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Fish Eggs and Larvae from the Flemish Cap Bank Area

by

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The Flemish Cap Bank is a unique area in the Northwest Atlantic, lying northerly of the Grand Newfoundland Bank beyond the narrow deepsea strait with depths down to 1200 m and the minimum width of 10 miles. The hydrological conditions in the area are determined by the interaction between the Flemish Cap branch of the Labrador Current and the mixed waters of the Atlantic Current, which constitute closed cyclonic and anticyclonic gyres within the Bank (Buzdalin and Elizarov, 1962; Kudlo and Burmakin, 1972). This pattern of water circulation seems to be responsible for the occurrence of isolated populations of cod, redfish, American plaice and other fishes in this area. A closed cycle of relatively short passive migrations of commercial fishes within the Flemish Cap Bank and its comparatively small area contributed towards choosing this region as a polygon for the investigations of the fluctuations in commercial fish year-class abundance. The respective recommendation was approved by the ad hoc Working Group on the Flemish Cap Project of NAFO in Murmansk, 1977.

Comprehensive international ichthyoplanktonic studies were initiated in the Flemish Cap Bank area in 1978, according to an appropriate program aimed at the determination of abundance, distribution and drift patterns of pelagic eggs and larvae and of survival and mortality of commercial fishes during early ontogeny. The identification of species from the ichthyoplanktonic samples taken during these investigations involves

significant difficulties, as no identification keys or annotated descriptions of eggs and larvae are available for the Northwest Atlantic areas situated northward of Nova Scotia. The goal of this paper is to alleviate the problem of identification of the Flemish Cap ichthyoplankton.

The paper contains illustrated descriptions of 30 species only which are (or may be) recorded most frequently in the ichthyoplanktonic samples obtained in the Bank area. Descriptions of fish eggs and larvae of the families Myctophidae, Gonostomatidae and Bathylagidae, which may be found in the Flemish Cap Bank and in the adjacent areas, are not provided.

The eggs and larvae are described based on the 4 phases of fish development suggested by T.S.Rass (1946): an egg, a prelarvae, a larva and fry. Phase I includes 4 stages: Stage I - from the time of fertilization to the beginning the embryonic shield formation; Stage II - from the embryonic rod formation to the time of separation of the postanal part from the yolk sac surface. Stage III - from the postanal part isolation to the time when the body of the embryo may occupy the entire periphery of the yolk and Stage IV - from the yolk occupation to the emergence time. The prelarval phase lasts from the emergence time to the time of a complete yolk sac resorption. The larval phase occupies the period from the yolk sac resorption to the end of metamorphosis. The fry phase covers the time from the end of metamorphosis to the maturity time.

HERRING Clupea harengus harengus Linnè

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 embryo development (from fertilization to hatching) are given below.

Temperature, average	Days		
0	50	Seliverstov 1972;	Williamson, 1910
3,5	49	Mayer, 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 embryo-development 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

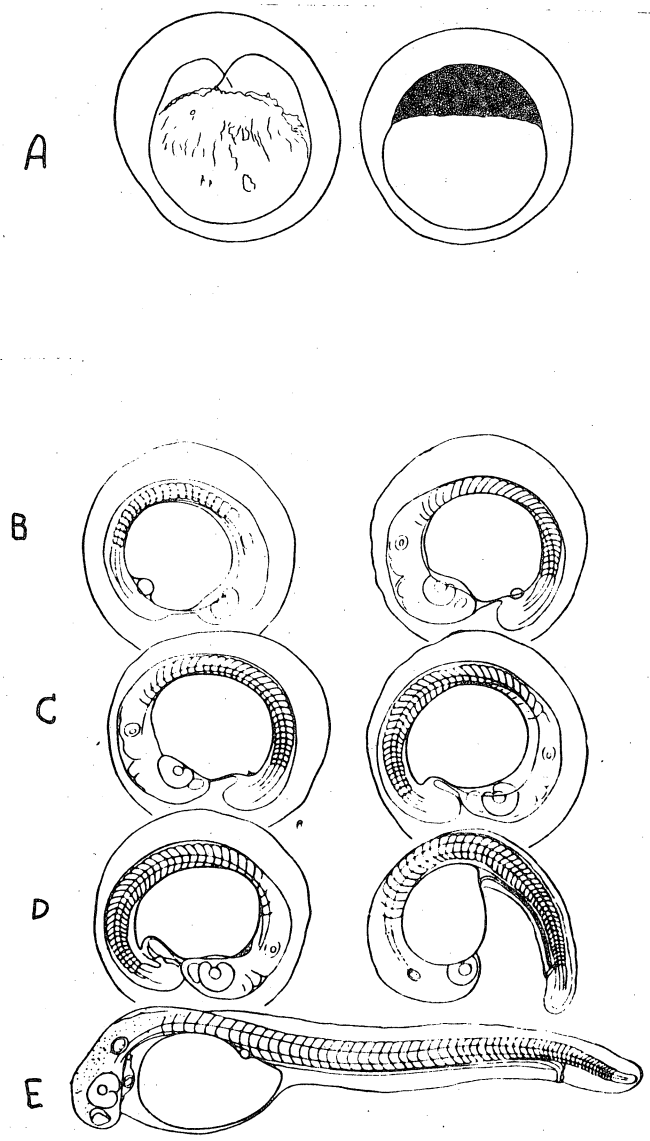


Fig.1. Herring Clupea harengus
A- Early developmental stages, B, C, D, E - The caudal end of the embryo is raising from the yolk. (Kryjanovsky, 1956).

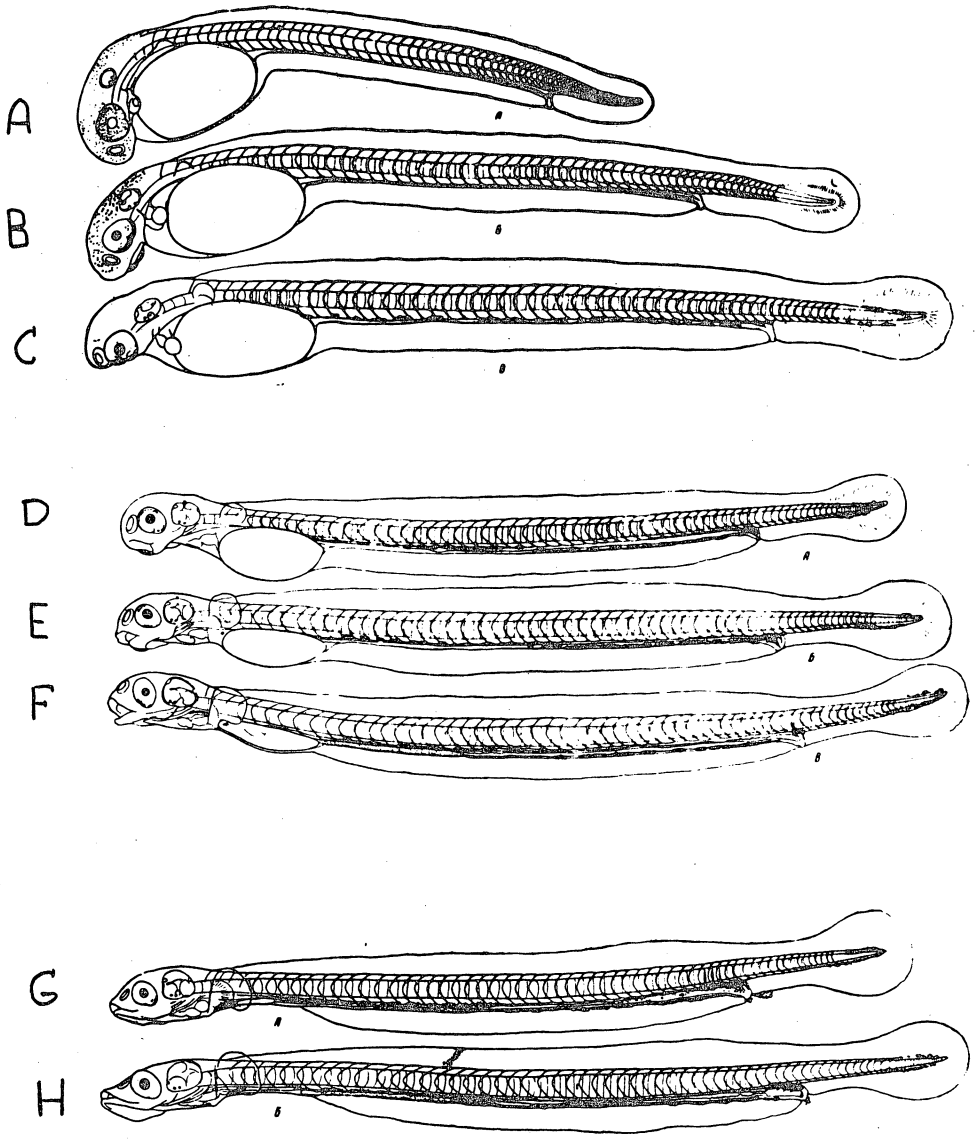


Fig.2. Herring Clupea harengus
A, B. The embryos artificially released from the egg membrane, 4.32 - 6.25 mm. C - prelarvae 6.62 mm 6 hours after hatching. D, E - prelarvae 7.48, 7.98 and 8.22 mm. 6.4 - larvae 7.32 and 7.95 mm 11 days after fertilization developing at 18°C. (Kryjhanovsky, 1956).

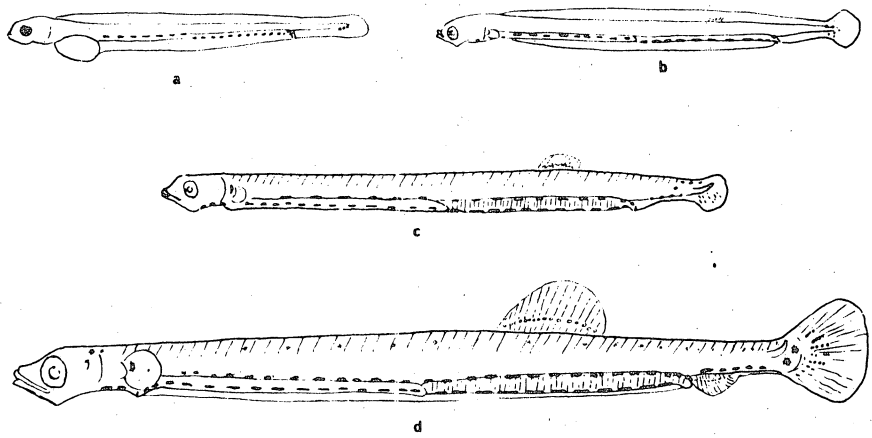


Fig.3. Herring Clupea harengus
a - newly hatched prelarvae 9.2 mm, b, c, d - 11.0, 14.5 and 22.0 mm larvae artificially reared. (Russel, 1976).

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; the beginning of the fry phase

48-50 mm - metamorphosis Fig 1-3.

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

CAPELIN, Mallotus villosus villosus Müller

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 carotenoid 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 blastodise 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 lowar 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. Fig 4-5.

Rass, 1949

Pozdnyakov, 1960

Fridgeirsson, 1976

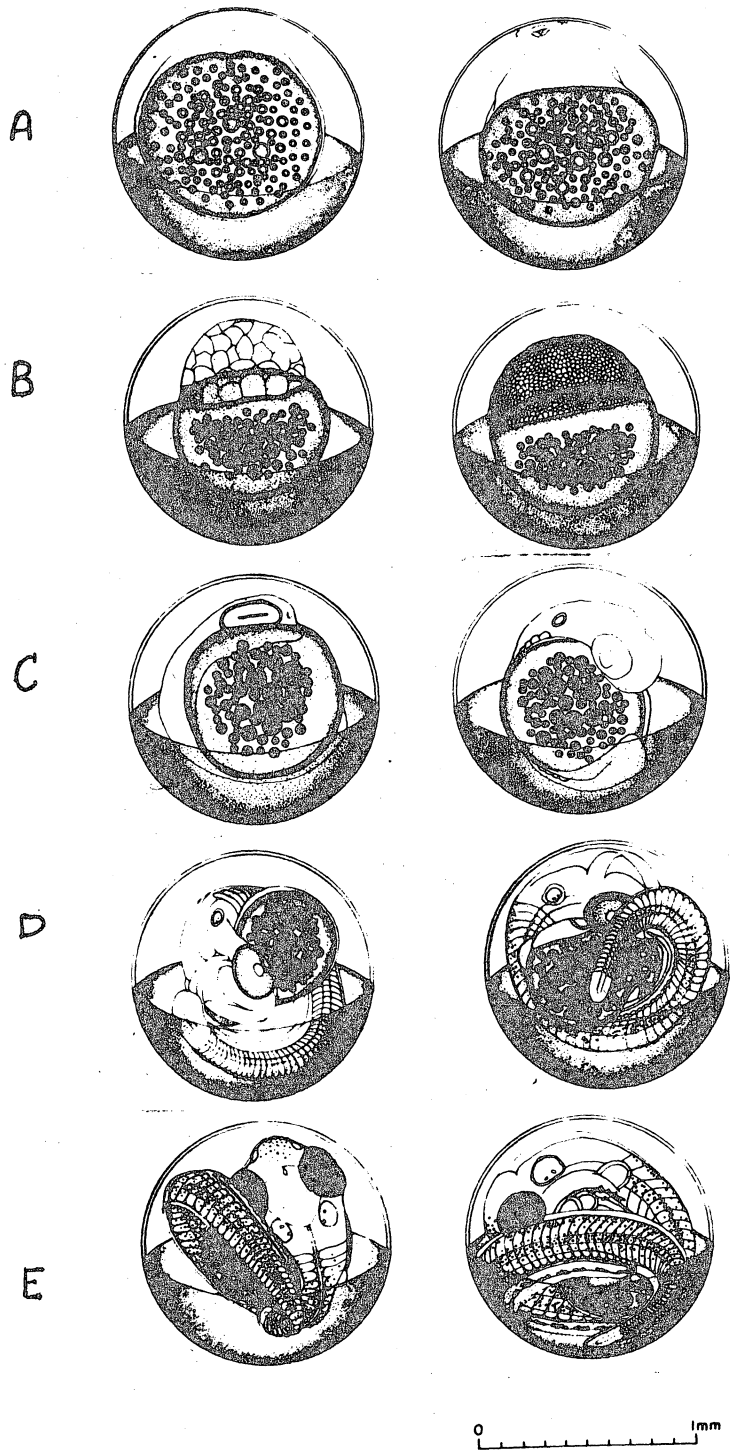


Fig.4. Capelin Mallotus villosus villosus.
Egg development: A, B - Stage I, C - Stage II,
D - stage III, E - Stage IV. (Fridgeirsson, 1976).

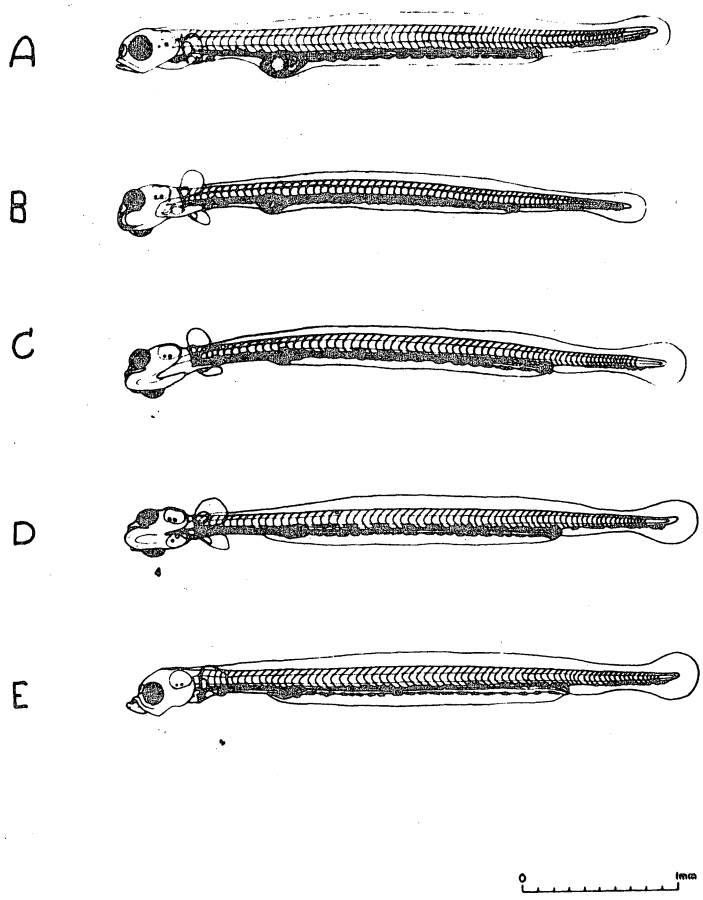


Fig.5. Capelin Mallotus villosus villosus
Prelarvae: A,B - 7.2 mm, C - 7,7 mm, D - 7.7 mm,
Larva: E - 7,7 mm (Friedgeirsson, 1976).

ATLANTIC ARGENTINE, ARGENTINA SILUS ASCANIUS

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 reddish 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 elongated, 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 myomers in the anus region when the prelarvae have reached the length of 8.0 mm. The second aggregation of melanophores develops near the last cauded myomers 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 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

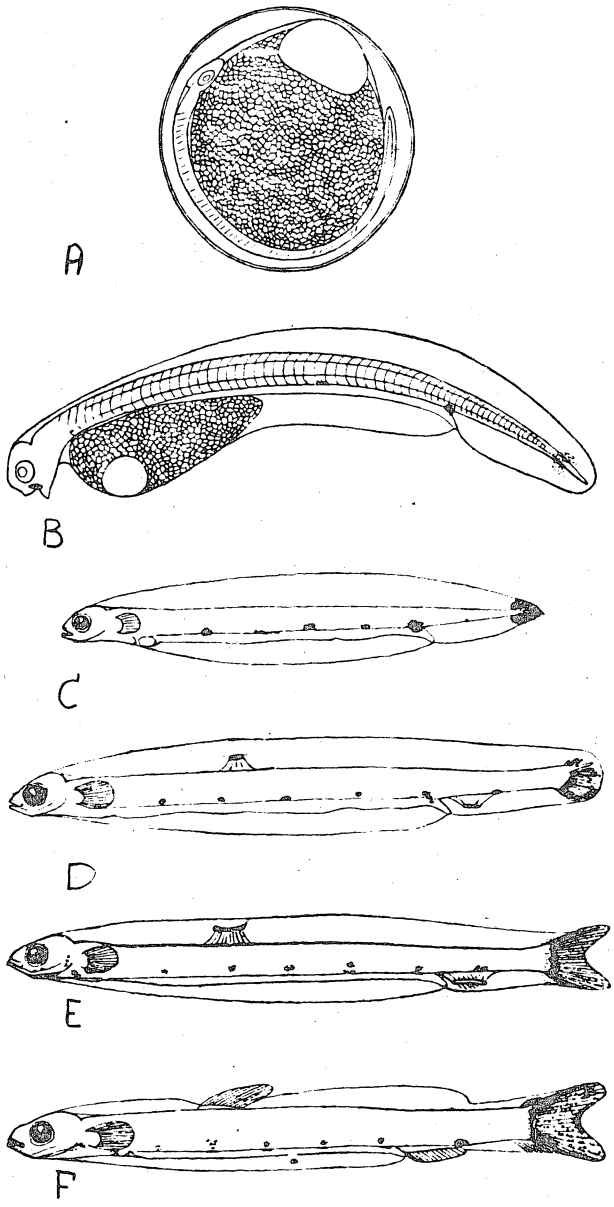


Fig.6. Great silver smelt Argentina silus. A - egg, B - prelarva 12,0 mm, C, D, E, F - larvae 17.7, 28.0, 35.5 and 45.0 mm) (Schmidt, 1906).

at a length of 50 mm and the ventral fins are present below the dorsal fin base. Fig 6.

Schmidt, 1906.

CYCLOTHONE BRAUERI YESPERSEN AND TÄNING

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 [illegible] opens at the remnants of protopterigium, the head is about 8 times into 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. Fig 7.

Jespersen et Täning, 1926.

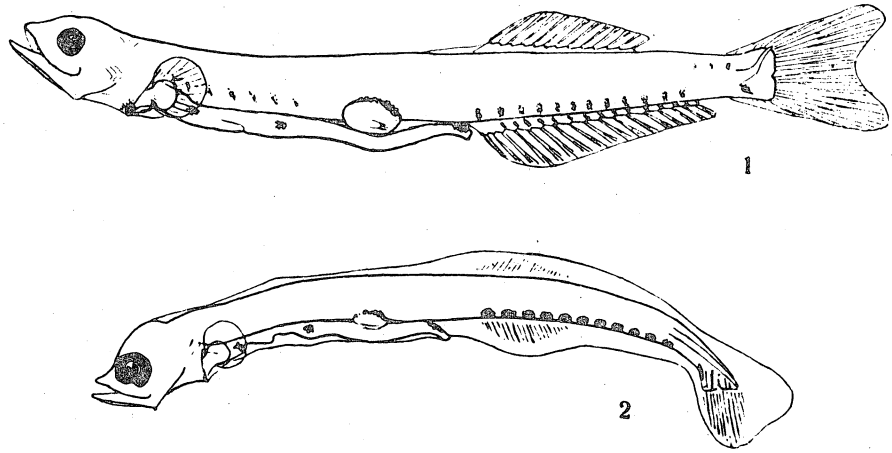


Fig.7. Cyclothone braueri
Larvae 13.7 mm (I) and 4.8 mm (2). (Jespersen and Taning, 1926).

NOTOLEPIS RISSOI KROYERI (LUTKEN)

Eggs unknown.

Larvae are 9.5-45.0 mm long and of the sudid type. At the length of 9.5 mm protopterygium and pectoral fins are present, unpaired fins are lacking, the preanal partion constitutes 32.5-33.7% of the body length. Larvae are transparent with

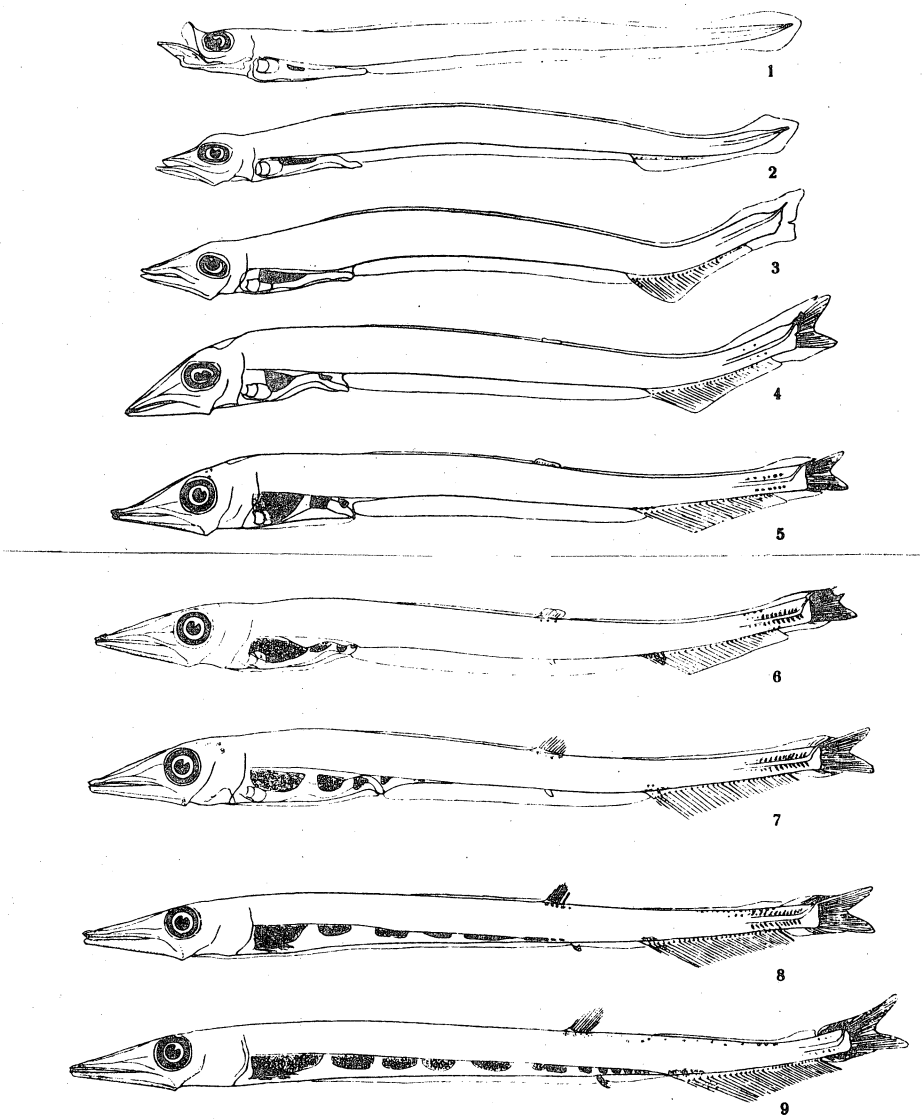


Fig.8. Notolepis rissoi krogeri
Larvae and larbajuvenus: 1-9.5 mm, 2-13.0 m.
3- 18.0 mm, 4-20.5 mm, 5 - 23.0 mm, 6-28.0 mm,
7- 30.0 mm, 8-38.0 mm and 9 - 45.0 mm (Ege, 1931).

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 elongated at early stages and becomes of the typical adult form at the larval length of 18-20mm.

Figs. Ege, 1931.

CUSK, BROSME BROSME

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, 0.23-0.30 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 cell become large 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 above the gut and on the dorsal part of the body and 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 pig--mented, 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 dorsal 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.

Fig 9.
Russel, 1976.

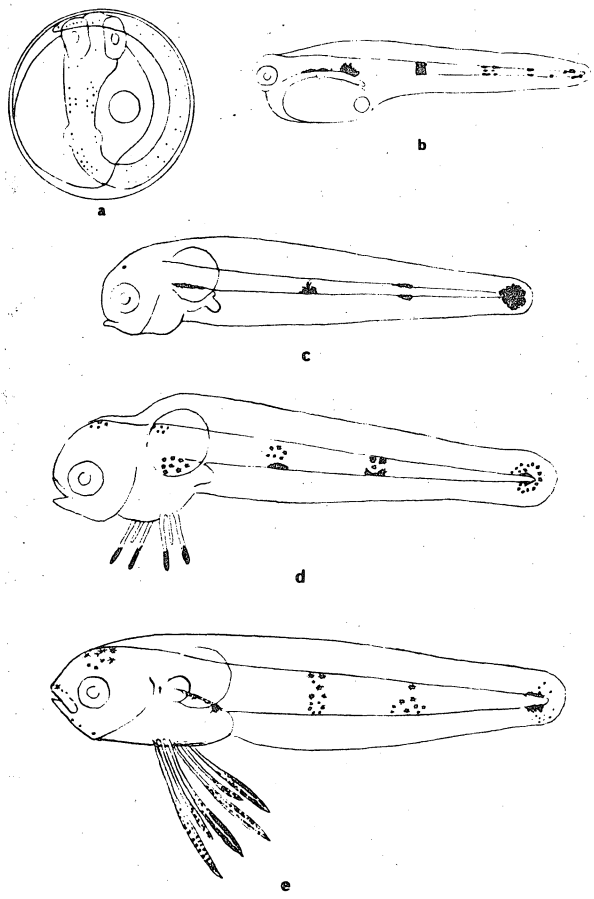


Fig.9. Ling Brosme brosme
A- egg 1.1 mm in diameter (McIntosh, 1892)
B - prelarva 4.1 mm (McIntosh, 1892), C,D,E - larvae 5.0, 6.8 and 10.5 mm (Schmidt, 1905).

FOURBEARD ROCKLING, ENCHELIOPUS CIMBRIUS (LINNE)

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 had 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. 10-11.

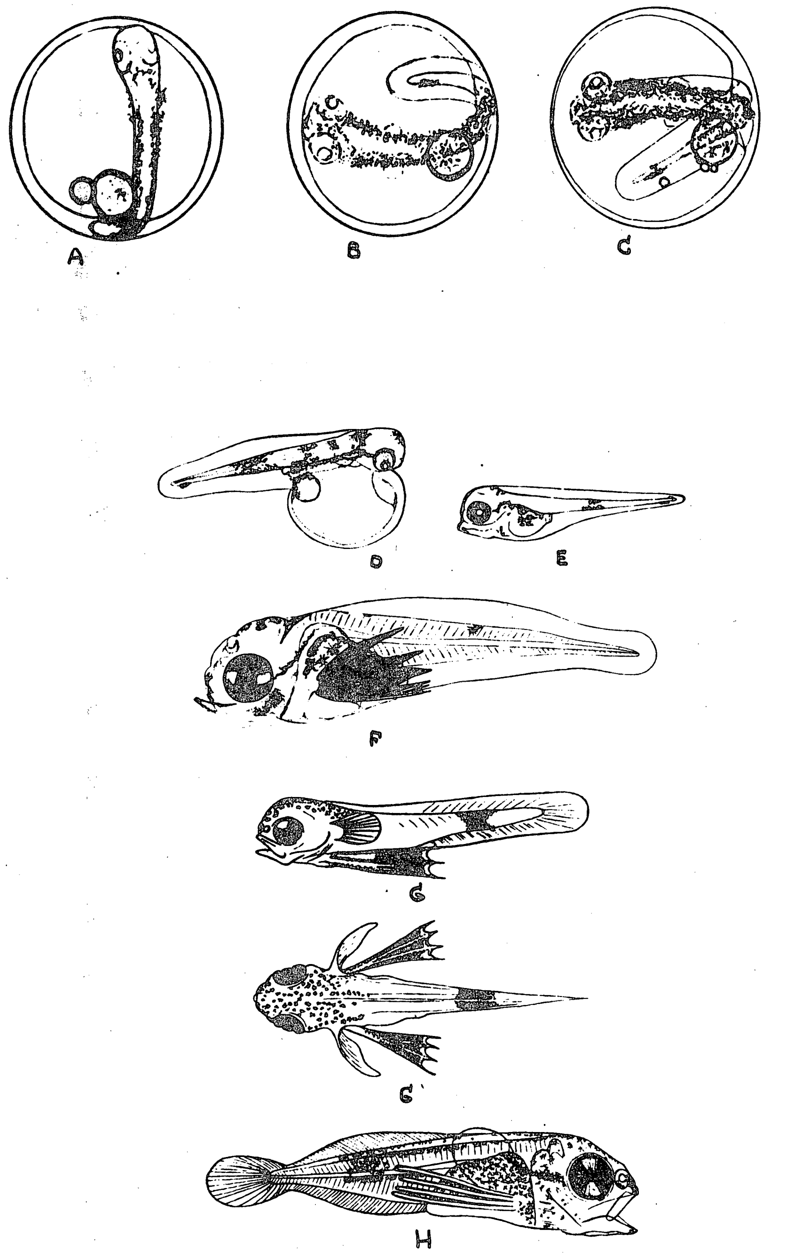


Fig.10. Four-beard rockling Enchelioppus cimbrius A,B,C - eggs, D-prelarva 2.15 mm, E,F,G,H - larvae 2.75, 3.65, 5.3 and 9.0 mm. (Ehrenbaum, 1905-1909).

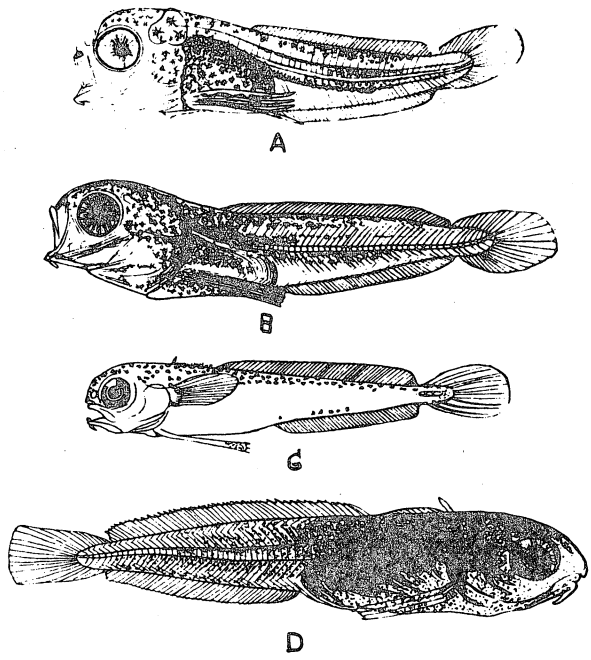


Fig.11. Four-beard rockling Enchelíopus cimbrius Larvae and larvajuvenus: A - 10.0 mm, B-13.8 mm, C-17.5 mm, D-22.0 mm. (Ehrenbaum, 1905-1909).

RED HAKE UROPHYCIS CHUSS (WALBAUM)

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 mesencephalon and two caudal groups of melanophores on the ventral and dorsal sides, one above the other.

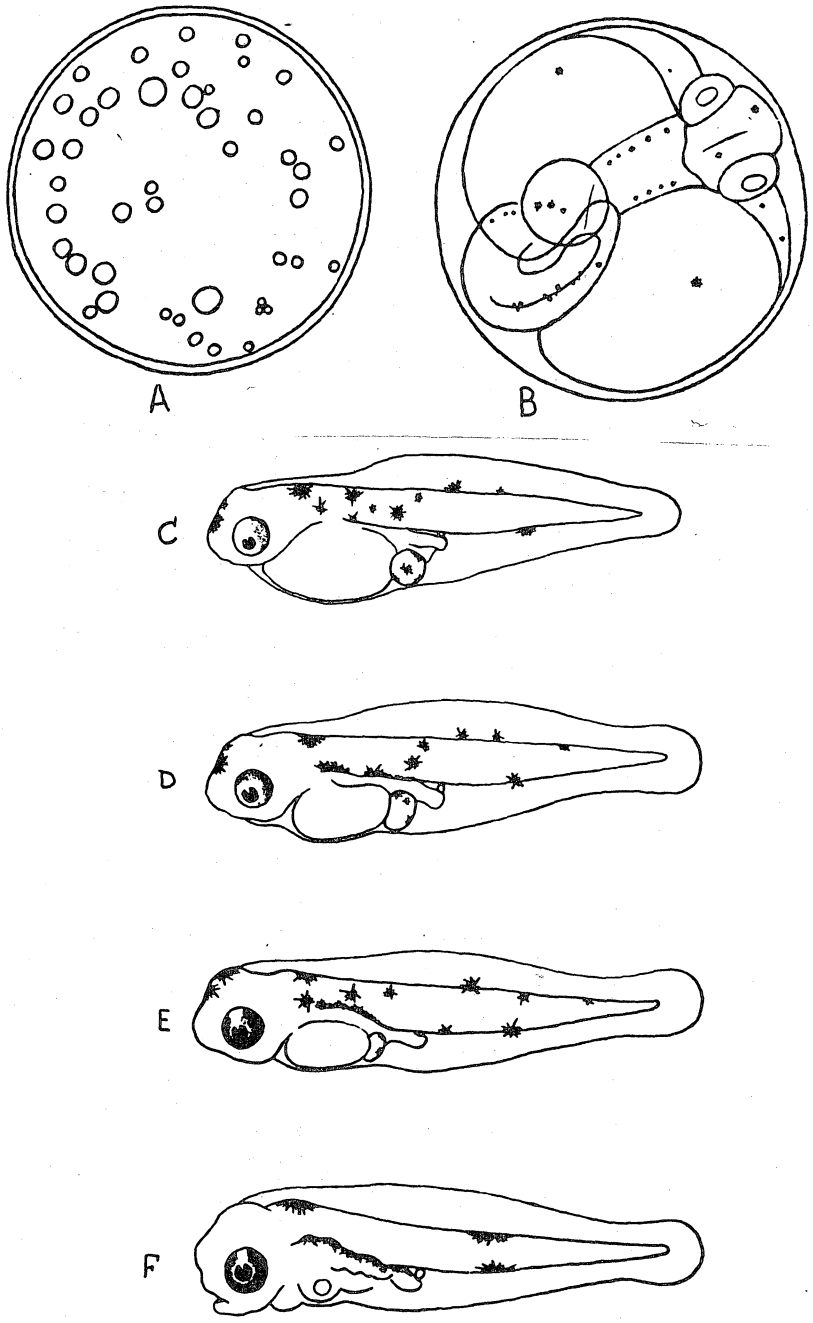


Fig.12. Red hake Urophycischuss
A,B - eggs, C,D,E,F - prelarvae 2.1 mm - 2.22 mm long.
(Miller and Marack, 1959).

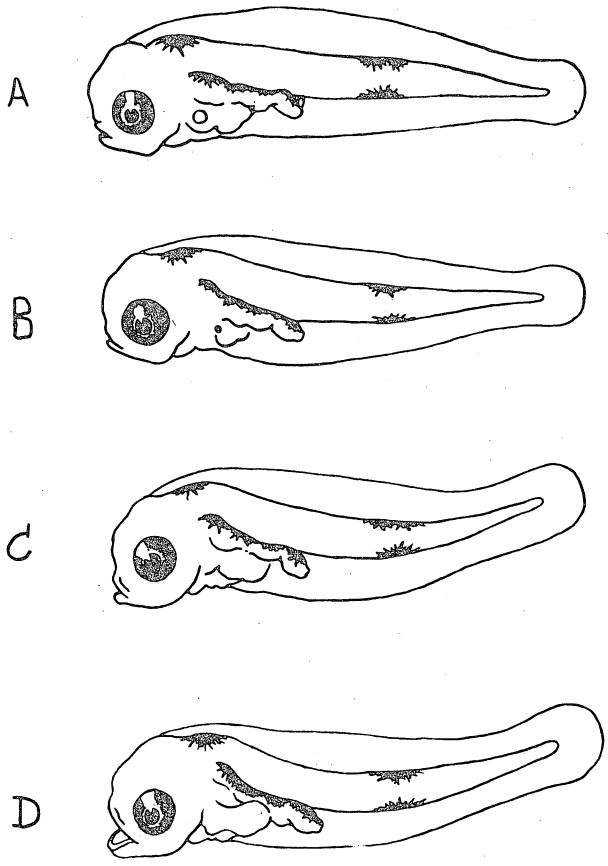


Fig.13. Red hake Urophycis chuss
A,B,C,D - larvae, 2.2. mm (Miller and Marack, 1959).

Larvae are 6.9-9.0 mm long; D begin 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 and in the number and length of fin rays in fry, at later stages. Fig. 12-14.

Bigelov and Schroeder, 1953.
Miller and Marack, 1959.

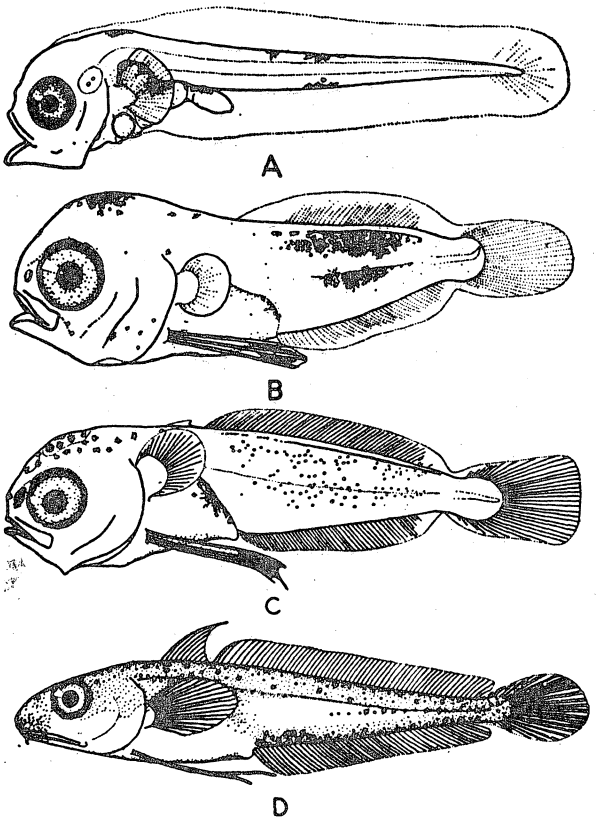


Fig.14. Red hake Urophycischuss
A - larva 2.2 mm, B,C - larvae 6.2 and 9.0 mm,
D - young fry 40.0 mm (Bigelow and Schroeder, 1953).

SPOTTED HAKE UROPHYCIS REGIUS (WALBAUM)

Eggs 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 hole 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

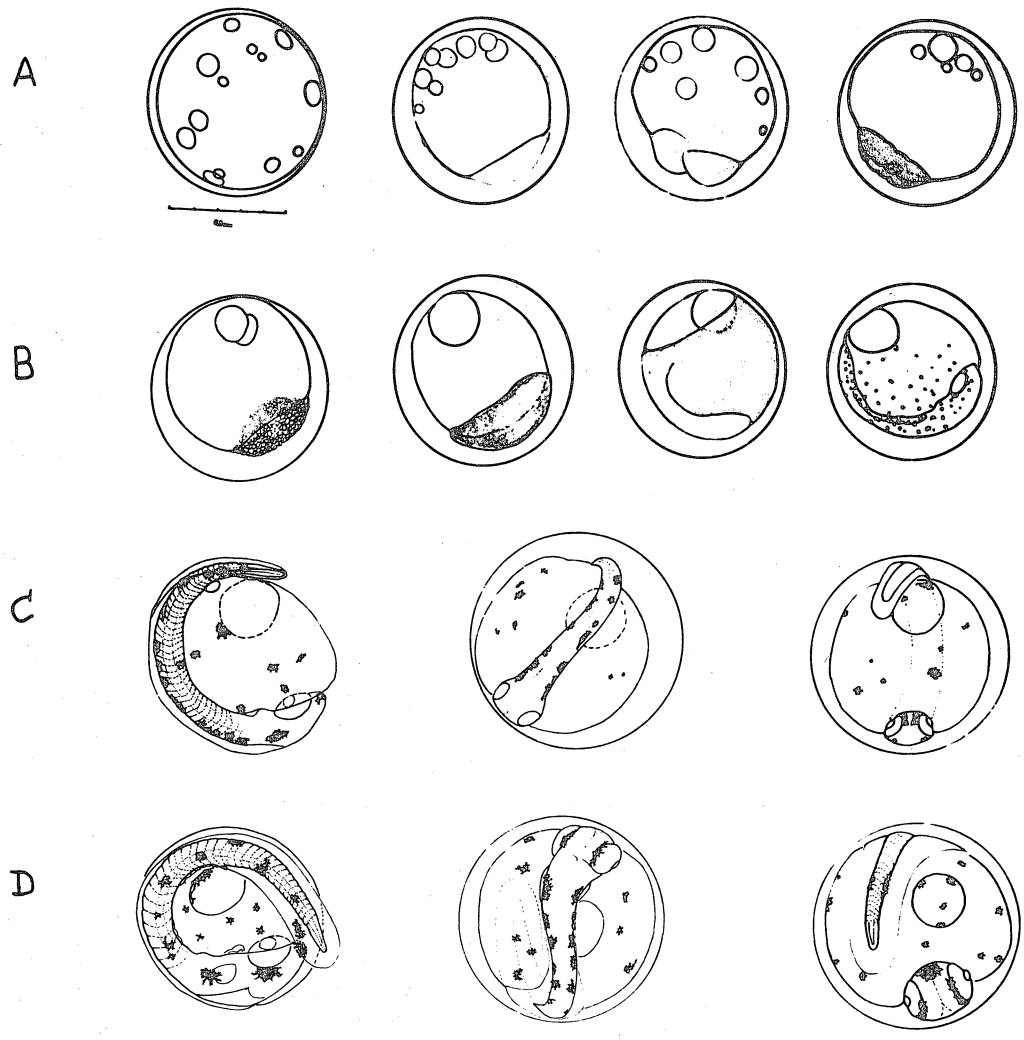


Fig.15. Spotted hake Urophycis regius
A, B, C, D - egg development Stages I, II, III, IV.
(Serebryakov, 1978).

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 myomers 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 the 26th- 28th myomer and weaker ventral pigmentation at the 27th-30th myomere.

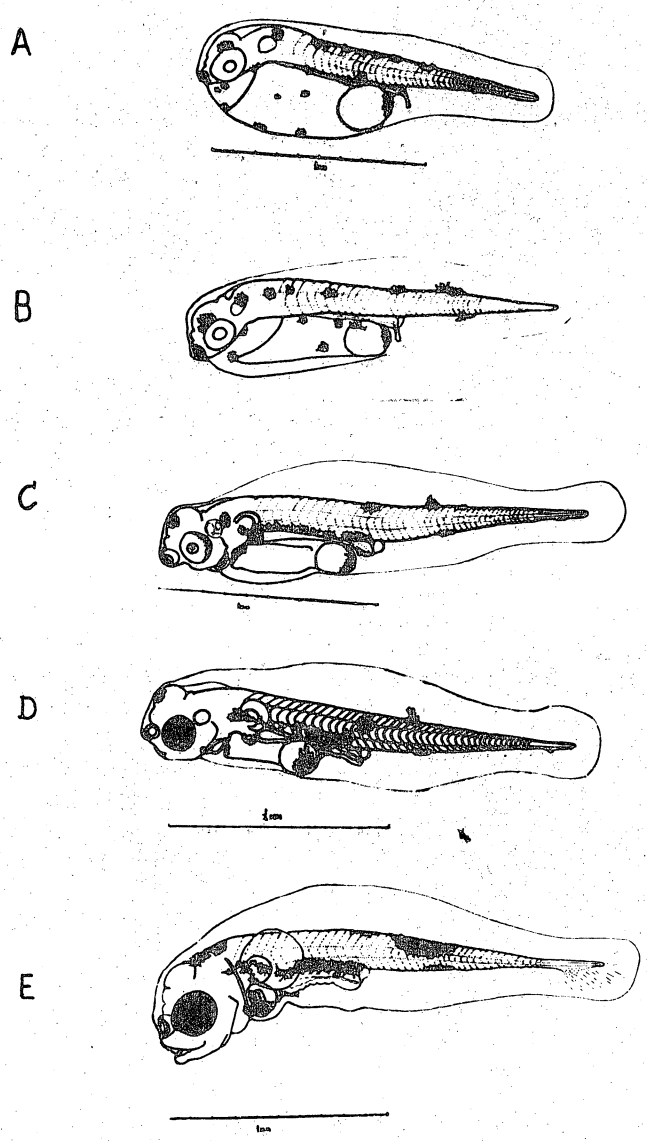


Fig.16. Spotted hake Urophycis regius
A - newly hatched prelarva 1.6 mm, B, C, D - prelarvae 1.83, 1.95 and 2.0 mm, E-larva, 2.25 mm (Serebryakov, 1978).

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. Fig. 15-16.

Serebryakov, 1978.

SILVER HAKE, MERLUCCIUS BILINEARIS MITHILL

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 4.42-8.00 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.

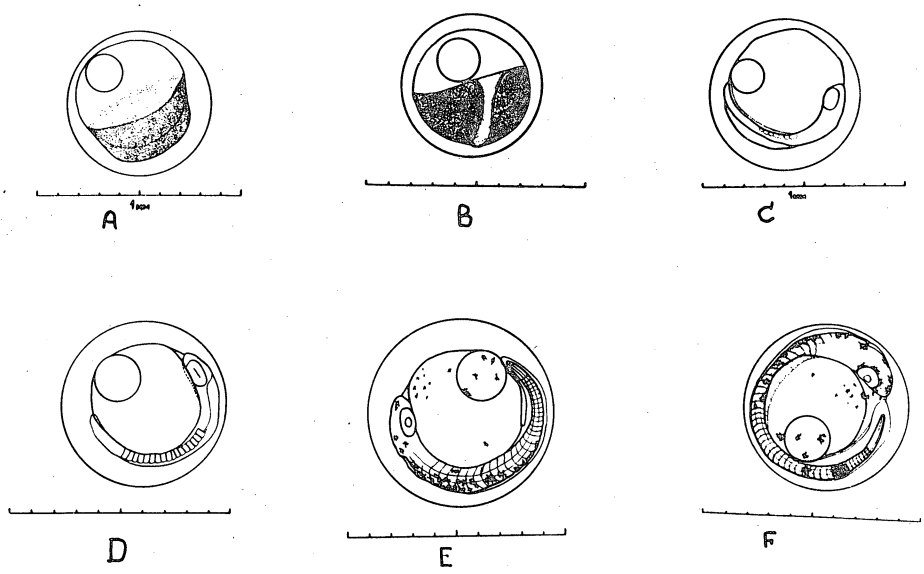


Fig.17. Silver hake Merluccius bilinearis
Egg development: A-Stage I, B,C,D - Stage II,
E - Stage III, F - Stage IV. (Sauskan, Serebryakov, 1968).

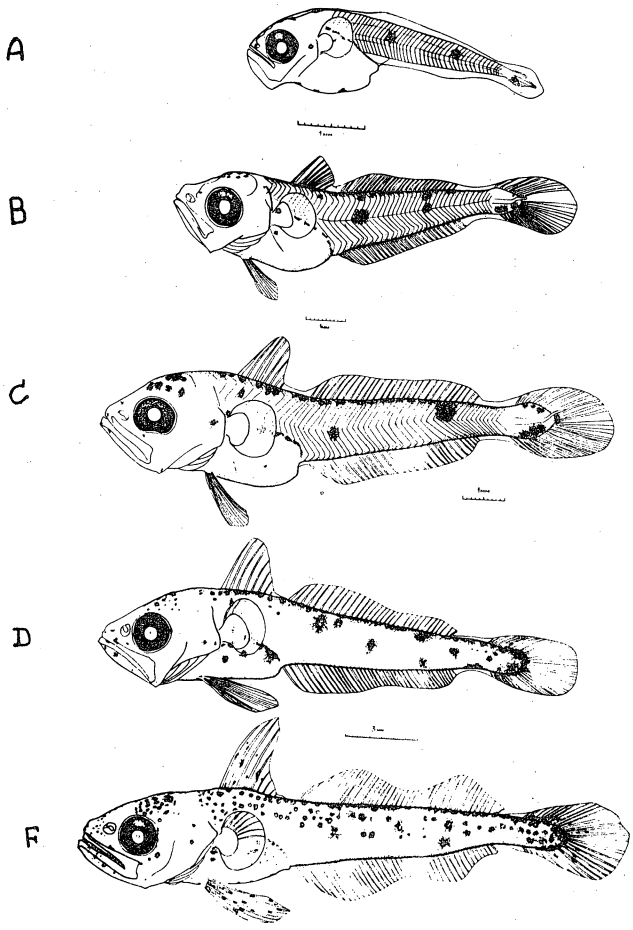


Fig.18. Silver hake Merluccius bilinearis
A - prelarva, 4.42 mm, B, C, D - larvae 9.93, 12.5 and 15.3 mm, E - young fry 22.5 mm (Sauskan, Serebryakov, 1968).

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.

Fig.17-18.

Sauskan, Serebryakov, 1967

POLLOCK, POLLACHIUS VIRENS (LINNE)

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. Fig. 19-21.

McIntosh and Masterman, 1897.
Ehrenbaum, 1905-1909.
Russel, 1975
Schmidt, 1905.

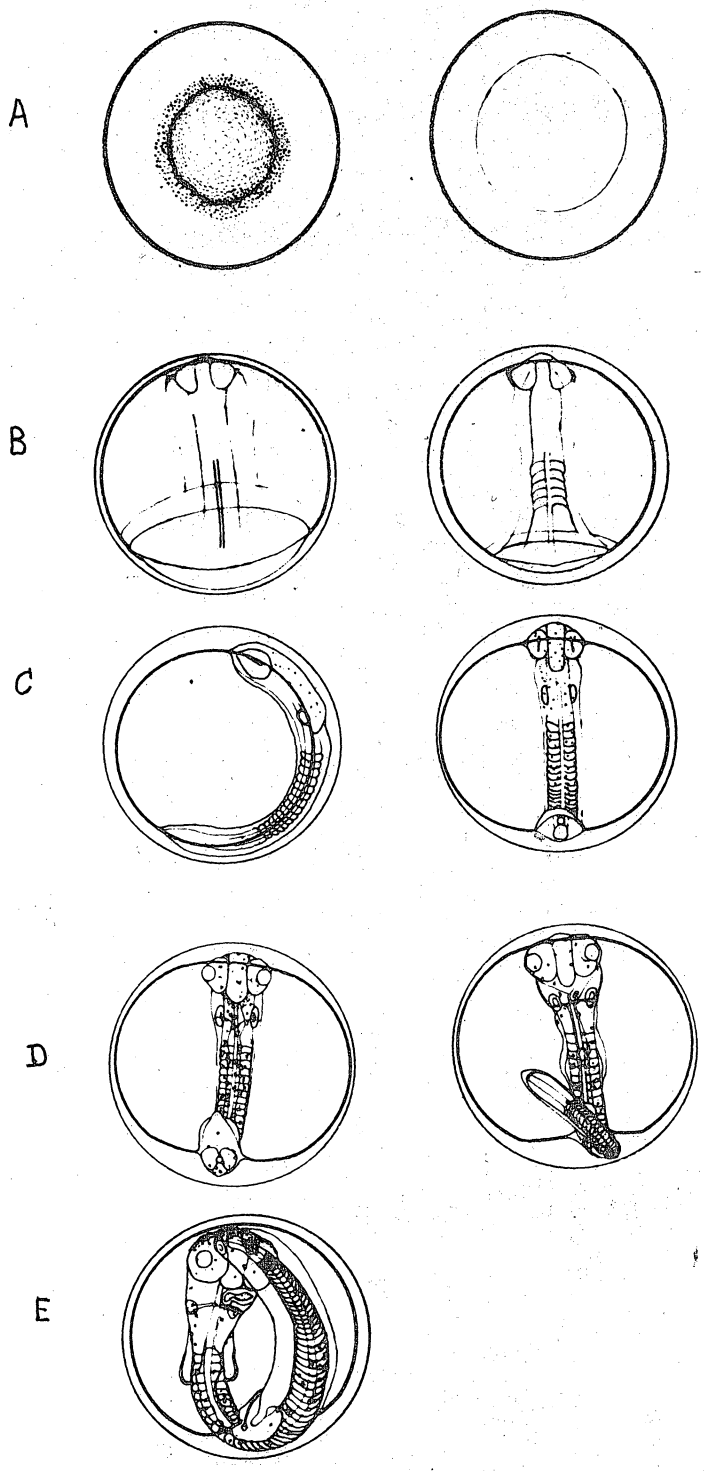


Fig.19. Pollack Pollachius virens
Egg development: A - Stage I, B - Stage II, C, D - Stage III, E - Stage IV. (Friedgeirsson, 1978).

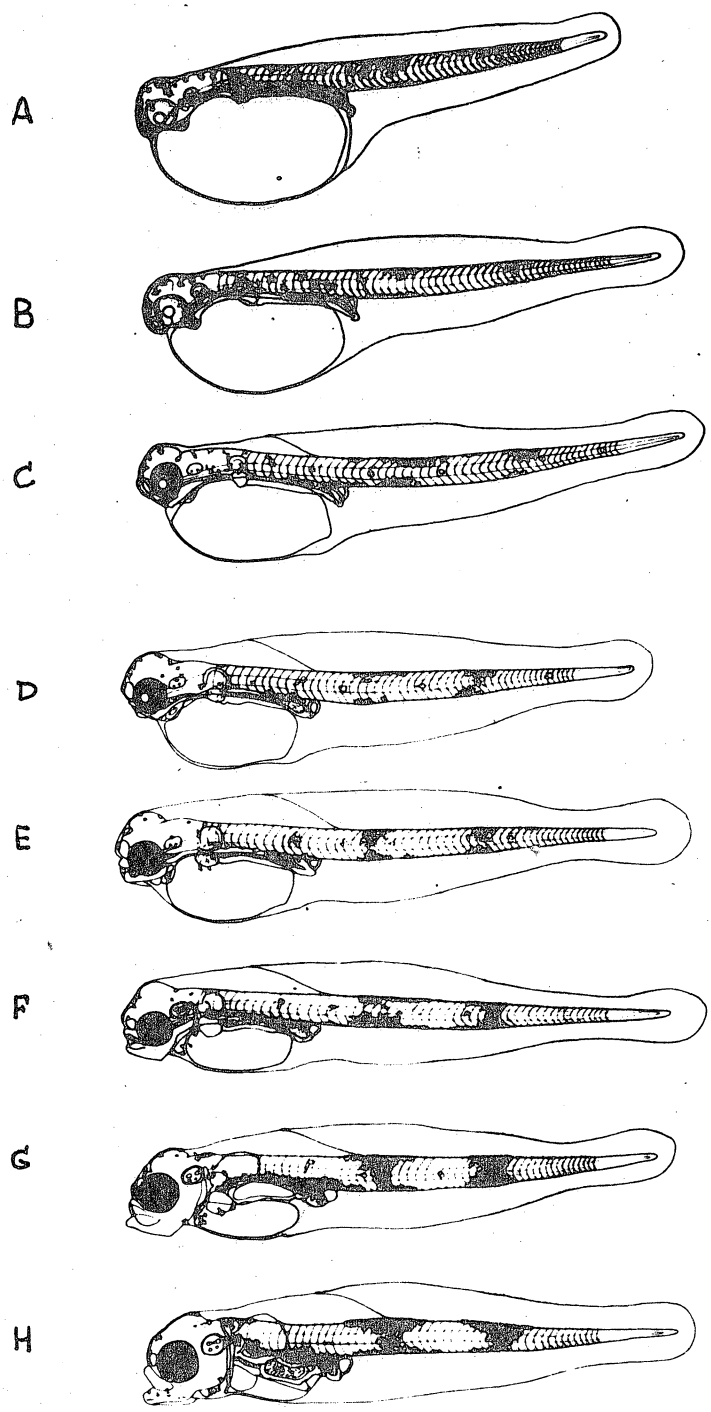


Fig. 20. Pollack Pollachius virens
A - prelarva 2 days after hatching, B,C,D,E,F - prelarvae 4.5, 4.7, 4.8 mm and 5.0 mm G - Start of active feeding, 5.0 mm, H - larva 5.0 mm 10 days after hatching (Friedgeirsson, 1978).

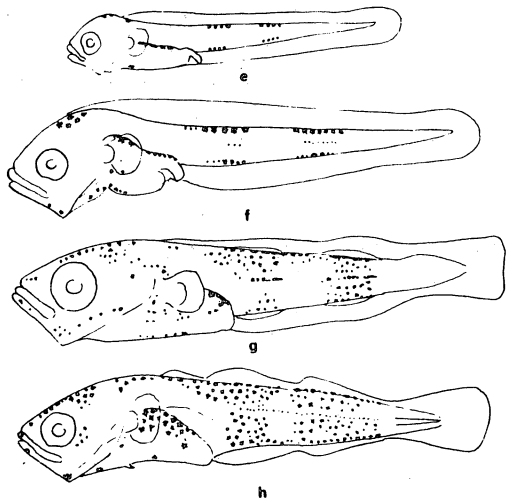


Fig.21. Pollack Pollachius virens
A, B, C, D - larvae 4.0, 7.0, 11.0 and 14.0 mm
(Russel, 1976).

HADDOCK MELANOGRAMMUS AEGLEFINUS (LINNE)

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.

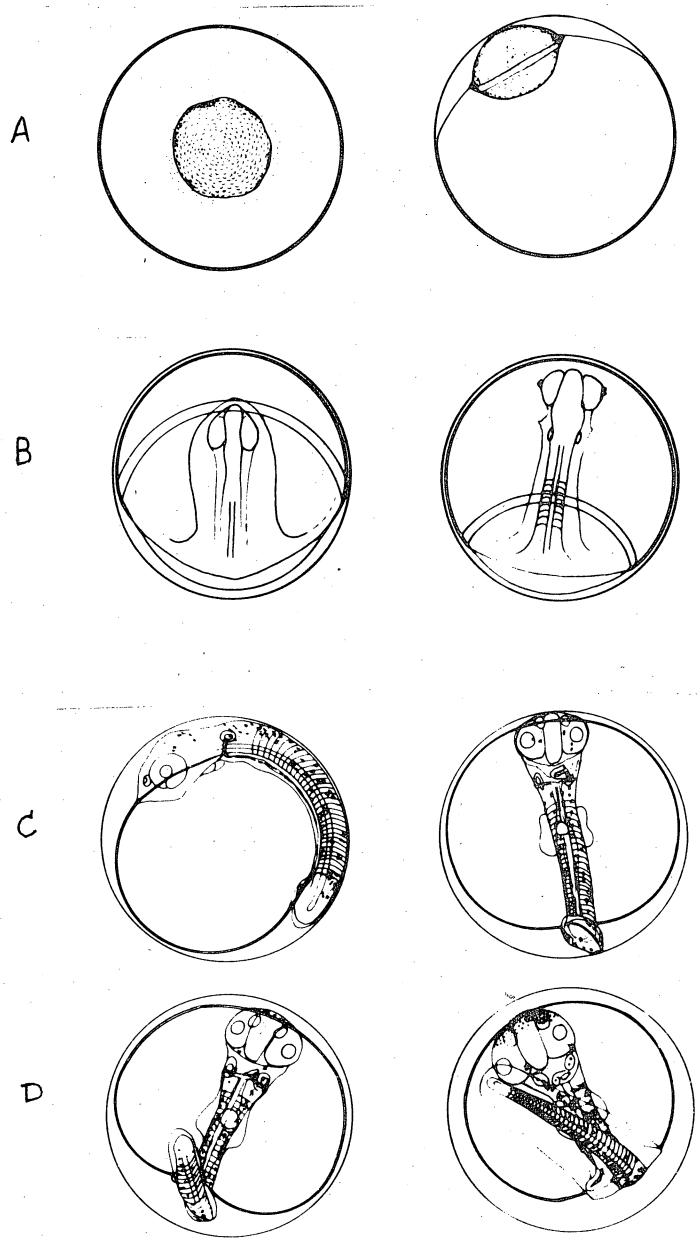


Fig.22. Haddock Melanogrammus aeflefinus. Egg development: A - Stage I, B - Stage II, C - Stage III, D - Stage IV. (Friedgeirsson, 1978).

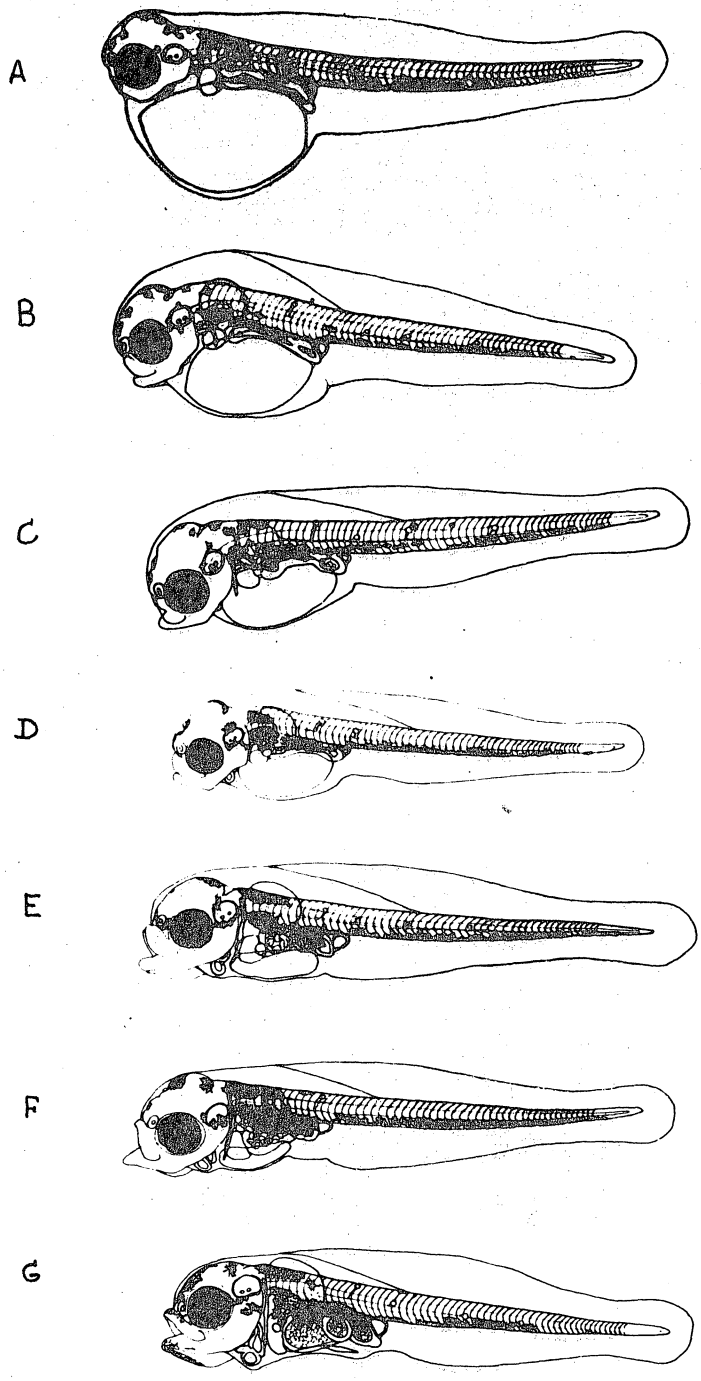


Fig.23. Haddock Melanogrammus aeglefinus
A,B,C,D and E - prelarvae 1, 2, 3, 4 and 5 days after hatching, F - larvae 15,2 mm 6 days after hatching, H - larvae 5.2 mm 10 days after hatching, Temperature - 7.2°C, salinity - 29.5‰ (Friedgeirsson, 1978).

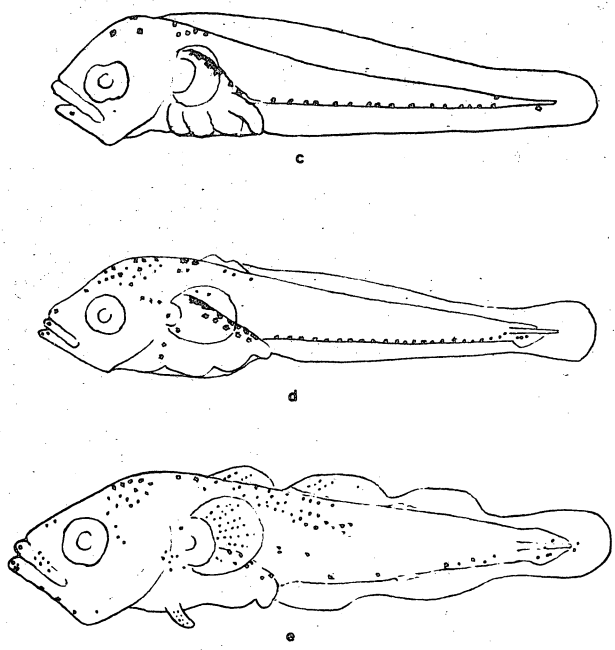


Fig.24. Haddock Melanogrammus aeglefinus. Larvae: A - 6.0 mm, B - 8.8 mm, C - 13.0 mm. (Russel, 1976).

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. Fig. 22-24.

Raas, 1949

Schmidt, 1905

Ehrenbaum, 1905-1909

Russel, 1976

Fridgeirsson, 1978

C O D , GADUS MORHUA MORHUA LINNE

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 be 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 in between. The yolk sac is fully absorbed at lengths 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 ventral and dorsal rows of melanophores at a length of 9 mm. Fig. 25-27.

Pertseva, 1936
Rass, 1949
Schmidt, 1905
Ehrenbaum, 1905-1909
Russel, 1976.

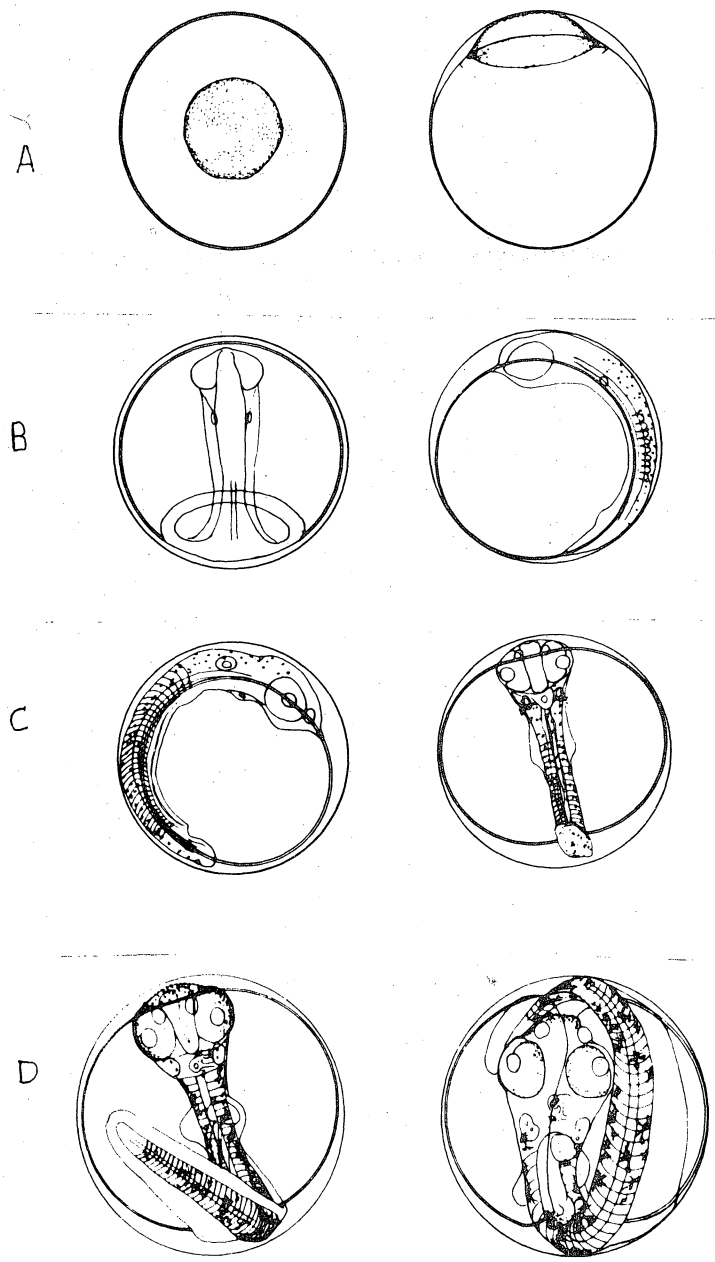


Fig.25. Cod Gadus morhua morhua
Egg development A - Stage I, B - Stage II, C - Stage III and D - Stage IV. (Friedgeirsson, 1978).

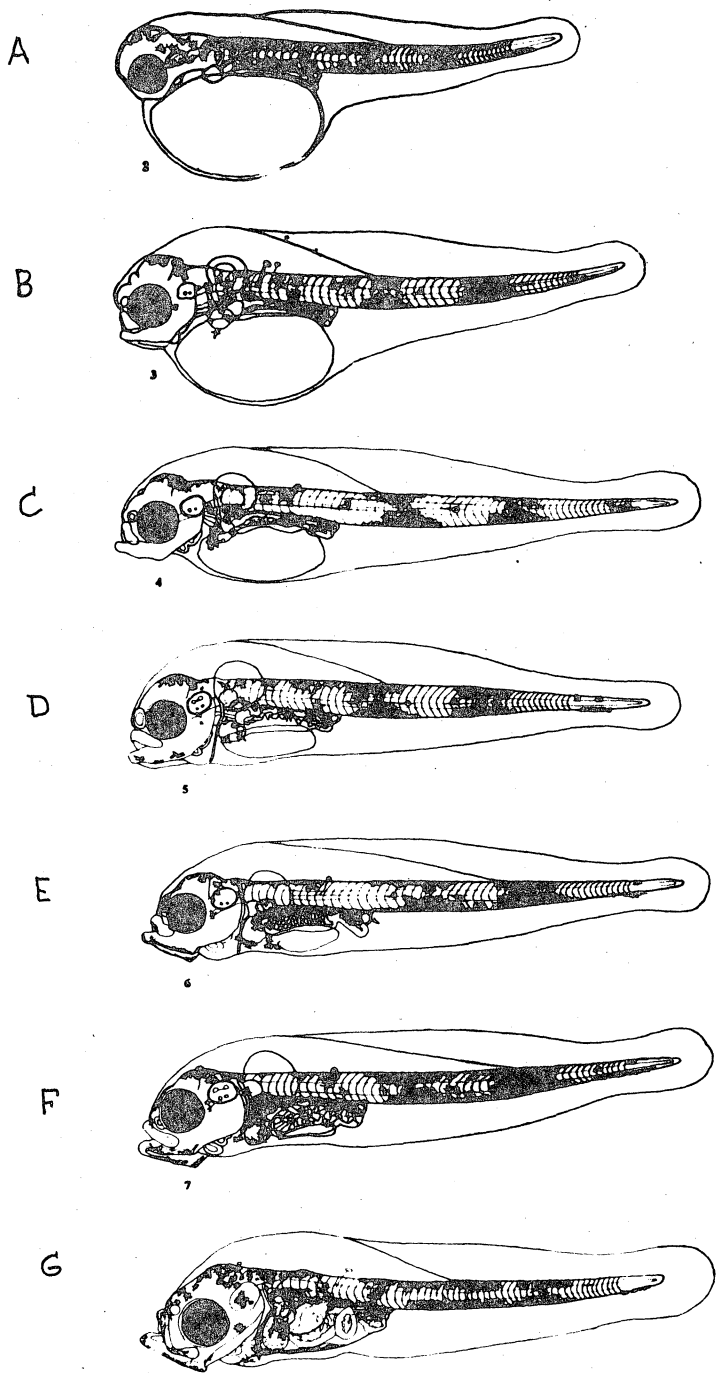


Fig.26. Cod Gadus morhua morhua
A,B,C - prelarva 1,2,3 days after hatching
D - the 4th day after hatching; mixed feeding; 5.8 mm. E - the 5th day after hatching; active feeding; F - the 6th day after hatching; 5.9 mm, G - 10 days after hatching; 6.0 mm (Friedgeirsson, 1978).

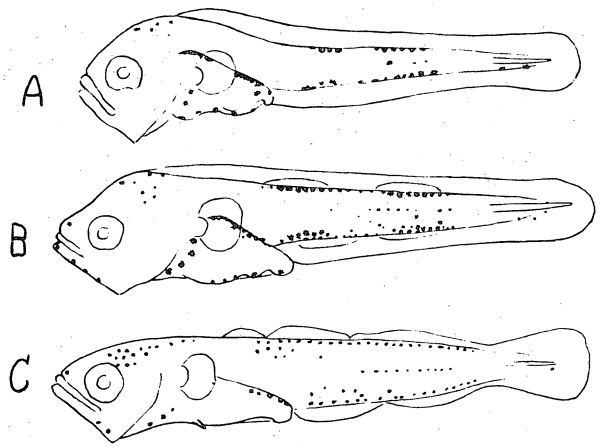


Fig.27. Cod Gadus morhua morhua
Larvae: A - 6.0, B - 8.0 and C - 12.5 mm (Russel, 1976).

NORTHERN WOLFFISH ANARHICHAS LATIFRONS STEENSTRUP ET HALLGRIMSON

Eggs are bottom, 7.25-8.0 mm in diameter, deposits are globe-shaped.

Prelarv al and larval stages seem to develop within the egg membrane.

The minimum length of fry taken in the pelagic areas is 25.0 mm. No remnants of yolk sac are viseble. There are 77 rays in D, 47 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. Fig. 28.

Barsukov, 1959.

SPOTTED WOLFFISH ANARHICHAS MINOR OLAFSEN

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, $\frac{77}{\vee}$ in D, $\frac{47}{\vee}$ in A and in $\frac{19}{\vee}$ 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. Fig. 28.

Barsukov, 1959

McIntosh and Masterman, 1897.

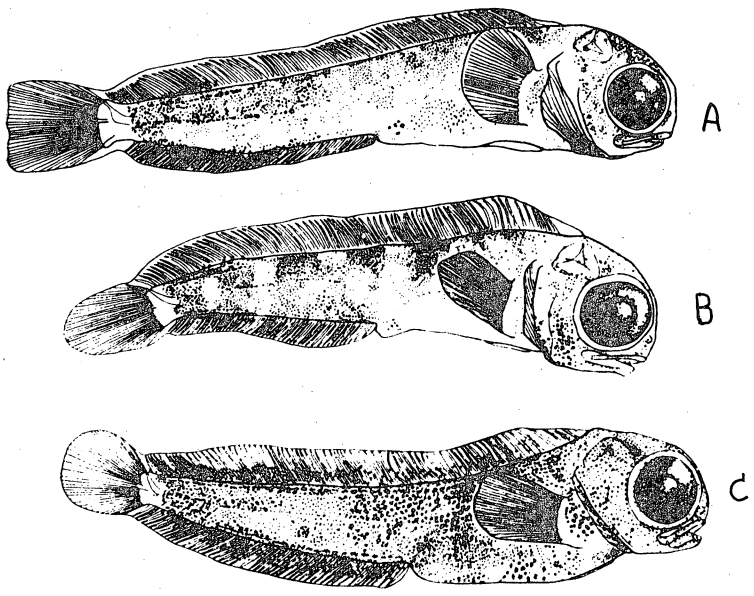


Fig.28. Wolffishes Anarhichadidae
A - Anarhichas lupus 25.0 mm. B - A minor 24.0 mm,
C - A. latifrons 25.0 mm (Barsukov, 1959)

ATLANTIC WOLFFISH ANARHICHAS LUPUS LINNE

Eggs 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 more (or sometimes equal to the length of the last ray of the anal fin. The number of caudal fin rays is 23 or over. Fig. 28.

Rass, 1949
Barsukov, 1959
McIntosh and Masterman, 1997.

SANDLANCE AMODYTES AMERICANUS DE KAY

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.

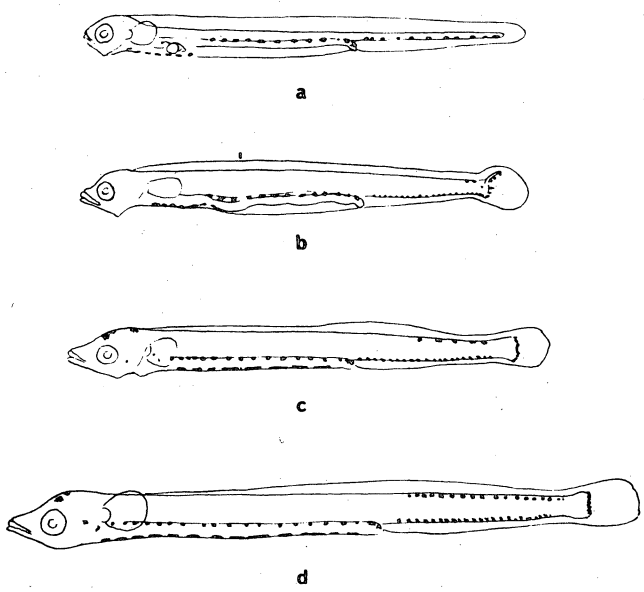


Fig.29. Sandlaunce Ammodytes marinus. A species clouse to Ammodytes americanus. Larvae: A-6.0, B-12.0, C-16.0 and D-21.0 mm (Russel, 1976).

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. Fig. 29.

Rass, 1949.

Russel, 1976.

MACKEREL, SCOMBER SCOMBRUS LINNE

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 pigment 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 prenal portion forms 46% of the total length. The

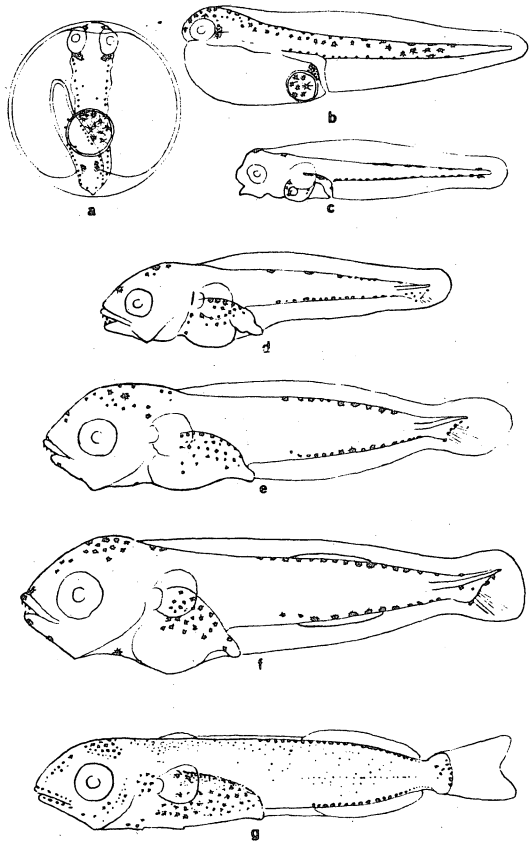


Fig.30. Mackerel Scomber scombrus
A - egg diameter 1.2 mm (Holt, 1893)
B - prelarva 2.4 mm (Holt, 1893),
C,D,E,F,G - larvae 3.7, 5.2, 7.0, 8.0 and 14.0 mm.
(Russel, 1976).

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 concaved when larvae are 14-15 mm long. Fig. 30.

Bigelow and Schroeder, 1953.
Russel, 1976.

BLUEFIN TUNA, THUNNUS THYNNUS (LINNE)

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 beyond 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 in 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 peritoneal 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. Fig.31.

Gorbunova, 1974.

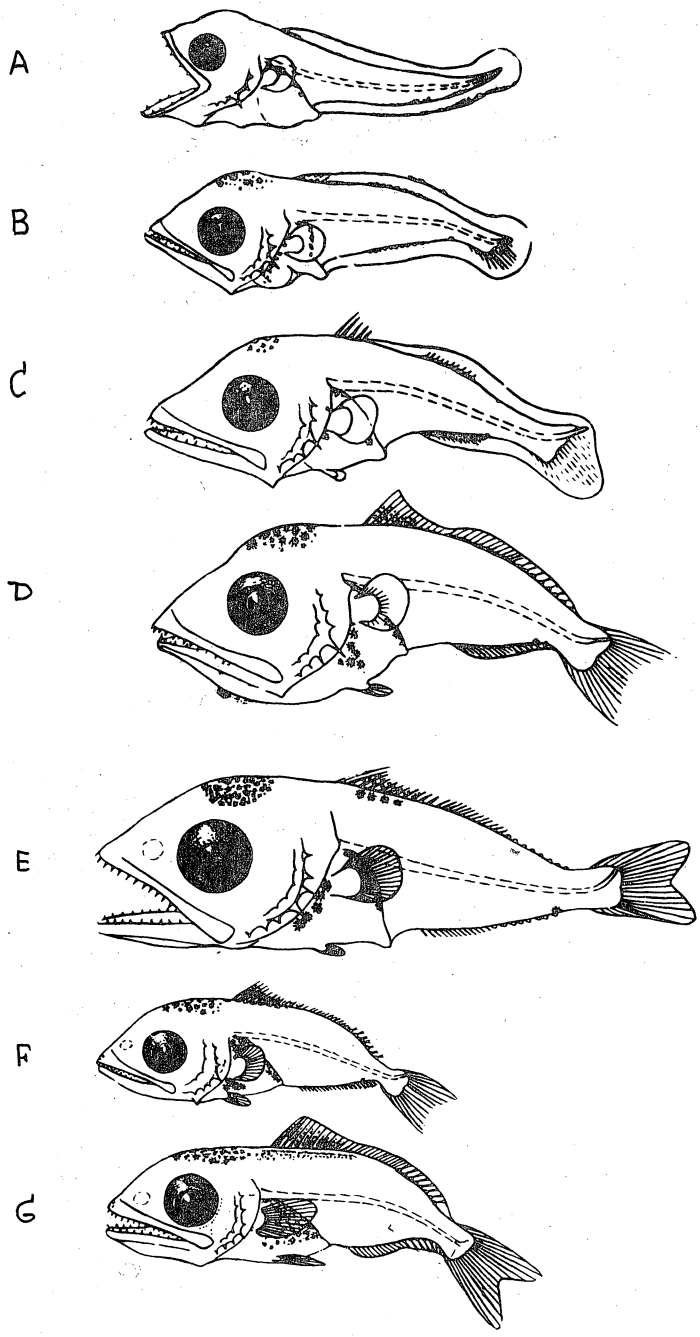


Fig.31. Bluefin tuna Thunnus thynnus
Larvae: A - 4.3, B - 4.75, C - 6.7, D -7.3,
E-9.0 and F-10.5 mm (Gorbunova, 1974).

LITTLE REDFISH, SEBASTES VIVIPARUS KROYER

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 0.70 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. Fig. 32-33.

Taning, 1961.

GOLDEN REDFISH SEBASTES MARINUS LINNE

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

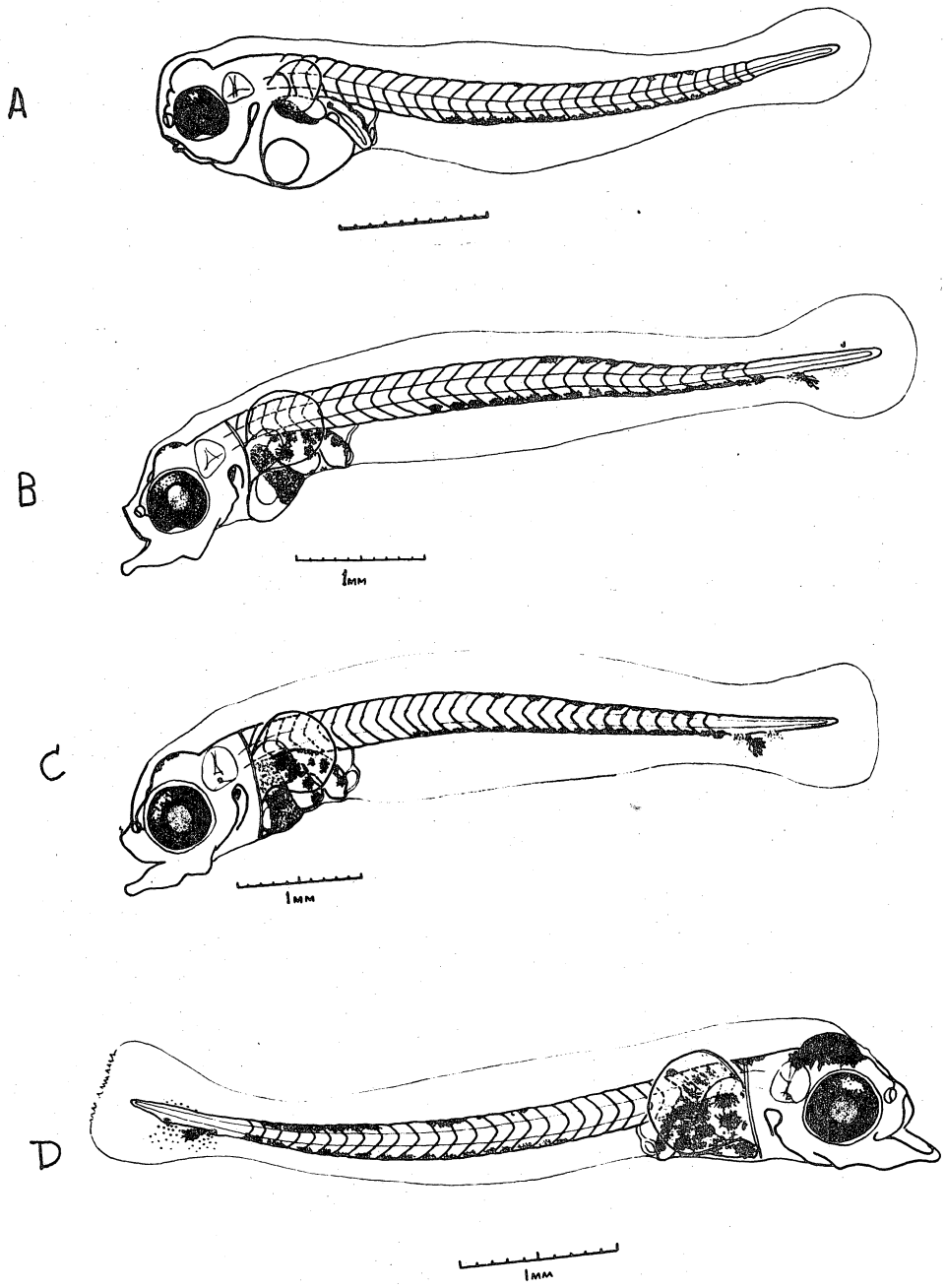


Fig.32. Little redfish
Sebastes viviparus. Prelarvae: A-4.3 mm preextrusion, B-6.2 mm 5 days after extrusion in aquaria, C- 6.15 mm 7 days after extrusion, D - 5.1 mm, 11 days after extrusion. No food was given.

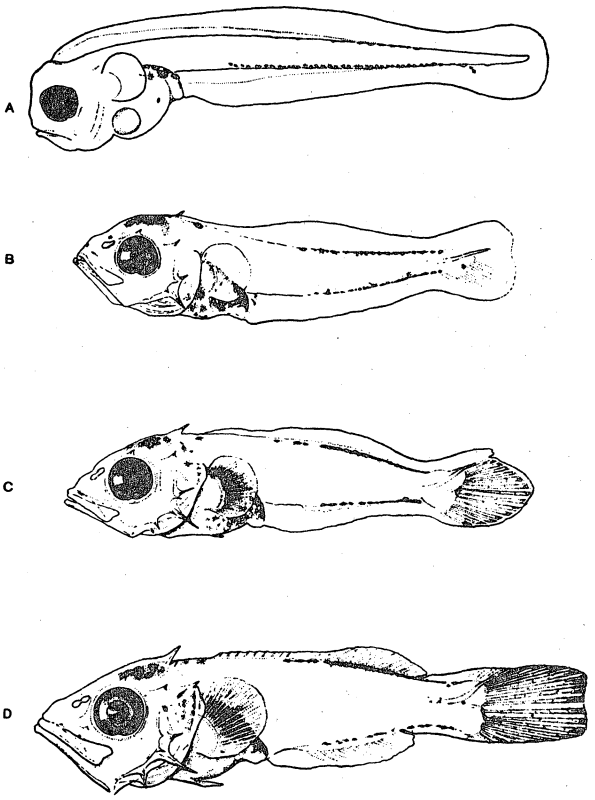


Fig.33. Little redfish Sebastes viviparus.
A - prelarva 5.8 mm before extrusion, 5.8 mm
B,C,D - larvae 8.9, 10.1 and 13.1 mm (Taning, 1961).

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 myotomes. 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-opperculum. 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. Larval 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. Fig. 34-36.

Taning, 1961.

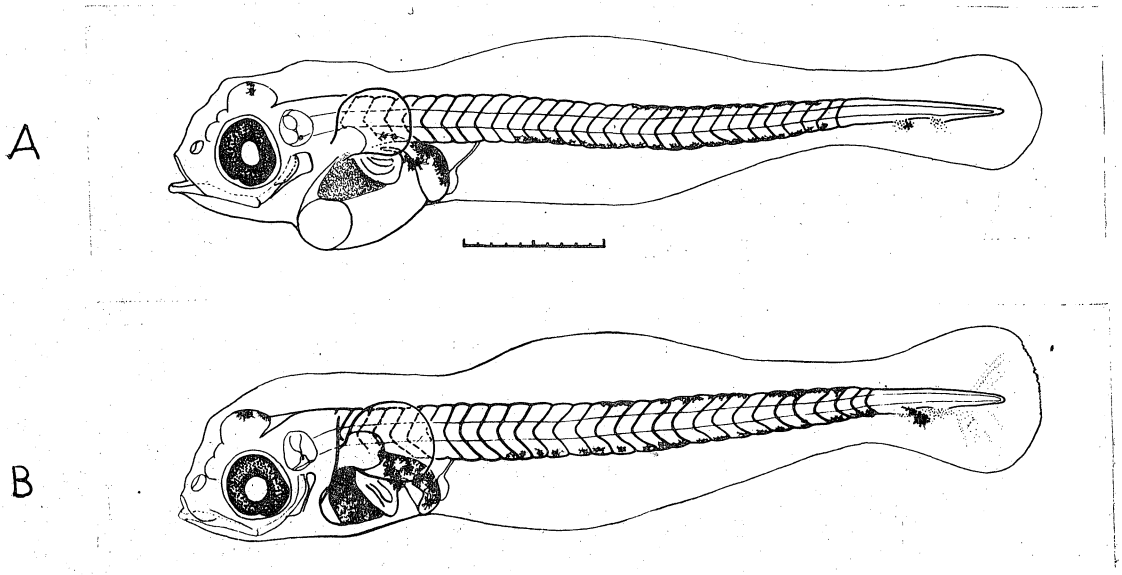


Fig.34. Redfish Sebastes marinus
Prelarvae begore extrusion: A - 6.25, B-7.19 mm.

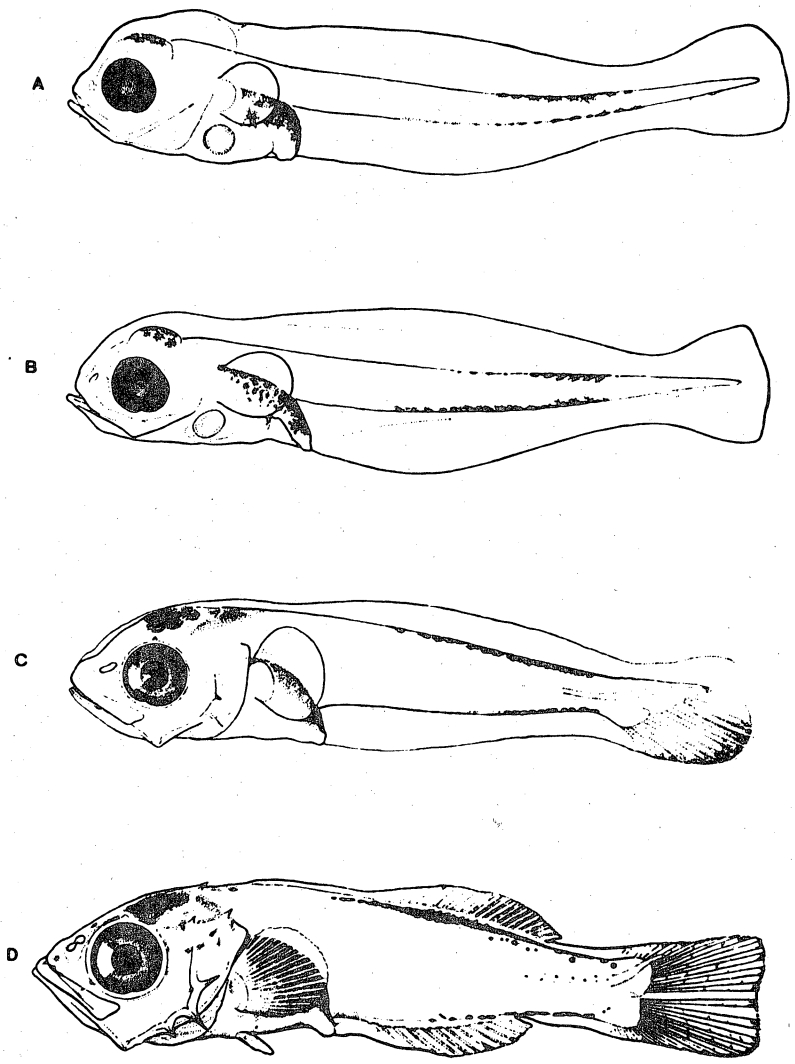


Fig.35. Redfish Sebastes marinus
A - 6.7 prelarva before extrusion
B,C,D - larva 7.4 mm, 10.5 mm, 15.7 mm (Taning, 1961).

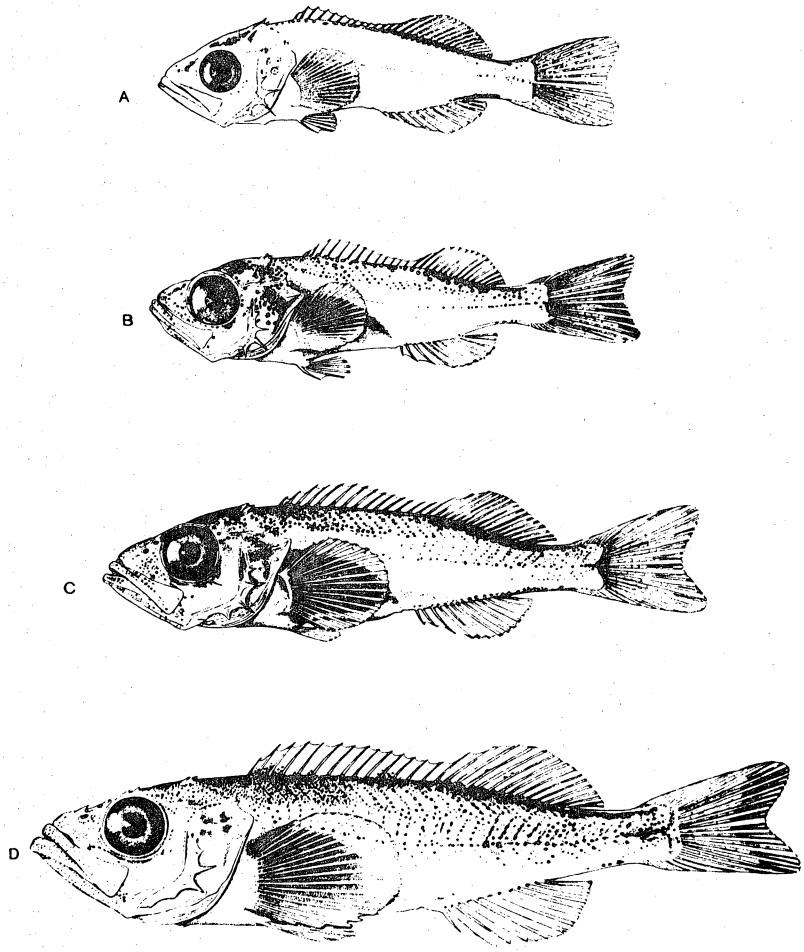
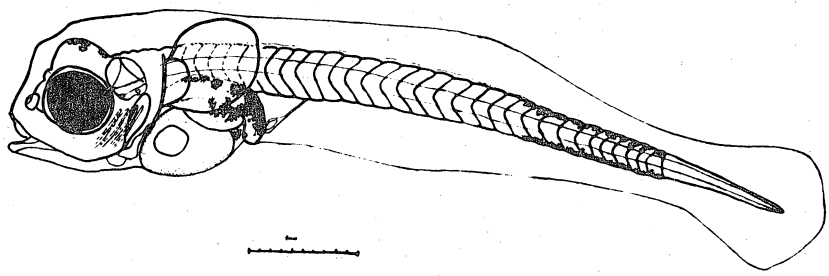


Fig.36. Redfish Sebastes marinus
Young fry: A - 20.5, B - 27.0, C - 34.5 mm and D - 52.0mm

DEEPWATER REDFISH, SEBASTES MENTELLA TRAVIN

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 0.90 x 0.70 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 melanopheres 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.37.



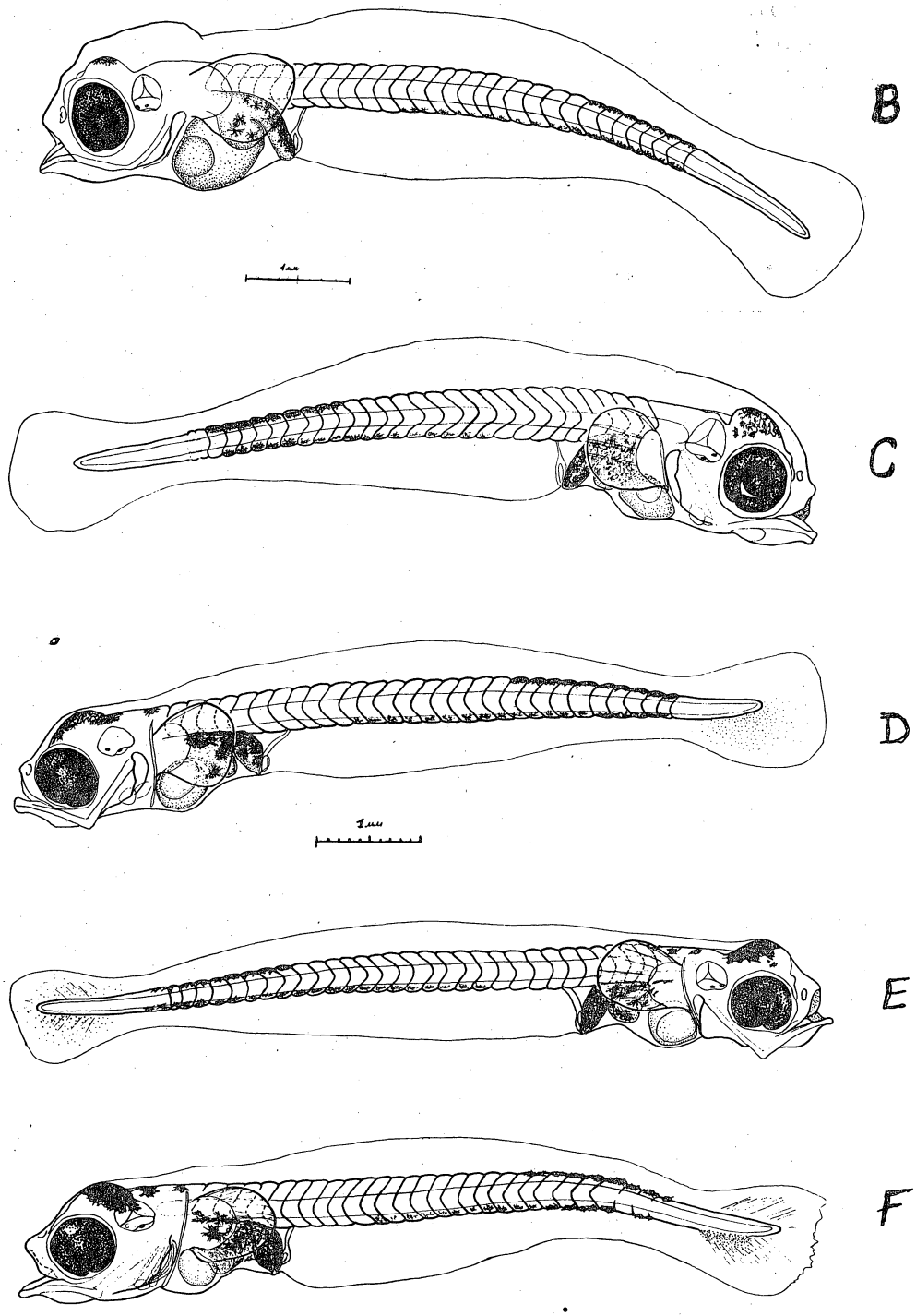


Fig.37. Deepwater redfish Sebastes mantella.
Prelarvae: A - 7.7 mm (preextrusion), B - 8.15 mm
30 hours after extrusion in aquaria, C - 8.0 mm,
153 hours after extrusion in aquaria, D,E,F,G - larvae
8.0, 7.9, 7.8 and 7.45 mm 153, 170, 185 and 220 hours
after extrusion respectively.

BLUE MOUTH HELYCOLENUS DACTYLOPTERUS DELAROCHE

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

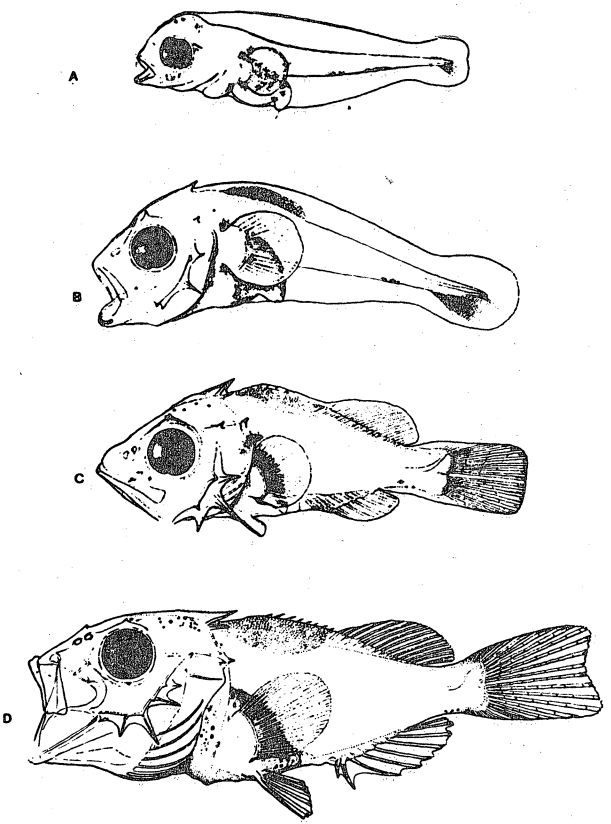


Fig.38. Blue mouth Helicolenus dactylopterus
Larvae: A - 3.6, B - 5.6, C - 10.0 and D - 19.0 mm.
(Taning, 1961).

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. Fig. 38.

Tåning, 1961.

SCULPIN, MYOXOCEPHALUS SCORPIUS (LINNE)

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 on P. Fig. 39.

Rass, 1949.
Ehrenbaum, 1905-1909.
Russel, 1976.

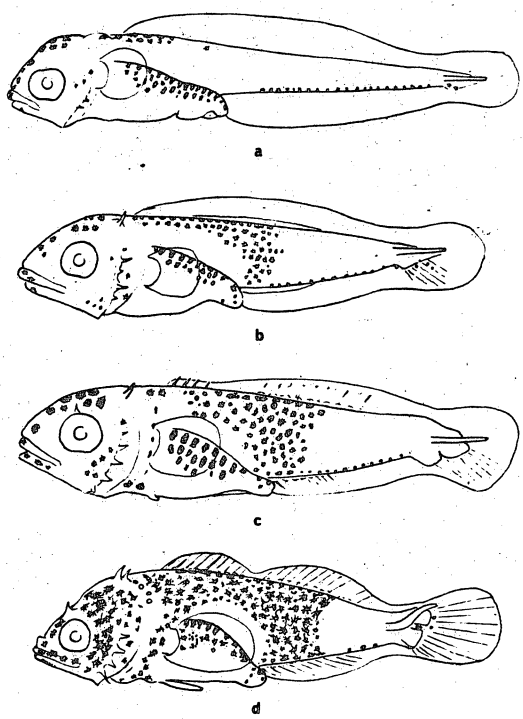


Fig.39. Sculpin Myoxocephalus scorpius
Larvae: A - 7.5, B - 9.5, C - 10.0 and D -14.0 mm.

ATLANTIC SEA POUCHER.

LEPTAGONUS DECAGONUS (BLOCH ET SCHNEIDER)

Larvae are 10.0-21.0 (?) mm long is elongated and rounded in the presnal 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 concaved. 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. Fig. 40.

Rass, 1949.

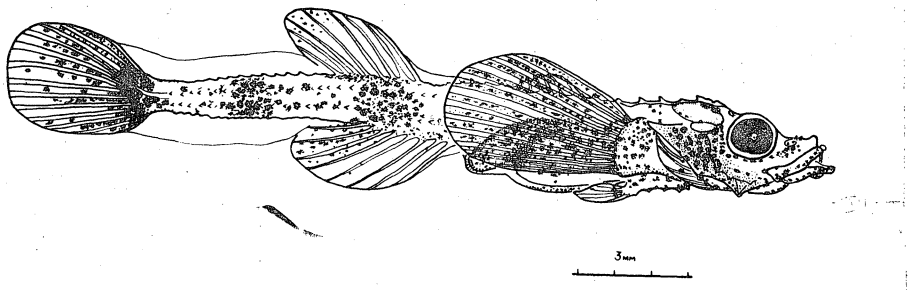


Fig.40. Atlantic sea poucher Leptagonus decagonus

CYCLOPTERUS LUMPUS LINNE

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 absorved. 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 pecteral fin has radial rows of melanophores.

Larvae are 9.0-11.0 mm long and more. Fins are rayed at a length of 11 mm. Fig. 41.

Rass, 1949
Russel, 1975.

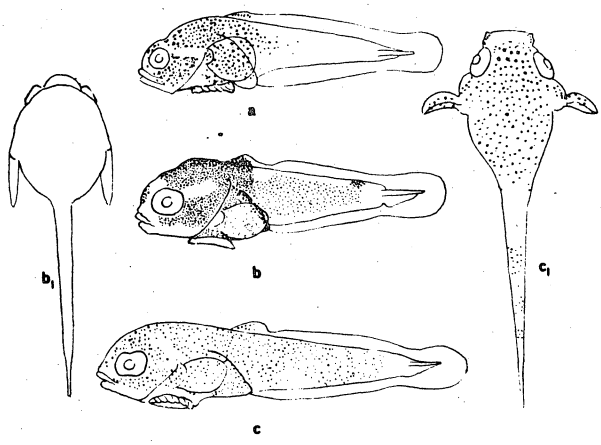


Fig.41. Lumpfish Cyclopterus lumpus
Larvae 5.5 mm, (a), 5.6 mm (b), and 6.6 mm (c).

AMERICAN PLAICE HIPPOGLOSOIDES PLATESSOIDES PLATESSOIDES (FABRICIUS)

Eggs are pelagic, spherical, 1.5-3.2 mm in diameter, the perivitelline space is wide. During Stage IV pigment cells are arranged in latitudinal 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 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 visible 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 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. Three indistinct caudal raws are visible and heavy postanal pigmentation is present on the ventral side of the embrynic 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 a length 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 is 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 lengths of 11.7-13.8 mm when the eyes migrate and the edges of the left eye and the olfactory 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. Fig. 42-43.

Pertseva-Ostroumova, 1961

Hunstman, 1918.

Bigelow and Schroeder, 1953.

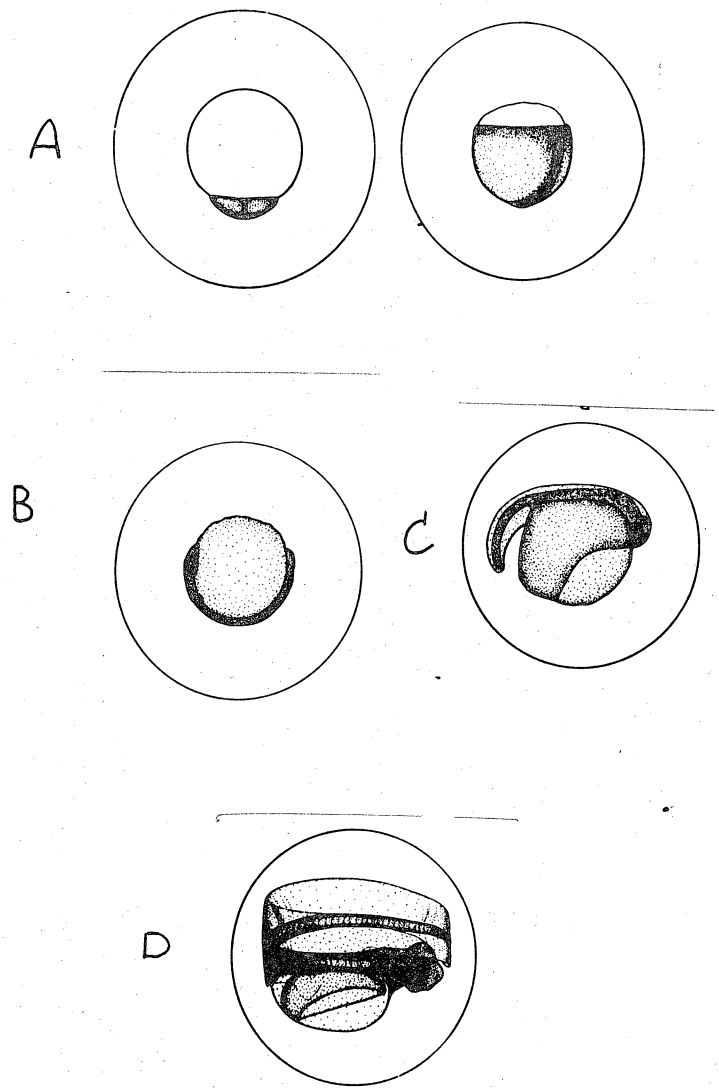


Fig.42. American plaice Hippoglossosides platessoides platessoides. Egg development: A - Stage I, B - Stage II, C - Stage III, D- Stage IV. (Hunstman, 1918).

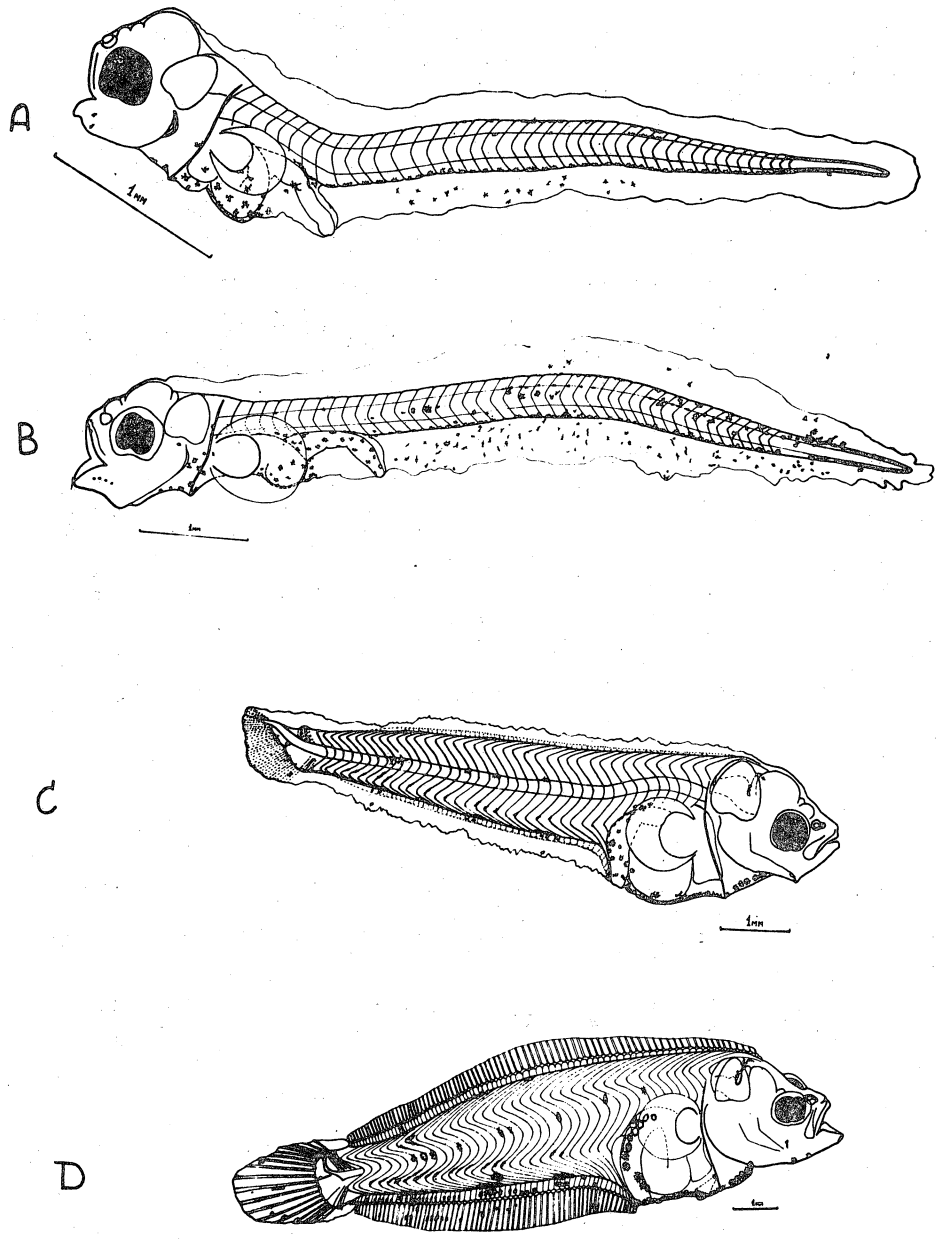


Fig.43. American plaice Hippoglossoides platessoides platessoides. Larvae; A - 4.85, B - 7.8, C - 8.2 and D - 11.7 mm.

YELLOWTAIL LIMANDA FERRUGINEA (STORER)

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, and two longitudinal rows running ventrally and dorsally tend to form at Stage III. The width of embryo is 8-10 times lower than the egg diameter. At Stage IV, just before hatching, eyes are still free of pigment and a clearly visible 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. There are 11 preanal and 35 postanal myomers. Anus is beoyond the yolk sac, the head is not raised from 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 large 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 near 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 height 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 melanophores is on the carebellium, a pigment row is along the ventral contour of the body stretching up to the ventral region and to the gut. Two dorsal groups are between 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 is 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 visible. There are 3 melanophores

above the mesencephalon, 3 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. Thus 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. Fig. 44-45.

Bigelow and Schroeder, 1953.
Evseenko and Nevinskij, 1980.

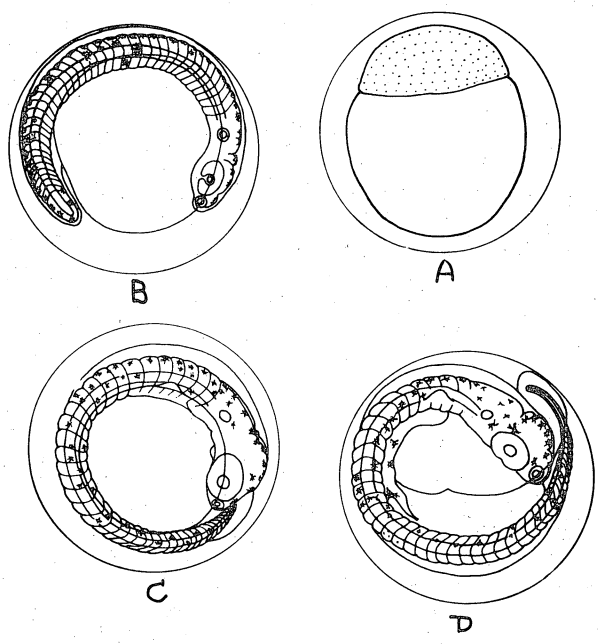


Fig.44. Yellowtail Limanda ferruginea
Egg development: A - Stage I, B - Stage II,
C - Stage IV. (Evseenko and Nevinsky, 1975).

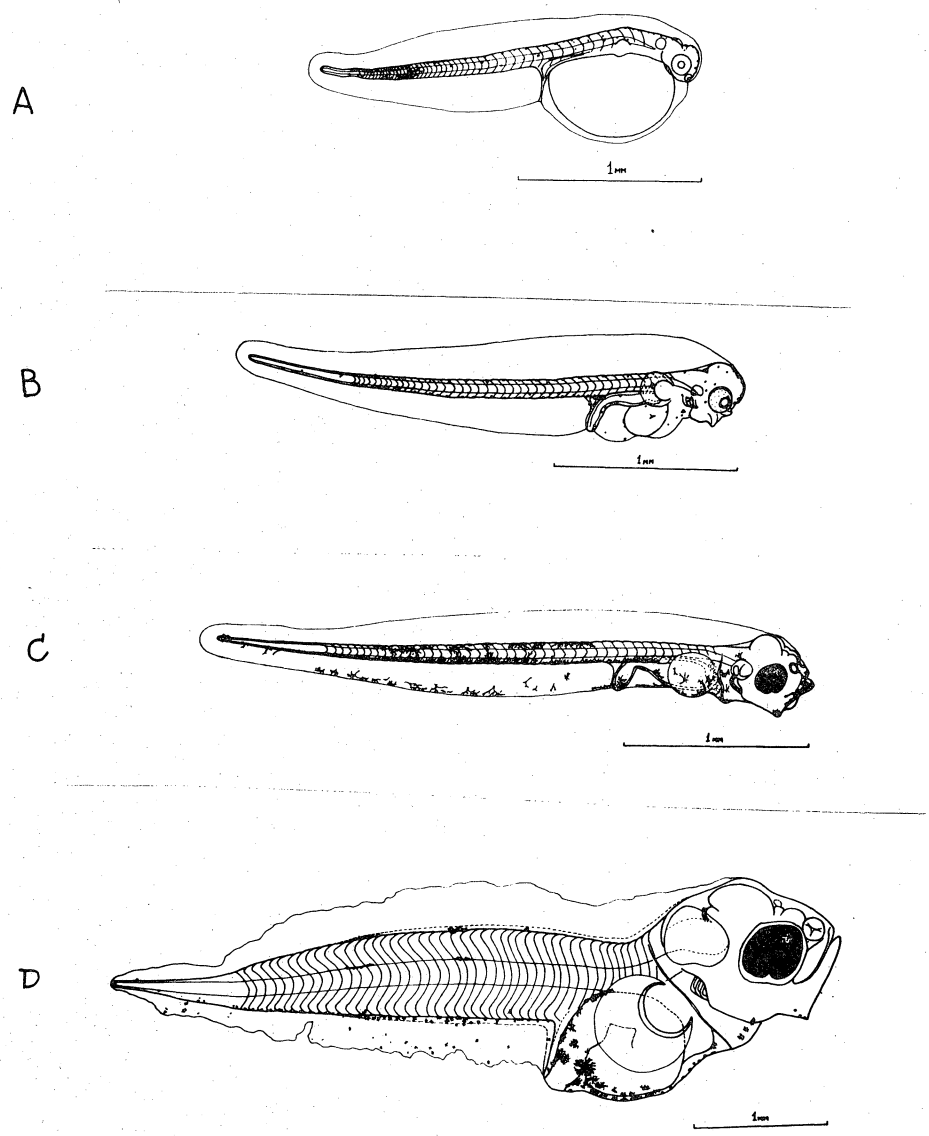


Fig.45. Yellowtail Limanda ferruginea.
A - prelarva 2.1 mm, B - 2.65 mm, C,D - larvae 3.15 and 5.5 mm respectively. (Evseenko, Nevinsky, 1980).

WITCH FLOUNDER, GLYPTOCEPHALUS CYNOGLOSSUS (LINNE)

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 portion of the body are extremelly will 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 melanopheres 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 but heavier than that in prelarvae.

The metamorphosis starts at a length of 22.5 mm when the left eye begins to migrate on 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 pigmentation pattern is the same as at lower lengths. The metamorphosis is prolonged and ends at lengths of 40-50 mm. Fig.46.

Holt, 1893.
Petersen, 1904.
Bigelow and Schroeder, 1953.
Evseenko and Nevinskij, 1975

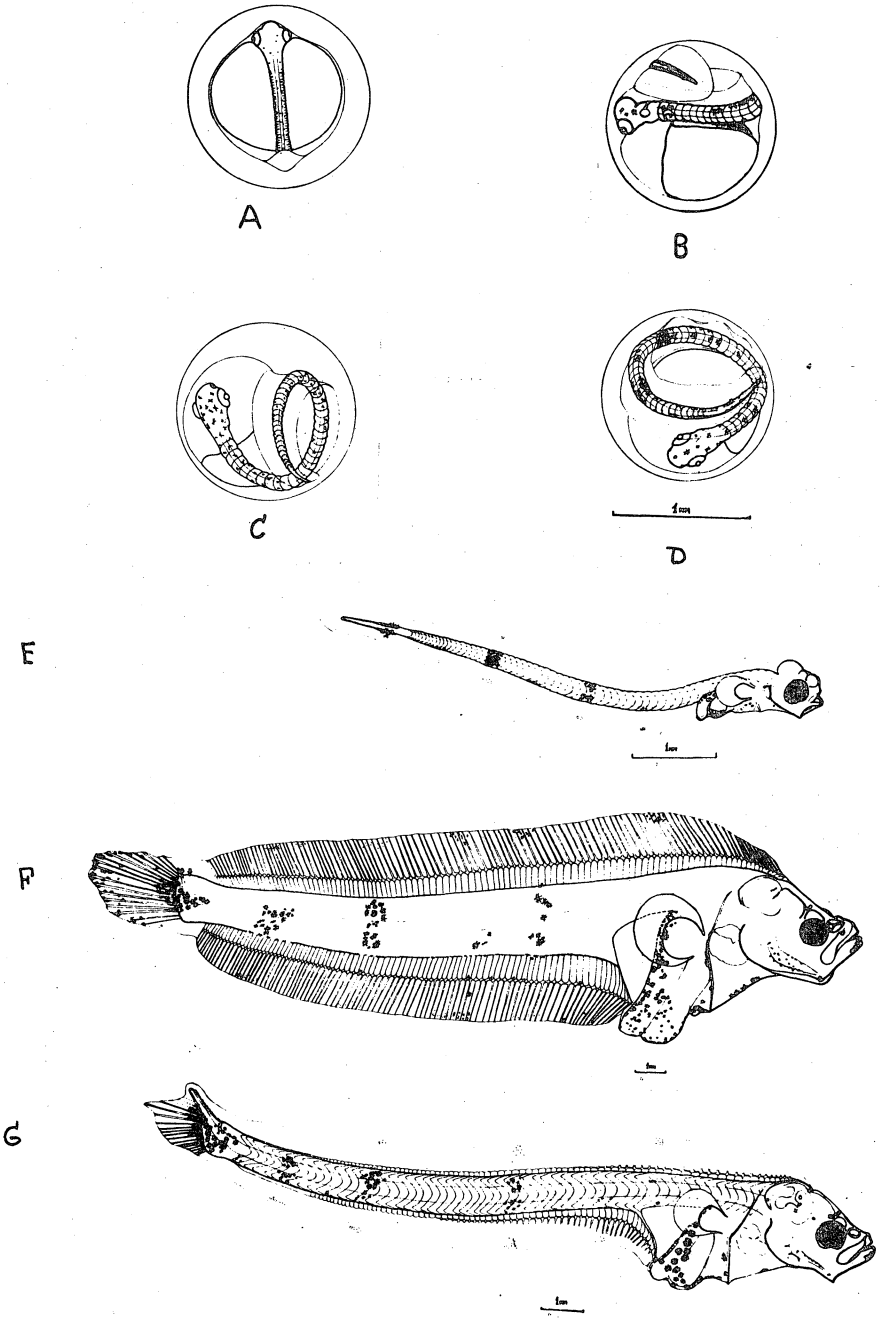


Fig.46. Witch flounder Glyptocephalus cynoglossus. Eggs development: A - Stage II, B - Stage III, C, D - Stage IV. E - prelarva 5.8 mm, F, G - larvae 16.7 and 22.5 mm respectively. (Evseenko, Nevinsky, 1975).

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