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PLANKTONIC FISH EGGS OF FAXAFLÓI, SOUTHWEST ICELAND, 1948—1957

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PLANKTONIC FISH EGGS OF FAXAFLÓI,

SOUTHWEST ICELAND,

1948—1957

By

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Surveys of fish eggs and larvae can furnish information on early mortality, rates of development, dispersal from spawning ground, bathymetric distribution, and conditions of life of early developmental stages. Indirectly they provide information on adults, such as faunal composition, stock sizes, and time and place of spawning. This report deals only with planktonic eggs, and relates mainly to faunal composition, spawning season, and egg dispersal. Both embryonic and larval development are prolonged at Icelandic temperatures. Considerable dispersal may occur before hatching, and a larva may conceivably have originated far from where it is collected. Collections of eggs would seem a more reliable source of information on local stocks than collections of larvae.

Faxaflói is an open embayment of about 50 × 100 km on the southwest coast of Iceland. It is of special interest because of its economic importance and productivity, its accessibility from Reykjavík, and its protected status under international agreement. We hope that this report will be useful in planning research and can provide a basis of comparison for future investigations.

All work afield and some in the laboratory were done by the senior author in the years 1948–57. At his suggestion the junior author completed the laboratory work during a sabbatical year in Reykjavík (1966–7). At the senior author's death the work was still unfinished and the manuscript not yet started. The junior author accepts responsibility for all errors of fact or interpretation.

LOCALITIES, MATERIALS, AND METHODS

About half of Faxaflói is less than 50 metres deep and most of it less than 100. Atlantic water enters from the south and keeps it warmer than most other Icelandic coastal regions (Malmberg, 1962). Standard collection localities (fig. 1) were occupied in linear order on cruises one to three weeks apart in 1948 (table 1). In later years (1950–7) coverage was less frequent and often incomplete (table 2), but the total for these later years may approximate average conditions and can be instructively compared with 1948.

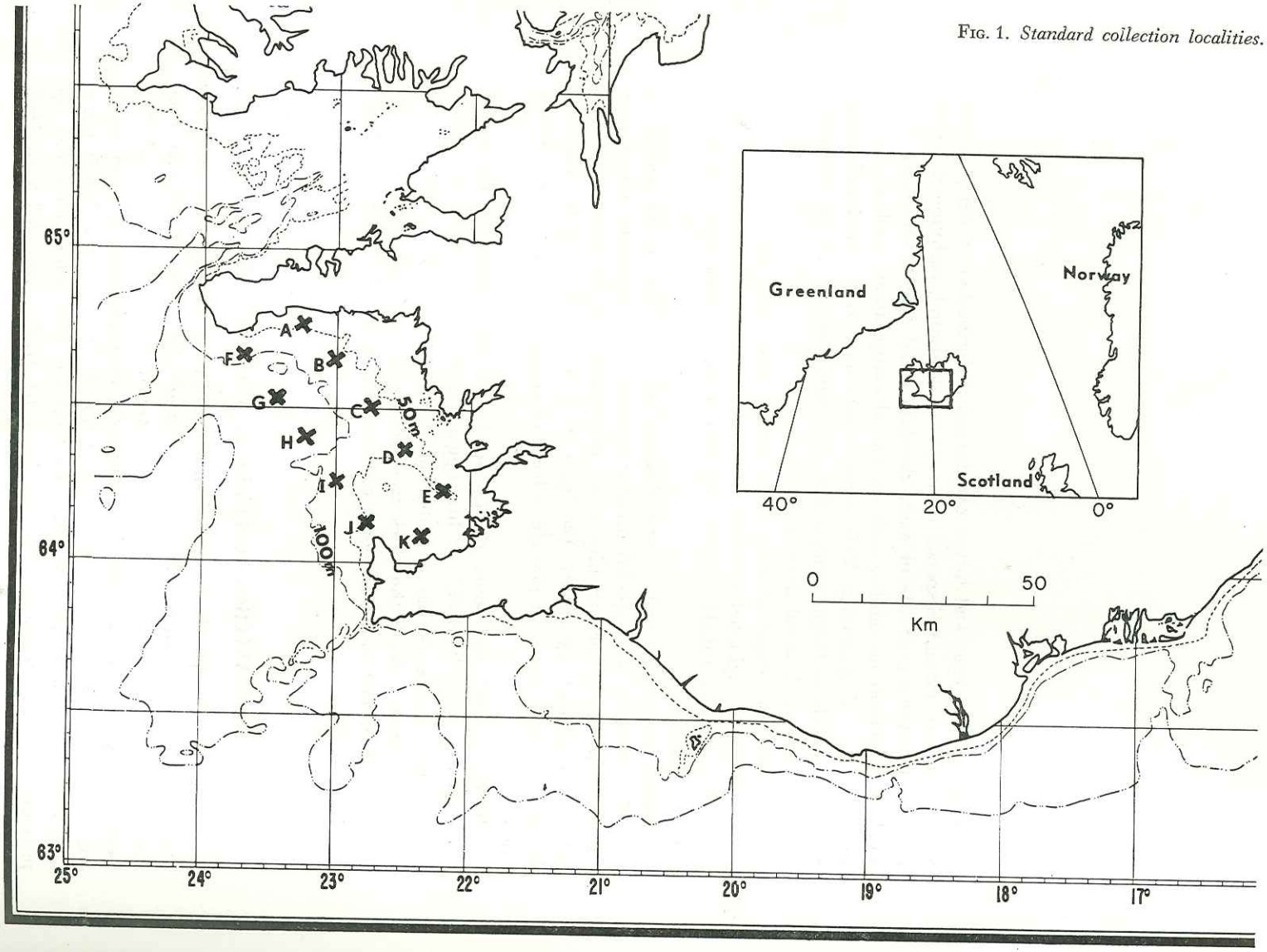

FIG. 1. *Standard collection localities.*

TABLE 1.
Numbers of quantitative samples according to locality and date in 1948

Locality	*April*		*May*		*June*	Σ
	early	*late*	*early*	*late*	*early*	
North (A–C, F–H)	4	0	5	0	5	14
South (D, E, I–K)	6	8	10	0	8	32
Inshore (A–E, K)	4	8	7	0	8	27
Offshore (F–J)	6	0	8	0	5	19
Σ	10	8	15	0	13	46

TABLE 2.
Numbers of quantitative samples according to locality and date in 1950—1957

Locality	*April*		*May*		*June*	Σ
	early	*late*	*early*	*late*	*early*	
North	3	6	0	3	1	13
South	2	7	0	5	2	16
Inshore	0	6	0	3	1	10
Offshore	5	7	0	5	2	19
Σ	5	13	0	8	3	29

For regional comparisons, localities are considered in groups: inshore (*A* to *E*, *K*), offshore (*F* to *J*), north (*A* to *C*, *F* to *H*), south (*O* to *E*, *I* to *K*). A few samples from about 10 km southwest of *J* are included with that locality.

Temperatures and salinities for each station were recorded for the surface and ten-meter subsurface intervals. Surface temperatures were generally around 5° C in April and rose to above 8° by June. Salinity varied only from 33.6‰ to 35.1‰. Some of the data for 1948 are published (EINARSSON and JÓNSSON, 1952). Usually a strammen-net of two-meter diameter was let out on enough line to put it near the bottom and then towed obliquely to the surface. These collections were sometimes supplemented by parallel tows with a fine-mesh net of 30-cm diameter. Hensen egg nets were towed vertically from near the bottom.

It may be that the oblique tows did not start as near the bottom as was intended, but inasmuch as the water was usually more than 50 meters deep,

and the eggs largely confined to surface layers, it is unlikely that any important error is introduced by failure to reach the intended depth. COLTON (1964) found that sampling to a depth of 20 meters gave reliable samples of haddock eggs. Mesh openings of the strammen net were about 1.5 mm, which is greater than all egg diameters except those of plaice and long rough dab. Collections made by this net are used only for qualitative information on species composition and for quantitative data on developmental stage frequencies. Sizes remain constant during development, and no bias should result from loss of part of the sample through the net. Only those samples taken by the Hensen egg nets and fine-mesh plankton nets are considered in comparisons of species abundance.

Samples were preserved and stored in formalin. English and Latin names of fishes follow SVETOVIDOV (1962) for the Gadidae and the International Council for the Exploration of the Sea (1964) for all others. Developmental stages I to V are those of SIMPSON (1959).

SPECIES ABUNDANCE

During the main spawning season in 1948, from 8 April to 8 May, 22 Hensen-net samples (covering $\frac{1}{3}$ m^2 each) included 2668 fish eggs, an average of 121 per haul, or 363 per square meter. A species' proportional contribution multiplied by this number should estimate its absolute density.

EINARSSON's data on species abundance for 1948 and WILLIAMS' for later years were derived independently but show general agreement (table 3). Einarsson identified his material partly to species and partly to more general groups. One of these groups included cod, haddock, and lemon sole. Another included species not identified. This 1948 material, which was collected by Hensen-net and should be quantitatively reliable, was not saved, but further resolution is possible by analogy with available strammen-net material from the same year. In these collections the lemon sole proved to be a minor component and may be neglected. Cod and haddock eggs are distinguishable only after embryonic pigment patterns are established. There were 128 such eggs in the 1948 material, 98 cod and 30 haddock. Collections from other years showed nearly the same ratio, 46 cod and 15 haddock. The same relative abundance should be found in both Hensen-net and strammen-net material, because the two species have nearly the same frequency distribution of egg diameters, and no bias should result from loss of part of the catch through the meshes of the strammen-net.

Williams' data (table 3) are based on samples from 1948 to 1957 and extend to later in the season (June 7). This explains the greater importance of "other" in this material, because many of the minor species spawn late. Egg biomass is correlated with the biomass of adults that produced them.

TABLE 3.
Relative abundance of planktonic fish eggs

Species	*1948 (Einarsson)*	*1950–7 (Williams)*	Σ	*Biomass*
Cod	1934 (72.5%)	1399 (60.8%)	3333 (67.1%)	66.0%
Haddock	650 (24.4)	442 (19.2)	1092 (22.0)	21.6
Onos spp.	——	88 (3.8)	——	0.4
Long rough dab ..	34 (1.3)	57 (2.5)	91 (1.8)	8.7
Dab	——	56 (2.4)	——	0.3
Plaice	10 (0.4)	13 (0.6)	23 (0.5)	1.0
Others	40 (1.5)	247 (10.7)	287 (5.8)	2.1
Σ	2668	2302	4970	

TABLE 4.
Abundance of larval fishes hatching from planktonic eggs (after Magnússon, 1966)

Species	*May 1961–3*	*June 1961–4*	Σ
Cod	12880 (55.0%)	799 (52.2%)	13679 (54.8%)
Haddock	2018 (8.6)	98 (6.4)	2116 (8.5)
Onos spp.	405 (1.7)	55 (3.6)	460 (1.8)
Long rough dab ...	1084 (4.6)	254 (16.6)	1338 (5.4)
Dab	2102 (9.0)	175 (11.4)	2277 (9.1)
Plaice	10 (0.0)	13 (0.8)	23 (0.1)
Others	4919 (21.0)	136 (8.9)	5055 (20.3)
Σ	23418	1530	24948

The calculations of relative egg biomass (table 3) are based on the product of egg numbers and the cube of egg diameter. They give a rough indication of stock sizes.

Our findings conform rather well with indications of faunal composition based on larval numbers (table 4) reported by MAGNÚSSON (1966). Her observations relate largely to Faxaflói, but include contributions from other coastal areas. A notable contrast is the smaller representation of plaice in Magnússon's counts. The difference would be reduced somewhat if some of the specimens that Magnússon listed as dab were really plaice. These larvae are difficult to distinguish. Otherwise the data suggest a reduction in plaice stocks in the late 1950's. Other differences, such as the greater numbers of some of the less common species ("other" in the table), may be

ascribed to influx of larvae from other areas and to the broader areal coverage of Magnússon's study.

Our findings on relative numbers of cod, haddock, and plaice agree also with species composition based on catch statistics for these species for the same years (GULLAND, 1961).

SPECIES ACCOUNTS

The above information relates to the more abundant species, of which significant numbers were taken by quantitative methods (mainly Hensen-net tows). The following accounts are based on all available material, including strammen-net samples, which can not be used for quantitative conclusions on species abundance.

Torsk *(Brosme brosme)*: Eggs of this species in Icelandic waters are the largest that have an oil droplet, and are thus easily identified. We found them only once, on 4 June 1948, when we took three specimens at station D (south, inshore). They were in stages IV and V and might have drifted in from south of Reykjanes. The abyssal spawning habits of this species (SVETOVIDOV, 1962: 43) make it unlikely that eggs are ever abundant in Faxaflói.

Fourbeard rockling *(Enchelyopus cimbrius)*: This species is included among *Onos spp.* in tables 3 and 4. Their eggs are easily identified by a diameter less than .9 mm and the presence of an oil droplet. All the advanced embryos we saw seemed to be of this species, rather than the related species of *Onos*. Eggs were taken twenty times by strammen-net, and they seem to be abundant throughout Faxaflói. In 1948 they occurred from 20 April to 3 June, in other years from 11 April to 7 June.

Spawning undoubtedly starts before the collection dates indicate, because among 33 specimens taken before the middle of April there were three in stage IV and one in stage V. This probably means a late March spawning. Of 31 specimens taken on 7 June 1957, 8 were in stage I. Spawning apparently extends well into June.

Ling *(Molva molva)*: Ling eggs are recognizible by a diameter of 1.05 to 1.20 mm, large oil droplet (.4 mm) and dusky appearance of the yolk. We took one on 3 June 1948 at station H (north, offshore) and another on 28 May 1957 at J (south, offshore). Both were in stage IV and probably spawned in May.

Norway pout *(Trisopterus esmarkii)*: This identification is provisional. The eggs are not readily distinguished from those of the coalfish. Both lack oil droplets and range from about 1.00 to 1.15 mm in diameter. We attri-

bute only six specimens to the Norway pout, one from station E (south, inshore) on 20 April 1948, one from J (south, offshore) on 3 June 1948, and four from H (north, offshore) on 7 June 1952. All were newly spawned, but spawning must begin several weeks earlier, because the senior author found four larvae on 4 May 1948 at station D.

Whiting *(Odontognathus merlangus)*: Eggs of this species are difficult to distinguish from the smaller specimens of cod and haddock. Those that we attribute to whiting are 1.27 to 1.31 mm in diameter. This is within the range for cod and haddock, but cod and haddock eggs in the same samples were distinctly larger. Whiting eggs are also a bit paler and yellower in diffuse transmitted white light.

Eggs identified as whiting were found four times: 13 from station I (south, offshore) on 7 June 1952, 28 from H (north, offshore) on the same date, 2 from J (south, offshore) on 20 May 1956, and 7 from the same locality on 28 May 1957. One of those taken on 20 May was in stage IV and indicates spawning early in May. The June specimens were mainly early stages (I and II) spawned undoubtedly during June.

Coal fish *(Pollachius virens)*: As noted above, coalfish are scarcely distinguishable from those of the Norway pout. The coalfish is reported to spawn earlier than the pout (Svetovidov, 1962), and 16 larvae taken in two samples in early April by the senior author indicate spawning in Icelandic waters. Accordingly, five specimens, all in stages III and IV, taken on 11 April 1957 (localities H and I), are assigned to this species rather than the Norway pout.

Cod *(Gadus morhua)* and **haddock *(Melanogrammus aeglifinnis)*:** Because their eggs are distinguishable only in stage V, these species are considered together. As noted earlier, cod predominate over haddock eggs, in about a 3:1 ratio among stage V embryos. Larval ratios are even more biased in favor of cod. The senior author took 140 cod and only 3 haddock larvae in 1948. Magnússon's (1966) data show about a 7:1 cod:haddock ratio among the larvae. There can be little doubt that cod eggs were the most abundant planktonic fish eggs in Faxaflói during the period studied, and that the cod had the greatest biomass among species with planktonic eggs.

The cod probably spawns a bit earlier than the haddock. Five stage-V cod were taken at various stations (north and south, offshore) on 11 April 1957. Another was found at station J (south, offshore) on 12 April 1948. No stage V haddock was found before early May in any year.

Egg size varies considerably, and as a number of workers have noted (the first perhaps being Kramp, 1913), these are among several species that show a progressive decrease in average diameter as the season advances (tables 5 and 6).

TABLE 5.

Sizes of cod and haddock eggs in 1948

	Egg diameters (mm): mean, range, sample size					
	Stages I–IV cod & haddock		*Stage V cod*		*Stage V haddock*	
April 1–15	1.39 (1.30–1.55)	n = 13	1.40	n = 1	——	
April 16–30	1.41 (1.28–1.55)	n = 119	——		1.51 (1.49–1.52)	n = 3
May 1–15	1.28 (1.13–1.44)	n = 173	1.31 (1.17–1.48)	n = 93	1.35 (1.26–1.43)	n = 4
May 16–31	——		——		——	
June 1–7	1.28 (1.21–1.36)	n = 31	——		——	
Σ	1.37 (1.13–1.55)	n = 336	1.31 (1.17–1.48)	n = 94	1.42 (1.26–1.52)	n = 7

TABLE 6.

Sizes of cod and haddock eggs in 1950—1957

	Egg diameters (mm): mean, range, sample size		
	Stages I–IV cod & haddock	*Stage V cod*	*Stage V haddock*
April 1–15	1.40 (1.26–1.53) n = 183	——	——
April 16–30	1.42 (1.26–1.57) n = 169	1.44 (1.35–1.53) n = 21	——
May 1–15	——	——	——
May 16–31	1.33 (1.18–1.49) n = 87	1.28 —— n = 1	1.36 (1.33–1.41) n = 3
June 1–7	1.27 (1.21–1.35) n = 44	1.15 —— n = 1	1.40 —— n = 1
Σ	1.38 (1.18–1.57) n = 483	1.42 (1.15–1.53) n = 23	1.37 (1.33–1.41) n = 4

Long rough dab *(Hippoglossoides platessoides)*: This species is easily identified by its large size (2.2 to 3.3 mm in the material examined), large perivitelline space, and delicate capsule. It occurred in larger numbers and in more samples than any other species in the strammen-net collections. Its large size make it one of the few species completely retained by the meshes of this gear. In 1948 it was present from 9 April to 4 June, in other years from 11 April to 20 May. The earlier occurrences were mainly to the south. Before 20 April the southern section yielded 89 specimens in 9 positive samples and 2 negative. The north yielded only 9 specimens in 2 positive samples and 6 negative. Of the 89 specimens from the south, 17 were in stages III to V and may have been spawned south of Reykjanes and carried in by the current.

Only 5 specimens were taken during June 1948. None was in stage I and only one in stage II. In other years those from 15 to 20 May included 13 in stages I and II and 56 in later stages. It would seem that spawning in Faxaflói is relatively brief. The high frequency of later stages in most of the samples suggests that many of them originate farther south, and that spawning may begin in March south of Reykjanes.

Plaice *(Pleuronectes platessa)*: Plaice eggs are easily identified by their large size (1.6 to 2.0 mm), absence of an oil droplet, rigid capsule, and distinctive pink color. In 1948 they were found from 8 April to 4 June, and in other years from 11 April to 19 May. Specimens from before the middle of April totalled 110 in 8 positive samples and 3 negative in the southern half of Faxaflói. In the northern half there were 3 specimens in 2 positive samples and 3 negative. These early occurrences included 52 specimens in stages IV and V. These must have been spawned in March and may have originated south of Faxaflói. After the middle of May, all specimens but one were in stages III, IV, or V. The season is apparently short in Faxaflói.

Dab *(Limanda limanda)*: All eggs smaller than one millimeter and without an oil droplet were assigned to this species. This is a doubtful procedure because of the great range of variation (0.6 to 1.0 mm). Identification must be considered provisional.

These eggs occurred from 20 April to 4 June in 1948 and from 11 April to 7 June in other years. These observations support Jónsson's (1966) inferrence that this species begins to spawn before the middle of April. Locality data and stage frequencies indicate that spawning begins earlier south of Reykjanes and that eggs found in Faxaflói early in the season may have originated farther south. Of those taken before the middle of April, there were 11 in stages I and II and 12 in later stages. The southern sector yielded 18 of these specimens in 4 positive samples, the north only 5 in 2 positive samples. Of specimens taken in June, 5 were in stages I or II and 9 in later stages.

Lemon sole *(Microstomus kitt)*: Absence of an oil droplet and size range of 1.20 to 1.35 make this species difficult to distinguish from some of the gadids. Identification is aided by its faint pinkness and fine sculpturing on a rather rigid capsule. The late embryo is more slender and has a smaller head than that of any gadid.

We found this species from 3 May to 4 June in 1948 and from 30 April to 7 June in other years. None of the 40 specimens was in stage I and only 2 were in stage II. Thus there is no evidence that the species actually spawns in Faxaflói in the season covered, and spawning must start well before the collection dates indicate. Thus our observations conflict with SAEMUNDSSON's (1926: 328), who reported that spawning does not occur before late May in Icelandic waters.

Witch *(Glyptocephalus cynoglossus)*: This species is distinguishable from the preceding only by the pigmentation of the late embryo. The eggs are about the same size or slightly larger (1.23 to 1.38 mm) and lack an oil droplet. The late embryo has a relatively narrower fin fold than the lemon sole and an irregular and partly discontinuous row of pigment dorsally on the tail. These were found only once, at station D (south, inshore) on 4 June 1948. Other less advanced specimens in the same sample, including 3 in stage I, looked much the same in size and yolk color and are included with this species. The presence of late embryos in early June probably indicates mid-May spawning, possibly south of Faxaflói, and the presence of the early stage indicates June spawning in Faxaflói.

Species not taken: Absence of a species from samples can scarcely demonstrate absence from the fauna, but may nevertheless be taken to indicate rarity. Several additional species have been reported to spawn in Faxaflói or adjacent waters and their absence from this survey should be noted.

Two flatfishes, *Zeugopterus megastoma* and *Z. norvegicus*, are reported to spawn planktonic eggs in the spring in the waters surveyed (SAEMUNDSSON, 1926) and their eggs were expected, but not found. The halibut *(Hippoglossus vulgaris)*, Greenland halibut *(H. hippoglossoides)*, poutassou *(Micromistius potassou)*, and a lanternfish *(Myctophum glaciale)* are known to spawn near Iceland in waters deeper and farther from shore than Faxaflói. Conceivably the eggs might be carried in by currents in the two or more weeks of development required at Icelandic temperatures. The single occurrence of torsk eggs, which must have been spawned far offshore from where they were collected, suggests this possibility for the other species listed. Eggs and larvae of the lanternfish have been found just outside the area surveyed (MAGNÚSSON, MAGNÚSSON and HALLGRÍMSSON, 1965).

SUMMARY

Planktonic eggs of eight gadids and five pleuronectids were found between early April and early June in the years 1948 to 1957. The cod was the dominant form. There is evidence that many of the pleuronectid eggs found in Faxaflói were brought there by the current from south of Reykjanes, where spawning begins earlier.

ÍSLENZKT ÁGRIP

Rannsóknir voru gerðar á fiskaeggjum í Faxaflóa í apríl til júní árin 1948—1957. Alls fundust sviflæg egg 8 þorskfiskategunda og 5 tegunda af flatfiski. Mest var af þorskeggjum. Það er ljóst, að mikið af eggjum flatfiska, sem fundust í Faxaflóa, hefur borizt þangað með straumum sunnan og vestan fyrir Reykjanes, þar sem hrygning hefst fyrr að vorinu.

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