RIT FISKIDEILDAR VOL. IV — NR. 3

CONTRIBUTION TO THE BIOLOGY OF THE DAB (*Limanda limanda* L.) IN ICELANDIC WATERS

By

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CONTENTS

I. INTRODUCTION

Although the dab (*Limanda limanda* L., syn. *Pleuronectes limanda* L.) is one of the most common flatfish species in Icelandic waters, its biology has not been studied since SÆMUNDSSON (1909, 1926) published his general description of Icelandic fishes. Thus the biology of the dab has been more or less unknown. The main reason is that the dab — being neither fat nor delicious — is of little commercial value and therefore it has not been considered important to spend time in investigating its biology.

Considerable material on the dab's biology has, however, been collected in previous years during several demersal surveys carried out by Atvinnudeild Háskólans, Fiskideild (The University Research Institute — Department of Fisheries)[1]) as well as by Danish investigators during their research cruises to Icelandic waters in earlier years (i.e. prior to 1939). However, this material had not been worked up along with other data collected in the above-mentioned surveys. BOHL (1957) studied the biology of the dab in the North Sea and some data exist on the dab in the Baltic (HESSLE 1923, POULSEN 1937, MOLANDER 1938, JENSEN 1959, KÄNDLER and THUROW 1959). Therefore it was considered worth while to evaluate the Icelandic material available and add some if necessary. Encouraged by Professor Dr. R. Kändler[2]), the head of the Fisheries Department of the Institut für Meereskunde at the University in Kiel, Western Germany, I began my investigations on the biology of the dab in Icelandic waters in early 1960. In March—April and July—August that year I collected additional material during the research trips made on behalf of Fiskideild on the research vessel "María Júlía". I began the evaluation of the material at Fiskideild in Reykjavík and continued later at Institut für Meereskunde in Kiel where I finished the work and made a report on the results. The present paper is a shortened version of this paper.[3])

[1]) since September 1965: Hafrannsóknastofnunin (Marine Research Institute).

[2]) I would like to express my sincere thanks to Dr. R. Kändler for his help during this work. I would also like to thank Mr. Jón Jónsson, mag. scient., Mr. Aðalsteinn Sigurðsson, mag. scient., Dr. Hermann Einarsson and others who made valuable suggestions during my work. Finally, thanks are due to Dr. H. A. Cole for kindly correcting the English text.

[3]) „Beiträge zur Biologie der Kliesche (*Limanda limanda* L.) in den isländischen Gewässern", Kiel 1962.

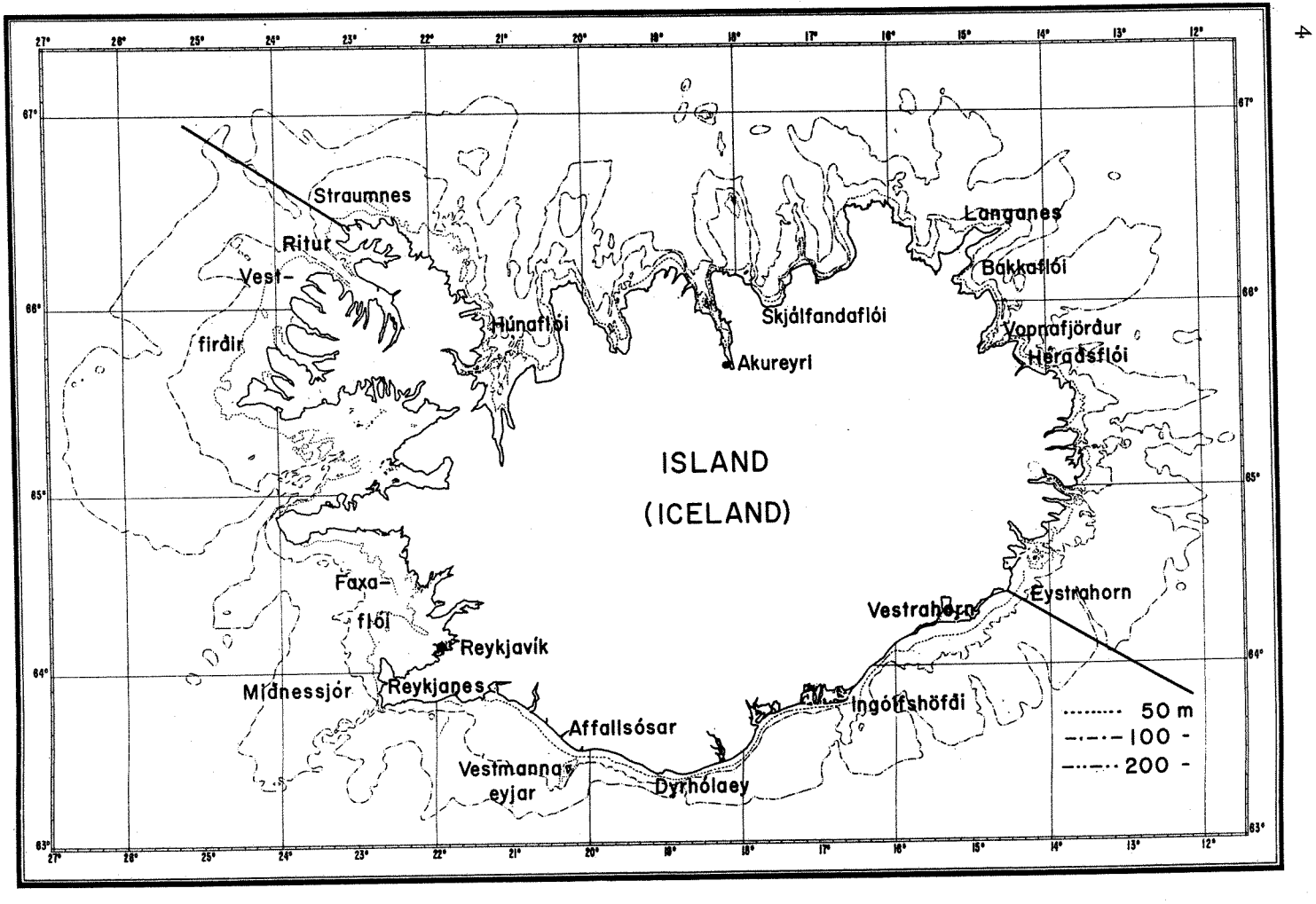


FIG. 1. *The region investigated divided into areas.*

II. MATERIAL AND AREA INVESTIGATED

The material can be divided as follows:

1) The "Danish" material collected by the research vessel "Dana" during 1924—1939.
2) The "Icelandic" material collected during 1947—1959.
3) The material collected by the author during 1960.

The Danish and Icelandic material from 1924—1959 consists of otoliths, length-measurements, sex analyses and larvae. The 1960 material consists of otoliths, length-measurements, sex analyses as well as fecundity analyses, stomach samples and race analyses (counts of vertebrae and fin rays). The material will be described in more detail in each chapter.

The above-mentioned material gives a fair representation of the age and growth rate of the Icelandic dab, distribution, size of the stock, catch per hour, sex ratio, spawning and growth of the larvae, food, races, etc. Finally, there is a survey of the catch of dab of different nations in Icelandic waters 1924—1958.

The Region investigated covers the Icelandic shelf and is divided into the "warm water area" off the south and west coasts and the "cold water area" off the north and east coasts. The boundaries between the "warm" and "cold" water areas are drawn at Eystrahorn and Straumnes (Fig. 1).

A comparative study is made of the results from these two areas, as well as of the relationship to results of similar investigations from the North Sea and the Baltic, when possible.

III. DISTRIBUTION AND SIZE OF STOCK

The dab lives at 0—200 m in the northeastern Atlantic from the Barents Sea south to the Bay of Biscay. In the North Sea it is the most common fish species. In the Baltic its distribution extends as far east as to the island of Gotland (EHRENBAUM 1936) and the west Atlantic boundary of the dab distribution is in Icelandic waters where it is very common at 0—120 m. Although dab can be found at greater depths than 120 m in Icelandic waters, it is not usually found there. The dab does not migrate any long distances. During winter, however, it seeks deeper water but moves shorewards in late winter for spawning.

Table 1 shows the catch per hour according to depth during 1956—1960 (not commercial). An otter trawl with a 50 ft headline was used as gear. The table shows that the dab is common at 20—40 m around Iceland. In

TABLE 1.

Catch per fishing hour at different depths 1956—1960.

Stat.	month	20—40 m number	20—40 m hours	40—60 m number	40—60 m hours	60—80 m number	60—80 m hours
May 56	V	1061	19	87	4	—	—
S56	VII—VIII	3346	36½	747	17	696	11
T56	XI	581	8	—	—	—	—
K57	II—III	1604	19½	—	—	128	6
N57	V	1089	18	—	—	—	—
O57	VII—VIII	2559	41	774	20½	569	18¾
K58	III	1154	22	—	—	680	10
L58	V	373	16	2	½	102	1¼
N58	VII—VIII	1469	25	398	22½	221	8½
O58	XI	4105	20	—	—	—	—
L59	VIII—IX	5994	24	971	17	634	9
K60	III—IV	848	29	—	—	8	3
	total	24183	278	2979	81½	3038	67½
average per hour		87.0		36.6		45.0	

Stat.	month	80—100 m number	80—100 m hours	100—120 m number	100—120 m hours	>120 m number	>120 m hours
May 56	V	—	—	—	—	—	—
S56	VII—VIII	—	—	63	14	—	—
T56	XI	—	—	—	—	—	—
K57	II—III	695	6½	—	—	—	—
N57	V	—	—	265	2	—	—
O57	VII—VIII	84	5½	12	7	1	14
K58	III	6	½	163	7½	—	—
L58	V	—	—	—	—	—	—
N58	VII—VIII	50	12½	8	11	—	—
O58	XI	—	—	—	—	—	—
L59	VIII—IX	5	6	3	5	1	8
K60	III—IV	695	7	331	13	15	1
	total	1535	38	845	59½	17	23
average per hour		40.4		14.2		0.7	

the North Sea it is also most common at 20—40 m (BOHL 1957). At 40—100 m the dab is also rather common in Icelandic waters, but at 100—120 m it decreases rapidly and it is rare at depths of more than 120 m. Information on its frequency at depths less than 20 m in Icelandic waters is insufficient.

cold water area off the north and east coasts than in the warm water area off the south and west coasts. In the summer of 1960 17.8% of the dab from the cold water area had crystalline otoliths but only 11.6% in the warm water area. In Skjálfandaflói 29.3% of the fish had crystalline otoliths in the summer of 1960, 25.6% in Bakkaflói but only 5.1% in Húnaflói — all these places belonging to the cold water area. In the warm water area the frequency of dabs with crystalline otoliths increases from the south coast (5.4%) westwards into Faxaflói (14.2%) to Vestfirðir (17.6%). I do not know how common this abnormality is in other fish species in Icelandic waters because it has not been studied. Bohl (1957) mentions that ca 0.1% of the dab otoliths from the North Sea were crystalline and in the western Baltic less than 1% of dab have crystalline otoliths (Thurow, personal communication).

The fishes with crystalline otoliths did not seem to be abnormal in any other respect, neither as to length nor general appearance. I did not examine whether the crystalline otoliths occurred more frequently within certain year groups. It would be interesting to investigate this phenomenon more closely and also in different fish species e.g. plaice, cod, haddock, etc.

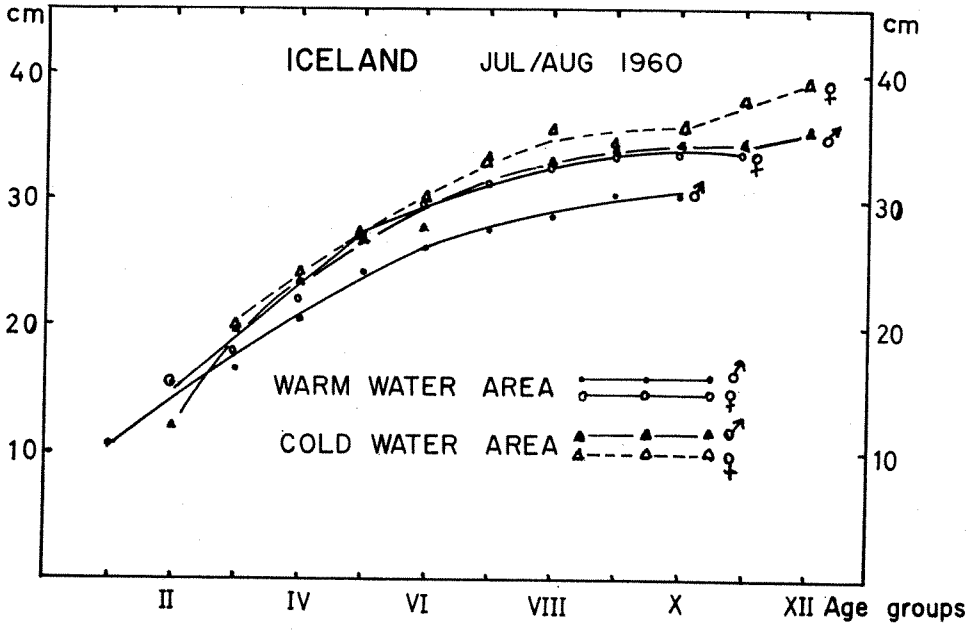
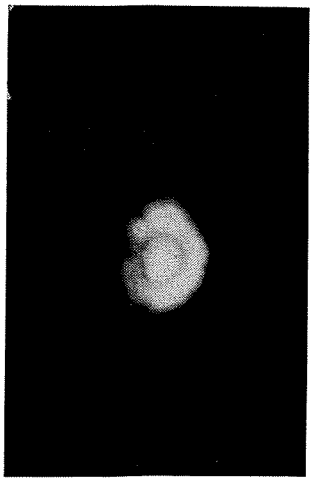
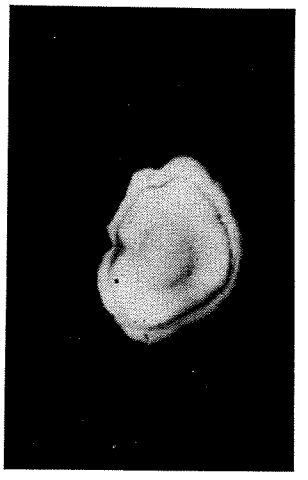


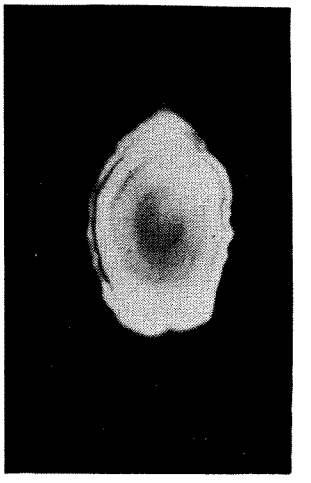
Fig. 4. *Growth of the dab in the warm water and the cold water areas in the summer of 1960.*



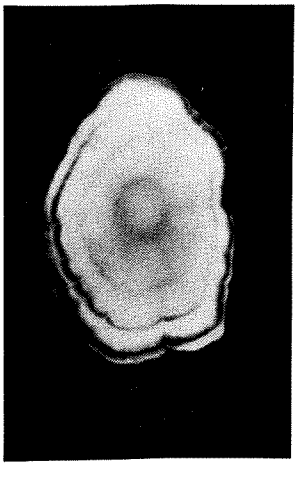
a
I ♂
9 cm
August



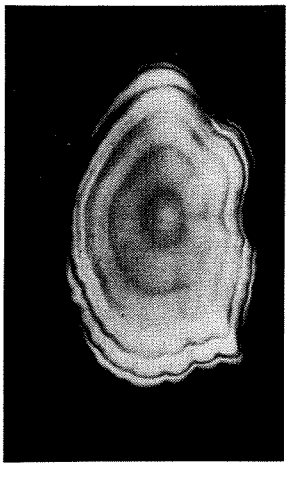
b
II ♂
16 cm
July



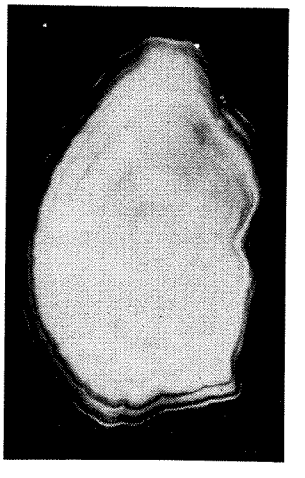
c
III ♂
18 cm
August



d
IV ♀
26 cm
July



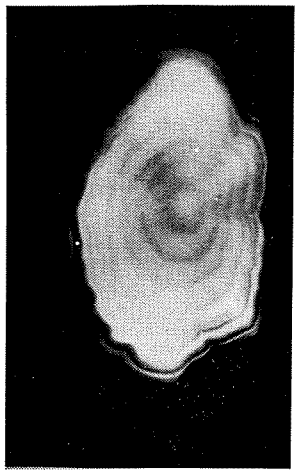
e
V ♂
28 cm
August



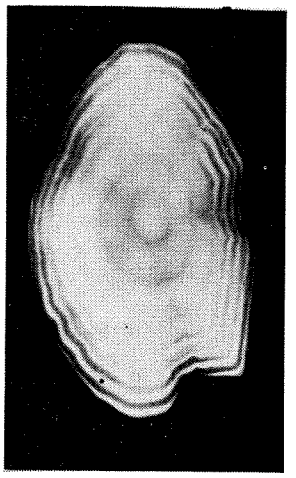
f
VI ♀
31 cm
August

FIG. 2. *Dab otoliths from Icelandic waters, age groups I—VI.*

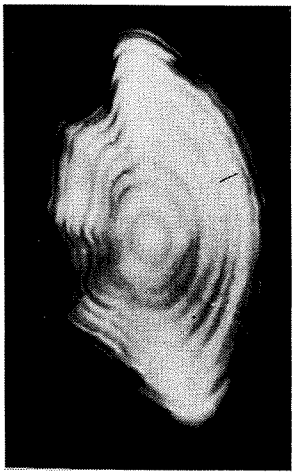
Photos: Sverrir Guðmundsson



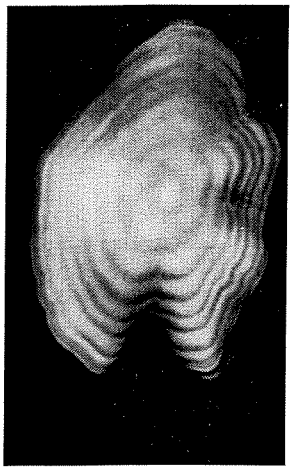
a
VII ♀
27 cm
March



b
VIII ♀
34 cm
May

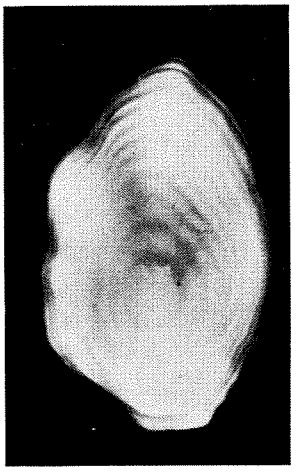


c
IX ♀
32 cm
August



d
X ♀
32 cm
August

e
XI ♀
37 cm
August



f
XII ♀
37 cm
March

FIG. 3. *Dab otoliths from Icelandic waters, age groups VII—XII.*

Photos: Sverrir Guðmundsson

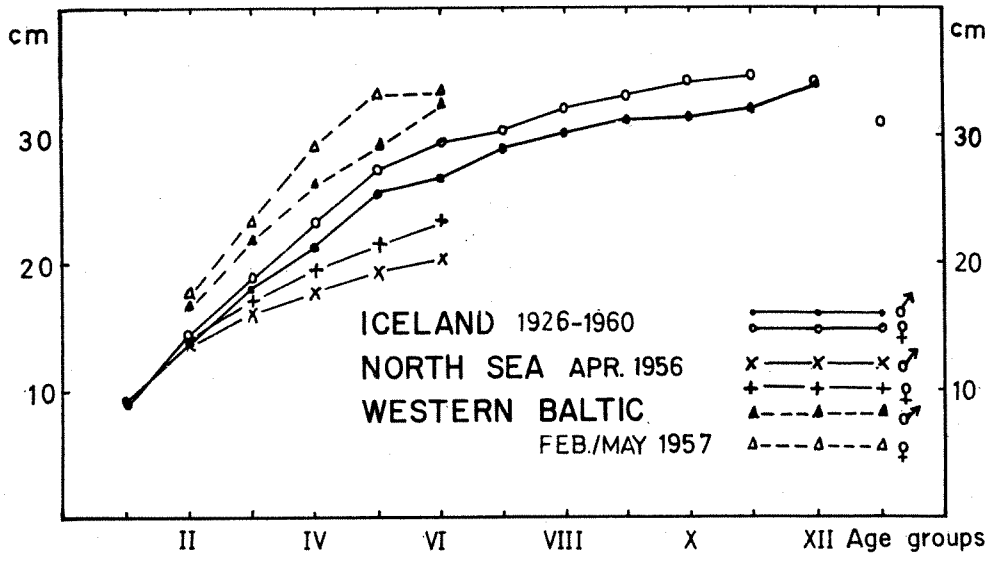


FIG. 5. *The growth of the dab around Iceland (1926—1960), in the North Sea (1956) and in the Baltic (1957).*

C. Growth.

The growth analysis from the summer of 1960 showed — contrary to expectations — that the dab in the cold water area off the north and northeast coasts grows faster than the dab in the warm water area off the south and west coasts (Fig. 4). In general, the Icelandic dab grows rather slowly. It reaches 12—13 years in age. The oldest individual in samples that could be agedetermined turned out to be a 13 years female from Garðsjór (Faxaflói) caught in March 1960. The maximum length of dab in the samples was 42 cm (total length). Females grow faster than males (Fig. 4). The rate of growth is shown in Table 3. During the first 2—3 years the growth rate of both sexes is approximately the same, but from then on the growth rate of the females begins to increase, thus gaining 2—3 cm. This increase in length has a lasting effect. The reason is that the males reach maturity sooner and then the growth slows down. The growth rate of the dab is slowest off the eastern south coast then it increases westwards and north to Faxaflói and Vestfirðir where the growth is about equal and into Húnaflói and Skjálfandaflói at the north coast and into Bakkaflói at the northeast coast where the growth is fastest.

The reason why the dab in the cold water area grows faster than the dab in the warm water area could be that food conditions are better in the cold water area as a result of the less crowded fish stocks and less competi-

TABLE 3.

Mean length (in cm) of the age groups around Iceland 1926—1960. (n = 7035).

	I		II		III		IV		V		VI		VII	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
n	23	21	122	133	608	481	728	495	727	620	634	650	372	390
m	9.3	9.1	13.9	14.1	18.2	18.8	21.5	23.3	25.6	27.4	26.8	29.7	29.2	30.4
n♂ + ♀ ...	44		255		1089		1223		1347		1284		762	
%	0.6		3.6		15.5		17.4		19.1		18.3		10.8	
M♂ + ♀ ..	9.2		14.0		18.4		22.2		26.4		28.3		29.8	

	VIII		IX		X		XI		XII		XIII	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
n	238	311	105	149	56	86	23	50	4	8	—	1
m	30.2	32.2	31.4	33.1	31.5	34.3	32.2	34.5	34.0	34.0	—	31.0
n♂ + ♀ ...	549		254		142		73		12		1	
%	7.8		3.6		2.0		1.0		0.2		—	
M♂ + ♀ ..	31.3		32.4		33.2		33.8		34.0		31.0	

tion for food between dab and different fish species living on the same or similar diet (plaice, haddock). Thus, because of great exploitation of the stock, together with exploitation of other flatfish species, the dab in the western Baltic grows for instance faster than the dab in the North Sea where the population is dense and the competition for food is greater.

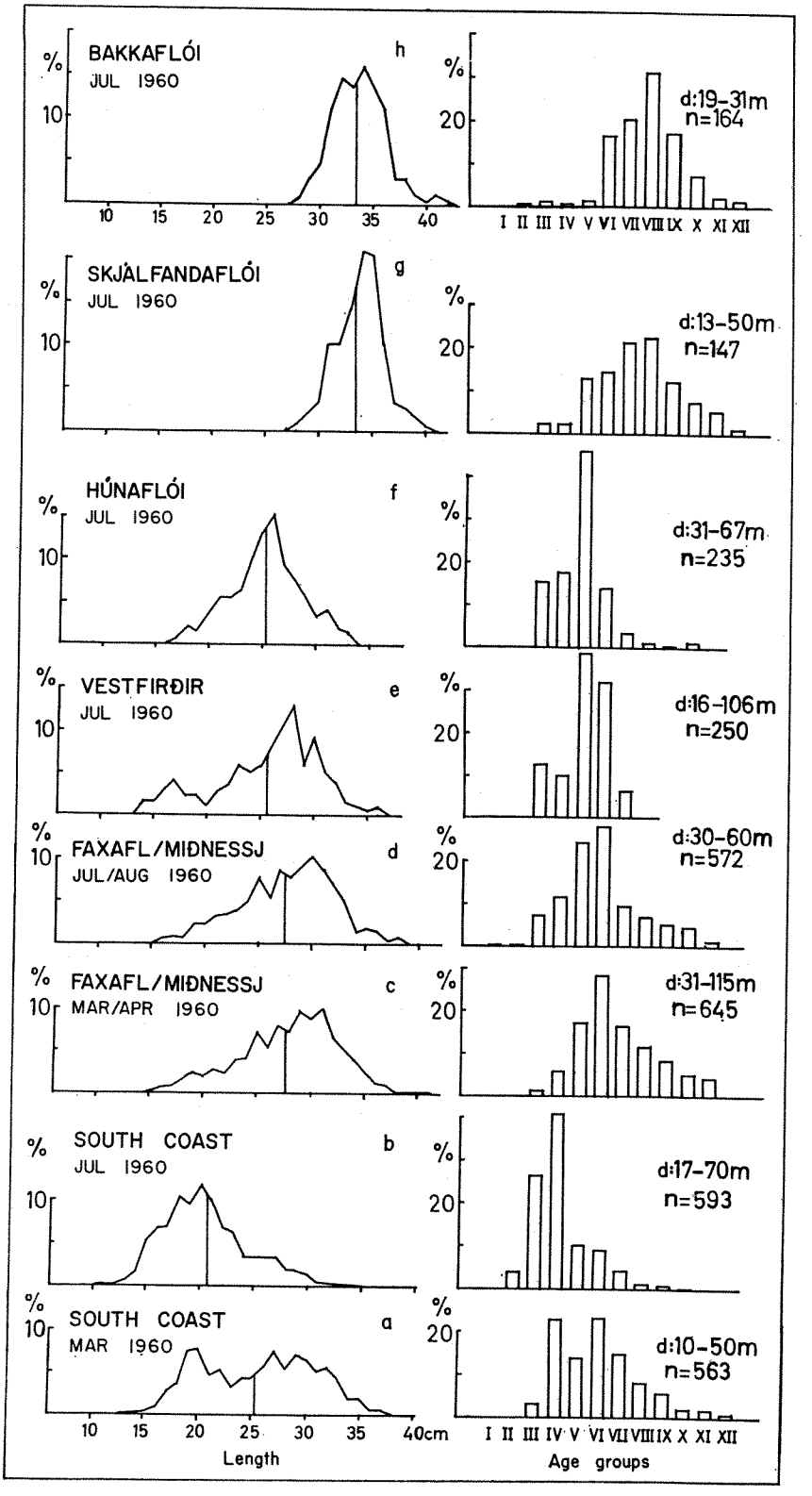
Comparison of the growth of the dab around Iceland with that in the North Sea (BOHL 1957) and western Baltic (KÄNDLER and THUROW 1959) shows that the Icelandic dab stands intermediately between the fast-growing dab in the western Baltic and the slow-growing dab of the North Sea (Fig. 5).

V. LENGTH AND AGE OF THE DAB

A. The Icelandic catches.

The length of the dab investigated ranged from 7—42 cm. The lower number was determined by the size of the mesh and the higher is most likely the maximum length that the dab reaches in Icelandic waters. Fish

FIG. 6. *Length and age distribution of dab in winter and summer of 1960.*


BAKKAFLÓI
JUL 1960
h
d:19-31m
n=164
SKJÁLFANDAFLÓI
JUL 1960
g
d:13-50m
n=147
HÚNAFLÓI
JUL 1960
f
d:31-67m
n=235
VESTFIRÐIR
JUL 1960
e
d:16-106m
n=250
FAXAFL/MIÐNESSJ
JUL/AUG 1960
d
d:30-60m
n=572
FAXAFL/MIÐNESSJ
MAR/APR 1960
c
d:31-115m
n=645
SOUTH COAST
JUL 1960
b
d:17-70m
n=593
SOUTH COAST
MAR 1960
a
d:10-50m
n=563
%
10
20
10 15 20 25 30 35 40
40cm
I II III IV V VI VII VIII IX X XI XII
Length
Age groups

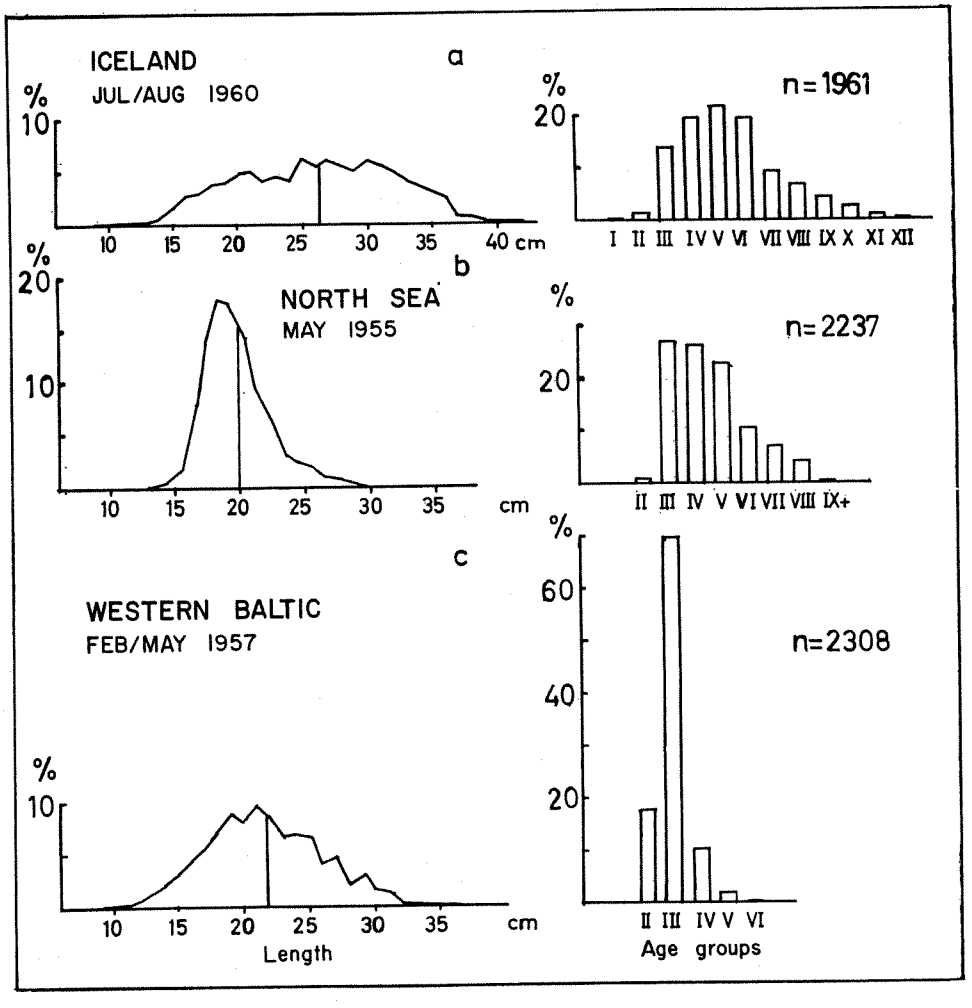


FIG. 7. *Length and age distribution of dab in Icelandic waters in the summer of 1960, in the North Sea in 1955 and in the western Baltic (Kiel Bay) in 1957.*

of 17—34 cm length are most frequent in the catches, with a maximum frequency at 27—29 cm. There are 13 age groups (I—XIII). Their frequency increases from age group I to age group V (19%) and then decreases from age group VI to age group XIII (Fig. 7). Age and size distribution in percentages at different localities around Iceland in 1960 are shown in Fig. 6. It is obvious that the stocks in Skjálfandaflói and Bakkaflói differ from other stocks in question as to length or size. Comparison of the length and age of the dab at different places around Iceland shows the following main features: In Bakkaflói the length groups 30—38 cm and the age groups from 6—10 years old predominated (92%). In Skjálfandaflói there was also

TABLE 4.

Length distribution according to depth.

cm	< 40 m		%	> 40 m < 80 m		%	> 80 m		%
7	1								
8	7								
9	22								
10	17	47	1.0						
11	18			1					
12	43			1					
13	84			5			1		
14	78	223	4.8	13	20	1.3	1	2	0.2
15	99			29			1		
16	109			37			12		
17	150			40			25		
18	182	540	11.6	63	169	11.2	32	70	8.1
19	202			74			46		
20	168			110			50		
21	130			105			44		
22	147	647	13.9	90	379	25.1	42	182	21.0
23	170			99			36		
24	187			90			41		
25	255			93			46		
26	239	851	18.3	108	390	25.8	47	170	19.7
27	313			100			48		
28	273			90			56		
29	293			98			65		
30	298	1177	25.2	70	358	23.7	64	233	26.9
31	290			71			59		
32	244			44			49		
33	190			35			40		
34	168	892	19.1	14	164	10.9	28	176	20.3
35	127			10			13		
36	82			11			10		
37	42			3			5		
38	22	273	5.9	4	28	1.9	—	28	3.2
39	5			—			—		
40	3			1	1	0.1	2		
41	2						2	4	0.5
42	1	11	0.2						
n	4661	4661	100.0	1509	1509	100.0	865	865	99.9
m	25.5			24.5			26.2		

a predominance of 30—38 cm fish but these were 5—11 years old. In Húnaflói, also located in the cold water area as were the two above-mentioned places, 20—31 cm fish were most frequent and these were 3—6 years old.

Fifty per cent of the catches consisted of age group V. In the warm water area off the south and west coasts the catches in the summer of 1960 consisted mainly of small dabs, 15—23 cm in length and 3—4 years old. During March of that year the length distribution has two maximal peaks, i.e. 17—23 cm and 24—33 cm. These correspond to the maxima in the age distribution, i.e. age groups IV and VI. In Faxaflói and Miðnessjór the catches during summer consisted mainly of 24—33 cm, 6—7 years old fish but in the previous winter, when the length distribution was similar, the age groups V—VIII were dominant. At Vestfirðir there were also two distinct length ranges, i.e. one from 14—20 cm (age group III) and another much more common one from 20—33 cm and age groups V—VI.

Table 4 shows the length distribution of the catches according to different depths. In shallower water than 40 m the mean length was 25.5 cm (4661 fish), between 40 and 80 m the mean length was 24.5 cm (1509) and at greater depths than 80 m the mean length was 26.2 cm (865).

The mean age of the dab was lowest at 40—80 m. Age groups IV—V were most common and the mean age was 4.7 years. In waters shallower than 40 m, the age groups V and VII were most frequent and the mean age was 5.4 years. At greater depths than 80 m the age group VI was the most commonly found and the mean age was 6.2 years.

B. Comparison with stocks in the North Sea and the Baltic.

It is interesting to compare the results of the investigations from Iceland with results of similar investigations from the North Sea and the Baltic. Fig. 7 shows the length and age distribution of the catches around Iceland during the summer of 1960 (warm and cold water area together) as compared with catches from the southern North Sea in May 1955 (Bohl 1957) and catches from the western Baltic (Kiel Bay) in Februar/May 1957 (Kändler and Thurow 1959). The differences are obvious and reflect the different life conditions of the dab in various areas. The catch from the western Baltic consists of relatively young fish characterized by high growth rate. The length distribution is from 10—37 cm, with maximum at 19—22 cm. Mean length is 21.8 cm. Age groups II—V are the only ones of importance in the catches and age group III contributes 70% of the catches. The mean age is 3.0 years. The catches in the southern North Sea consist of small and very slow-growing fish. The length distribution is 13—32 cm and 16—23 cm fish are most frequent, with maximum frequency at 18—20 cm. The mean length is 30.0 cm. Three fourths of the catches consist of age groups III—IV (76.3%). Age groups VII—VIII are of little significance and older fish are rare. Mean length is 4.6 years. The dab around Iceland in 1960 had a wide length range (9—42 cm) and many age groups (I—XIII). Mean length was 26.4 cm and average age 5.5 years.

TABLE 5.

Distribution of males and females according to areas and age groups.

			Total	%	
	♂	♀	♂+♀	♂	♀
I	23	21	44	52.3	47.7
II	122	133	255	47.8	52.2
III	608	481	1089	55.8	44.2
IV	728	495	1223	59.5	40.5
V	727	620	1347	54.0	46.0
VI	634	650	1284	49.4	50.6
VII	372	390	762	48.8	51.2
VIII	238	311	549	43.4	56.6
IX	105	149	254	41.3	58.7
X	56	86	142	39.4	60.6
XI	23	50	73	31.5	68.5
XII	4	8	12	33.3	66.7
XIII		1	1		
Total	3640	3395	7035	51.7	48.3

This comparison shows in a very interesting manner the different life conditions of these three stocks. The dab in the western Baltic grows very rapidly because of intense exploitation of all flatfish species, resulting in fewer dabs and decreased competition for food, as already mentioned. This high growth rate thus causes a recruitment of the dab to the exploited phase at a very early age (III) so older fish are rare. The stock in the southern North Sea is very different. It is very large but with a low growth rate and therefore the fishing only starts with older fish (from age group VI). The stock around Iceland is characterized by medium growth rate and relatively great quantity of large and old examples due to little or no exploitation.

VI. SEX RATIO

Of the 7035 dabs from 1926—1960 examined, males totalled 3640 (51.7%) against 3395 (48.3%) females. The males were more common in the younger groups, viz. from age group I to V (53.9%). The male proportion was largest in age group IV (59.5%). Then the males decreased in proportion and were nonexistent in age groups XII and XIII, but the female proportion increased accordingly (see Table 5). This proportional decrease of males in correlation with increased age is presumed to be caused by their higher death rate but no satisfactory explanation is available in detail.

TABLE 6.
Sex ratio according to depth.

I < *40 m*	II *40—80 m*	III > *80 m*
♂♂: 2125 = 45.6%	♂♂: 835 = 55.3%	♂♂: 680 = 78.6%
♀♀: 2536 = 54.4%	♀♀: 674 = 44.7%	♀♀: 185 = 21.4%
♂♀: 4661 = 100.00%	♂♀: 1509 = 100.0%	♂♀: 865 = 100.0%

The sex ratio was variable depending on depth, area and time. Females were more common in shallower waters (Table 6). On the spawning grounds the males were more abundant; they arrived earlier and stayed longer. This increases the possibilities of fertilization of the eggs and is explained thus: firstly, the males reach maturity earlier, secondly, males of younger age groups are more common than females and thirdly, the reproductive organs of the males are active for a longer period each year than the female ones.

Comparison of the sex ratio and the length shows (Table 7) that from 7—14 cm males and females are equally common (146 each). From 15—27 cm males are more common (68.5%). At 28 cm the ratio is equal (209 ♂ : 210 ♀) and from 29 cm females are dominant (63.8%). The largest fish (39—42 cm) are exclusively females (16 fish).

VII. MATURITY AND SPAWNING

A. Maturity-analyses of the catches in March-April and July-August 1960.

The following survey on the maturity of the dab around Iceland is based on 2763 analyses from the year 1960. In March–April, i.e. shortly before spawning, 1207 dabs caught off the south coast and in Faxaflói and Miðnessjór were examined as to maturity, and during the following summer (July–August) 1556 dabs were examined — 1143 from the warm water area off the south and west coasts and the remaining 313 from the cold water area off the north and northeast coasts.

The eight phase Heincke-Maier-scale (Jugendlich, Ruhe, Vorbereitung, Zusammendrängung, Streckung, Laichreife, Halbausgelaicht, Ausgelaicht), explained by BÜCKMANN (1929) and used by BOHL (1957) was not used here. Instead I used the following 4-phase scale generally used in Iceland (in parenthesis the corresponding Heincke-Maler-scale): I: immature (I), II: sex organs developed (II—IV), III: eggs and sperm running (V—VII), IV: spawning finished (VIII and II).

TABLE 7.

Length distribution (in cm) of males and females in Icelandic waters during 1926—1960.

cm	♂	♀	♂+♀	% ♂	♂	♂+♀	% ♂
7	1		1	100.00			
8	3	4	7	42.9			
9	11	11	22	50.0			
10	8	9	17	47.1	23	47	48.9
11	8	11	19	42.1			
12	25	19	44	56.8			
13	44	46	90	48.9			
14	46	46	92	50.0	123	245	50.2
15	81	48	129	62.8			
16	102	56	158	64.6			
17	140	75	215	65.1			
18	183	94	277	61.1	506	779	65.0
19	212	110	322	65.9			
20	206	122	328	62.8			
21	181	98	279	64.9			
22	186	93	279	66.7	785	1208	65.0
23	204	101	305	66.9			
24	187	131	318	58.8			
25	237	157	394	60.2			
26	223	171	394	56.6	851	1411	60.3
27	251	210	461	54.4			
28	209	210	419	49.9			
29	197	259	456	43.2			
30	177	255	432	41.0	834	1768	47.2
31	161	259	420	38.3			
32	114	223	337	33.8			
33	84	181	265	31.7			
34	73	137	210	34.8	432	1232	35.1
35	52	98	150	34.7			
36	22	81	103	21.4			
37	6	44	50	12.0			
38	6	20	26	23.1	86	329	26.1
39		5	5	0.0			
40		6	6	0.0			
41		4	4	0.0			
42		1	1	0.0	0	16	0.0
Total	3640	3395	7035		3640	7035	51.7

According to SÆMUNDSSON (1926) the dab around Iceland reaches maturity at 2—4 years. The males become mature at 2—3 years (10—15 cm) whereas the females reach maturity at 3—4 years (14—20 cm). BOHL

(1957) mentions that in the North Sea almost all males and ⅔ of the females are mature before the fish are three years old. The smallest mature males were 10.5 cm but females 11.5 cm. The largest juvenile males were 10.5 cm but females 18.5 cm. In the Baltic the males are mature at 2 years and females at 3 years and sometimes earlier (KÄNDLER, personal communication).

In my investigations from 1960 nothing indicates that females reach maturity before they are 3 years old. Males can reach maturity at 2 years, although most commonly they do not reach it until at 3 years. Females reach maturity at 3—4 years. The smallest mature male was 13 cm long and the smallest mature female was 16 cm. The largest juvenile males were 20 cm and females 21 cm. Both males and females may reach maturity when even smaller although I did not find any, possibly because of the low number of fish smaller than 15 cm I examined.

In March–April 1960 most of the fish, both males (82.6%) and females (58.4%), were at the stage II. 15.5% of the males but only 0.8% of the females had reached the maturity stage III, i.e. had already begun to spawn. Many females (40.5%) were already at stage IV, i.e. had not yet reached stage II. At the end of July and beginning of August by far the majority of the dabs had reached stage IV (spawning completed) — 79.6% males and 91% females. Yet males at stages II and III were also found (8.3% and 6.9% respectively) but almost no females at these stages.

In July–August 1960 the spawning season was well underway in the cold water off the north and northeast coasts. Most of the dabs had already reached stage IV, i.e. had spawned. Most likely the spawning in this area lasts until autumn because quite a few dabs were still at stage II and III.

B. Larvae.

1) ***Area investigated.***

The region of investigation was divided into four smaller areas, viz.: the south coast, from "Vestrahorn" to 64°00′N, west coast, from 64°00′N to "Ritur", the north coast from "Ritur" to "Langanes" and the east coast from "Langanes" to "Vestrahorn". This division into areas corresponds with the one that EINARSSON used in 1960 in his paper on "The Fry of Sebastes in Icelandic Waters and Adjacent Seas".

2) ***Material and Methods.***

The material was collected by Danish research vessels during 1924—1939 and Icelandic vessels during 1948—1951. The gear was a 2 m stramin-net.

During 1924—1937 two 10 or 15 minute hauls were made at most stations: a surface haul and a deeper haul with wire length of 65 or 100 m. During 1938—1952 only one haul was made of 30 minutes' duration, taken

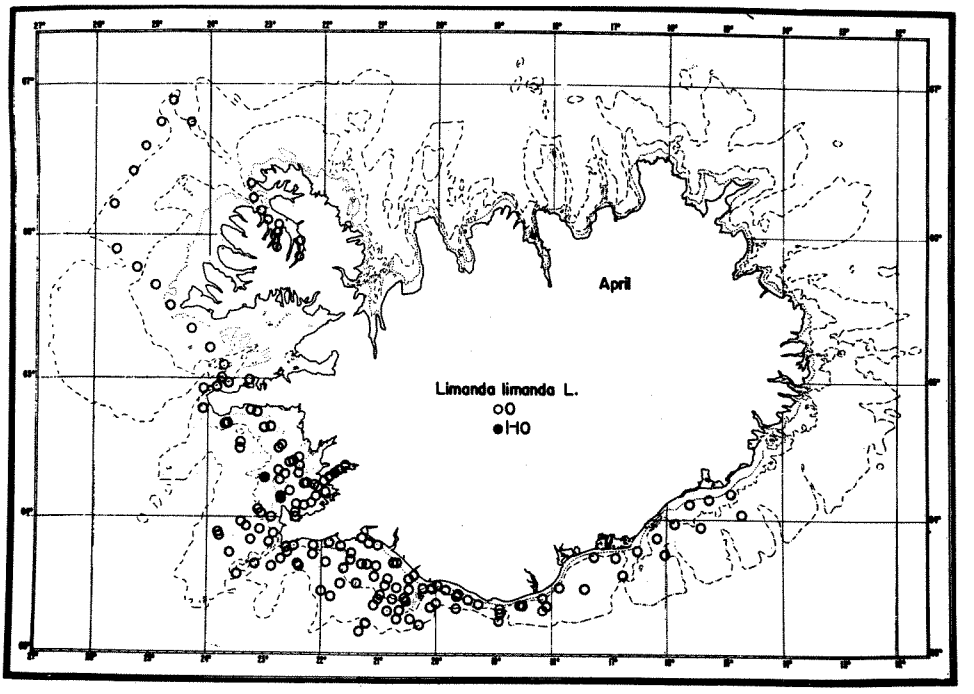


FIG. 10. *Frequency and distribution of dab larvae around Iceland in April. Number per 30 min stramin-net haul.*

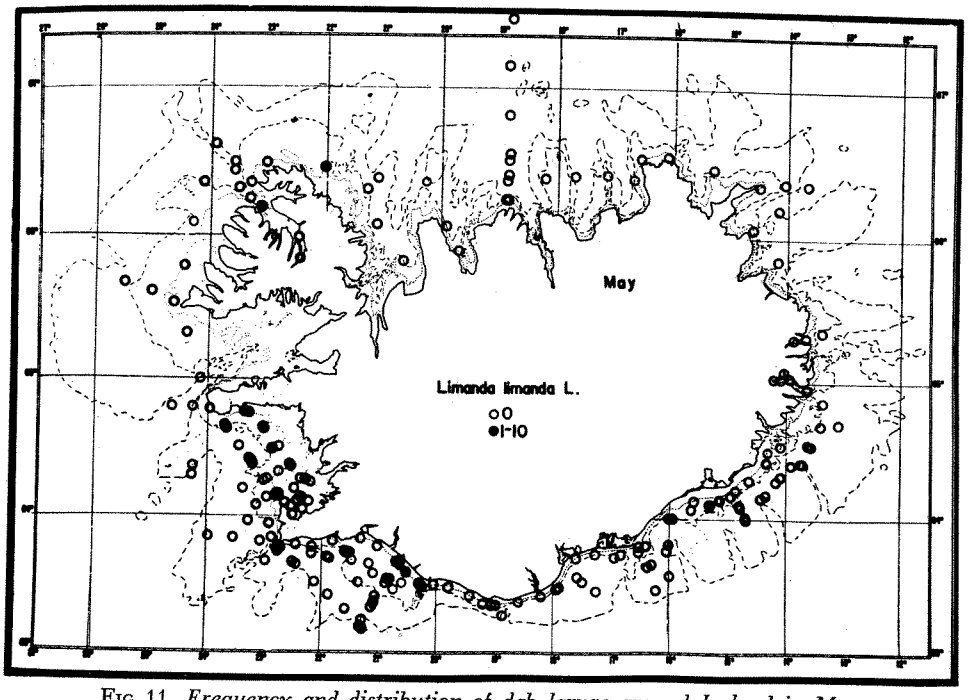


FIG. 11. *Frequency and distribution of dab larvae around Iceland in May. Number per 30 min stramin-net haul.*

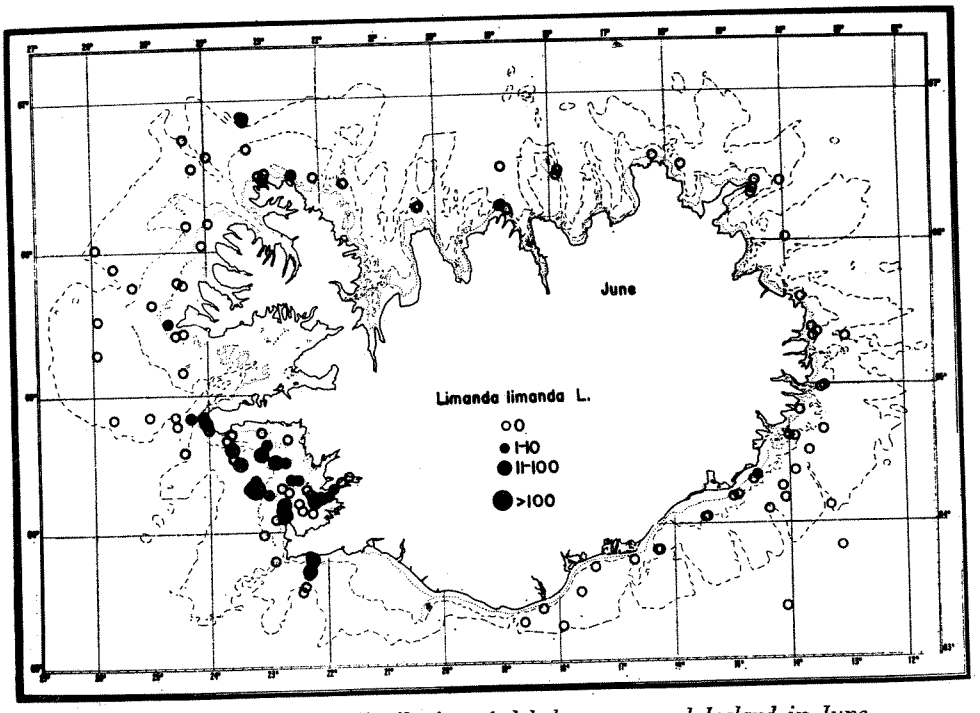


FIG. 12. *Frequency and distribution of dab larvae around Iceland in June. Number per 30 min stramin-net haul.*

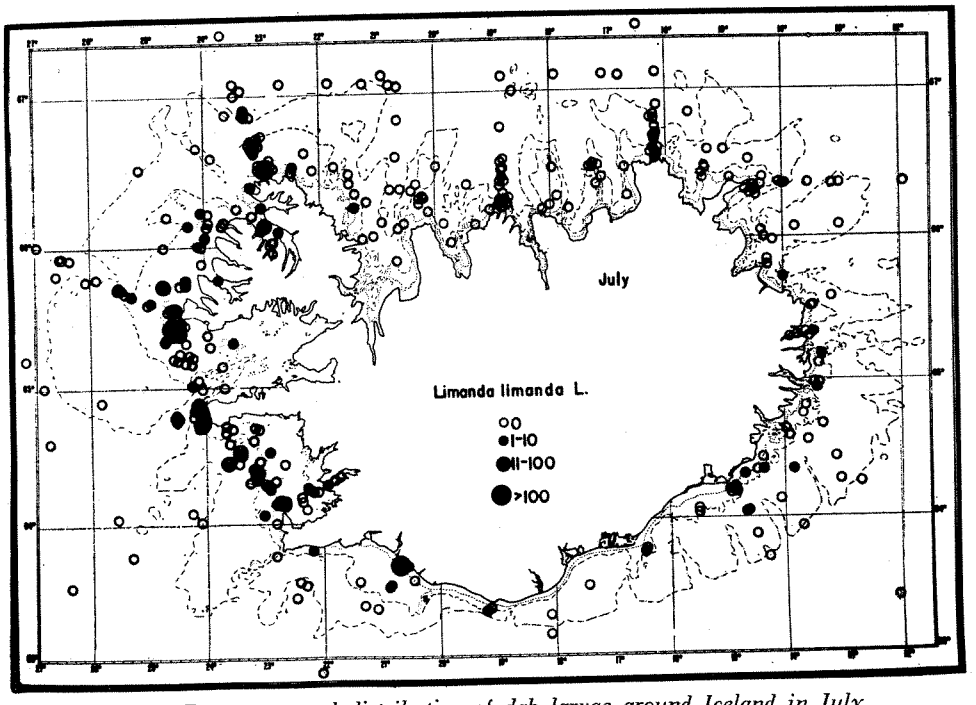


FIG. 13. *Frequency and distribution of dab larvae around Iceland in July. Number per 30 min stramin-net haul.*

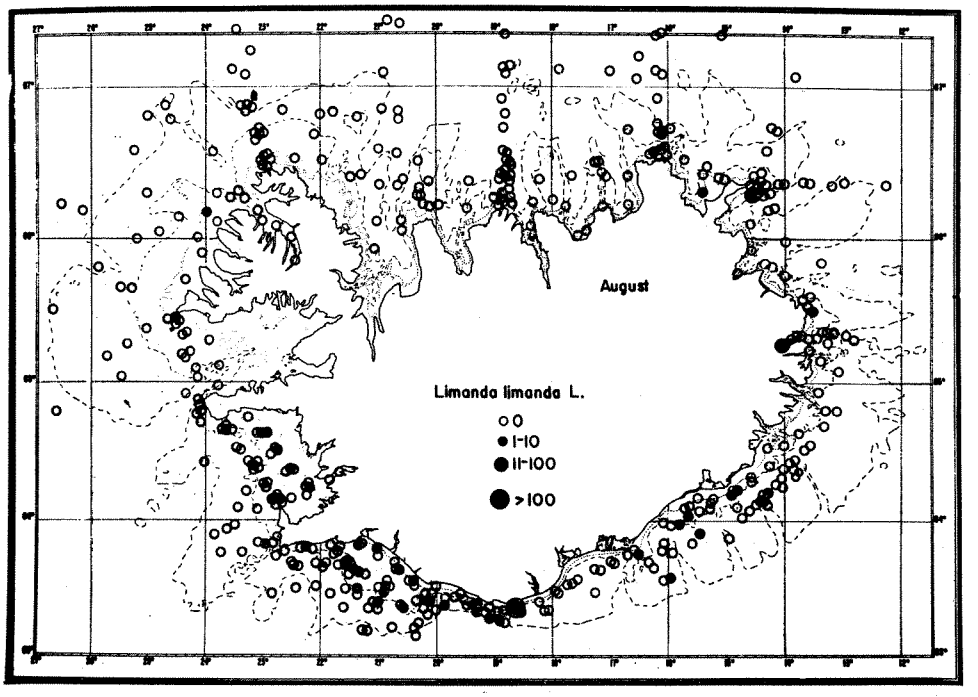


FIG. 14. *Frequency and distribution of dab larvae around Iceland in August. Number per 30 min stramin-net haul.*

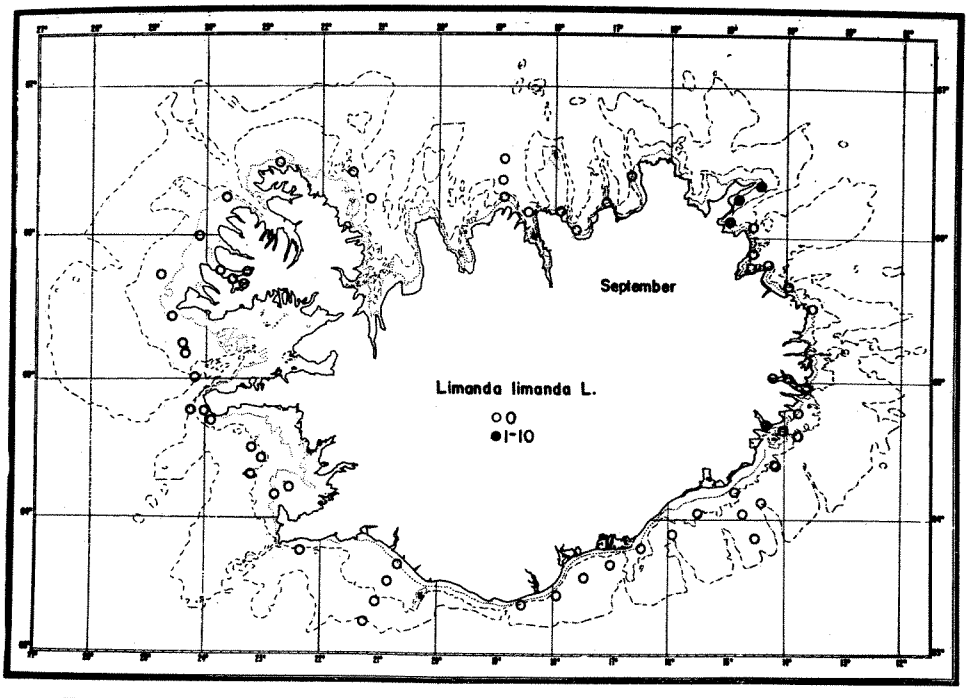


FIG. 15. *Frequency and distribution of dab larvae around Iceland in September. Number per 30 min stramin-net haul.*

in three steps. The lengths of wire used were most frequently: 300–200–100, 200–150–50, or 150–100–50 m. For comparison the numbers have been calculated per 30 minutes' haul (EINARSSON 1960). There were 1330 stations and these were worked during the months April to September.

The larvae material I used for analysis was mostly sorted into "*pleuronectes sp.*" which I had to separate into *Pleuronectes platessa* (plaice) and *Limanda* (syn. *Pleuronectes*) *limanda*, dab. The larvae of the Danish material had been sorted out during the research trips and some of the larvae of the Icelandic material had been sorted out by Dr. H. EINARSSON. He placed the material and his files at my disposal and I am greatly indebted to him for his kindness. I checked the determinations and measured all the larvae.

3) ***The development of the larvae.***

At hatching the dab larvae are symmetrical like all other flatfish larvae. The length is about 3 mm (EHRENBAUM 1909, SNAKENBECK 1925). When the larvae are 9—10 mm long the vertebrae have already been formed. At 11—13 mm length the rays in the dorsal and anal fins are so well developed that their number can be seen distinctly and at 12 mm length the caudal fin rays are visible enough to be used in the determination of the species (see later). Generally, when the larvae have reached 12—13 mm length the metamorphosis begins — sometimes it begins later — but at 18 mm length it is completed in most of the larvae (Fig. 8).

The dab becomes demersal when it has reached 12—17 mm length and differs in that respect from its close relative, the plaice, but during metamorphosis plaice larvae are pelagic.

TABLE 8.

Differences between the larvae of dab and plaice.

Dab	*Plaice*
1) size at hatching: ca 2,7 mm	size at hatching: ca 6—7,5 mm
2) black pigment at the pectoral fin	no black pigment at the pectoral fin
3) dark spots at the base of the dorsal and anal fin rays	no dark spots at the base of the dorsal and anal fin rays
4) No. of vertebrae: (9)10—11+(29)30—31(32) = 39—42	No. of vertebrae: 12—13+30—31 = 42—43
5) No. of caudal fin rays: 18	No. of caudal fin rays: 20

4) ***Recognition and characteristics.***

The larva that has the closest resemblance to the dab larva is the larva of the plaice. However, they are easily distinguished, e.g. by the characteristics shown in Table 8.

The first three criteria can easily be observed with a microscope but to be able to see the two last mentioned criteria, the larva must first be stained — for example in Alizarin dye solution. Fig. 9 shows a larva stained in this way.

5) ***Distribution, frequency and size of the larvae.***

Figs. 10—15 show where the larvae were found and their distribution around Iceland during April through September. Table 9 shows the number of stations, the total number of larvae, the number of larvae at each station and the number of positive stations according to month and area.

It is clear that the dab larvae are found all around Iceland. The occurrence of the first larvae in spring depends on the area. Larvae have been found at the end of April in Faxaflói (west coast area). One larva, 8 mm in length, has been found off the south coast on May 1. This indicates that they are already there in April. By the end of May larvae have been found off the north coast but not until shortly before the middle of July off the east coast.

The number of the larvae reaches a maximum off the south coast and in Faxaflói during June and July. Off the north coast the number of larvae reaches a maximum in July but not until August off the east coast.

Table 10 gives the mean length of the larvae according to month and area. Material is too limited, especially from the areas off the north and east coasts, to make it possible to come to any reliable conclusion about the mean length.

C. Conclusion.

The investigations on maturity and larvae indicate that the dab spawns all around Iceland.

The spawning starts off the southeast coast and presumably shortly before the middle of April, reaches its peak in the middle of May and is mostly finished by the end of June. The spawning spreads westwards along the south coast to the west coast, passes Reykjanes and moves into Faxaflói where spawning has already begun before the end of April. Off the north coast the spawning most likely begins at the end of May but the larva that was found off the north coast in the beginning of May must have drifted there with currents and originated elsewhere. Off the east coast the spawning could possibly begin around the middle of June.

TABLE 9.

Number of dab larvae caught in horizontal stramin-net haul of 30 min duration according to month and area.

Month	*area*	*no. of stat.*	*total no. of larvae*	*av. no. per stat.*	*av. no. per pos. stat.*
April	S	91	0	0	0
—	W	64	4	<1	2
—	N	5	0	0	0
—	O	—	—	—	—
April	Total	160	4	<1	2
May	S	95	11	<1	4
—	W	52	29	<1	10
—	N	29	1	<1	1
—	O	20	0	0	0
May	Total	196	41	<1	15
June	S	29	29	1	3
—	W	62	631	10	24
—	N	23	5	<1	2
—	O	17	0	0	0
June	Total	131	665	5	29
July	S	44	207	5	11
—	W	135	284	2	39
—	N	131	22	<2	11
—	O	39	17	<1	6
July	Total	349	530	2	67
August	S	150	226	2	29
—	W	90	29	<1	9
—	N	133	6	<1	3
—	O	58	54	1	3
August	Total	431	315	1	44
September	S	17	0	0	0
—	W	19	0	0	0
—	N	11	0	0	0
—	O	16	3	1	3
September	Total	63	3	<1	3

Because the material at hand was inadequate for studying fully the beginning and development of the spawning, it is impossible to reach any final conclusion about it. Future investigations might contribute to a better understanding of these questions.

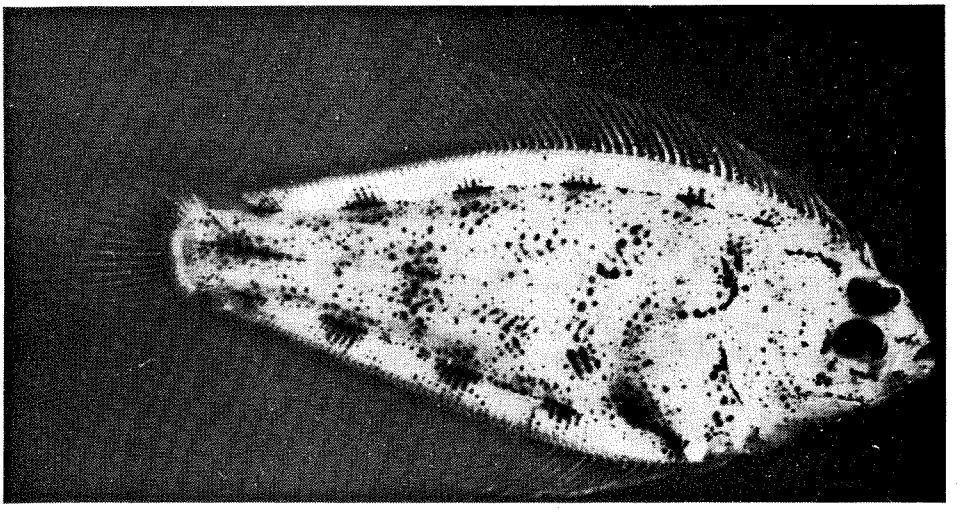


FIG. 8. *Larva of dab. Length 21 mm.*

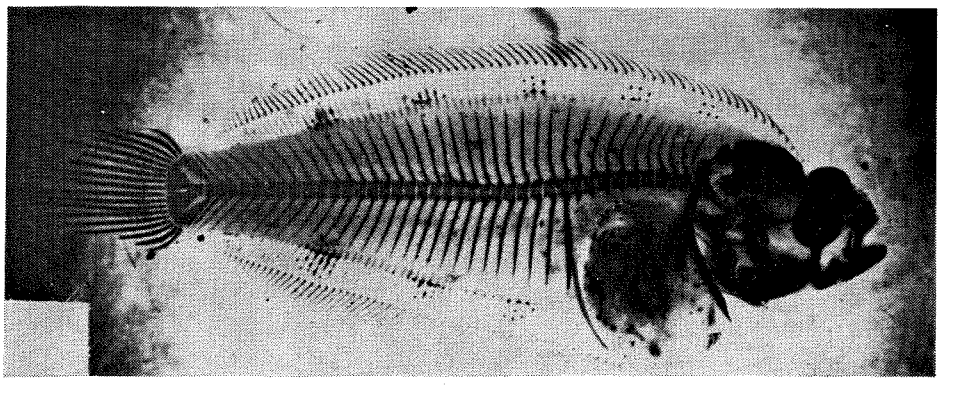


FIG. 9. *Larva of dab stained in Alizarin dye solution. Length 19 mm.*

Photos: Sverrir Guðmundsson

TABLE 10.

Length distribution and mean length (in mm) of dab larvae according to month and area.

	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	*n*	*M*
South coast:																																
May 1948—1951	2	1	7	–	–	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11	4.8
June 1924—1932	.	.	.	1	4	4	6	2	3	7	–	5	6	4	3	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	50	12.5
July 1927—1939	.	.	.	–	3	3	6	14	18	24	23	33	31	20	22	6	1	–	1	.	.	.	.	.	.	.	.	.	.	.	205	13.6
August 1948—1951 ..	.	.	.	1	1	9	20	25	18	9	16	6	4	7	3	3	–	1	–	.	.	.	.	.	.	.	.	.	.	.	123	11.5
	2	1	7	2	8	17	32	41	39	40	39	44	41	31	28	13	2	1	1	.	.	.	.	.	.	.	.	.	.	.	389	
West coast:																																
April 1951	.	.	.	.	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	7.3
May 1934—1950	1	5	9	9	2	–	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	26	5.2
June 1924—1951	.	7	13	14	10	21	15	17	20	29	23	18	26	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	217	10.6
July 1924—1950	.	.	.	.	1	4	9	31	35	51	47	27	35	9	4	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	259	12.6
August 1925—1951 ..	.	.	.	.	–	–	–	2	1	3	3	4	4	2	2	–	2	5	–	1	.	.	.	.	.	.	.	.	.	.	29	15.4
	1	12	22	23	16	26	24	50	56	83	73	49	65	15	6	4	4	5	–	1	.	.	.	.	.	.	.	.	.	.	535	
North coast:																																
May 1948	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	9.0
June 1926—1936	.	.	.	.	.	2	–	–	–	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	11.2
July 1926—1950	.	.	.	.	.	.	2	–	3	2	6	2	4	2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	22	13.7
August 1925—1927 ..	.	.	.	3	–	2	–	1	–	–	–	–	–	–	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6	7,3
	.	.	.	3	–	4	3	1	3	4	7	3	4	2	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	35	
East coast:																																
July 1927—1938	.	.	.	.	3	1	5	1	1	4	–	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	10.1
August 1927	.	.	.	.	1	2	1	2	–	–	2	–	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	9.8
September 1948	.	.	.	.	–	–	–	–	–	–	–	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	3	25.3
	.	.	.	.	4	3	6	3	1	4	2	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	28	

VIII. FOOD ANALYSIS

Investigations carried out on the food of dab in Denmark (PETERSEN 1893, BLEGVAD 1917), Helgoland (FRANZ 1910) and the Baltic (SCHULZ 1911, HERTLING 1929) indicate that the dab is a fairly greedy fish that eats almost every living creature it can master. Molluscs seem to be the main constituent in its food as well as polychaetes (errant and sessile), crustacea, gastropods, brittle stars and fishes. Also fish eggs and algae are eaten. SÆMUNDSSON (1909, 1926) mentions that the food of dab around Iceland consists of different species of invertebrates, as for instance crustacea (*Eupagurus, Gammarus, Caprella*), large and small polychaetes, small molluscs, *Mytilus* and also gastropods. Small fishes and often algae (green, brown and red) are also eaten.

During 1960 I collected 485 stomach samples for analyzing the food of dab around Iceland. In March–April 100 samples were collected in Faxaflói and 35 samples at Vestmannaeyjar. In July–August 350 samples were collected at different localities around Iceland (Table 11).

Stomach and intestines were cut out of the fish as soon as possible after it had been caught and put into a glass jar containing 8% formaldehyde to stop the digestion. Otoliths were also collected for age analysis and the fish were measured. Later the contents of stomach and intestines from each fish were examined. It should be mentioned that these investigations were only qualitative not quantitative — only the kind of food (species) was determined, not the amount. The samples were not weighed.

The result proved that the dab is a greedy fish that possibly competes with the plaice for food, at least for molluscs, but they are the main food for both these fish species. *Cyprina islandica* was found in great amounts

TABLE 11.

Food analysis of the stomach contents of dab in Icelandic waters.

Place	*Month*	*No. of dabs*	*length in cm*	*age*
Vestmannaeyjar	III	35	21—34	4—11
Faxaflói (Bollasvið)	III—IV	100	21—38	4—11
Húnaflói	VII	50	20—39	3—8
Skjálfandaflói	VII	50	16—38	3—11
Bakkaflói	VII	50	29—39	5—11
Vestmannaeyjar	VII	100	15—37	2—11
Faxaflói (Bollasvið)	VII—VIII	100	16—38	3—11
Total		485	15—39	2—11

in the food samples, also *Spisula elliptica.* Only one Mytilus mussel was found in these 485 samples (in Faxaflói, April). Apart from molluscs there were several species of polychaetes in the food samples. Fish were very common — almost exclusively *Ammodytes sp.* and *Mallotus villosus* — and very large individuals (up to 12 cm fish in dabs 20 cm long). They were swallowed whole with head first. Often there was more than one fish in each stomach. It is clear that the dab swallowed its food whole without chewing it, contrary to the plaice which for instance crushes the molluscs it devours with the pharyngeal teeth (HERTLING 1929). Crustacea were not as common in the samples as might be expected. *Eupagurus sp.* or parts of it were sometimes found. Most likely the younger dabs catch the smaller crustacea. Brittle stars and gastropods were also devoured. The dab probably avoids sea urchins as food.

The food depends on the time of the year. In late winter *Ammodytes sp.* and *Mallotus villosus* were most common in the samples (in 49.6%) followed by different molluscs (21.5%). During summer polychaetes were most abundant (36.9% against 3% during winter) followed by molluscs (34.5%).

The food differs also according to the size of the dabs. The smallest dabs investigated (16—25 cm) seemed to eat mostly polychaetes, dabs of 26—30 cm length preferred polychaetes and smaller molluscs (*Spisula*) but the largest dabs (>30 cm) chose fish and larger molluscs like *Cyprina islandica.*

The food did not only differ according to time of the year and size of the fish but also according to living grounds. In Faxaflói (Bollasvið) fish were most common in the samples during March–April, followed by molluscs (*Cyprina*). At Vestmannaeyjar fish were also most common in the samples followed by brittle stars. During summer molluscs (especially *Spisula*) were most common in the samples in Faxaflói but polychaetes at Vestmannaeyjar.

In the samples from the cold water area off the north and northeast coasts polychaetes were found in most of the samples from Húnaflói (68% of the samples). From Skjálfandaflói molluscs (*Cyprina*) were found in most of the samples (54%) and finally in Bakkaflói (Eiðisvík) green algae were the main food subject and found in 46% of the samples followed by molluscs (*Cyprina*).

IX. RACE ANALYSIS

A. Material.

Race analyses have been carried out on dab from the Baltic, Danish waters, North Sea and other places. The number of vertebrae and fin rays in dorsal and anal fins have been determined (KÄNDLER 1932, POULSEN 1933,

TABLE 12a.

Numbers of vertebrae in different areas.

Area	*n*	*Vert. S*	*Vert. precaud.*	*Vert. caud.*
Iceland S+SW	517	40.52±0.02	10.04±0.01	30.48±0.02
Iceland N	100	40.56±0.06	10.00±0.00	30.56±0.06
Iceland total	617	40.53±0.02	10.04±0.01	30.49±0.02
Iceland larvae	259	40.70±0.04	10.06±0.02	30.73±0.04
SE North Sea[1])	50	40.24±0.08	10.00±0.00	30.24±0.08
western Baltic[2])	38	40.21±0.10	10.50±0.04	30.16±0.10
eastern Baltic[3])	152	40.03±0.06	——	——

[1]) POULSEN 1933.
[2]) POULSEN 1933.
[3]) KÄNDLER 1932.

TABLE 12b.

Differences between the areas.

	Vert. S	*Vert. precaud.*	*Vert. caud.*
Iceland S+SW and Iceland N ..	0.04±0.06	0.04±0.01	0.08±0.06
Adults and larvae	0.26±0.04	0.02±0.02	0.24±0.04
Iceland and North Sea	0.29±0.09	0.04±0.01	0.25±0.09
North Sea and western Baltic ..	0.03±0.15	0.05±0.04	0.08±0.15
western Baltic and eastern Baltic	0.18±0.12	——	——

JENSEN 1937). According to the results obtained from these investigations, it seems as if the mean number of anal fin rays is variable in different areas. The dab in the North Sea presumably has more fin rays than the dab in the Baltic. It should be noted that the investigation has shown that abnormal vertebrae (fused) are more common in the Baltic dab than in the North Sea dab (KÄNDLER 1932).

In 1960 I counted the number of vertebrae and dorsal and anal fin rays in some dabs from Icelandic waters, both from the warm water area and the cold water area, and I also counted these same particulars in some dab larvae from the warm water area collected during 1936, 1938, 1946 and 1951 and compared the results with similar analyses from the North Sea and the Baltic. In addition to the results already at hand I also counted the dorsal and anal fin rays in 130 newly caught dabs from the western Baltic, 101 dabs from the North Sea (Deutsche Bucht) and 78 dabs from Kattegat, all collected in spring 1961. The Icelandic dabs I examined were collected during March–April 1960 along the south and west coasts and in July–August along the north and northeast coasts and along the south and west coasts. They were salted into barrels and examined later on land where the individuals were measured and sex-determined, otoliths collected and

TABLE 13a.
Mean numbers of anal fin rays (A) in different areas.

Area	*No. of dabs*	*A mean*
Iceland S+SW	761	57.71±0.07
Iceland N	311	57.65±0.11
Iceland total	1072	57.69±0.06
Iceland larvae	147	57.56±0.17
SE North Sea	101	56.57+0.19
W Baltic	130	54.64±0.16

TABLE 13b.
Differences between the areas.

Iceland S and Iceland N	0.06±0.13
Iceland adults and Iceland larvae	0.13±0.18
Iceland total and North Sea	1.12±0.20
North Sea and western Baltic ..	1.93±0.25

finally the number of vertebrae and anal and dorsal fin rays counted. Vertebrae were counted in 617 adult dabs, 100 of these coming from the cold water area, and also in 259 larvae. Dorsal and anal fin rays were counted in 1072 adult dabs, 311 of these coming from the cold water area, and dorsal fin rays were counted in 147 larvae and anal fin rays in 148 larvae.

B. Results.

EHRENBAUM (1936) mentions in his "Handbuch der Seefischerei Nordeuropas II" that the numbers of dorsal fin rays (D), anal fin rays (A) and vertebrae (V) in the dab are as follows: D: 65—80, A: 51—62, V: 10—11+30 = 39—40[1]). SÆMUNDSSON (1926) gives the following numbers for the Icelandic dab: V: 10+30, A: 50—62, D: 65—80. I got the following results: V: (9)11—11+(29)30—31 = 39—42, A: 50—66, D: 62—83.

Tables 12—14 give the results of race analyses from Icelandic waters, first on adult dab from the warm water and cold water areas and then on larvae from the warm water area. In addition, the results of race analyses from the North Sea, Kattegat and Baltic are given. It is clear that there is no marked difference between the dab in the warm water area in Icelandic waters and the dab in the cold water area, neither as to the number of vertebrae nor the number of dorsal or anal fin rays. On the other hand, the difference between the number of vertebrae of the larvae and the mature dab is greater than expected. The difference between the average num-

[1]) must be a misprint, should be 40—41.

TABLE 14a.

Mean numbers of dorsal fin rays (D) in different areas.

Area	*No. of dabs*	*D mean*
Iceland S+SW	761	74.16±0.09
Iceland N	311	74.04±0.14
Iceland total	1072	74.12±0.08
Iceland larvae	148	73.81±0.21
North Sea SE	101	73.72±0.24
Baltic W	130	71.18±0.19

TABLE 14b.

Differences between the areas.

Iceland S+SW and Iceland N .	0.12±0.17
Iceland adults and Iceland larvae	0.31±0.22
Iceland and North Sea	0.40±0.25
North Sea and western Baltic..	2.54±0.31

ber of precaudal vertebrae is negligible (0.02±0.02) but the difference between the mean numbers of caudal vertebrae is 0.24±0.04 and the difference between the total number is 0.26±0.04 and quite significant. The reason could be that the larvae with fused vertebrae are omitted in the calculation of the mean. The numbers of anal and dorsal fin rays are lower in the larvae than in the mature dabs but this difference is not significant.

When the results of these investigations on the dab around Iceland are compared with the results of similar investigations from the North Sea and the Baltic, it can be seen that the numbers of vertebrae and dorsal and anal fin rays decrease from Iceland through the North Sea and into the Baltic.

Briefly, it can be stated that the dabs around Iceland do not differ as to numbers of vertebrae, anal fin rays or dorsal fin rays. On the other hand they differ very much from the dab in the North Sea and the Baltic as to all these factors. In general the numbers are higher in the Icelandic dab.

It should be mentioned that TÅNING's investigations (1929) show that the mean numbers of vertebrae and dorsal and anal fin rays in the plaice around Iceland are higher than in the plaice in the North Sea and JOHANSEN (1929) shows that these same particulars in the plaice in the western Baltic are lower than in the North Sea. The analyses of JOHS. SCHMIDT (1930) on cod have also shown that the mean number of fin rays in the second dorsal fin (D_2) decreases from Iceland through the North Sea, Kattegat and Beltsea into the western Baltic.

The dab around Iceland also follows the suggested rule that fishes in northern regions differ from the more southern fishes of the same species in having higher numbers of vertebrae and dorsal and anal fin rays.

TABLE 15.

Quantities of dab landed from vessels of different nations from the seas around Iceland during the years 1924—1939 and 1945—1958.

Year	*Dab*	*Icel.*	*or %*	*Belg.*	*Denm.*	*Far.*	*Engl.*	*Scotl.*	*Ger.*	*Holl.*
1924	1130	—	—	—	—	—	815	68	246	1
25	1162	—	—	—	—	—	862	53	247	—
26	894	—	—	—	—	—	693	17	183	1
27	1203	—	—	—	—	—	997	8	198	—
28	988	—	—	4	16	—	943	1	24	—
29	918	—	—	8	5	—	876	9	20	—
30	714	—	—	1	15	5	665	2	25	1
31	724	—	—	1	37	13	635	3	32	3
32	819	29	3.54	7	40	7	709	12	15	—
33	642	22	3.43	2	44	—	554	4	16	—
34	562	13	2.31	2	18	7	514	—	7	1
35	645	26	4.03	8	12	—	574	18	7	—
36	781	45	5.76	4	18	—	695	16	3	—
37	747	27	3.61	10	19	8	662	18	3	—
38	626	36	5.75	9	16	5	532	17	11	—
39	50	—	—	11	—	—	—	23	16	—
1945—1946	253	—	—	3	—	—	139	111	—	—
1947	303	72	23.76	50	—	—	151	30	—	—
48	397	47	11.84	67	6	—	217	53	—	7
49	600	192	32.00	118	19	—	187	80	11	—
50	471	22	4.67	99	15	—	236	65	2	32
51	505	33	6.53	140	7	—	288	26	3	7
52	489	26	5.32	179	2	—	261	19	1	1
53	498	14	2.81	273	—	—	198	11	2	—
54	497	3	0.6	301	2	—	171	20	+	+
55	469	4	0.85	270	1	—	188	6	+	+
56	469	17	3.62	310	—	—	131	10	1	—
57	535	+	—	304	—	—	226	5	+	+
58	563	24	4.26	333	—	—	199	55	2	—
Mean 1924—1939	787.8	12.4	1.57	4.2	15.0	2.8	670.4	16.8	65.8	0.4
Mean 1945—1958	432.1	32.4	7.50	174.8	3.7	—	185.1	35.1	1.6	3.4
Mean 1924—1958	621.8	21.7	3.49	83.8	9.7	—	443.9	25.3	35.8	1.8

X. THE CATCHES IN ICELANDIC WATERS

The dab has never been caught in any amounts in Icelandic waters because it has no commercial value. Table 14 shows the amounts of dab landed from vessels of different nations from the sea around Iceland during the years 1924—1939 and 1945—1958. Table 16 shows the amount of other flatfish species from the same areas at the same dates for comparison. It

TABLE 16.

Catches of flatfish species other than dab landed from vessels of different nations from the seas around Iceland during the years 1924—1939 and 1945—1958.

Year	*Plaice*	*Lemon sole*	*Witch*	*Halibut*	*Megrim*	*Turbot*
1924	5244	1228	561	6052	87	—
25	5920	1163	443	6082	41	—
26	6534	1638	412	5000	24	—
27	7881	2184	565	5694	30	—
28	6445	2681	972	3754	279	—
29	6563	2565	996	2485	375	—
30	8278	2451	663	2538	321	—
31	8497	1930	1323	3044	322	—
32	6398	2416	1182	2958	312	—
33	4642	2201	1058	3065	239	—
34	4670	2368	1283	3058	356	—
35	5337	2366	1229	2818	385	—
36	5149	2719	1289	2607	397	—
37	5567	3003	1058	2868	324	—
38	4150	2257	1166	2629	415	—
39	ca. 959	ca. 492	ca. 775	1183	389	+
1945—1946	7656	1383	183	3291	1220	+
47	7237	1055	688	2051	203	+
48	9310	1777	1718	4698	540	+
49	10572	1859	1823	5861	643	+
50	9172	2313	1106	5937	516	2
51	8439	2023	1164	6626	638	+
52	5578	1694	750	5730	503	10
53	4693	1628	594	4798	673	1+
54	5663	1605	778	3956	698	5
55	7733	1329	775	3219	597	3
56	7888	1484	782	3259	559	1
57	9603	2578	1092	4766	710	1
58	8163	1612	1186	6698	701	+
Mean 1924—1939	5764.6	2103.9	935.9	3489.7	268.5	
Mean 1945—1958	7264.8	1595.7	902.8	4349.3	585.8	1.6
Mean 1924—1958	6464.7	1866.7	920.5	3890.8	416.6	

should be mentioned here that in landings, as well as in sorting and later in the statistics, the dab (*Limanda limanda* L. syn. *Pleuronectes limanda* L.) and the long rough dab (*Hippoglossoides platessoides* Fabr. syn. *Drepanopsetta platessoides* Fabr.) are often mixed up and simply called dab according to LUNDBECK (1937).

The catches of dab from Icelandic waters have decreased from 788 t average during the years 1924—1939 to 432 t 1945—1958. The year 1924

was a record year with 1203 t. During the period 1945—1958 the best catches — of 600 t — were taken in 1949.

During the period 1924—1939 the dab in Icelandic waters was mainly fished by the English. During 1945—1958 most of the fishing was carried out by the English and also Belgians. The proportion caught by Icelandic fishermen has always been small. It is not until 1932 that the Icelandic catch of dab appears in statistical tables. The quantity of dab fished before the World War II varied between 13 t as minimum in 1934 and 45 t as maximum in 1936, i.e. 2.3% and 5.8% respectively of all dab landings from Icelandic waters. After World War II the Icelandic catch reached 192 t as maximum in 1949, i.e. 32% of the landings from Icelandic waters and Icelanders reached first place in dab fishing. After that the landings dropped to less than 1 t in 1957.

As to amounts of flatfish species landed from Icelandic waters, the dab ranks sixth, preceded by plaice, halibut, lemon sole, witch and megrim.

XI. SUMMARY

The present paper is about the biology of the dab (*Limanda limanda* L.) in Icelandic waters. It deals with analyses of the stock size, otoliths, age and growth, sex ratio, maturity and spawning, larvae, food, race analysis and finally the commercial catches of previous years are discussed. The results are often compared with similar results of investigations on dab in the North Sea and the Baltic.

The material was collected by Danish research vessels from 1924—1939 and Icelandic vessels from 1948—1960.

The dab is very common around Iceland at 0—120 m and most frequent at 20—40 m depth.

Age analyses were carried out on 7035 dabs. Remarkable was the great number of crystalline otoliths, especially in dabs from the cold water area off the north and northeast coasts.

The dab in the cold water area seems to grow faster than the dab in the warm water area. The reason could be better food conditions due to smaller stock size. The females grow faster than the males. The Icelandic dab grows faster than the dab in the North Sea but slower than the dab in the western Baltic.

The stock of dab around Iceland is characterized by medium size, medium growth rate and a relatively large number of old fish.

During the first five years of life the males are more common but after

that the females are predominant. This is reflected in varying length ratio according to sex. Up to a length of 27 cm males are more common, but females from 29 cm, and fishes larger than 39 cm are exclusively females. Females are more frequent in shallow waters but males at greater depths (>40 m).

Males reach maturity at 2—3 years and 10—15 cm length — females at 3—4 years and 14—20 cm length.

The larger larvae are easily distinguished from plaice larvae by the numbers of precaudal vertebrae and numbers of caudal fin rays.

The dab spawns in the warm water area as well as in the cold water area. The spawning begins off the south coast, probably a little before the middle of April, and then slowly progresses westwards and to the north.

The food of the dab depends on the bottom animals in their habitats, the size of dab and time of year. The food consists mainly of various molluscs, but during winter fish are important, as well as polychaetes during summer.

Race analyses do not show any difference between the dab in the warm water area and the dab in the cold water area, neither as to numbers of vertebrae nor dorsal and anal fin rays. On the other hand, there is a great difference between the dab in Icelandic waters and the dab in the North Sea and western Baltic with respect to all these factors.

The commercial value of the dab in Iceland is negligible.

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