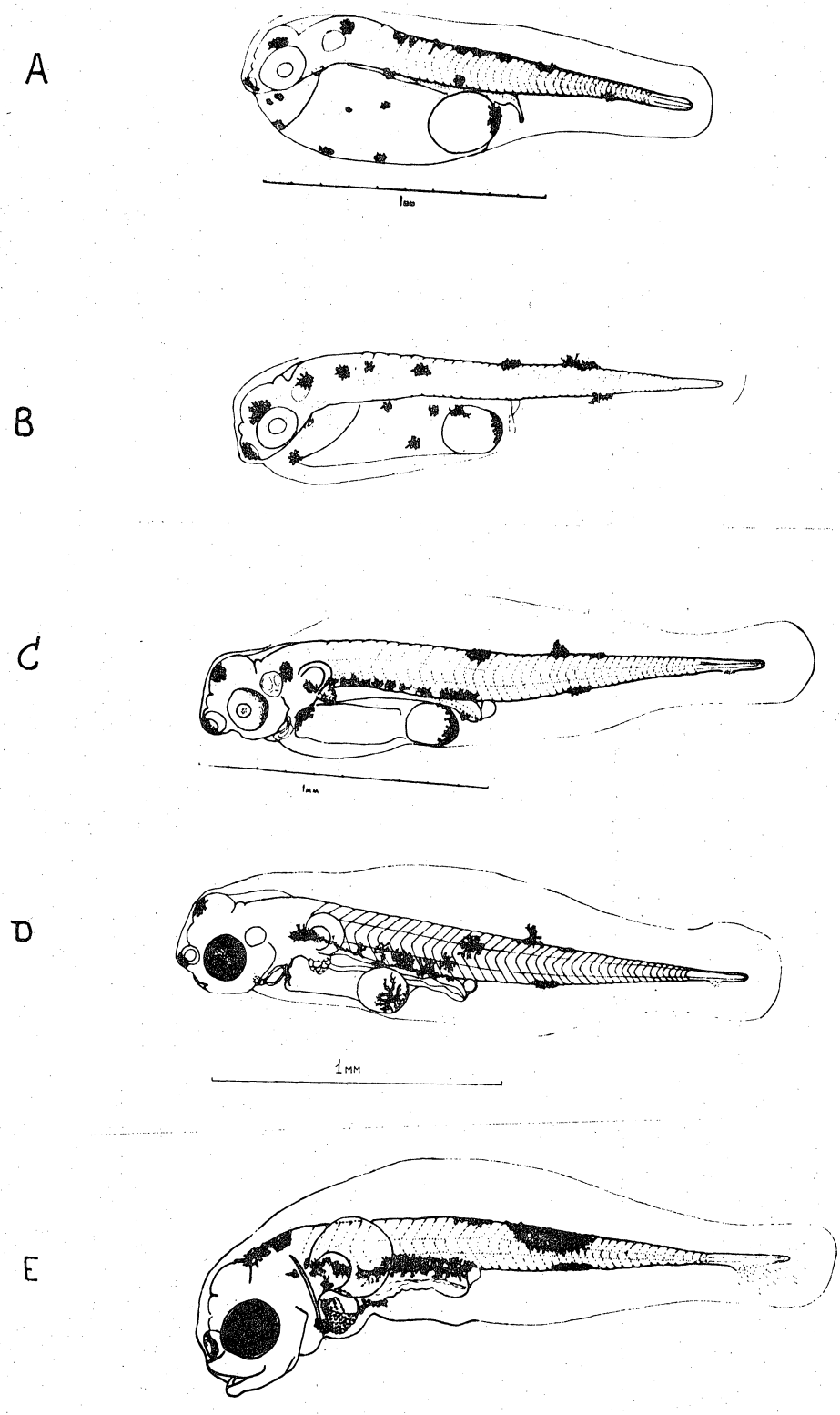


Fig.42. Urophycis regius

A - prelarva at 1.6 mm at hatching;
B,C,D - prelarvae at 1.83, 1.95 and 2.00 mm;
E- larva at 2.25 mm.
(Serebryakov, 1978)

POLLOCK, POLLACHIUS VIRENS (LINNÉ, 1758).

Eggs are pelagic, spherical, 1.03-1.22 mm in diameter. The membrane is smooth and transparent, yolk sac unsegmented, no oil globule. The perivitelline space forms 6-8% of egg diameter. The differentiating character is the width of the embryo which constitutes 20-25% of egg diameter. Scattered pigment spots appear during Stage II and are sometimes arranged in 2 longitudinal rows on the dorsal side. Single ramified large melanophores are sometimes present on the yolk at later stages.

Prelarvae are 3.0-4.0 mm long and are typically gadoid in appearance 2 days after hatching when the length of 3.9-4.0 mm is reached. Anus is situated in the middle region on one side of the fin fold, the preanal portion forms 46-50% of the total length. In some prelarvae two latitudinal rows of pigment cells are present in the postanal portion with the posterior third of the tail region being free of pigment untill the time when larvae is fully formed. This characteristic feature distinguishes larval P.virens from other gadoid species.

Larvae are 4.1-14.0 mm long. Indications of rays appear at a length of 5.0 mm in C and at 11 mm in D_2, D_3, A_1 and A_2. Rudiments of ventral fins are visible when larvae are 12.5 long. Pigmentation develops at lengths of 6.0-7.0 mm and is arranged in the mediolateral row of melanophores with strongly pigmented latitudinal stripes. Ref.: McIntosh and Masterman, 1897; Ehrenbaum, 1905-1909; Russel, 1975; Schmidt, 1905.; Friedgeirsson, 1978.

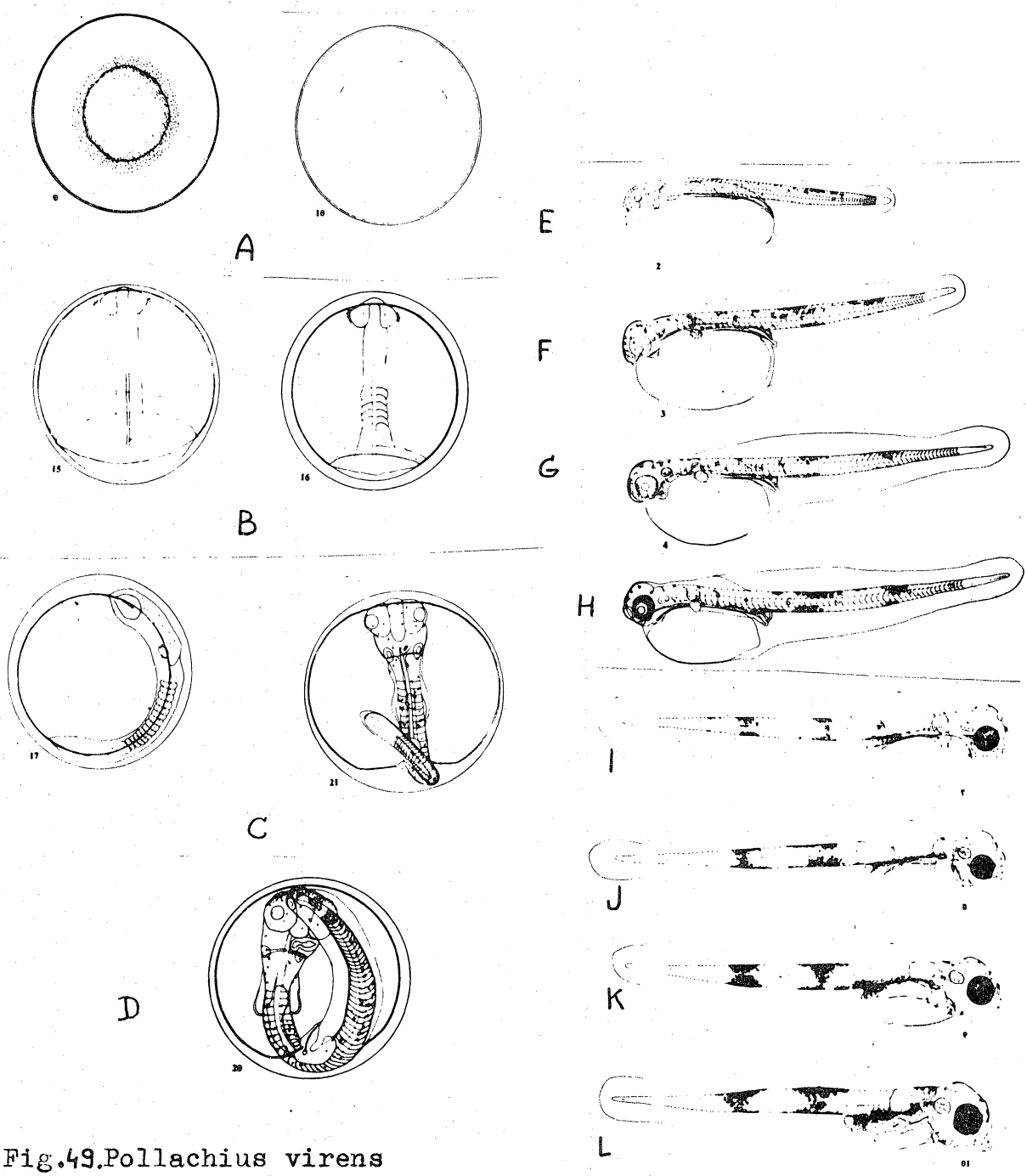


Fig.49.Pollachius virens

Eggs: A - Stage I; B - Stage II; C - Stage III; D - Stage IV;
E - prelarva at hatching; F - prelarva 2 days after hatching;
G, H, I, J - prelarvae at 4.5; 4.7; 4.8 and 5.0 mm.
K - start of active feeding at 5.0 mm; L - 10-day-old larva
at 5.0 mm.

(Friedgeirsson, 1978)

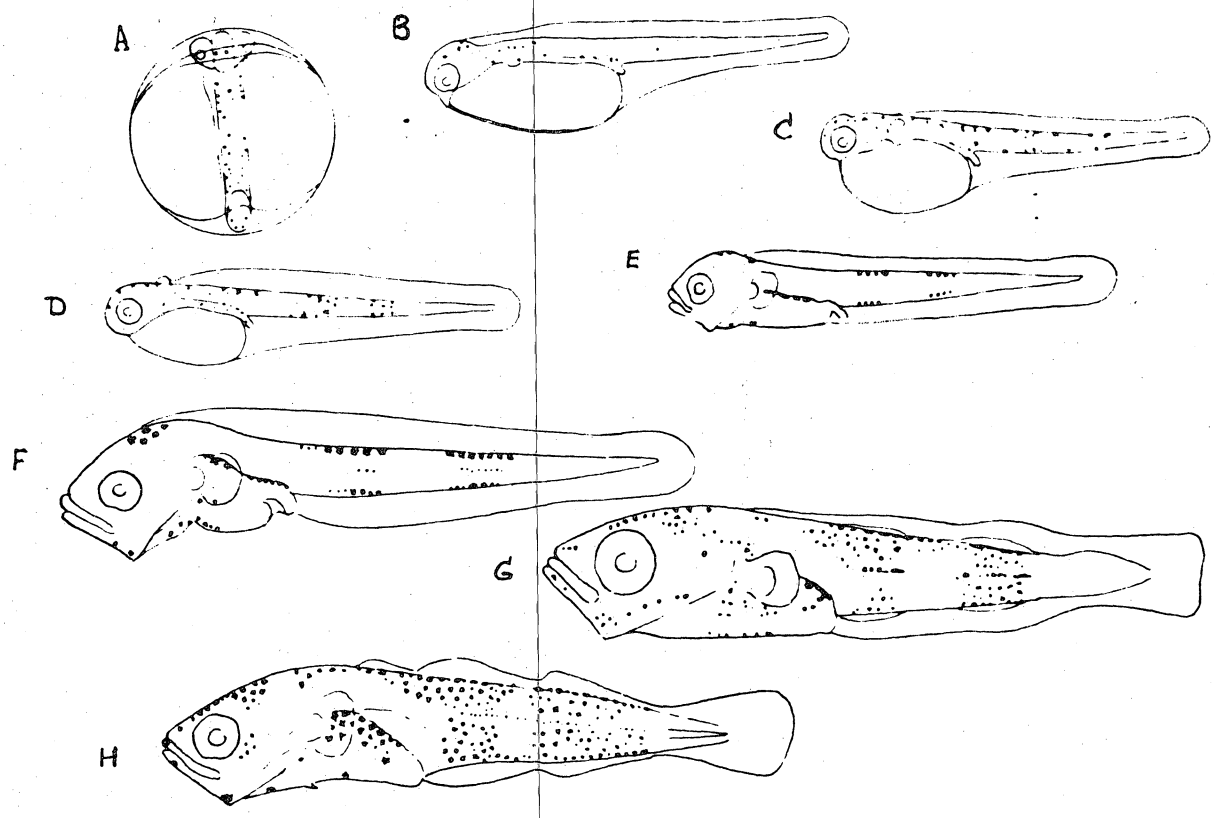


Fig.50 Pollachius virens

A - egg; B, C, D - prelarvae; E, F, G, H - larvae at 4.0, 7.0, 11.0 and 14.0 mm.
(Russel, 1976)

HADDOCK MELANOGRAMMUS AEGLEFINUS (LINNE, 1758)

Eggs are pelagic, spherical, 1.2-1.7 mm in diameter. The membrane is smooth and transparent. At Stage I the eggs of haddock are practically non distinguishable from those of cod. During Stage II 2 rows of pigment cells appear along the contours of the body which are less pronounced and more ramified than in cod. At Stage III the pigment is aggregated along the ventral side of the body and forms a clearly visible double postanal row of melanophores, during Stage IV. Eyes are pigmented at Stage III and become completely dark on hatching.

Prelarvae are 3.5-5.5 mm long and of the typical gadoid form. The anus is on one side of primordial fin, the preanal portion constitutes 48-50% of the total length and is decreasing with prelarvae growth down to 38-39% at a length of 6.0 mm. Pigmentation is arranged in 2 ventral rows of melanophores in the postanal region, while the dorsal area is free of pigment. Eyes are wholly pigmented. Melanophores are present on the head and above the pectoral fin base and are aggregated in the peritoneal region.

Larvae are 5.5-11.5 mm long and over. Yolk sac is fully absorbed at lengths of 5.2-5.5 mm. In larvae 8.8 and even 13.0 mm long the prelarval pigmentation pattern still persists with the postanal dorsal area being free of pigment and a double ventral row of melanophores due to which haddock larvae are easily separable from other gadoids. Indications of fin rays appear at a length of 9.0 mm and melanophores develop between clearly visible ray rudiments of D_1 and D_2, P and C when larvae are 11.5 mm long. Ref.: Rass, 1949; Schmidt, 1905; Ehrenbaum, 1905-1909; Russel, 1975; Fridgeirsson, 1978.

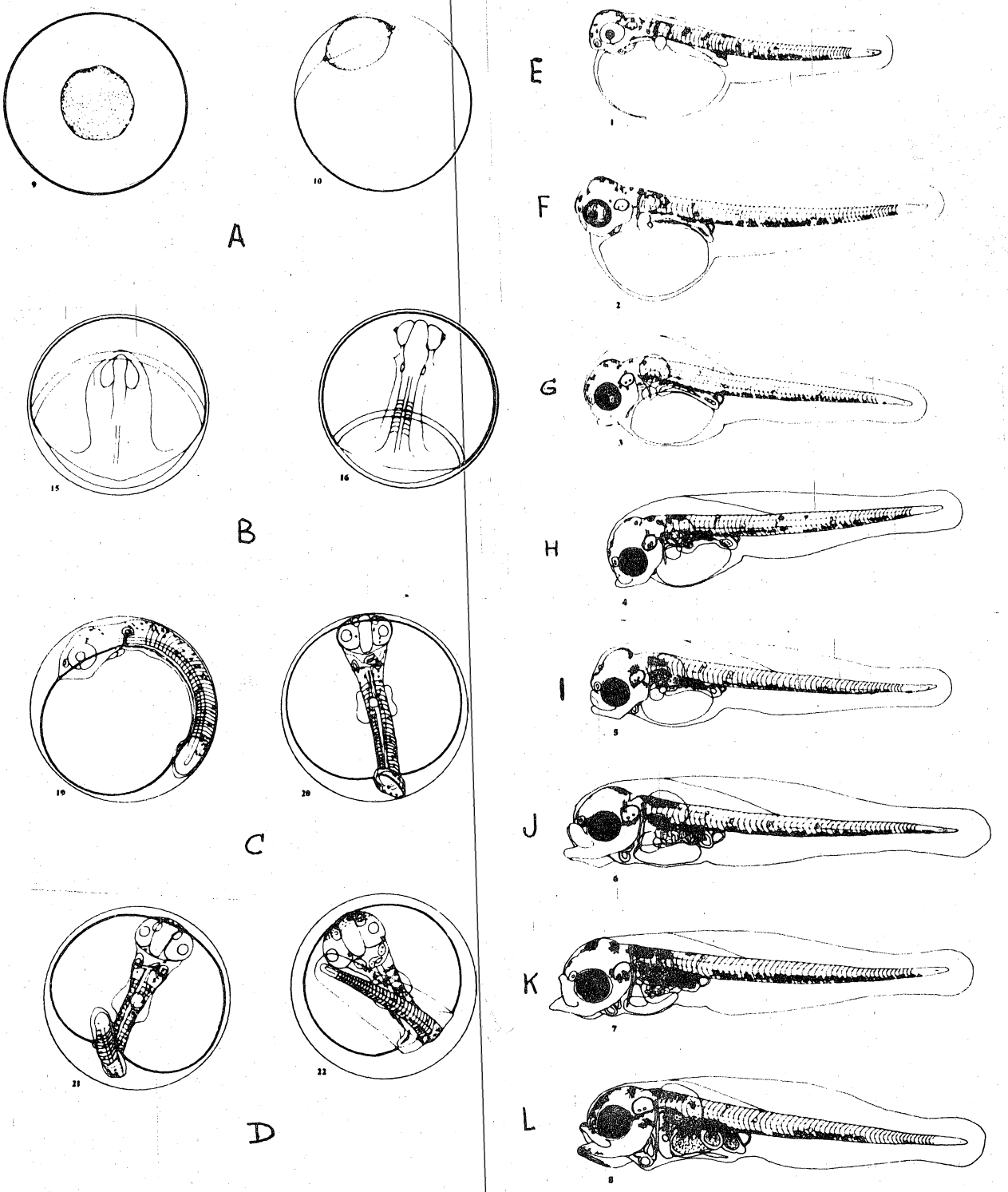


Fig.5I. Melanogrammus aeglefinus

A,B,C,D - eggs at I, II, III and IV stages;
E,F,G,H,I,J - newly hatched larvae on 1,2,3, 4 and 5 day
K - larvae 6 days after hatching at 5.2 mm; L - larva 10 days after hatching at 5.2 mm at water temperature of 7.2° and salinity of 29.5°/$_{oo}$.

(Friedgeirsson, 1978)

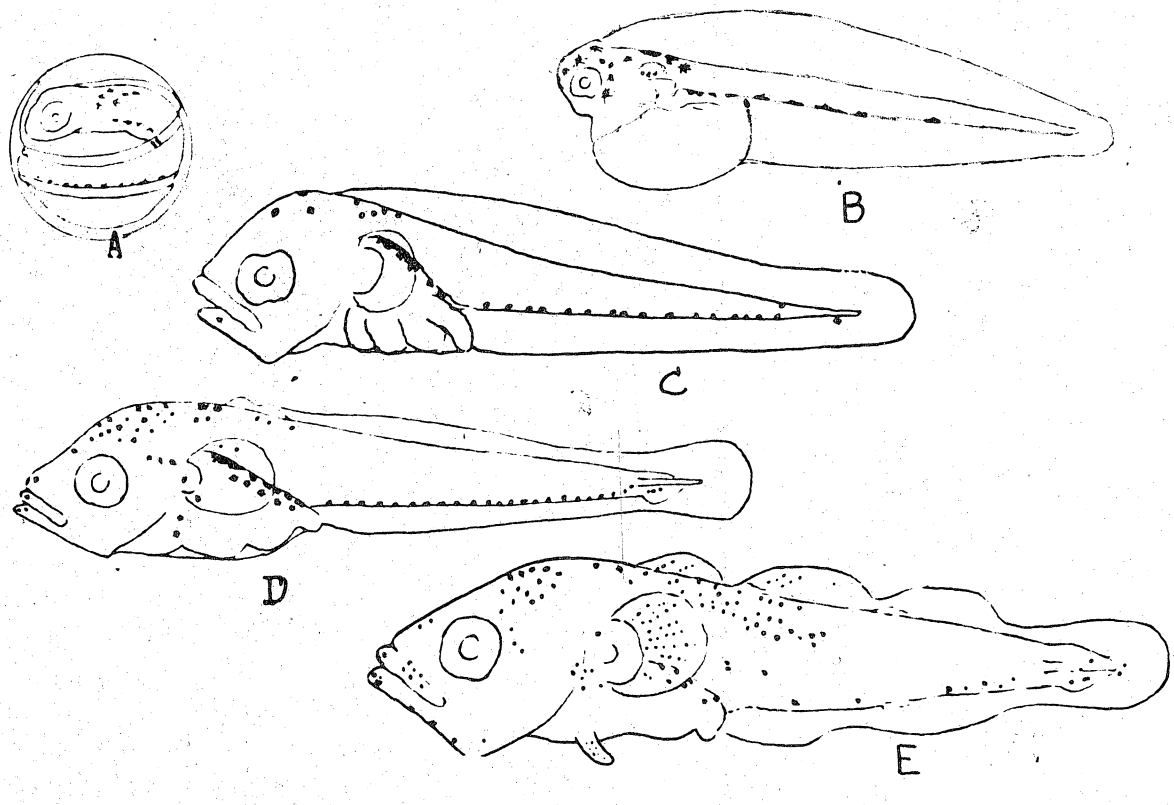


Fig.52. Melanogrammus aeglefinus

A - egg (Ehrenbaum, 1905-1909); B - prelarva at 4.19 mm (Holt, 1893); larvae: C - at 6.0 mm; D - at 8.8 mm, E - at 13.0 mm (Russel, 1976).

C O D, GADUS MORHUA MORHUA LINNE, 1758.

Eggs are pelagic, of regular spherical form, 1.13-1.65 mm in diameter. The membrane is thin, transparent, yolk sac unsegmented, yellowish, no oil globule. Melanophores are uniformly dispersed all over the body at Stage II and are arranged in the following 4 typical latitudinal zones at Stage IV. 1 - in the pectoral fin area, 1 - beyond the anus and 2 - in the caudal region. A group of 2-3 melanophores is present on the ventral side along the caudal end of notochord. Pigment appears in eyes at Stage III and they are usually fully pigmented on hatching.

Prelarvae are 3.8-5.2 mm long and typically gadoid in appearance. The preanal portion forms 40-42% of the total length. Anus opens on one side of protopterigium just beyond the yolk sac. The pigment is arranged in latitudinal rows. Two distinct postanal stripes of pigment cells and 1-3 subcaudal melanophores develop at length over 4.5 mm. Latitudinal rows may fuse when larvae are over 5.5 mm due to melanophores developing inbetween. The yolk sac is fully absorbed at length of 4.5-5.2 mm.

Larvae are 5.5-35.0 mm long. The preanal portion constitutes 40.3-48.6% at lengths below 10-11 mm and the eye diameter forms 7.2-9.2% of the body length. Rays in unpaired fins are separate, when larvae are 10-11 mm. The length of fully formed larvae varies from 10-11 to 25-35 mm, when the greenish colour disappears and the specific staggered pigmentation of the transitional stage develops. Postanal latitudinal stripes are arranged in ventral and dorsal rows of melanophores at a length of 9 mm.

Pertseva, 1936; Rass, 1949; Schmidt, 1905; Ehrenbaum, 1905-1909; Russel, 1975 .

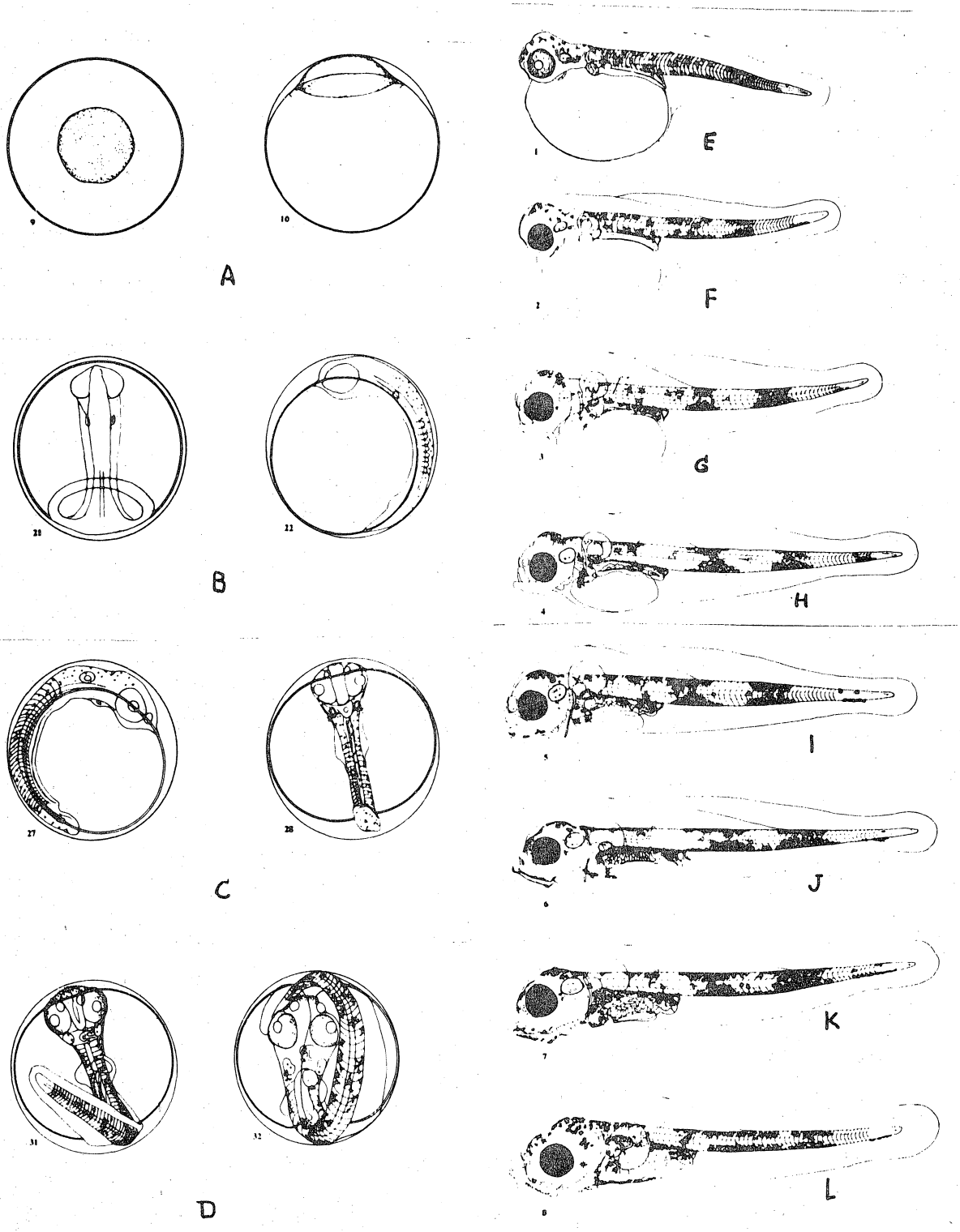


Fig.53. Gadus morhua morhua

A,B,C,D - eggs at Stages I, II, III, IV;
E,F,G,H - prelarvae on 1, 2, and 3 day after hatching, -I- at 5.5 mm; mixed feeding on 4 day after hatching; J - larva on the 5th day after hatching, active feeding; K - 6 day after hatching at 5.9 mm; L - larva on 10 day after hatching at 6.0 mm. (Friedgeirsson, 1978).

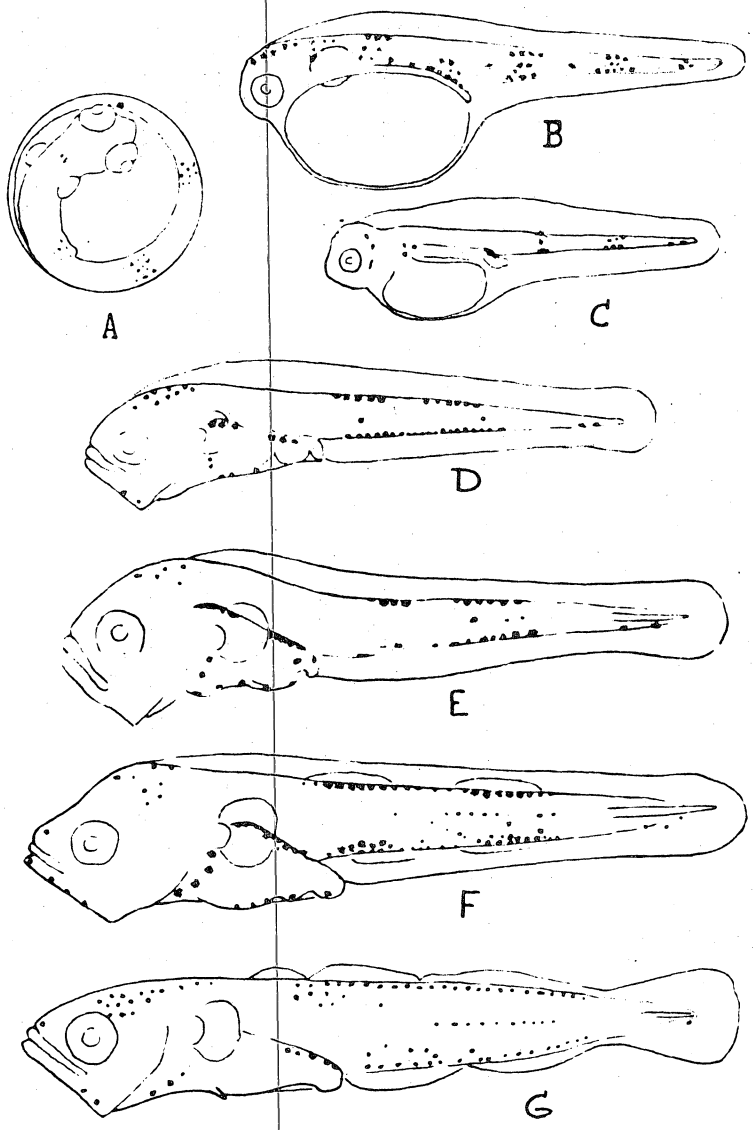


Fig.54. Gadus morhua morhua

A - egg (Heicke & Ehrenbaum, 1900); B - prelarva at hatching (McIntosh & Masterman, 1897); C - prelarva at 3.0 mm; D, E, F, G - larvae at 5.0, 6.0, 8.0 and 12.5 mm.
(Russel, 1976)

SILVER HAKE, MERLUCCIUS BILINEARIS (MITCHILL, 1814)

Eggs are pelagic, spherical, 0.70-1.00 mm in diameter. Membrane is thin, transparent, smooth. Yolk sac unsegmented and has single oil globule, 0.20-0.25 mm in diameter. The embryo body and the yolk are pigmented at late Stage II.

Prelarvae are 4.42-5.00 mm long and typically gadoid in appearance. There are separate melanophores and groups of pigment cells. 2-3 pigment cells are on the head, 3-4 in the occipital region, 1 on the operculum and 3-4 on the ventral side of the yolk sac. A large pigment cell is present in the anterior part of the caudal region along the lateral line, and there is one more of the same size between the anus and the caudal fin margin and the third one at the end of notochord on the ventral side.

Larvae are 9.93-20.0 mm long, the body is rather high and elongated (the height constitutes 17-25% of the length). Primordial fin is between D_1 and D_2, C and A, D_1 - 8, D_2 - 27-32, A - 26-40.

Fry are 22.5 mm long and over. V streches to beyond the anus. D_1 -9, D_2 - 40, P -14, C - 32-36. The preanal region forms 37% and the height 17% of the total length. The pigmentation is diffuse. The ventral side is light and the dorsal is dark. Melanophores are present on D_1, C and V.

Sauskan, Serebryakov, 1967 .

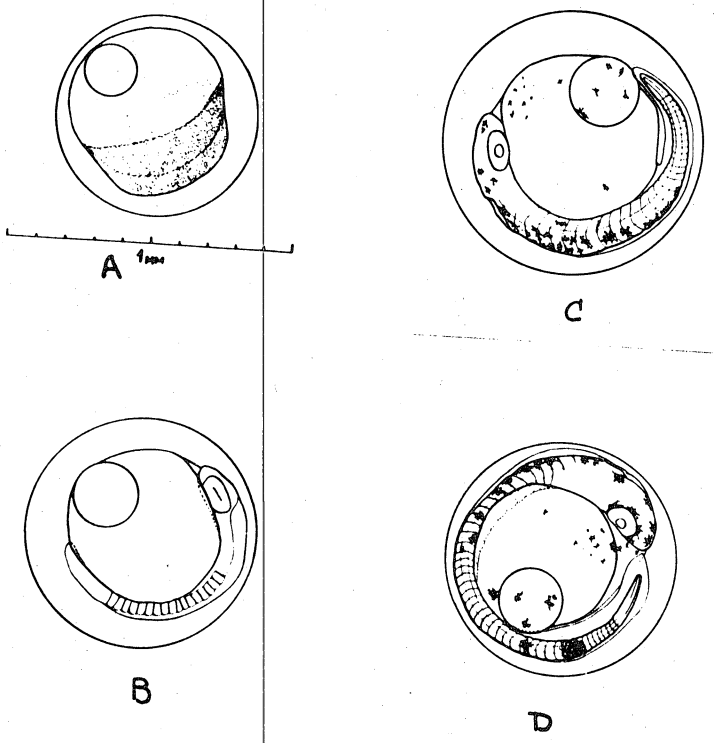


Fig. 55 Merluccius bilinearis

Eggs: A - Stage I; B - Stage II; C - Stage III; D - Stage IV.

(Sauskan & Serebryakov, 1968)

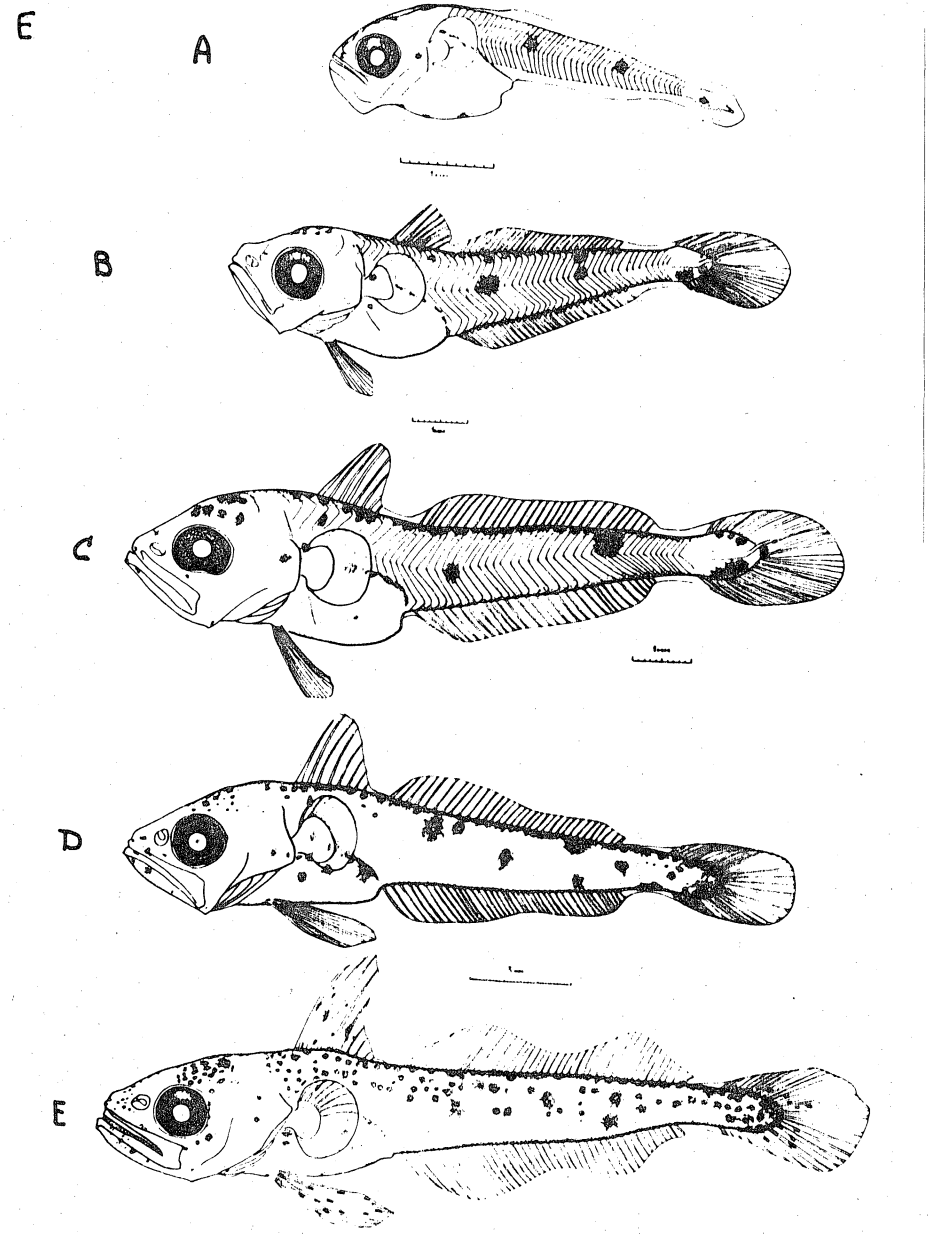


Fig.56. Merluccius bilinearis

A - prelarva at 4.42 mm; B, C, D - larvae at 9.93, 12.5, 15.3 mm, E - fry at 22.5 mm.
(Sauskan, Serebryakov, 1968)

ROCK GRENADIER CORYPHAENOIDES RUPESTRIS GUNNERUS. 1765

Eggs are spherical, transparent, probably mesopelagic, 2.30-2.40 mm in diameter or 0.15-1.25 mm larger. The egg capsule has a wavy cellular convex structure, particularly detectable in the falling light. The cells are 0.15-0.75 mm long and 0.05-0.20 mm wide. A single oil globule 0.80-1.02 mm in diameter. The perivitelline space width is increasing with growth from 0.08 to 0.25 mm.

Prelarvae undescribed.

Larvae are 8.3-43.1 mm SL.

The body is macrouroid-shaped and resembles adult fish. The trunk is short and deep, the caudal division is long, compressed laterally and whip-like. The preanal length is 34% SL - in early larvae and 24% SL in advanced larvae. The body depth is 23 and 14% SL in early and late larvae respectively. The relative head length varies from 1.5 mm (19% SL) in larvae 8.3 mm long to 6.9 mm (16.9% SL) in larvae 43.1 mm long. At the head length of 1.7 mm the gas bladder is 0.5 mm in diameter, the finfold is narrow and the incipient fan-like pectoral fin is with a thin stem-like base. At the head length of 1.9 mm gill rakers are apparent on the second arc, branchiostegocrotaphit rays are present and rays are evident in the ventral, dorsal and anal fins. The 1st and 2nd dorsal fins are conjugated by the finfold. The rays are comptete (8) in the ventral fin at the head length of 2.5-3.0 mm and in the 1st dorsal (8-13) at the head length of 3.0-4.0 mm. The barbel is apparent on the lower jaw at the head length of about 5.0 mm. The origin of the 2nd dorsal fin is posteriorly to the vertical line across the anus; a total of 6

branchiostegocrotaphic rays are present. 4 retiamirabelia are evident and 3-12 gill rakers are on the 2nd are.

Pigmentation. The body cavity is heavily pigmented by deeply embeded maculate and stellate melanophores. Melanophores are present above the eye and below the first dorsal fin. The caudal region is free of pigment.

The species is distinguishable from the related species by the nonpigmented caudal division, the lower number of retiamirabelia (4) and the ray number in the ventral fin (8).

Sanzo, 1931; Marschall & Yawamoto, 1973; Merrett, 1978; Grigor'ev & Serebryakov, 1981.

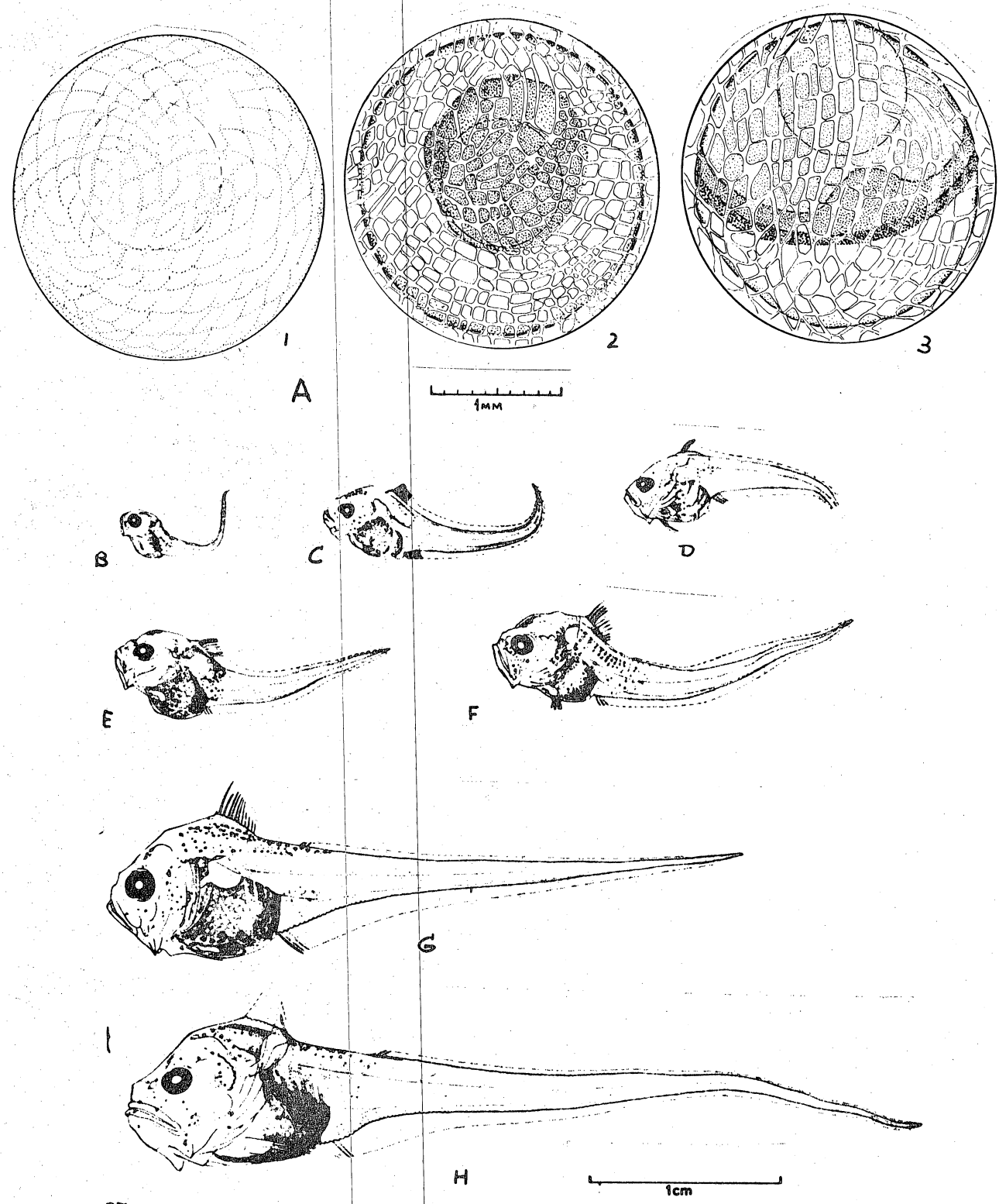


Fig. 57. Coryphaenoides rupestris

A - eggs 2.4 mm in diameter; A_1 - egg capsule structure; A_2 , A_3 - eggs at morula and medium gastrula; B-H - larvae at HL; B - 1.6, C - 2.5, D - 3.1, E - 3.3, F - 5.1 and G - 6.9 mm.

(A - Grigor'ev & Serebryakov, 1981; B-H - Merret, 1977)

NORTHERN WOLFFISH ANARHICHAS DENTICULATUS KROYER, 1845.

Eggs are bottom, 7.5-8.0 mm in diameter, deposits are globe-shaped.

Prelarval and larval stages seem to develop within the egg mambrane.

The minimum length of fry taken in the pelagic areas is 25.0 mm. No remnants of yolk sac are visible. There are .77 rays in D, 4.7 in A, 1.7 in P and 22 or less in C.

The length between the last ray of the anal fin and the closest ray of the caudal fin is several times lower then that of the last anal fin ray. Ref.: Barsukov, 1959 .

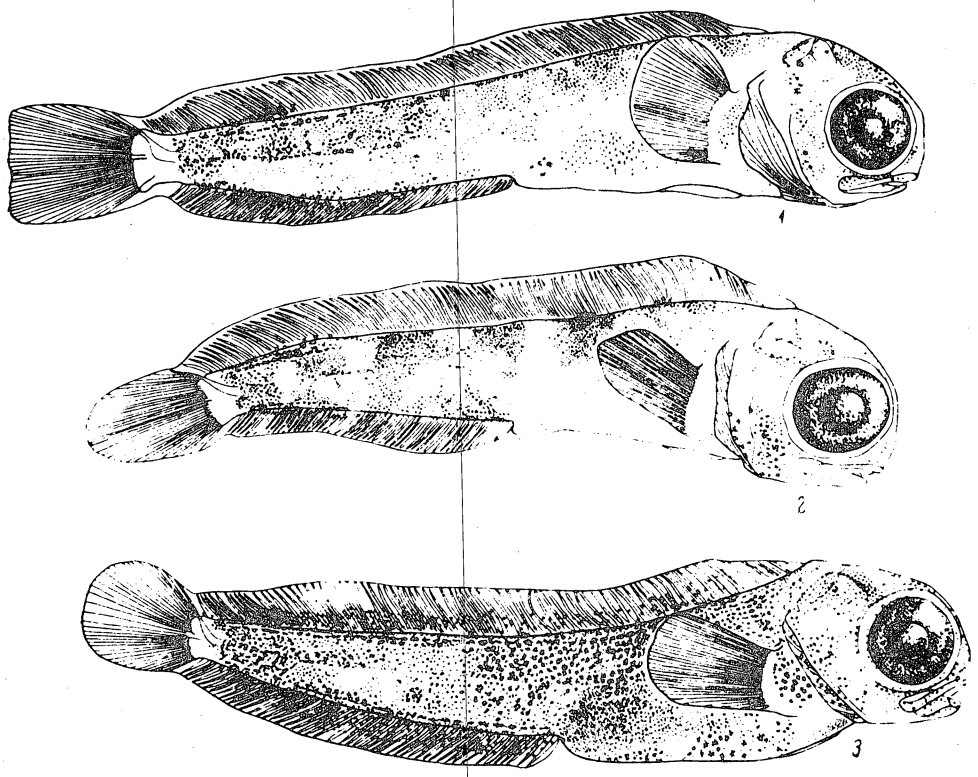


Fig. 58 Anarhichas lupus at 25 mm;
2- A.minor at 24 mm;
3- A.denticulatus at 25 mm.

ATLANTIC WOLFFISH ANARHICHAS LUPUS LINNE ,1758.

E g g s are bottom, deposits are rounded. The diameter of ripe eggs is 5.5-6.5 mm.

Prelarvae and larvae are 19.0-25.0 mm long, and very much resembling adults. The head is rounded with mouth almost in the low position,the snout is round and protruded,the base of the pectoral fins is wide. Dorsal melanophores appear in the anterior part and along the sides and then become unevenly dispersed all over the body with the posterior caudal region free of pigment. The distance between the last ray of the anal fin and the closest ray of the caudal fin is less or sometimes equal to the length of the last ray of the anal fin. The number of caudal fin rays is 23 or over. Ref.: Rass, 1949; Barsukov, 1959; McIntosh and Masterman, 1897.

SPOTTED WOLFFISH ANARHICHAS MINOR OLAFSEN, 1772.

Eggs are bottom, 5.5-7.0 mm in diameter deposits are globeshaped.

Prelarval and larval stages seem to develop within the egg membrane.

The only known are fully formed larvae, 22.0 mm long, with a rounded head and snout, the mouth in the low position, widely based P and scattered pigmentation. Anus is a little in front of the midpoint of the body. The number of rays is 21-22 (24) in P, (in 77) D, (in 47) A and 19 in C.

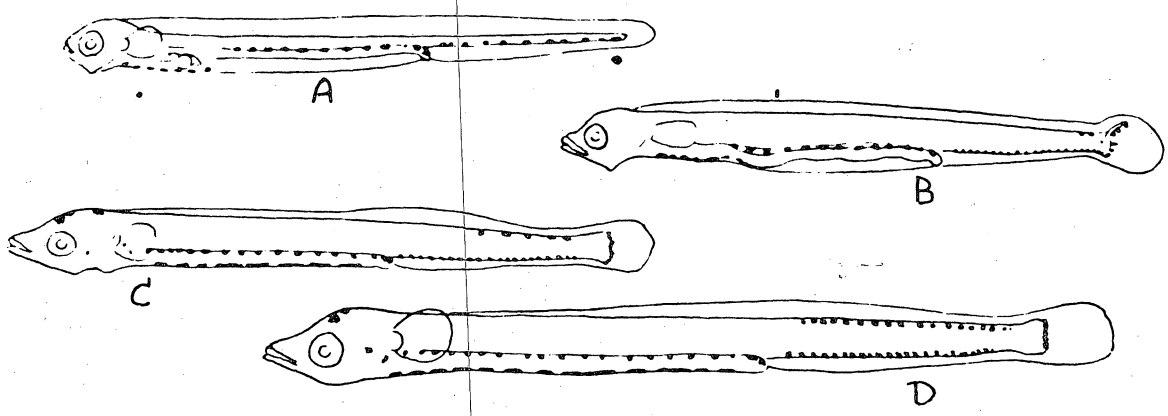
Fry are 30 mm long and are characterized by irregular distribution of melanophores. There are wide dark (almost black) latitudinal stripes in the dorsal area and in the ventral part of the caudal region, which are in the anterior position as compared to the lateral stripes. There are 5-9 (7 usually) dorsal stripes running from the head to the caudal fin. The number of rays in C is 21-22. Ref.: Barsukov, 1959; McIntosh and Masterman, 1897.

SAND LAUNCE AMMODYTES AMERICANUS DE KAY ',1842.

Eggs are bottom, irregular elliptical, 0.6-1.2 mm in size, the micropyle is clearly visible. The yolk sac is homogeneous and contains a single oil globule, 0.25-0.42 mm in diameter.

Prelarvae are (5.5) 7.5-12.0 mm long, elongated, with anus in the middle or a little behind the mid-point of a body. The preanal length exceeds the postanal one, the mouth is relatively small, the posterior margin of the upper jaw does not reach the vertical mid-point of the eye. The anus opens on one side of protopterigium, the remnants of the yolk sac with the oil globule 0.18-0.28 mm in diameter still resist. The dorsal area is almost free of pigment with few pigment cells only. There is a ventral row in the anterior part of the body and a ventro-lateral row of 5-14 melanophores above the gut.

Larvae are 12-50 mm long, elongated, the preanal length exceeds the postanal one. Pigmentation is arranged in evenly spaced dorsal, ventral, ventrolateral and subcaudal rows. The ventral row is extended to the anus, the number of melanophores in the ventro-lateral row is 12-14 or over. The epineural pigment row appears at a length of about 20 mm. At later stages scattered pigmentation is developing parallel to the extension of the lower jaw. Ref.: Rass, 1949; Russel, 1976,.



a species
Fig. 59. Ammodytes marinus close to Ammodytes americanus.
Larvae at: A - 6.0, B - 12.0, C - 16.0 and D - 21.0 mm.

(Russel, 1976)

MACKEREL, SCOMBER SCOMBRUS LINNÉ, 1758.

Eggs are pelagic, spherical, 0.97-1.38 mm in diameter, yolk sack unsegmented, the perivitelline space is very narrow, a single oil globule 0.28-0.35 mm in diameter. Large ramified melanophores appear on the anterior part of oil globule during Stage II and small lateral pugment cells develop at Stage III. Two double rows of melanophores run diagonally at Stage IV with aggregations on the head and in the occipital region.

Prelarvae are 3.0-6.0 mm long. The yolk sac is large and oval, the preanal portion forms 46% of the total length. The yolk sac is fully absorbed at lengths of 4.5-6.0 mm the oil globule is by then 0.21 mm in diameter. There is a group of melanophores on the head, a double unevenly spaces raw running along the dorsal and ventral postanal sides from behind the anus, a peritoneal aggregation and single melanophores on the snout with the eye free of pigment.

Larvae are 6.0-14.0 mm long. The head is larger than in prelarvae, the preanal region constitutes 1/3 of the total length. Indications of caudal fin rays are apparent when the length of 6 mm is reached. The mouth is fully formed, the jaws are toothed. Rudimentary rays appear in the second dorsal and anal fins. The caudal fin is coneaved when larvae are 14-15 mm long. Ref.: Bigelow and Schroeder, 1953; Russel, 1976 .

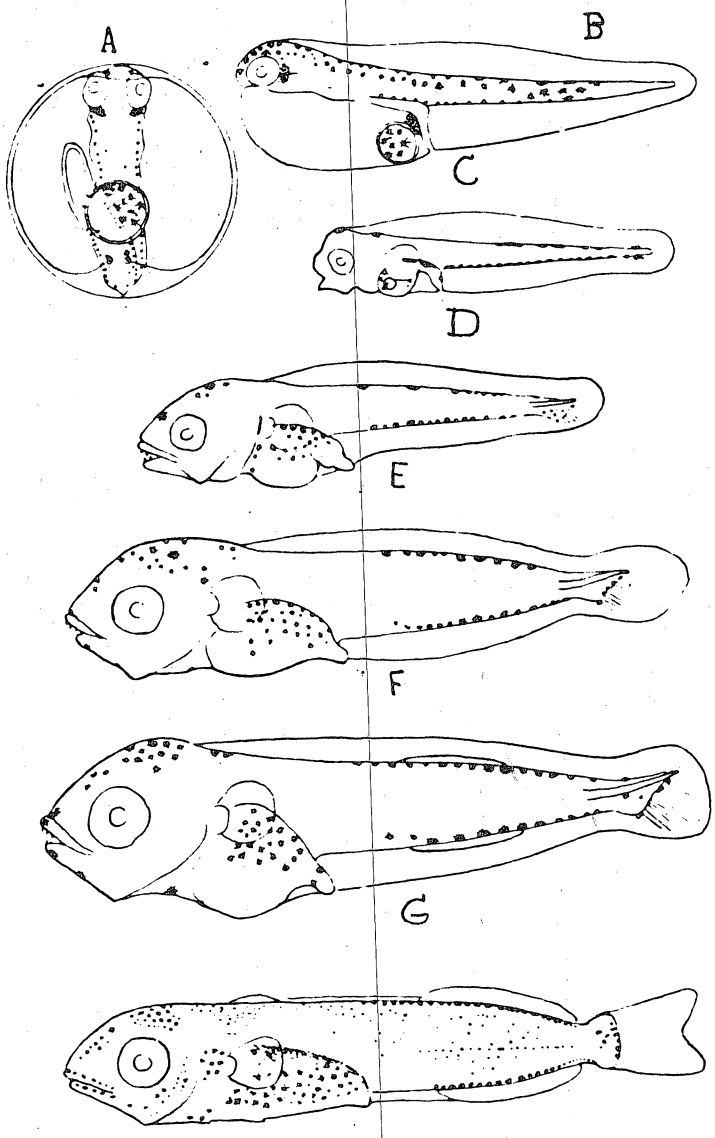


Fig.60.Scomber scombrus

A - egg 1.2 mm in diameter (Holt, 1893)
B - prelarva at 2.4 mm (Holt, 1893)
C, D, E, F, G - larvae at 3.7, 5.2, 7.0, 8.0 and 14.0 mm

(Russel, 1976)

BLUEFIN TUNA, THUNNUS THYNNUS (LINNE),1758.)

Eggs are pelagic, spherical, 0.95-1.12 mm in diameter, the yolk sac unsegmented, single oil globule 0.25-0.35 mm in diameter, the perivitelline space is narrow. Pigment appears on the trunk and on the oil globule at Stage II. The tail is far beyoned the head at Stage IV. Single large melanophores are present along the dorsal side and in the ventro-caudal region. There are small brown pigment cells on the trunk, the yolk sac and fin fold.

Prelarvae are 3.0-4.3 mm long, the yolk sac is not extended beyond the head. The oil globule is on the posterior margin of the yolk sac. The trunk region is shorter than the caudal one the preanal portion forms 45% of the total length. The pigment is very characteristic: single large melanophores are in the dorsal and ventrocaudal region with ramified cells on the protopterigium; there are melanophores on the oil globule and in the anterior part of the yolk sac Brown pigment runs along the anterior dorsal margin and the anterior part of the fin fold and along the lateral sides of the body. Brown pigment is present on the oil globule and on the yolk sac.

Larvae are 4.3-9.0 mm long and more Jaws are developed. P are large of the fan-shape, the preanal length is decreased due to the elongation of the caudal region. Indications of hypurals are present at a length of 4.3 mm. There are rudiments of rays in D_1 and C at a length of 4.75 mm and in D_2 and A at 5.14 mm. Ventral fins are also developing at this length. Unpaired fins are rayed and rays are being formed in P and V. when larvae are 6.0 mm long. P and V are rounded at lengths of 7.0-9.0 mm.

Pigment cells are aggregated above the cerebrum, there is a periteneal group, single dorsal melanophores in the posterior caudal region and a clearly visible ventrocaudal pigment raw. Pigment cells appear on the opperculum and along the anterior margin of the upper jaws. Duffuse pigmentation develops along the trunk sides beneath D_1 in larvae over 9.0 mm long.

Gorbunova, 1974 .

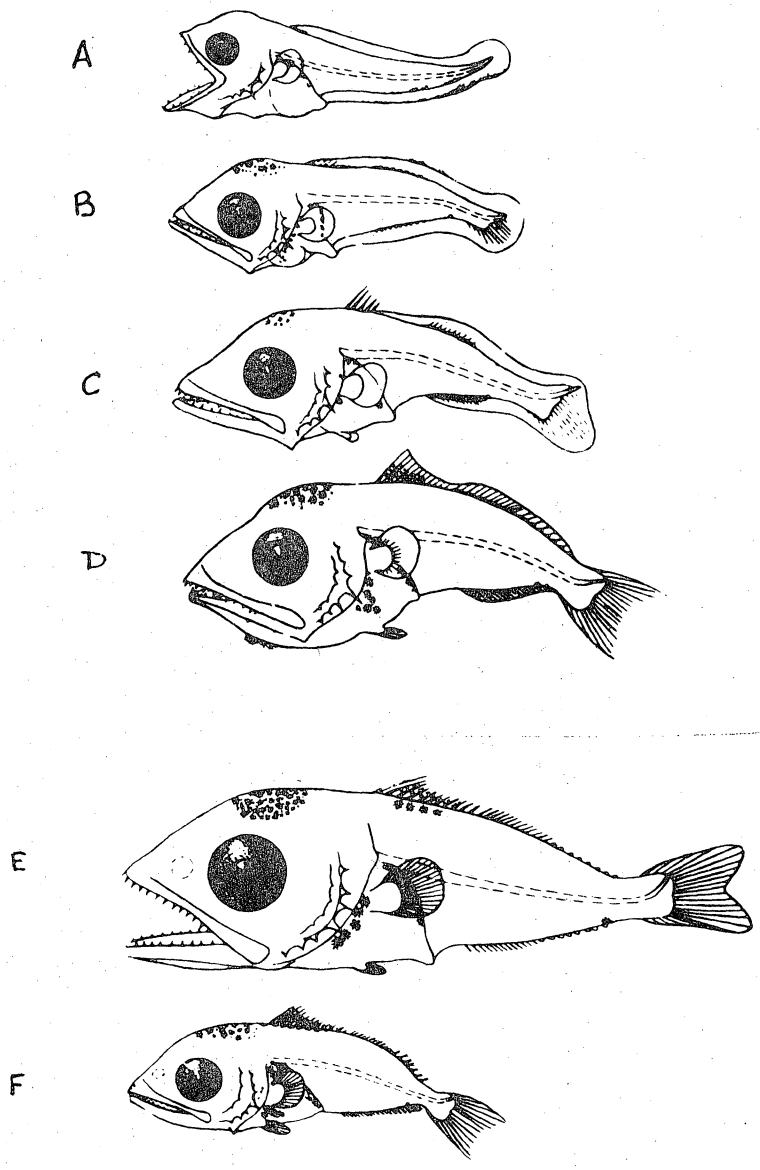


Fig.61. Thunnus thynnus
Larvae: A - 4.30 mm; B - 4.75 mm; C - 6.70 mm;
D - 7.30 mm; E - 9.00 mm; F - 10.5 mm.
(Gorbunova, 1974)

BUTTERFISH PEPRILUS TRIACANTUS (PECK, 1880)

Eggs are pelagic, spherical, spawned probably in a mass. The egg diameter is 0.68-0.82 mm (0.75 mm in the average). A single (0.17-0.22 mm in diameter) or 2-3 (0.06-0.16 mm in diameter) oil globules. The incubation lasts 72 hours at 14.6° and 48 hours at 18.3°.

Prelarvae are 1.68-2.67 mm long. The preanal length is 65% of the body length and does not exceed 40% in late larvae. The anus is in the posterior region of the body at a distance from the yolk sac, and opens at the finfold margin.

Pigmentation: a few melanophores are on the body and on the oil globule; 2 rows of small melanophores are gradually formed on the dorsal and dorsolateral surface of the body from the head to the caudal fin. A row of small melanophores is along the base of the ventral part of protopterigium is formed during 48 hours before complete absorbtion of the yolk sac. 48 hours after hatching a yellowish -brown pigment spot appears on the dorsal surface of protopterigium over the anus to become more distinct 72 hours after hatching and to increase in size 96 hours after hatching.

Larvae are 2.6-16.0 mm long. The body is mace-like, short deep and thickened anteriorly. A total of 30 myomeres are present 168 hours after hatching. The mouth is fully formed. At 3.7 mm incipient rays are in the caudal fin. At 5.0 mm the dorsal and anal fins are with incipient rays. At 6.0 mm the pectoral fin is formed and 2/3rds of the vertebrac are ossified.

Pigmentation; 120 hours after hatching yellowish-brown colour is prevailing; a separate row of melanophores is on the ventral surface of the body and a yellow-brown spot is on the dorsal surface of the finfold, spots increase in number to disappear later. 144 hours after hatching yellow-brown pigment becomes paler and disappears, the eyes are tinted blue; melanophores located over the gut and along the ventral side of the caudal region become more distinct. A large melanophore is present on the occipital region and peritoneum. At 3.1 mm and over a single large melanophore is on the mandible edge.

Spawning is usually offshore but sometimes in the Long Island Gulf and in the Narranganset and Chesapeake Bays. Spawns in June-July (Austin, 1973) off New England and in late spring-early summer in the Chesapeake Bay.

Range: off North America between 48°N and 27°30N in the Atlantic Ocean and in the Gulf of Mexico.

References: Agassiz, 1882; Agassiz & Whitman, 1885; Austin, 1973; Bigelow & Welsh, 1925; Colton & Honey, 1963; Colton & Marak, 1969; Haedrich, 1967; Horn, 1970; 1975; Herman, 1963; Lippson & Moran, 1974; Mc Hugh, 1960; Miller, 1958; Meriman & Selar, 1952, Truitt, Bean & Fowler, 1929; Wheatland, 1956.

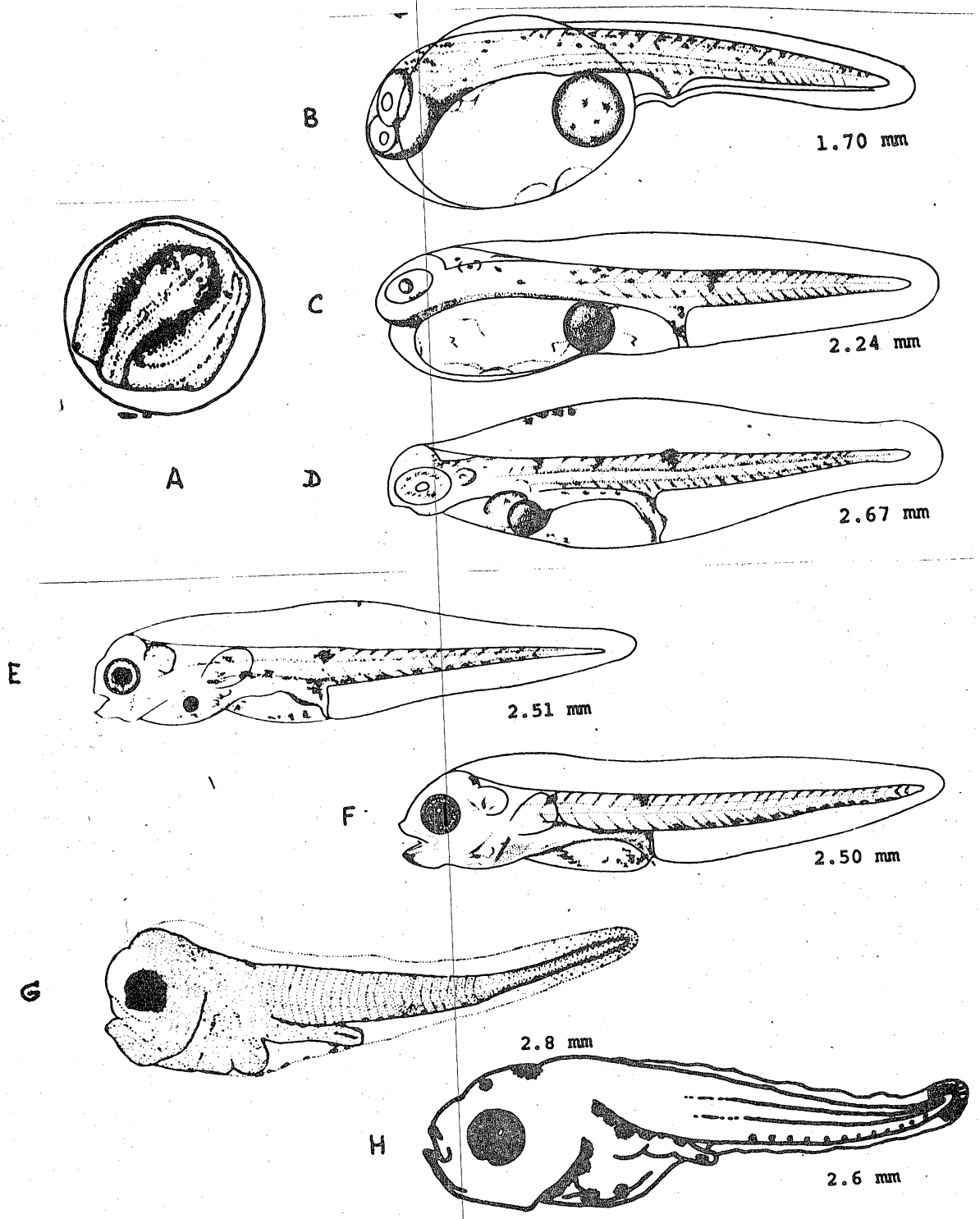


Fig.62.Peprilus triacantus (Peck, 1880)
A - egg at Stage III, diameter unknown; B,C,D - prelarvae at hatching, 24 and 72 hours after hatching; E - prelarvae 144 hours after hatching. (A - Perlmutter,1939;B-F-Colton a. Honey,1963;H-Miller,1958)

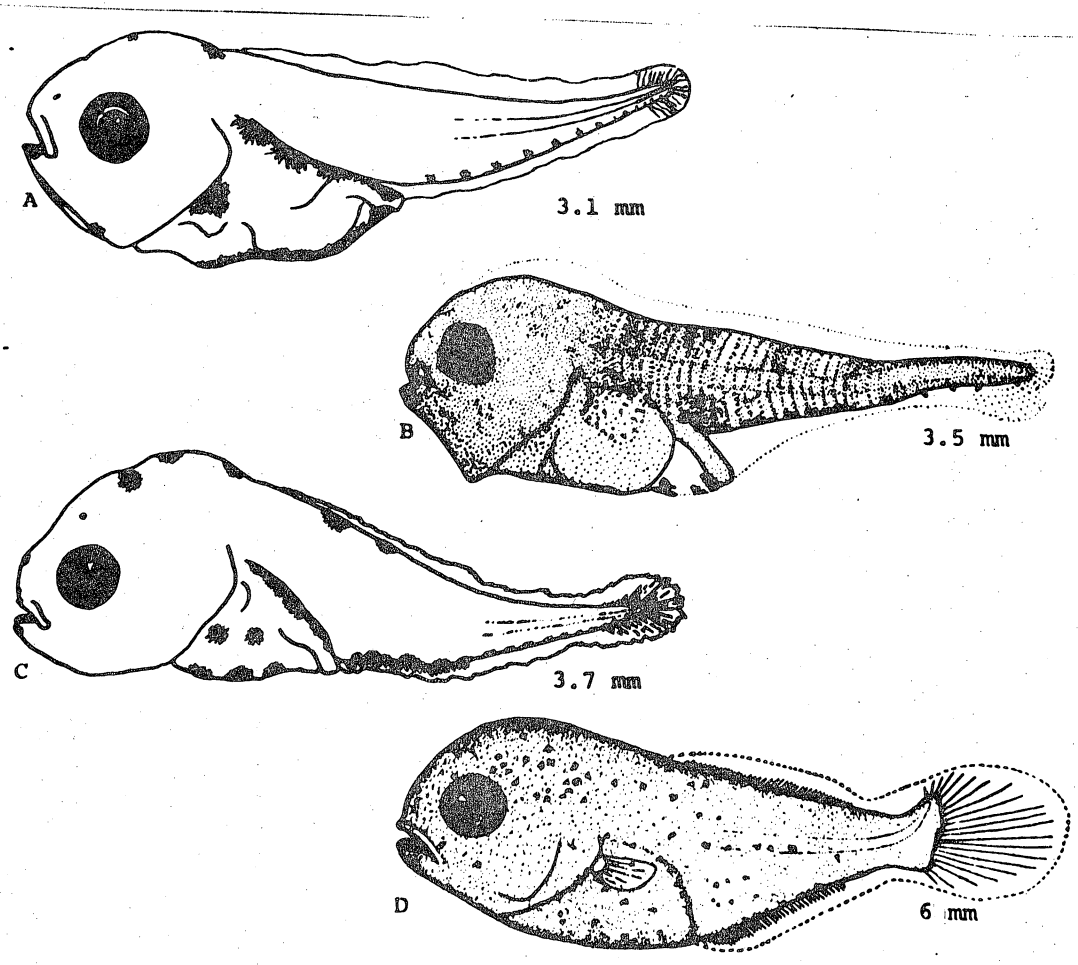


Fig.63. Peprillus triacanus.
Larvae of length : A- 3.1mm, B - 3.5mm, C - 3.7mm, D - 6 mm (A,C - Miller, 1958; B -Perlmutter, 1939; D - Hildebrand a. Schroeder, 1928).

HARWEST FISH PEPRILUS PARU (LINNÉ, 1758)

Eggs are pelagic, spherical, about 1 mm in diameter.

Prelarvae undescribed.

Larvae - 1.8-7.0 mm TL. At 1.8 mm the body is mace-like, the preanal length is about 55% of TL. The body depth is 4.3 times in TL; the gut is straight, a few melanophores are scattered laterally. At 2.5 mm TL the preanal length is decreased down to 48-50% of TL. A series of melanophores is along the lateral line, another row is along the ventral edge of the body over the gut; 2 melanophores are behind the eye on the opercle.

At 3.5 mm the preanal length is 50% of TL; the body depth is only 3.3 times in TL. Incipient rays are in the caudal fin and the mesenchyme is swelling in the region of future dorsal, anal and caudal fins. Pigmentation; 2 incomplete rows of large melanophores in the pectoral region reach the mid-point of the caudal pedancle below the lateral line; 1 row of melanophores is from the pectoral edge to the middle of the caudal region.

Spawning takes place at sea in spring and in June-July.

Range: from the Gulf of Maine to Uruguay.

References: Haldrich & Horn, 1969; Horn, 1970; Hildebrand & Schroeder, 1928; Miller, 1965; Pearson, 1941, Truitt, Bean & Fowler, 1929.

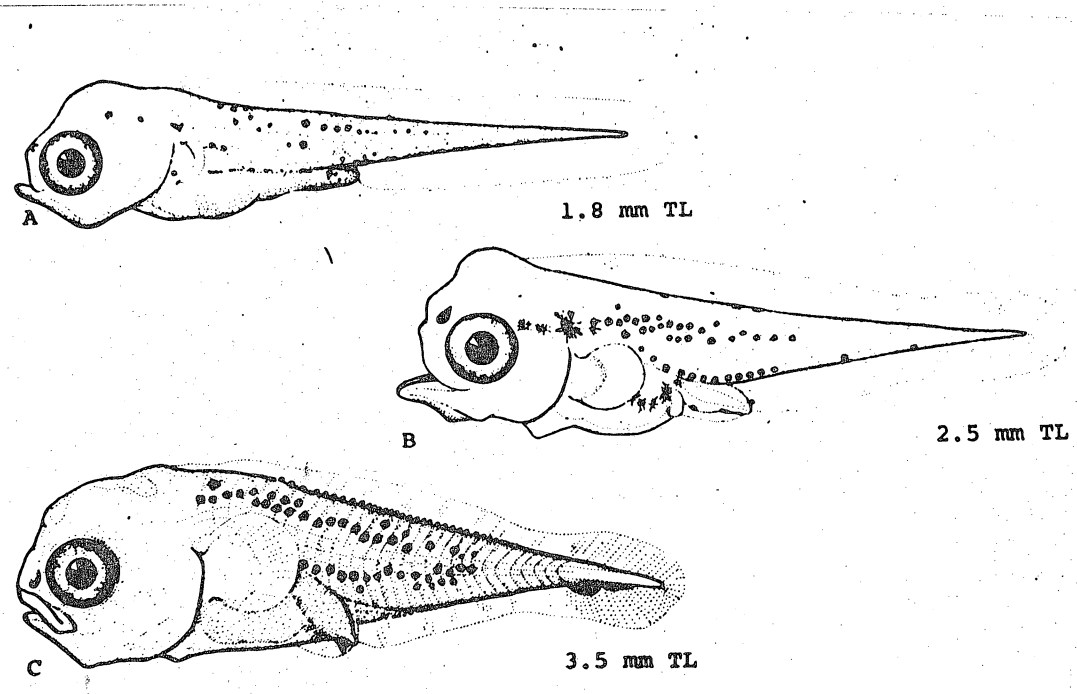


Fig.64 Peprilus paru.
Larvae 1.8, 2.5 and 3.5 mm (Pearson, 1941)

LITTLE REDFISH, SEBASTES VIVIPARUS KROYER, 1845.

Prelarvae are 5.1-7.9 mm long. Newly spawned specimens are 5.5-6.0 mm long and of the typical cottoid form. The yolk sac is 0.7 mm long the oil globule is 0.2 mm in diameter and greenish-yellow, with the colour much more intensive than in other species of this genus. The eye is fully pigmented, with both melanin and glittering guanin pigment. The number of myomers is 29-31. There is one or several pigment cells on the head, 8-12 on the gut and incomplete postanal dorsal row of 9-12 melanophores above the last 11-17th myotomes. The ventral row is also incomplete and consists of 19-21 melanophores which run from beneath the 11th myotome. A large melanophore is present under the caudal margin of the notochord.

Larvae are 7.0-14.0 mm (9). Rays appear in P at a length of 6.2 mm under experimental conditions. Indications of rays are present in C, ventral and dorsal pigment rows become longer, spines develop in the occipital region, above the eye and in the pre-opperculum at a length of 8.9 mm. When the larvae are 10.1 mm long the spines become elongated, the indications of ventral fins appear, the urostyle is upturned, there are rays in C and a well-developed peritoneal pigmentation. In fully-formed larvae rays in D_1 and D_2 are added and spines above the eye, in the occipital region and on the pre-opperculum become larger. Ref.: Taning, 1961.

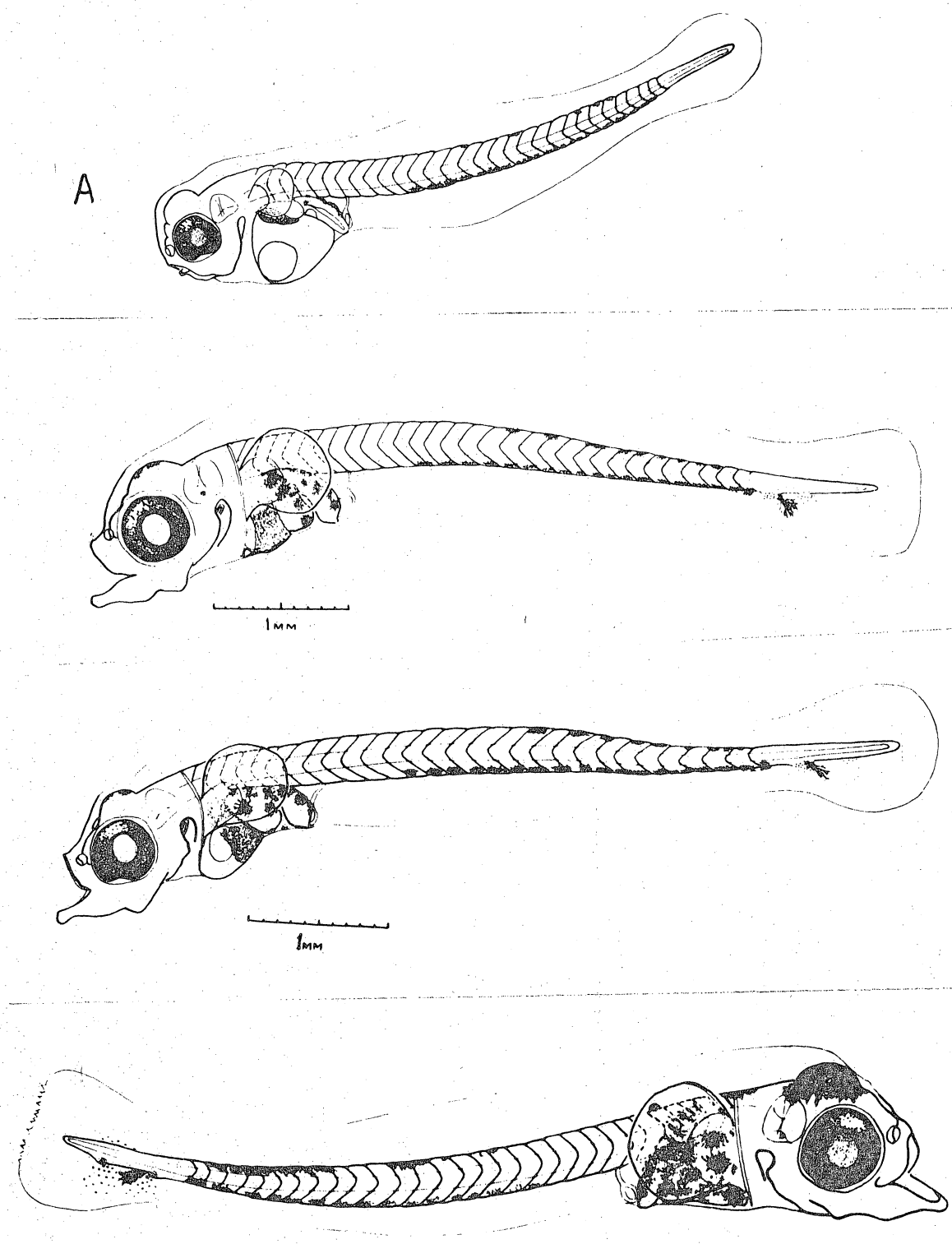


Fig.65. Sebastes viviparus
Prelarvae: A - at 4.9 mm; B - at 6.2 mm, 5 days after stocking in the tank; C - at 6.15 mm 7 days after stocking; D - at 5.1 mm 11 days after stocking. Larvae did not feed

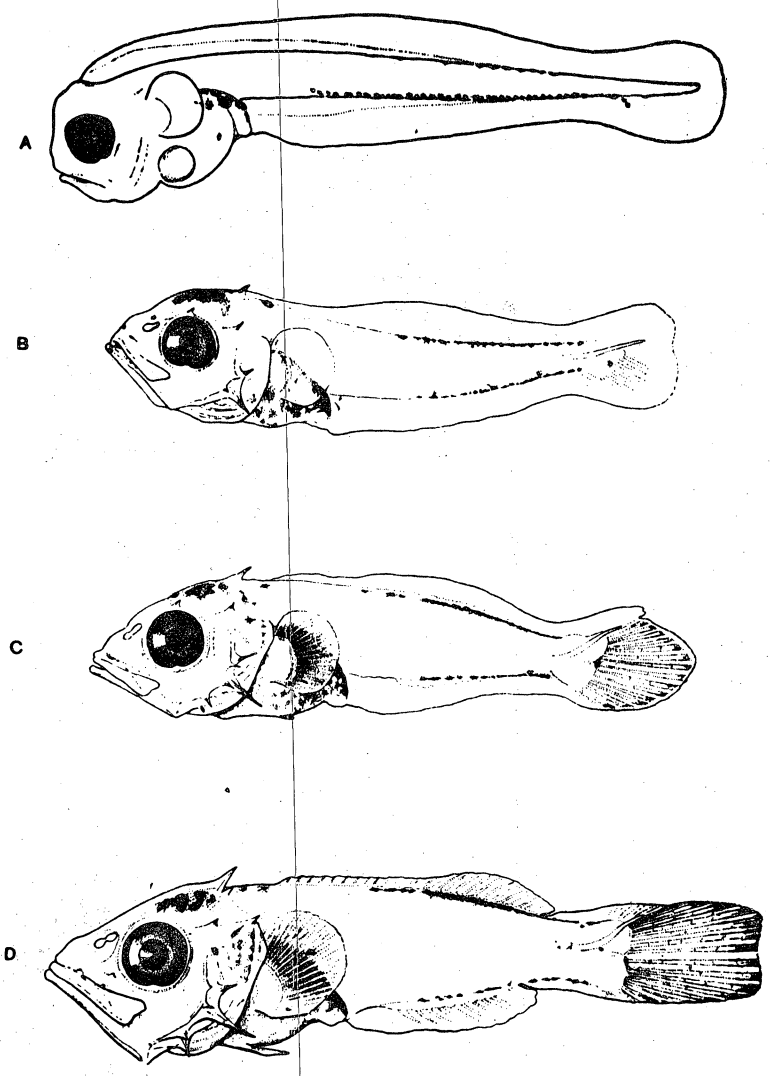


Fig.66.Sebastes viviparus
A - prelarva at 5.8 mm (interovarial);
B, C, D - larvae at 8, 9, 10.1 mm and 13.5 mm from plankton samples.

(Taning, 1961)

GOLDEN REDFISH SEBASTES MARINUS(LINNE,1758).

Prelarvae are 6.1 (7.2) - 10.5 mm long with the typical cottoid form, the yolk sac is 0.65 x 0.92 mm, the oil globule is weakly yellow, 0.3-0.4 mm in diameter, the preanal portion constitutes 29-32% of the total length. The anus is situated on the fin fold margin, the urinary bladder, rudimentary liver and acoustic capsule are visible. The number of myomers is 28-30. There are two or more pigment cells on the head and 11-12 on the gut on both sides of the body. The eye is fully pigmented with the melanin and guanin, 1-2 melanophores are present below the caudal margin of the notochord, the dorsal row of melanophores is incomplete with 8-12 pigment cells above the 14-27th myotones. The dorsal side of the last 1-2 myomers is always free of pigment. The ventral row consisting of more than 20 melanophores runs from beneath the 10th myomer to the last one.

Larvae are 10.5-20.9 mm long. The yolk sac and the oil globule is fully absorbed. There are indications of rays in C and spines on the pre-operculum. The dorsal row of melanophores reaches the mid-point of the body at a length of 10.5 mm. The spines on the head are as well developed at a length of 10.5 mm as in S.viviparus at 10.1 mm. There are rays in D_2 , A and P and indications of V. The remnants of protopterigium resist. Larbal characers disappear at a length of 20.9 mm. There are no protopterigium remnants, rays are present in D_1 and only traces of larval pigmentation which are represented by dorsal and ventral caudal rows of melanophores are notable. The fry colour appears at a length of 27.0 mm. Ref.: Taning, 1961 .

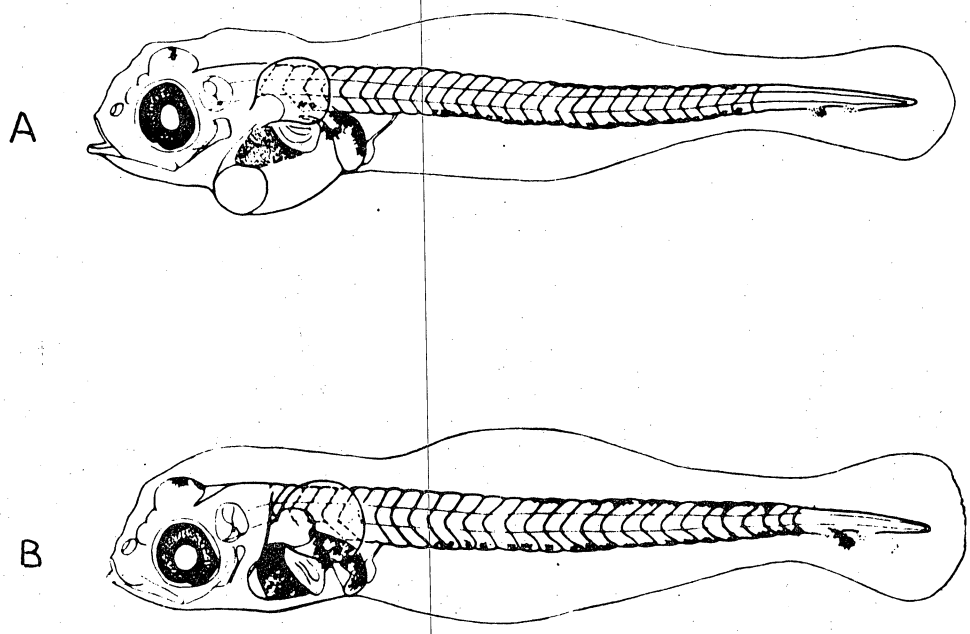


Fig. 87. Sebastes marinus
Prelarvae interovarial at 6.25 mm (A) and at 7.19 mm (B).

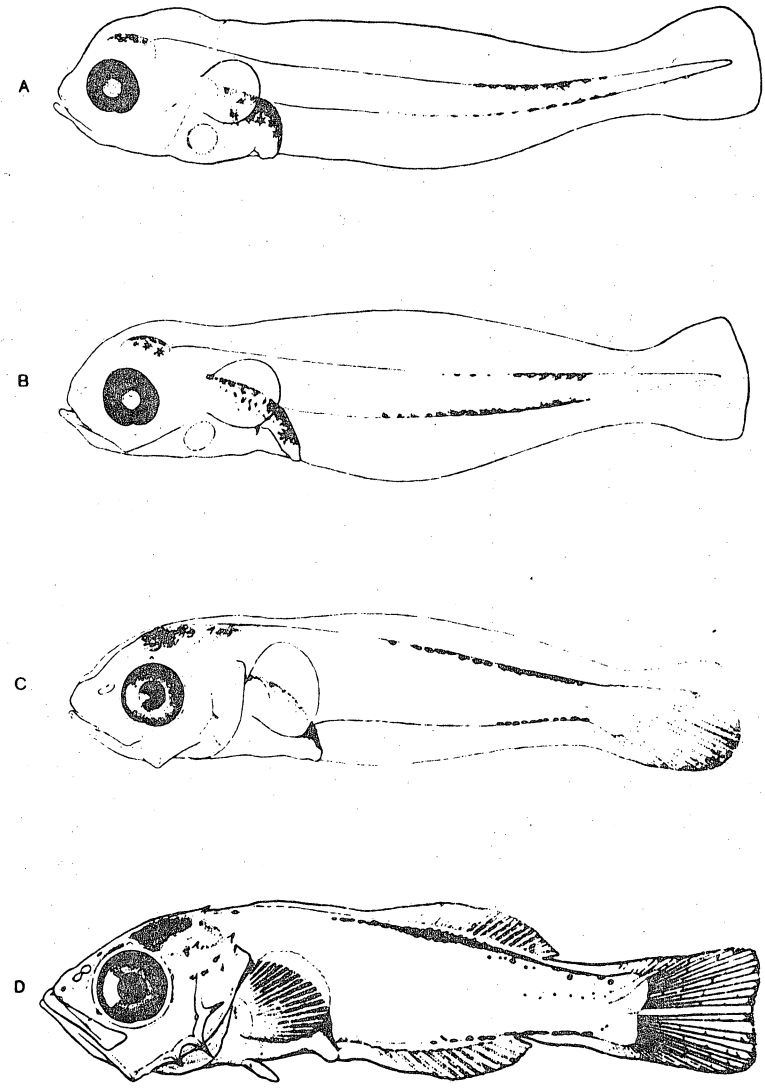


Fig.68. Sebastes marinus
A - prelarva interovarial at 6.7 mm;
B, C, D - larvae at 7.4, 10.5 and 15.7 mm
(Taning, 1961)

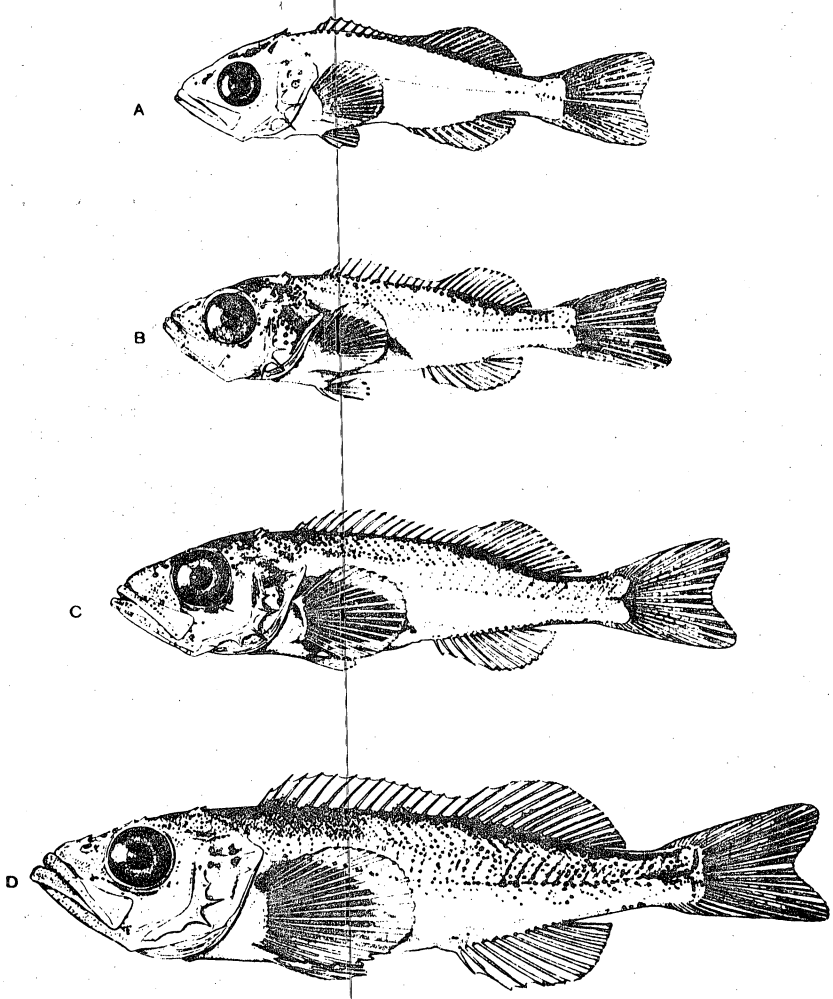


Fig.69. Sebastes marinus
A - 20.5, B - 27.0, C - 34.5 and D - 52.0 mm
(Taning, 1961)

DEEPWATER REDFISH, SEBASTES MENTELLA TRAVIN, 1951.

Prelarvae are 7.0-11.5 mm long (from observations on larvae in the aquarium. Newly spawned prelarvae 7.7 mm long are of the cottoid shape, the yolk sac is ovoid 0.90x0.70 mm, the oil globule is 0.3-0.4 mm in diameter, the preanal portion forms about 30% of the body length, the anus is on the margin of protopterigium, the urinary bladder is visible, the number of myomers is 28-31. Two or more pigment cells are on the head, 13 on more melanophores are on the gut on both sides of the body, the eye is fully pigmented with melanin and guanin and no melanophores under the caudal margin of the notochord. The dorsal row of melanophores is above the 21-31st myomere and is not stretched to beyond the 18th myomere. The ventral row begins at the 11-21st myomere and ends above the last one. With growth of larvae both raws are stretched forward to the head. Rays appear in P at a length 8.10 mm when the yolk sac is not wholly absorbed. Full absorption of the yolk sac occurs 219 hours after placing into the aquarium at the temperature of about 7.0°, the oil globule 0.35 mm in diameter being present. There are rays in P and indications of rays in C. The black pigment is all round the encephalon, heavily pigmented are the gut and rudimentary liver caudal pigment rows still resist.

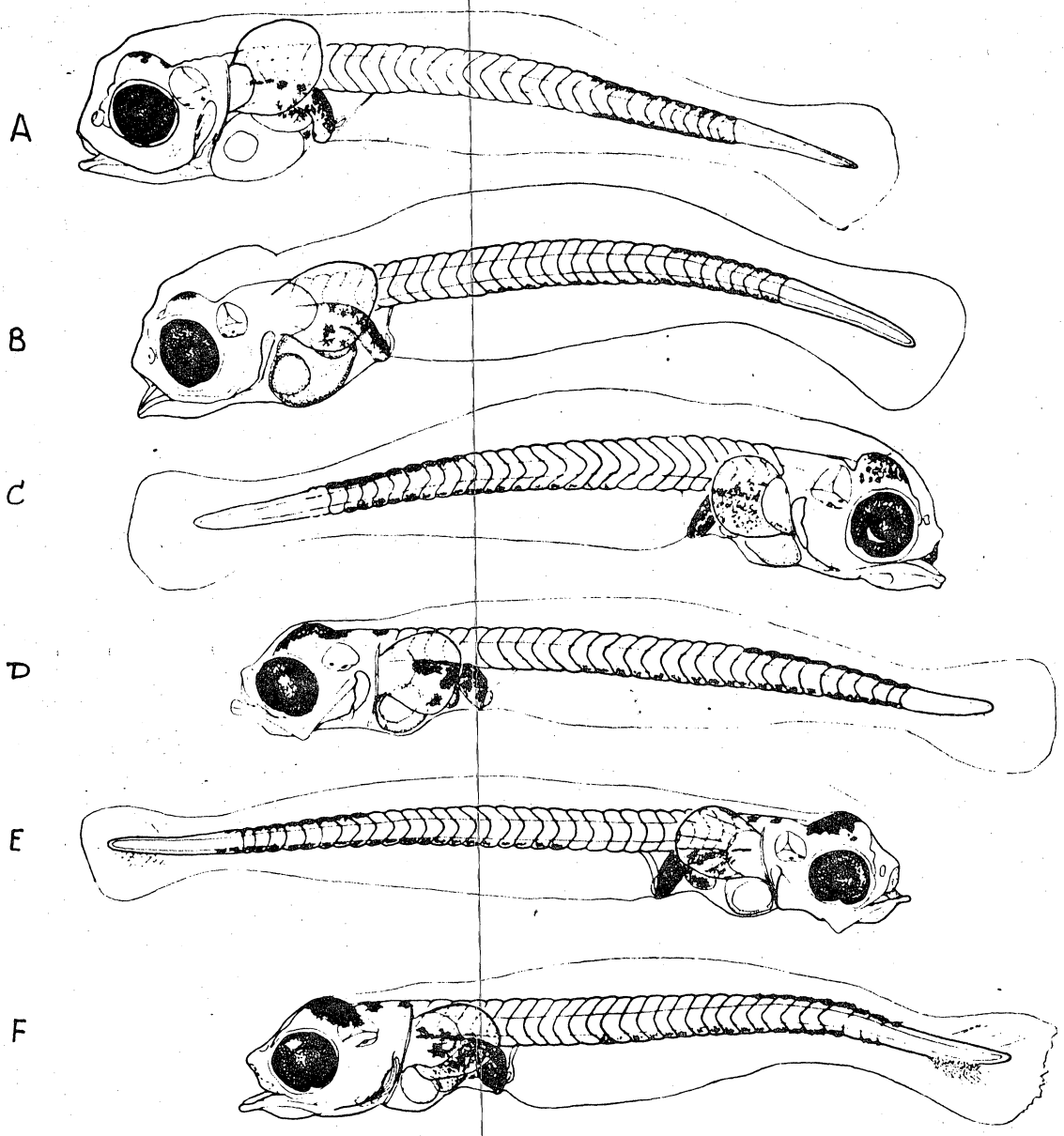


Fig.70.Sebastes mentella
Prelarvae at: A - 7.7 mm, interovarial; B - 8.15 mm 30.6 hours after stocking in the tank; C - 8.0 mm 153 hours after stocking; D, E, F - larvae at 8.0, 7.9, 7.8 and 7.45 mm 220 hours after stocking.

BLUE MOUTH HELICOLENUS DACTYLOPTERUS (DELAROCHE, 1809)

Eggs are unknown.

Prelarvae are 3.6-5.5 (?) mm long of the typical cottoid shape, the preanal portion forms 47% of the total length the mouth is fully formed. The eye is melanin-pigmented; there are 2-3 melanophores on the encephalon and 14-15 peritoneal and intestine melanophores which are visible on one side. The dorsal row is lacking and 3-5 ventral melanophores are present in the middle caudal region.

Larvae are 5.6-10.0 mm long. There are indications of rays in D_1 , C and P, and spines are present above the eye, in the occipital region, on the preoperculum and in the acoustic capsule area. At a length of 10.0 mm D_2 and C are rayed, the urostyle upturned and ridges are developed in the occipital region ending in spines. There are spines on the preoperculum and in the acoustic capsule area, 1 spine is present in V and the remnants of protopterigium are in the caudal region. 8 spiny rays are in D_1 , the occipital ridge is serrated and ends in spines. Spiny rays are developed in A.

Täning, 1961 .

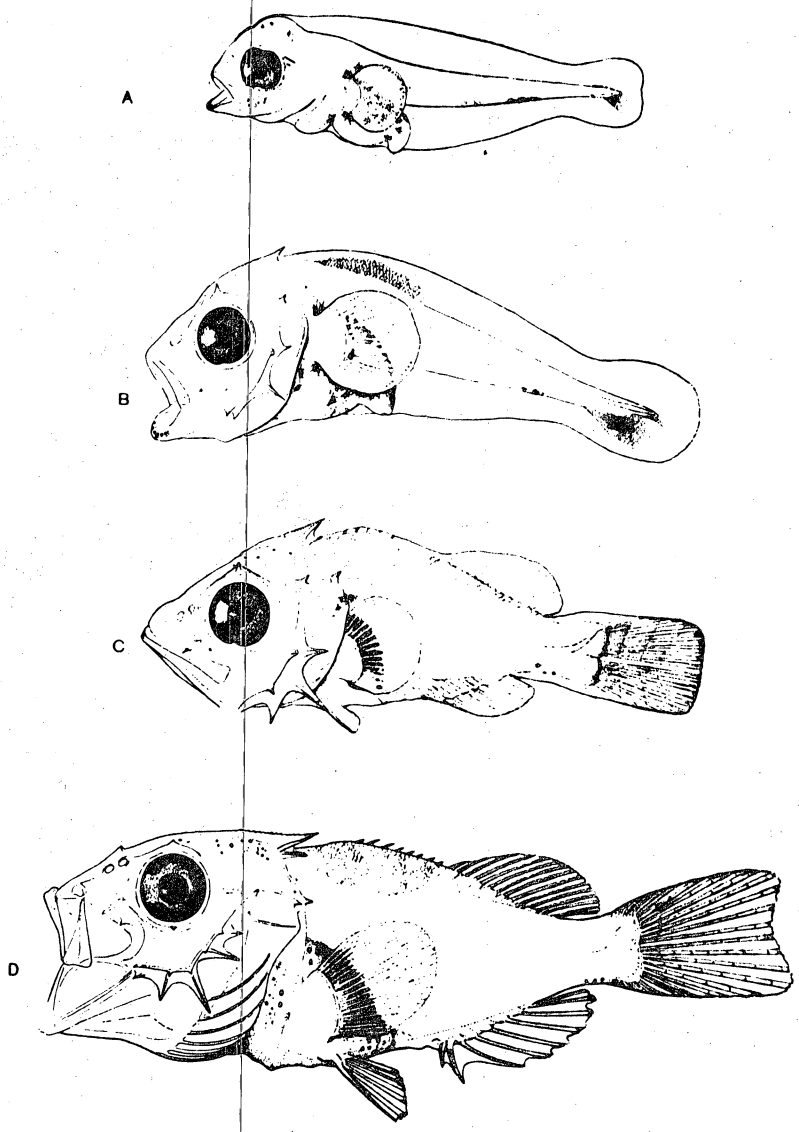


Fig.71.Helicolenus dactylopterus
Larvae: A - at 3.6; B - at 5.6; C - at 10.8 ; D - at 19.0 mm.
(Taning, 1961)

SCULPIN, MYOXOCEPHALUS SCORPIUS (LINNE 1758)

Eggs are bottom (deposits are 8.5 x 8.0 x 4.5 mm), spherical, 1.8 - 2.5 mm in diameter, the yolk sac is unsegmented, several oil globules are coalesced by the end Stage I to one 0.4-0.5 mm in diameter.

Prelarvae are 7.4-8.6 mm long with the typical cottoid form (the anterior third is thick while the caudal portion is slender). The anus is on one side of primordial fin, the preanal region constitutes about 40% of the total length, the oil globule is in the anterior part of the yolk sac. Eyes are pigmented black, the ventral row consists of 12-14 melanophores; several pigment cells are on the head, snout and on the P base. There is dorsal aggregation of melanophores behind the head, in the peritoneal region and 1-2 caudal melanophores on the gut.

Larvae are 9.0-14 mm long. There is a spine in the acoustic capsule area and 4-5 spines on the preoperculum. Spines are on the snout and above the eye at lengths of 10-14 mm. Ventral fins, rays in D_1 , D_2 , A and C appear at a length of 10 mm. The dorsal row of melanophores extends to the mid-point of the body to form a wide latitudinal pigment row. Melanophores are present in P. Ref.: Rass, 1949; Ehrenbaum, 1905-1909; Russel, 1976 .

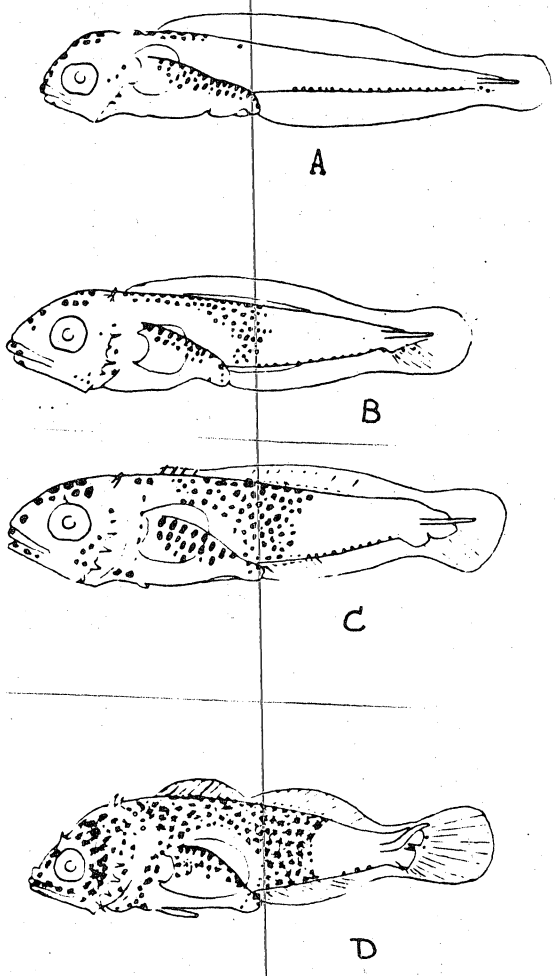


Fig.72 Myoxocephalus scorpius
Larvae: A - at 7.5, B - at 9.5, C - at 10.0 and D - at 14.0 mm
(Russel, 1976)

ATLANTIC SEA POUCHER

LEPTAGONUS DECAGONUS (BLOCH ET SCHNEIDER,1801)

Larvae are 10.0-21.0 (?) mm long is elongated and rounded in the preanal region which is below half the total length. The trunk region where the rectum is situated is isolated, processed and narrowed in the front part and the posterior part of the ventral protopterigium is coneaved. P are large, blade-like, pigmented. There are pigment rows on the fins and on the trunk. Small spines of the external skeleton all over the body by the time the fins are rayed when larvae are 13 mm long.

At a length of 21.0 mm V and D_2 are present and P extends to beyond the anus, the spines on the head and on the trunk are well developed, there are two distinct postanal pigment rows on the head and the trunk and the aggregation of pigment on the base of C. Ref.: Rass, 1949.

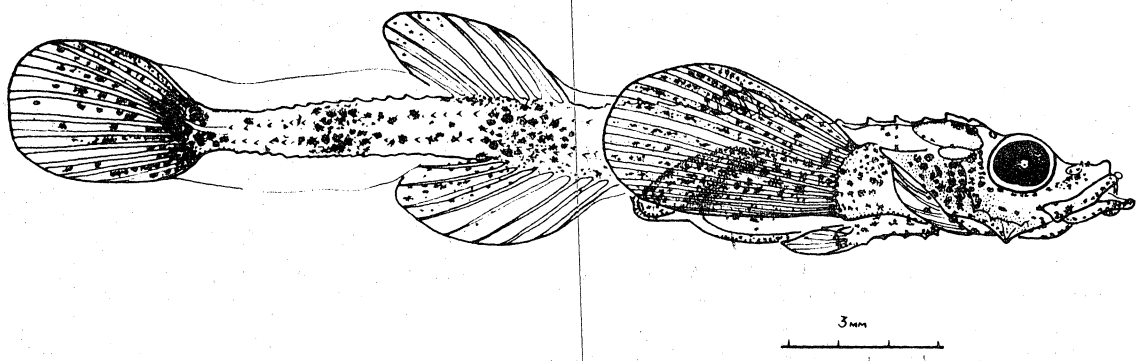


Fig.73.Leptagonus decagonus

CYCLOPTERUS LUMPUS LINNE ,1758.

Eggs are bottom, (deposits are 20-30 cm in size) spherical 2.2-2.6 mm in diameter, the yolk sac unsegmented the oil globule is 0.80-0.94 mm in diameter.

Prelarvae are 5.5-8.0 mm long of the typical cottoid form, the anus is just behind the yolk sac, the oil globule is 0.72-0.88 mm in diameter, the mouth is formed. D_1 appears before the yolk is fully absorbed. The wide anterior part of the body has intensive black and organge pigment while a relatively narrow postanal portion is free of pigment. A large pectoral fin has radial rows of melanophores.

Larvae are 8.0-11.0 mm long and more. Fins are rayed at a length of 11 mm. Ref.: Rass, 1949; Russel, 1976 .

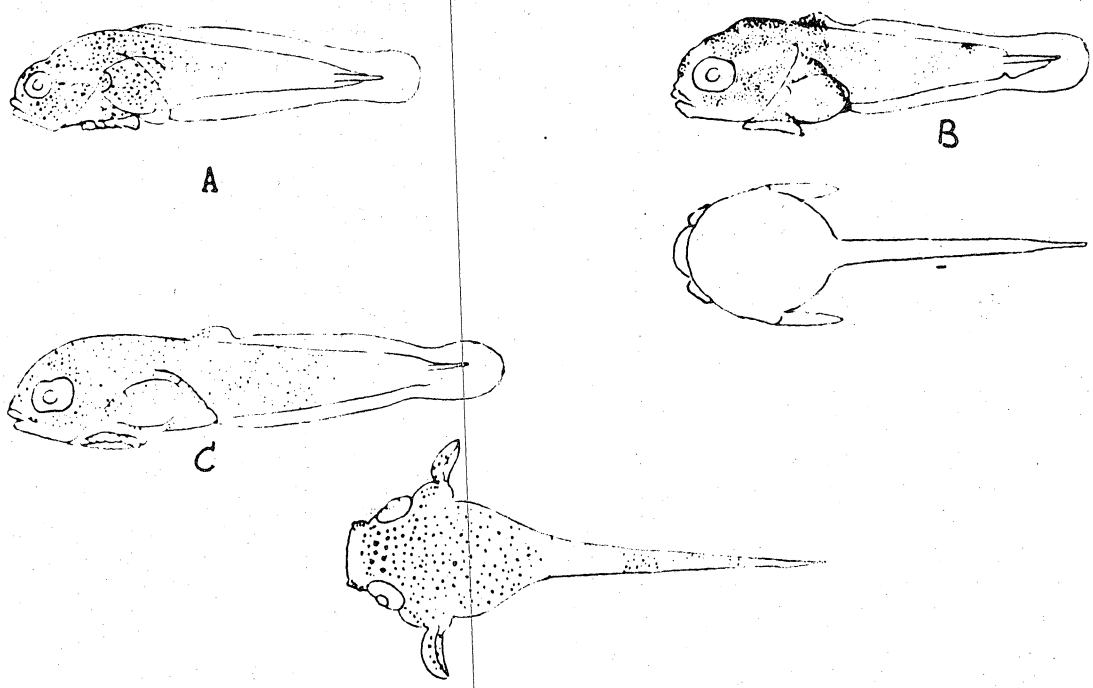


Fig.74.Cyclopterus lumpus
Larvae: A - at 5.5, B - at 5.6 and C - 6.6 mm.
(Russel, 1976)

LIPARIS LIPARIS (LINNE, 1766)

Eggs are spawned in small (4 cm) batches. The egg diameter is 1.35-1.67 mm. 12-13 oil globules are merged into one 0.28-0.35 mm in diameter. The egg clusters are attached to hydroid polyps. The egg envelope is thick (0.06-0.08 mm); eggs are spherical or rounded hexagonal. Incubation lasts 6-8 weeks. Eyes are black-brown when the embryo extends to the periphireal of the yolk sac; brown-reddish pigment appears in the peritoneum and pectoral fin region.

Prelarvae. Length at hatching is about 5.5 (4.75) mm. The body is mace-like, incipient suctorial disc is present. The total myomere number is 38-40, 8-10 are preanal. The preanal length is 64% of TL. Pigmentation: the ventral row of melanophores is in the postanal region, the peritoneal concentration of melanophores is evident, melanophores are on the inner side of the pectoral fin surface. The eye is black. The anus is at the edge of protopterigium.

Larvae are 7.0-16.0 mm long. The body is mace-shaped, the intestine is pear-like and looped. Fin rays are incipient at 9-10 mm and complete at 15-16 mm when the pectoral fin reaches the anus. Large stellate melanophores are on the pectoral base.

References: Rass, 1949; Ehrenbaum, 1904; Russel, 1976.

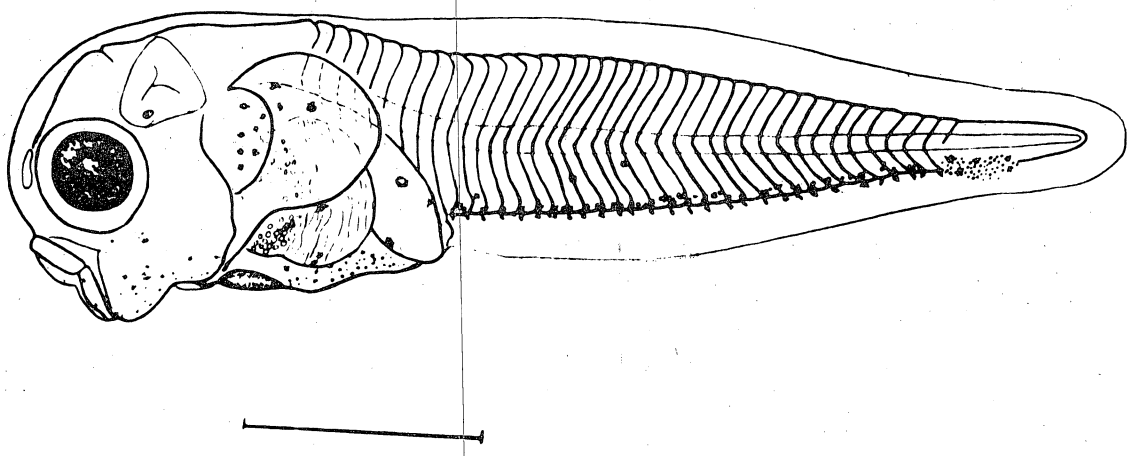


Fig.75.Liparis liparis at 4.75 mm TL

AMERICAN PLAICE HIPPOGLOSOIDES PLATESSOIDES PLATESSOIDES (FABRICIUS ,178o)

Eggs are pelagic, spherical, 1.5-3.2 mm in diameter, the perivitelline space is wide. During Stage IV pigment cells are arranged in latidudinal rows in the trunk and tail regions. Larvae are hatched 11-14 days after fertilization at a temperature during embryodevelopment of 3.9°C. The length of embryos is by then 4.0-6.0 mm.

Prelarvae are 4.85-7.70 mm long. The body is elongated threadlike and is surrounded by the fin fold, the remnants of the yolk sac are visible behind the eleitrum. The number of myomers is 41-43. Aggregations of melanophores are present on the ventral side of the yolk sac and of the looped intestine and above the ventral side of the anterior part of the hindgut. A continuous row of melanophores runs along the dorso-caudal margin and there are groups of pigment cells on the dorsal side of the postanal region between the 21-24th and the 30-32nd myotomes and single melanophores on the 17th, 19th and 26th myotomes. 2 pigment cells are present on the lower jaw and 2 on the pectoral fin blade. 6 melanophores are noticeable above the notochord; dispersed on the dorsal part of the primordial fin are small melanophores.

Larvae are 7.8-13.8 mm long, yolk sac is fully absorbed, the number of myomers is 43. There are groups of pigment cells beneath the pectoral fin base, on the stomach and on the hindgut. 3 indistinct caudal raws are visible and heavy postanal

pigmentation is present on the ventral side of the embryonic fin while single melanophores only are on the dorsal side above the pigment rows. Indications of rays appear in unpaired fins (60 in D and 50 in A) at alength of about 8.0 mm (8.2 mm). The urostyle is by then curved and extends beyond the tail peduncle. Rudiments of hypural are present. Pigmentation pattern has changed: a continuous caudal row of ramified melanophores runs along the ventral contour of the body and on the gut. Five aggregations of melanophores are on the ventral margin of the caudal portion and two are on the dorsal contour of the body. Delicate pigment cells are present on the ventral side of myosepts mainly above the pigment aggregations. There are two small melanophores above the 1st and 4th aggregations on the embryonic fin, two small pigment cells above the posterior part of mesencephalon and cerebellum behind the acoustic capsule and three melanophores above hypural rudiments.

Metamorphosis takes place at length of 11.7 - 13.8 mm when the eyes start to migrate and the edges of the left eye and the elfactory capsule are visible above the head contour. The number of rays in 87 in D, 69 in A, 18 in C and 6 in V. The trunk pigmentation is similar to that in larvae 8.2 mm long. 4 aggregations are present on the ventral and 2 on the dorsal side of the caudal region. One ramified melanophore is visible on the 23rd - 24th myotomes, small melanophores are present on the rays and A and C protopterigium. Ref.: Pertseva-Ostroumova, 1961; Hunstman, 1918; Bigelow and Shroeder, 1953; Evseenko a.Nevinsky(unpublished).

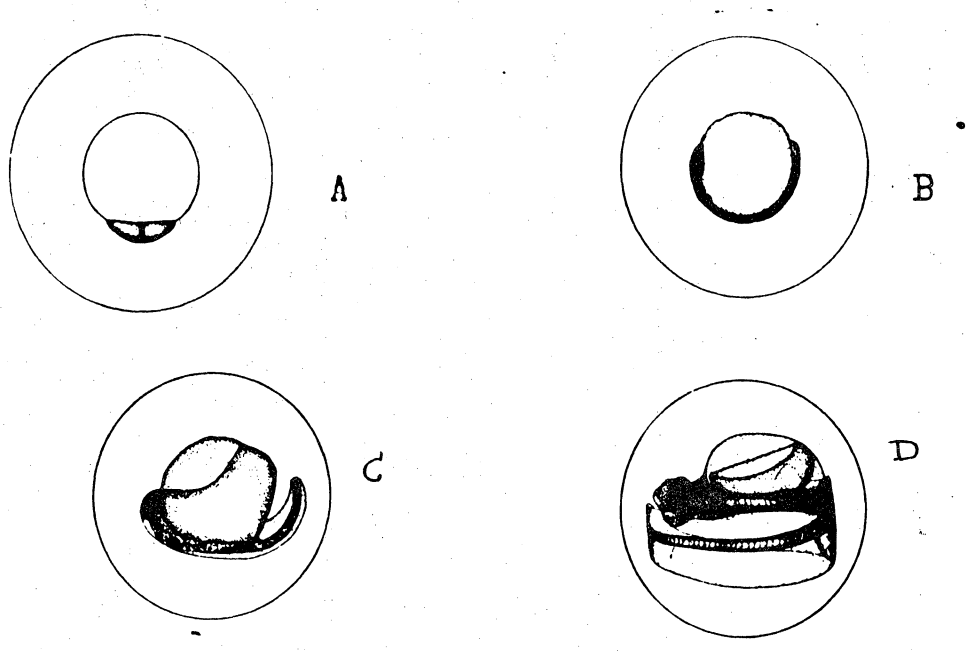


Fig.76. Hippoglossoides platessoides platessoides
Eggs: A - Stage I, B,C - Stage II, D - Stage III,
E - Stage IV (Hunstman, 1918).

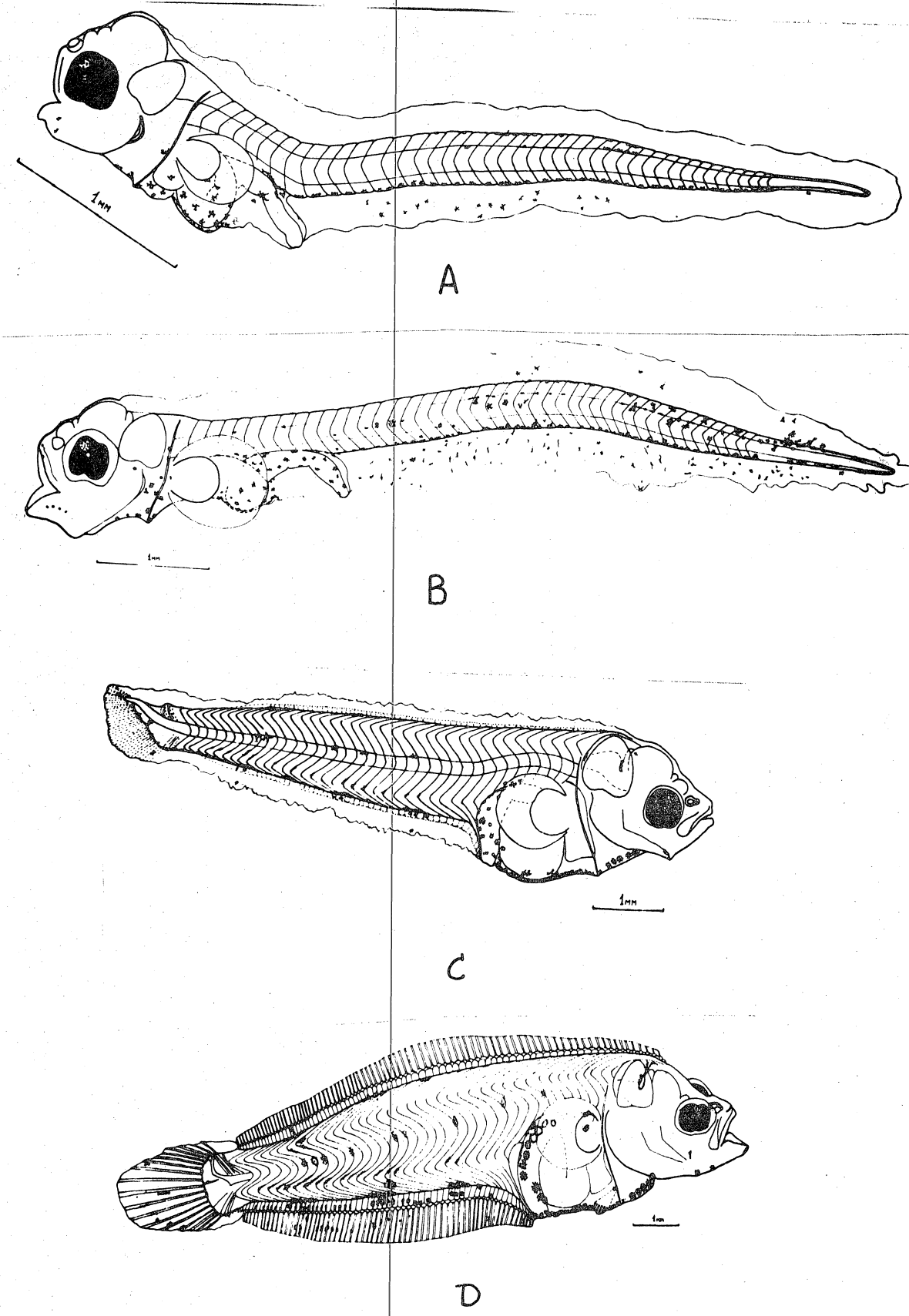


Fig. 77. Hippoglossoides platessoides platessoides
Larvae: A - at 4.85, B - at 7.8, C - at 8.2 and D - at 11.7 mm.

(Drawn by S.A.Evseenko)

YELLOWTAIL LIMANDA FERRUGINEA (STORER,1839)

Eggs are spherical, pelagic, 0.75-0.90 mm in diameter, the membrane is thin and transparent, the perivitelline space is narrow, the yolk sac unsegmented, no oil globule. At Stage II dispersed all over the embryo body are small pigment spots; two longitudinal rows running ventrally and dorsally tend to form at Stage III. The width of embryo is 8-10 times in the egg diameter. At Stage IV, just before hatching, eyes are still free of pigment and a distinct row is present beyond the mid-point of the caudal portion.

Prelarvae are 2.10 - 3.15 mm and the body is surrounded by the fin fold; 11 preanal and 35 postanal myomers. Anus is beyond the yolk sac, the head is not raised above the yolk sac surface. Eyes are free of pigment. When prelarvae are 2.65 mm long the head is raised and eyes are weakly pigmented. A continuous double ventral row of melanophores in the caudal portion up to the 38th myomere; several melanophores are on the yolk sac.

Larvae are 3.15-14.1 mm long. Yolk sac is absorbed completely; jaws are developed, cleitrum is distinctive; continuous double row of ventral melanophores runs from the 17th to the 41st myomere. There is a latitudinal pigment row near 32nd- 35th myomer, large ramified melanophores on the dorsal side of the caudal portion, 6 large melanophores on the peritoneum, and a large ramified melanophore on the gut at the anus. Jaws are pigmented. Melanophores are present on the ventral margin of primordial fin in the preanal and on the protopteregium in the postanal region. The pigment is lacking on the dorsal side.

The depth of the larvae forms 1/7 - 1/8 of the body length of 5.5 mm. Indications of pterigiophores in D and A are apparent. Jaws are free of pigment, a large melanophore is on the carebellum, a pigment row is along the ventral contour of the body stretching to the gut. Two dorsal groups of pigment cells are between the 22nd-24th and 32-34th myomers, primordial fin is pigmented in the postanal region only.

The metamorphosis starts at a length of 9.9 mm when the edge of the left eye becomes visible above the head profile. The urostyle is curved; the number of rays is 80 in D, 59 in A and 18 in C. Rudiments of V are seen. There are 3 melanophores above the mesencephalon, 2 above the cerebellum, 3 above the telencephalon, 1 on the opperculum and 2 beneath. A continuous row of melanophores runs along the ventral region of the body, 4 groups of ramified melanophores are on the dorsal and 5 postanal groups on the ventral side, which form pigment stripes with myosept melanophores. The pigmentation pattern on the left side of the body differs from that on the right one: 9 small melanophores are present on the lower jaw edge of the blind side. More than half of the left eye are visible above the head profile. The number of rays is 85 in D, 64 in A, 18 in C and 6 in V. Pectoral fins are of larval pattern. 5 groups of pigment cells are on the dorsal and 4 caudal groups on the ventral side of the body. Ref.: Bigelow and Schroeder, 1953; Evseenko and Nevinskij(unpubl.).

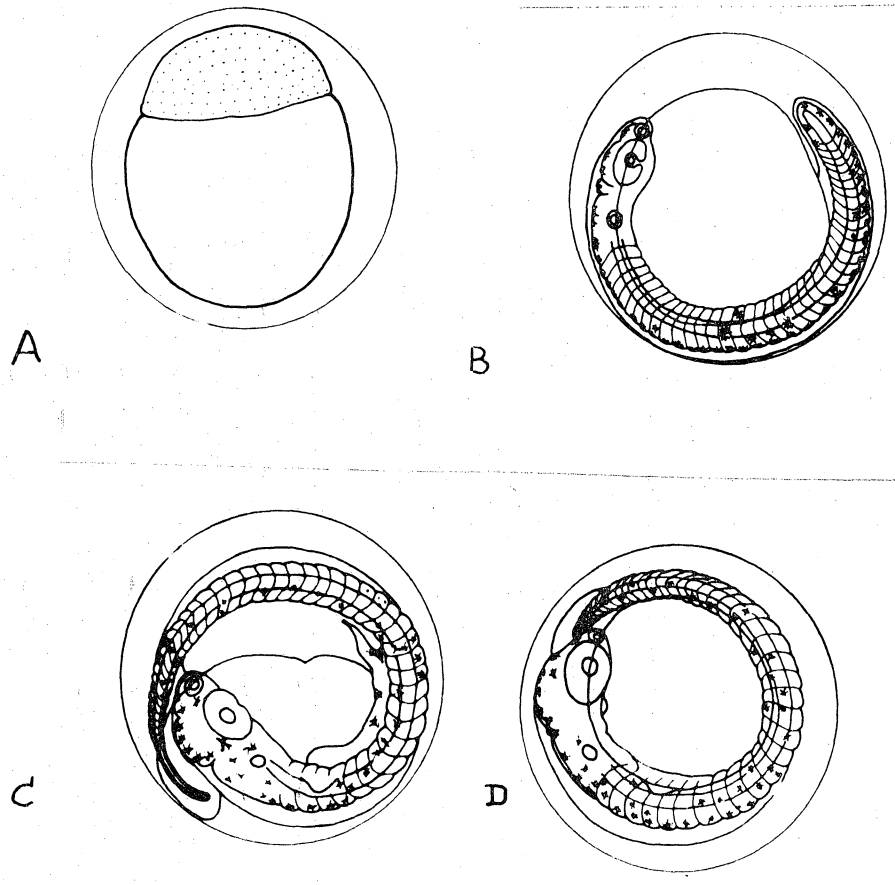


Fig.78.Limanda ferruginea
Eggs at different stages: A - I, B - II, C - III,
D - IV (after Evseenko & Nevinskij)

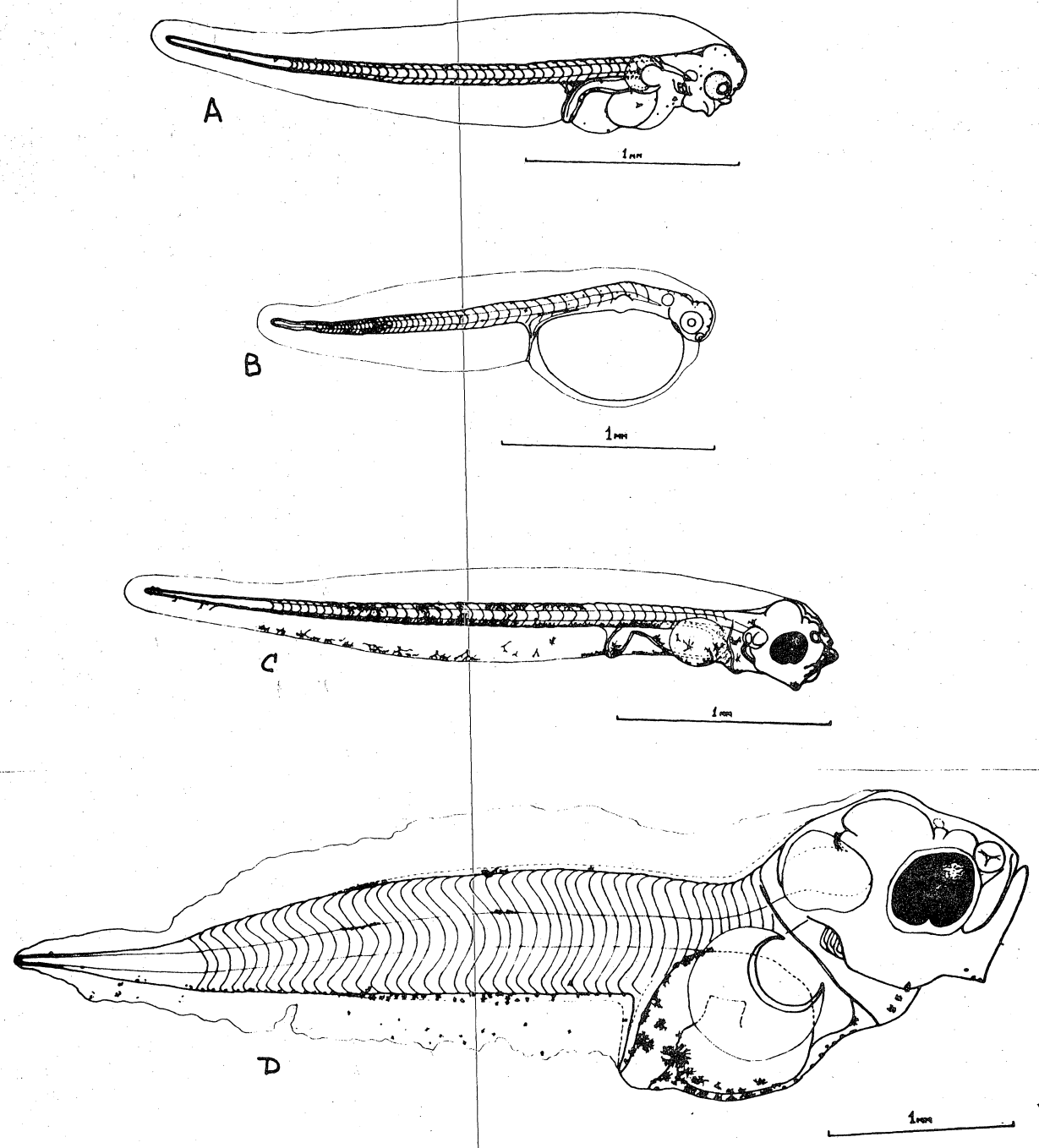


Fig.79.Limanda ferruginea

A - prelarvae at 2.1 mm; B - 2.65 mm; C, D - larvae at 3.15 and 5.5 mm (after Evseenko & Nevinskij)

WITCH FLOUNDER, GLYPTOCEPHALUS CYNOGLOSSUS (LINNE ,1758)

Eggs are pelagic, spherical, 0.1-1.45 mm in diameter, the membrane is tough with furrows, and numerous folds sometimes. At Stage II pigment spots are dispersed mainly over the dorsal side with few on the head. Two lateral rows of melanophores are visible at Stage III with the embryonic fin and yolk sac free of pigment. The aggregation of melanophores in the anus region and in the postanal pertion of the body are extremelly well pronounced.

Prelarvae are 4.9-8.0 mm (?). At a length of 5.8 mm they are filament-like with the anus on the fin fold margin. The gut is looped in the midpoint and turned downwards in the end. There are anal aggregations of large ramified melanophores and 3 postanal rows of pigment cells and small ventral groups of spots between the 17 and 18th, 32-33rd and 48th-51st myomers. Groups of spotted melanophores are present along the fin fold margin.

Larvae are 16.7-22.5 mm long, symmetrical, narrow, surrounded by the embryonic fin. The preanal portion forms 29-30% of the body length. The number of myomers is 57 (12 + 45). There are 85 indications of pterigiophores in D and 68 in A, 31 rudimentary ray in D and 41 in A and 18 rays in C. The urostyle is curved. Pigmentation is by and large similar to that in prelarvae but heavier.

The metamorphosis starts at a length of 22.5 mm when the left eye begins to migrate on to the right side with the upper part extending to beyond the head profile. The preanal portion

forms 35.1% of the body length, the number of myomers is 54-55 (11 +43 + 44). There are 3 rays in D, 95 in A, 20 in D and 5 in V. V is just beyond the ventral side of the cleitrum. The postanal pigment rows are indistinct. On the whole the pigmention pattern is the same as at lower length. The metamorphosis is prolonged and ends at lengths of 40-50 mm. Fig.
(Holt, 1893; Petersen, 1904; Bigelow and Schroeder, 1953; Evseenko and Nevinskij, 1975).

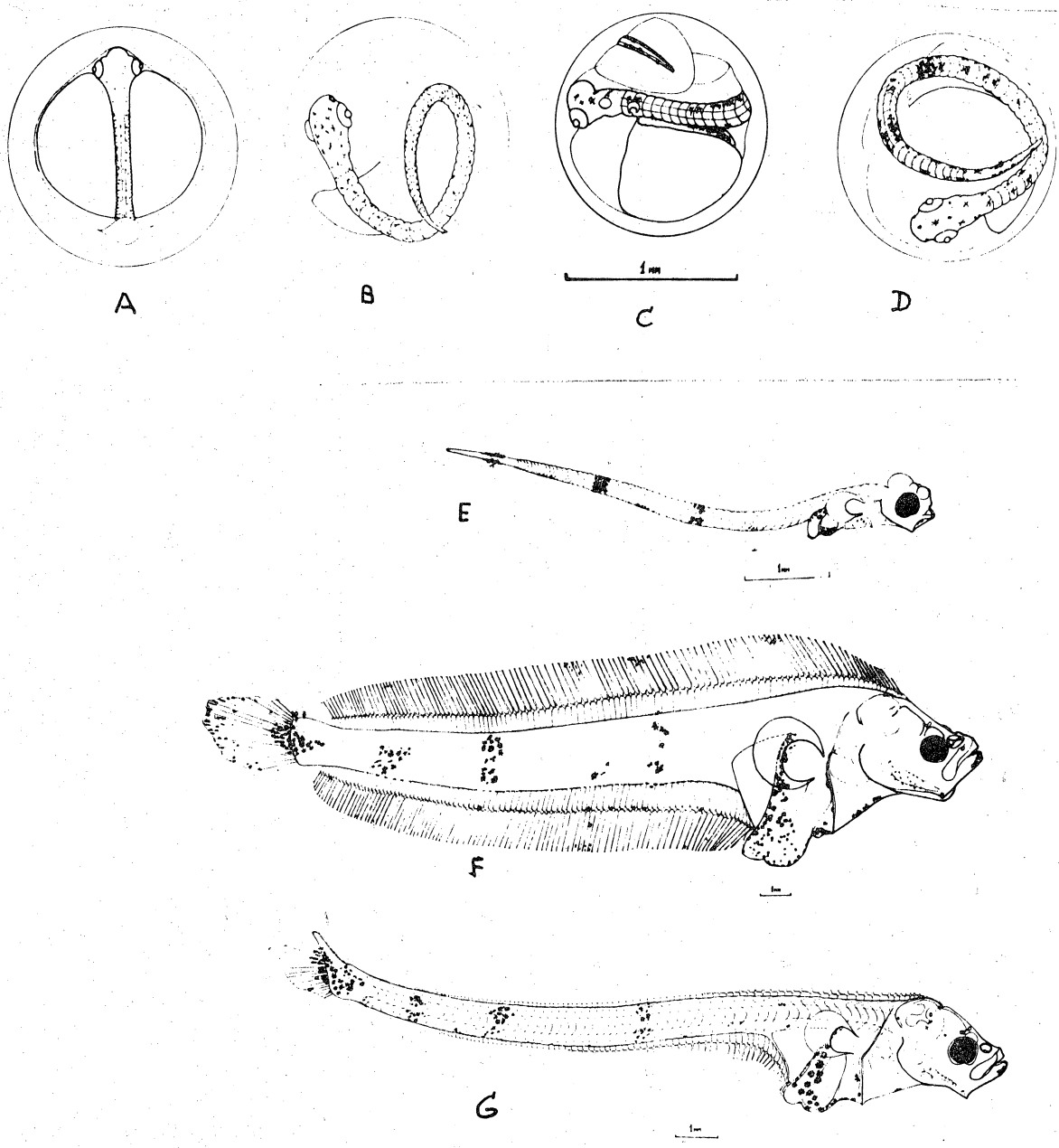


Fig.80.Clyptocephalus cynoglossus

Eggs: A - at Stage I; B - at Stage III; C, D - at Stage IV; E - prelarva at 5.8 mm; F, G - larvae at 16.7 and 22.5 mm. (Evseenko and Nevinskij, 1975)

ANGLERFISH LOPHIUS AMERICANUS VALENCIENNES, 1837

Eggs, are spawned as gelatine-like, mucous bands 10-15 m long and 1,0-1.5 m wide the clutch consists of hexagonal cells, with 1.2 or 3 eggs in each cell. The volume of the clutch is 25-27 l and 1 clutch contains about 1320000 eggs. Sometimes, particularly after storms songle eggs may be encounted. The eggs are slightly oval, the major axis is 1.61-1.84 mm and the minor axis is 0.05 mm shorter. A single oil globule 0.40-0.56 mm or several smaller oil globules in the beginning of development. The yolk is homogeneous and yellow.

The embryo at Stage II and III is rather wide (20-21% of the egg diameter). The length of the embryo does not embrace the periphereal part of the yolk sac. At Stage IV the finfold is wide; the second incipient ray is visible in the dorsal fin.

Pigmentation. The pigment is apparent at Stage II: several melanophores are evident in the anterior part of the body, in the caudal division and on the oil globule. At late Stage II when the caudal division is separated from the yolk sac surface the dorsal part of the head, the snout, the back and the caudal division are heavily pigmented. The caudal concentration of pigment is gradually isolated from the head and trunk region with development, the eye is strongly pigmented and pigment is present on the ventral side. Melanophores are on the yolk sac, oil globule and a dense concentration of melanophores is on the gut. The ventral side of the head is free of pigment. At more advanced stages the caudal concentration of melanophores is divided into two and later into three pigment bands in the caudal division.

Prelarvae are 3.3-5.5 mm long. The yolk sac is large, the preanal length is about 40% TL after hatching. Pectorals are developing, the protopterigium is wide (12-15% of the body length) The incipient elongated second ray is on the dorsal part of the protopterigium. Rays are apparent in the dorsal fin at 5.0 mm. The eye is fully pigmented, three distinct pigment strips are in the caudal division.

Larvae are 6.5-21.6 mm TL, typically shaped; the head is large, 25-30% of the body length. Thin and elongated rays are in the dorsal part of the protopterigium and in the incipient ventral fins. Pectorals are large, wide, fan-like. During larval development rays in the ventral fin are becoming longer and pigmented, the membrane is apparent and the width increases to reach that of pectorals. At 10.5 mm rays in the caudal fin are easily detectable.

Pigmentation. The prelarval pattern of caudal pigmentation is retained in larvae, with the first pigment band lacking pigment cells on the ventral side. While the second and the third band remain complete. These typical pigment bands disappear at about 30.0 mm TL.

Agassiz, 1882; Bigelow & Schroeder, 1953;
Bowman, 1920; Lehour, 1925; Stiastny, 1911, Taning, 1923.

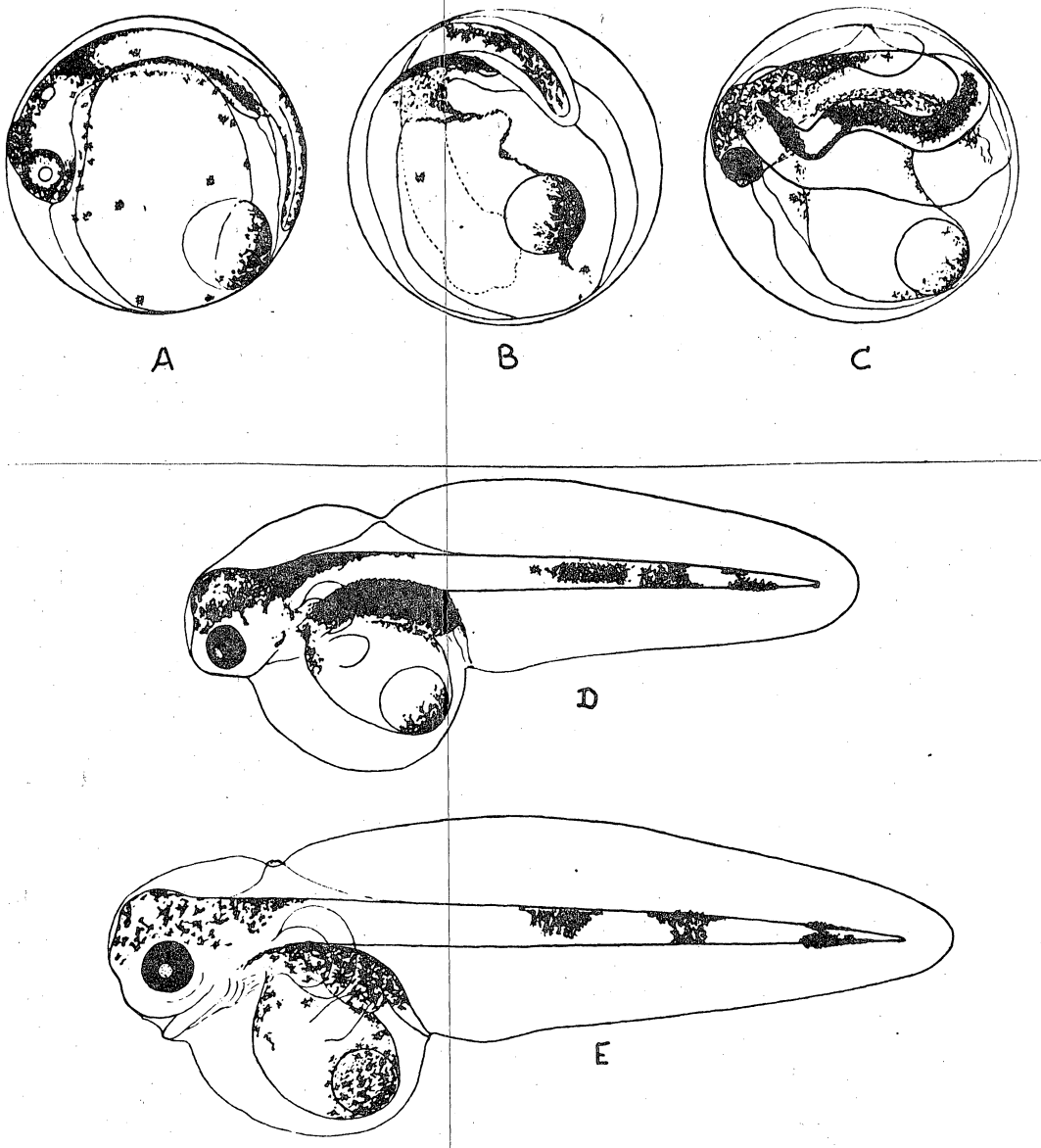


Fig.81. Lophius americanus

A, B - eggs at Stage III, C - Stage IV; D - embryo at 3.3 mm; E - prelarvae at 4.5 mm.

(Taning, 1923)

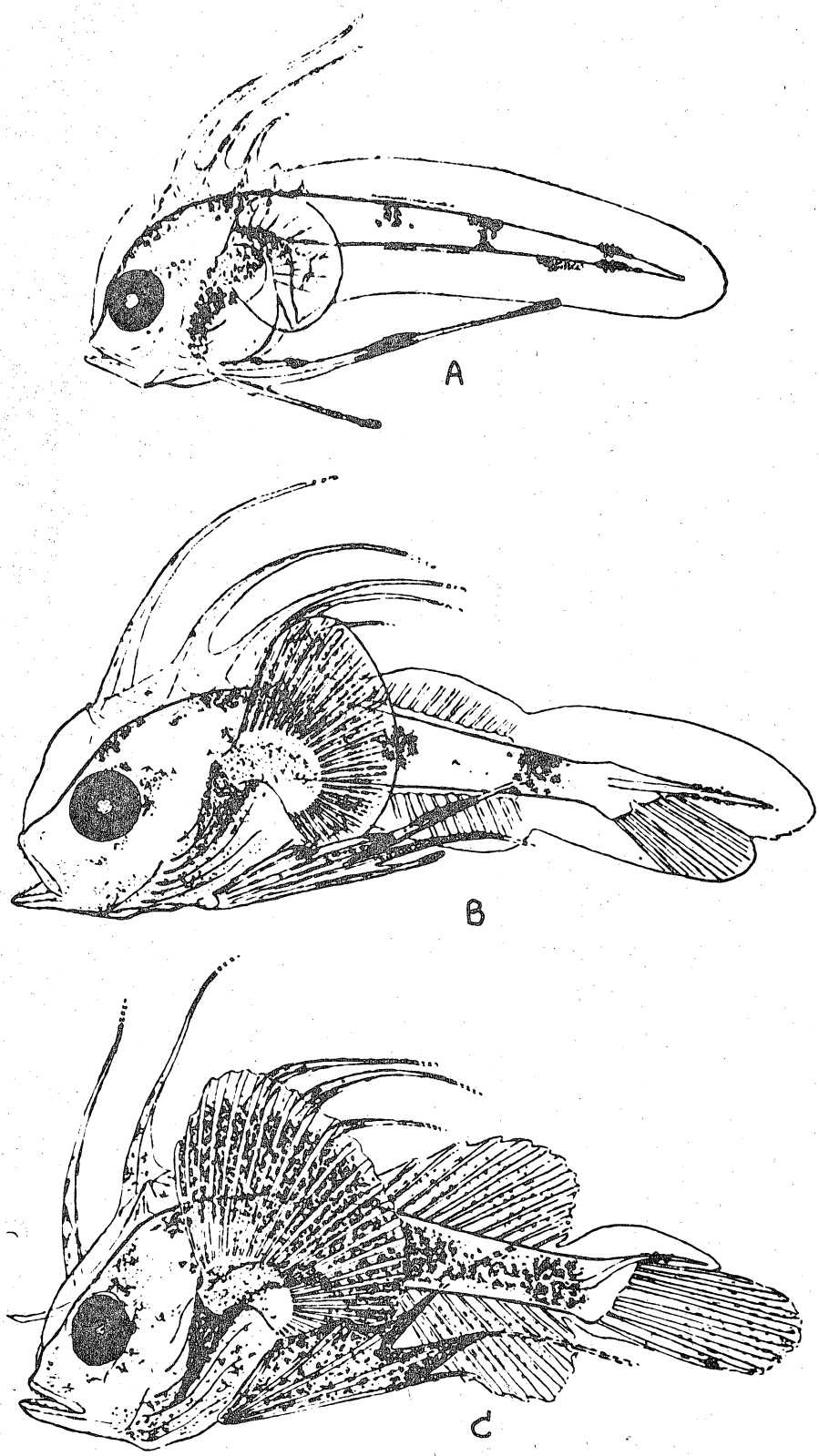


Fig.80. Lophius americanus

Larvae: A - at 16.5 mm, B - at 10.6 mm, C - at 21.26 mm.
(Taning, 1923)

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