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THE FLUCTUATIONS IN THE EUROPEAN STOCKS OF COD.

BY

OSCAR SUND.

WITH A NOTE ON THE FLUCTUATIONS IN THE NORTH-WESTERN AREA
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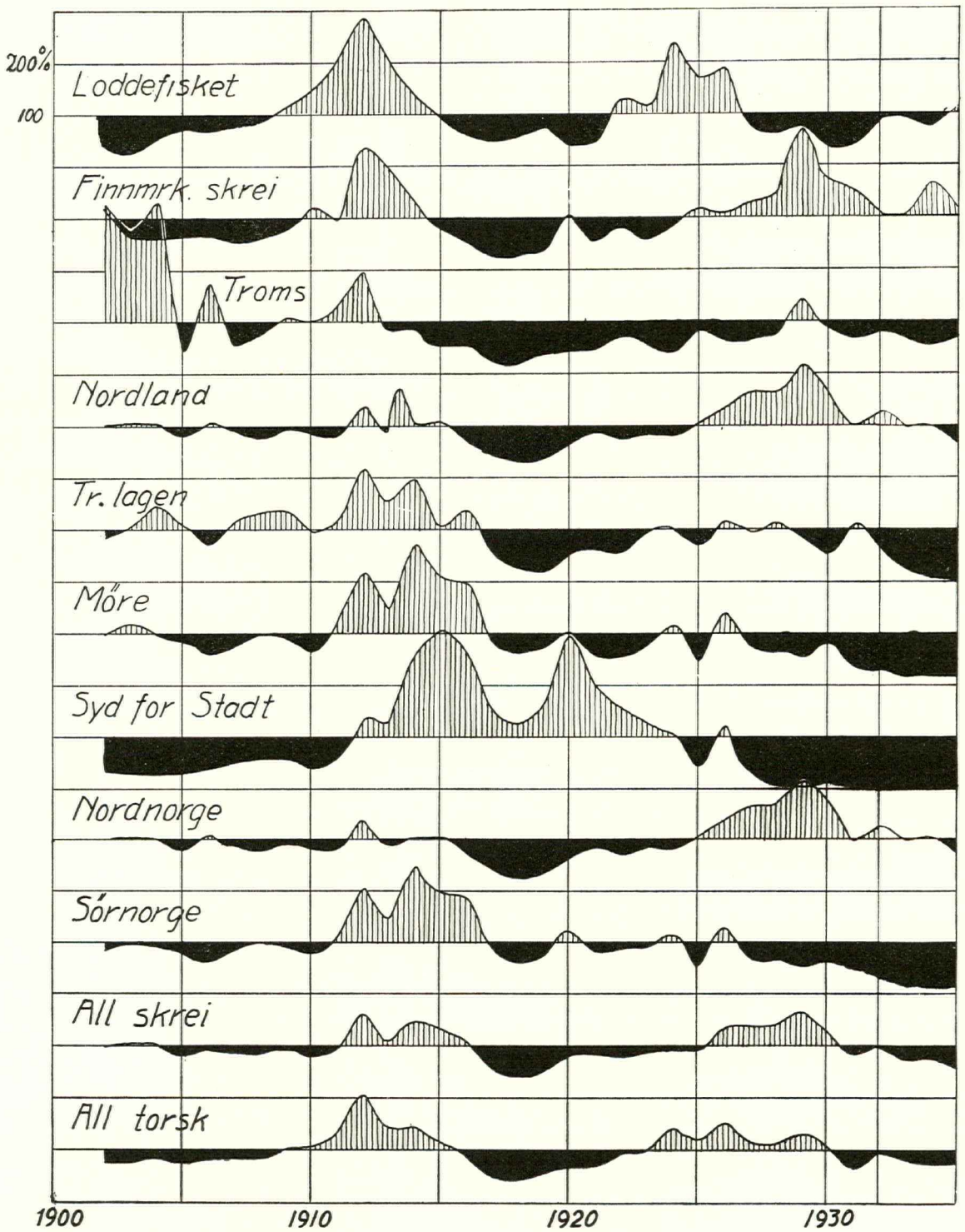


Fig. 1. Fluctuations in the Norwegian Cod Fisheries 1902—1935 given in percentages above (hatched) or below (black) the average catch. (Translation: *Loddefisket* = Finmark spring fishing; *Skrei* = spawning or mature fish. *Nordnorge* = Norway north of lat. 65°; *Sörnorge* = Norw. coast south of lat. 65°. *Torsk* = cod).

THE yield of nearly all fisheries is subject to considerable variations. The first to draw attention to one of the main causes of this, generally unpleasant, circumstance was Dr. Johan Hjort who in a paper, which appeared in 1914, offered the first general demonstration of the spasmodic recruitment of the Norwegian stocks of cod and herring which are the main objects of the fisheries of that country. (See Figs. 1—4).

Since then the different fish populations have been the subject of much research and a great deal of information has been gained as to the variations of these stocks in point of age composition, migrations and natural history generally.

Since knowledge of the present and especially the expected size of the populations of the important fishes is one of the foremost objects of fishery research, the International Council has considered the time as ripe at least for taking stock of the available data regarding the fluctuations of the different fish populations.

During the score of years which has passed since the publication of Hjort's paper, a vast amount of research work has been done, we must, however, confess a slight disappointment when trying to bring together the available data concerning the annual recruitment of the cod, this most important commercial fish — the data are not so extensive as might be desired it be in point of time or of space. On the other hand, it is believed that they are sufficiently extensive as a means of the first approach to the great question of the natural causes, to which the fluctuations are due.

The different Kinds of Data.

In the case of fish populations of great longevity (like some cod and herring stocks) a determination of the age composition of the commercial catch of a single year will provide qualitative information of the relative success of a long series of preceding broods, even if no account is taken of the absolute number of fish landed, and material of this kind is available, though of varying quality as to the certainty of the age determinations, from the two most important cod stocks, viz., the Iceland-Greenland and the Arcto-Norwegian ones. But in order to determine the true relation between the successive broods, knowledge of the mortality of each year-group is required as also data represensative of the actual size of the stock of the year in question. If, now, our sample of the long-living stock were known to be fully representative, the age determinations correct in every case, the mortality coefficient exact, and an estimate of the stock based on relevant and trustworthy material, one single year would give us the effective strength of as many broods as year-classes were represented in the age composition sample.

These ideal conditions are, of course, unattainable; we have to make the best out of more or less approximative data and especially to take recourse to time, — i. e. to compare and to combine the information gained from repeated investigation of the age composition during a number of years. By so doing we will be able to judge whether the sampling has been adequate and the method of age determination sufficiently correct to give consistent results from year to year.

Scale or Otoliths.

For young fish the scale and the otolith methods give results of approximately even value. This is not so, however, as soon as the fish attains sexual maturity as shown by Gunnar Rollefsen (1933 ff) who has produced very convincing evidence for his explanation of the extremely narrow outer year-rings seen in many large cod, — namely that these narrow growth zones are formed in years of sexual activity. To these narrow "spawning zones" (as we believe we are justified in calling them) very often the corresponding zones in the scales are absent.

In utilizing the Norwegian scale determinations of age, all fish, older than those determined as 9 years in the case of mature fish and 10 years as immature fish, have been excluded from consideration, thereby excluding the great majority of fish with misleading scales.

If no account can be taken of the varying strength of the stock, the percentage age composition will still give us a good qualitative idea of the preceding brood strengths in such stocks which consist of a number of year-groups, but even with as few as three one may arrive at interesting results as shown by comparing the different series of data from the Norwegian Skagerak coast where the catch statistics are considered of doubtful value and are, therefore, not used.

Measurement Series.

Still another kind of data might be used, namely the frequencies corresponding to the known mean lengths of young year-groups, as found in extensive ichthyometrics. This sort of data has proved of value in studying the brood strength of the Arcto-Norwegian stock although one might expect that the frequencies pertaining to one year-group must be infected by the nearness of the neighbouring groups. Comparisons between the result gained from scale and from otolith readings of the same source show, however, that also this sort of data may serve as corroborative evidence if used with circumspection, especially if only the smaller sizes are considered. The safest would have been if one could have used only the frequencies corresponding to the mean size of the youngest (3-year-old) fish taken in the Finnmark fishery (where all fish are caught by hook — either long lines or jig), but this is not feasible as new broods (in most of the known cases) do not arrive in the Finnmark coastal waters until 5 years old. It has therefore been necessary to consider the frequencies corresponding to 5 and 6 years. Trial calculations have shown that the two sets of figures thus obtained give the most consistent results.

Relative Catch.

In the case of a sampling which for one reason or another is limited to one year-class or to a very few ones, the relative number caught in each year will be our principal guide because there is no possibility of comparing and combining the estimates for the same brood through a sequence of sampling years. This sort of weighted sampling is available regarding the North Sea stock which has been studied with much ingenuity by Graham (1934) by combining the extensive English ichthyometrical data with the equally excellent statistics of the catch of the category "small" by Grimsby trawlers, — a large fleet which every year is sweeping the whole of the North Sea in a very regular and efficient manner.

Under this aspect also come the data which have been gained by the Danish Fishery Research — the amounts of young fish and larvae caught by the research vessels in corresponding seasons every year with standard gear (the "tog" — a miniature otter trawl — and plankton- (egg-)net), as set out in the excellent paper on the Danish investigations by Dr. E. M. Poulsen (1931). The comparison of the data gained from the relative quantities of the two younger stages (0- and I-group) is very interesting in giving consistent results as to brood strengths, and the obvious conclusion of this must be that the fate of a brood is not determined *between* the pelagic and the benthonic stage. The alternatives are then: either before the pelagic or after the benthonic stage, the former being, of course, the more likely one.

Method of Treatment.

In all cases, where data were available to allow a weighting of the figures given for each sampling year, this was done, though in one case (Finnmark measurement frequencies) also a calculation without such weighting was carried through (Ser. 9 and 11). The result (Ser. 9) is rather different from the corresponding weighted series and has not been considered in the "simplified view" of results. — But in many cases such necessary data were not available, and the different sampling years then had to be treated as of equal weight. This is the case, unfortunately, with Greenland and Iceland. Other data are by nature weighted, namely the figures concerning larvae and young fish in Danish waters.

But whether such "catch-weighting" is performed or not, another kind of weighting should be (and was) applied in every case where more than one year-class was considered: "age-weighting" or bringing all the figures relating to one year-class through a series of years (whether "catch-weighted" or percentual) up to a total for the period in question equal to the sum of figures relating to the averagely most numerous year-class. Suppose the number of 6-year-olds be only half that on an average, of the most numerous class, say, the 8-year-olds. The importance of 50 6-year-olds from a certain brood year will then evidently equal the importance of 100 8-year-olds. This procedure does not imply any theory about mortality or recruitment factors, it only re-states what the series of data contains. The longer the series, the better values are obtained for the average occurrence of the different ages. If the series is short, it may well happen that fish of a certain age have been more scarce than both adjoining year-classes, as in the case of the figures for Westman Islands. This will certainly not occur if a long series of sampling years can be used, and in the case mentioned the last sampling year (1935) was excluded from the calculation because it had a very unique age composition due to the continued prevalence of the two old broods, 1922 and 1924.

When the weighting in respect of age and (if possible) in respect of catch has been done, the so reduced values are arranged according to brood years and all entries in respect of each brood are

added. Their number will equal the number of sampling years only for the middle part of the series of broods; the figures for those broods which are represented by fewer entries are raised, but of course, the values so gained are of the less interest the fewer entries they are derived from. The first and the last sums are generally not considered, as they are each in most cases based on a single observation of one of the rarer year-classes (old or very young). Each of the sums is now expressed as percentage of the average of all sums of brood strength figures. These are the calculated brood strengths listed in the synoptical table.

Survey of the Material Considered.

I. The North-Western Area Stock.

Regarding *Iceland* we rely upon the otolith investigations of Arni Fridriksson, Reykjavik, covering samples from the years 1928—1935. The data concerning the years 1928—1933 have been published (Tåning, 1931, and Fridriksson, 1934), the data for 1934 and 1935 have been kindly submitted by letter.

It is true that also earlier age determinations from Iceland have been published, due to the zeal of Bj. Sæmundsson, (1923), but interesting as this work is from many other view-points, it does not provide such serial information as might be considered adaptable for the special question of brood estimation.

Sæmundsson gives, however, details of 2 samples from the SW. coast which render some interesting information for our purpose (Westman Isles), viz., August 1919, 237 ind. and (Eyrarbakki) July 1917, 133 ind. Arranged according to broods and expressed in per mille they give us the following figures:

Samples from	Brood Years W.-I. 1919	E. b. 1917
1904	4	—
05	—	8
06	4	8
07	8	15
08	13	23
09	51	15
1910	55	113
11	190	346
12	177	196
13	190	188
14	118	90
15	114	—
16	72	—
17	8	—

It appears thus that the broods 1911 and 1913 have been comparatively well represented at SW. Iceland at that time, while in Greenland waters

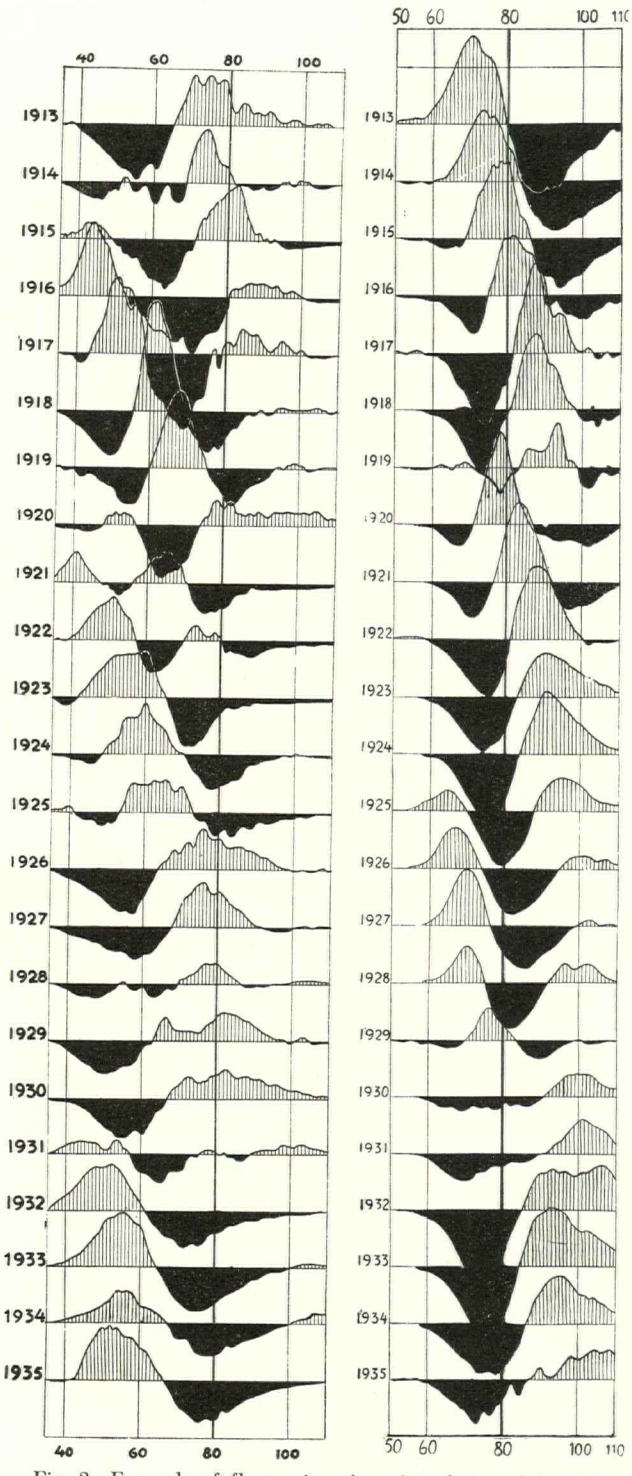


Fig. 2. Example of fluctuations in point of size of the fish. The ordinates represent No. of fish per 10 thousand within each cm.-class above or below corresponding average figure (average 1913 to 1932). Left row immature (Finnmark, Spring) fish, right row spawning fish.

the dominant cod broods in samples from 1924 and 25 seem to be those from 1909 and 1912 (not considering later years). We only note this, without drawing any definite conclusions as to broods on the basis of these small and lonely samples.

The material from *West Greenland* has been arranged and kindly submitted by Dr. Å. Vedel Tåning, Copenhagen, partly from the published work by Mr. Paul M. Hansen, partly from unpublished data.

Considering the results regarding Iceland and Greenland, as set out in the synopsis and in the simplified view, it is apparent that a general rough agreement prevails as to success of broods except for the broods 1914 and 17, the former appearing as a good brood at Greenland while very lean at Iceland, the 1917-brood as very rich at Greenland and medium at Iceland. The good brood of 1914 at Iceland rests, however, only on the high figure for 14-year-olds at Westman Islands, and if the figures from this place regarding the generally numerous year-classes (7—12) are considered (instead of 6—15 as in the calculation rendered in the synopsis), the year 1914 is not reached by the available data and the brood 1917 appears as somewhat above the average — namely 124 % — or in figures representing brood strength at Westman Islands:

Brood Strength

	Broods considering ages	
	7 – 15	8 – 12
1914	247	—
15	210	—
16	118	—
17	84	124
18	37	65
19	66	82
1920	32	34
21	39	22
22	273	265
23	127	122
24	142	159
25	26	25
26	33	23
27	26	—
28	42	—

The values gained from these two sets of calculation from the same material show, for one thing, that it is unsafe to pay too much attention to results resting on one or two sampling years only as will be the case regarding the first and last few broods revealed in any series, especially if the sampling conditions (regularity of the fishing in point of time and place) are unstable. It will therefore be safe to disregard altogether the Iceland broods earlier than 1917 and later than 1925.

Regarding the apparent great strength of the 1923 Iceland brood, there may be reason to believe that some of the 1922-fish were classed as 1923 in 1931 and 1932 as the detailed results from these years (Fridriksson, 1932 and 1933) show a gradual shift in preponderance from the 1923 to the 1922 year-class in the course of both the sampling seasons. The most likely way to account for this shift is that the last year-ring becomes more and more apparent at the edge of the otoliths as the season proceeds.

II. The Arcto-Norwegian Stock.

While the unity of the stocks of cod at Iceland and Greenland can not be looked upon as definite though the great number of recaptures in each area of fish marked in the other, the certainty on this point in respect of the fish which are found in Spring all along the coast of Norway from Bergen to West Finnmark, during the rest of the year at the Finnmark coast and all over the Barents Sea, including Spitsbergen, approaches 100 per cent. judging from numerous marking experiments and also from the racial resemblance of the fish from the different sections of the North-Eastern Area. But that does not do away with the fact that the fish appearing in the different parts of this vast area and at different seasons belong to very different biological categories, and it would therefore have been of interest to have material, not only from the different parts of the Norwegian coast, but also from different parts of the Barents Sea. The material from the open sea is, however, very scarce, the most coherent being the age determinations by Lundbeck, Wesermünde, of cod landed in Germany. Among the samples of which Dr. Lundbeck kindly has supplied the details (printed here as Ser. 6, 7) only 2 series could be used for our purpose. The sampling conditions connected with the trawl fishery can not be expected to give uniformly sampled material and the data obtained from these two short series do not furnish much striking evidence — which might, indeed, scarcely be expected when the numbers of sampling years are 3 only.

At the coast of Norway the sampling conditions are very good, with a fishery that has continued in the same way and with about the same intensity for a long period. Single samples were obtained as early as 1906, 1907 and 1909 but an annual sampling was not started until 1913, of spawning cod (skrei) as well as immature (and recovering) cod. Scale determinations are available up to the end of the twenties, and later on otolith reading has been taken up.

The difficulties attending scale reading (see Sund, 1927) are great and especially the narrow outer growth zones, so clearly seen in the otoliths, are frequently lost in the scales. The series of age determinations by scales have therefore been

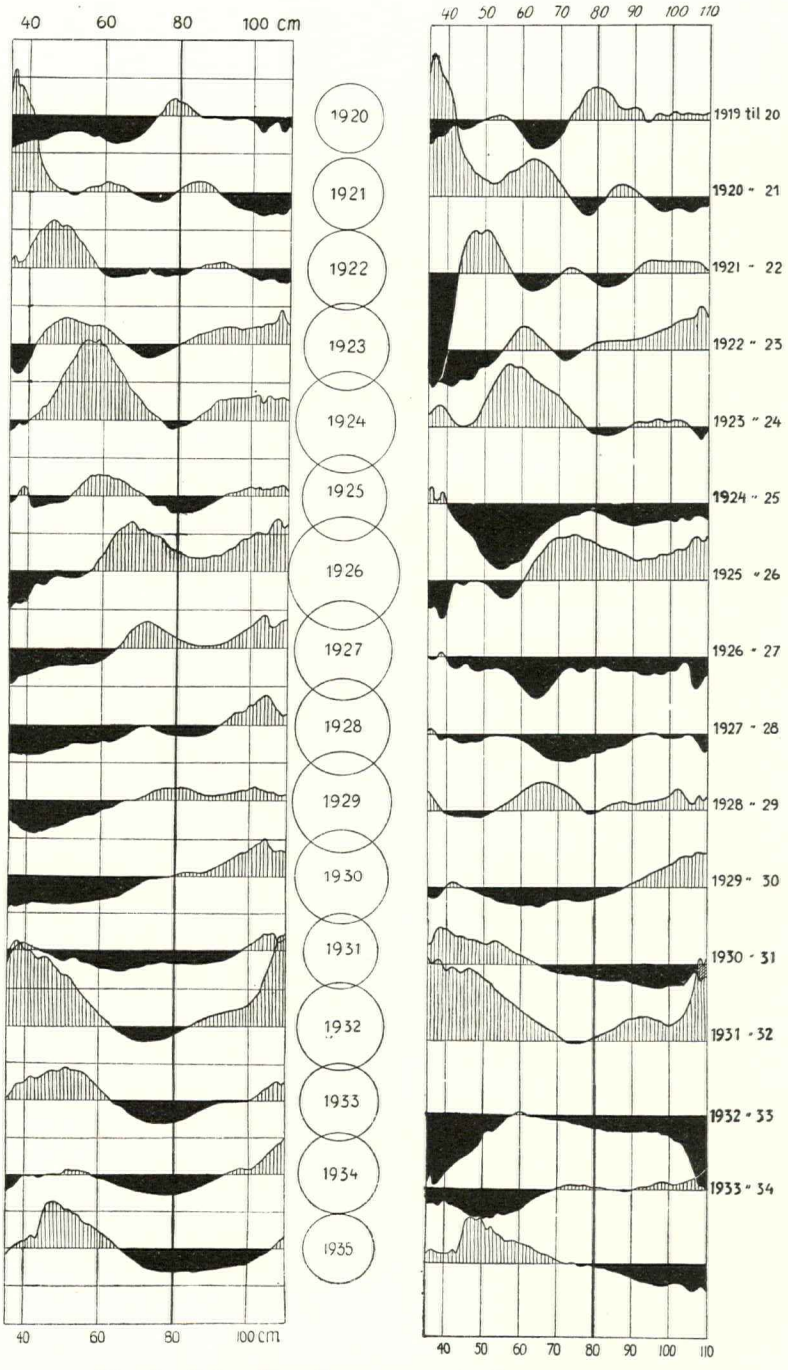


Fig. 3. Left: The fluctuations of all Norwegian cod fisheries, with consideration of size of fish *and* catch per unit ("per man per day at sea"). Ordinates are percentages of average number within each cm.-class. Right: Differences between the left-hand curves for two neighbouring years, the ordinates of one year lowered by the ordinates of the preceding to show change from year to year.

used after exclusion of the older year-classes only, down to 9 years (spawning fish) or 10 (immature), and also the youngest have been excluded because they cannot be very regularly sampled as the recruit broods in some cases do not appear until among the Loddetorsk or the Finmark section of the stock as IV-group and sometimes as V- or even VI-group. A further limitation to the consideration of the year-groups VI—VIII gave about the same results, apparently a proof of the consistency of the material.

A further source of error in the Norwegian material is the circumstance that the oceanic cod visiting the Norwegian coasts are very often mixed with a certain amount of coastal or local fish and this to some degree affects the relative numbers of the younger year-classes among spawning fish. Sufficiently extensive data for our purpose regarding the local cod stocks of N. Norway are, however, not extant at present, although efforts are made in this direction. But regarding the oceanic stock the fishing conditions in Norway afford a very good opportunity both of regular sampling and of weighting each sampling year by means of the output-figures.

III. The Baltic.

Unfortunately the series of determinations from the Baltic cover 3 sampling years only but still give good evidence for the preponderance of the year-class 1917. (H e s s l e, 1923).

IV. Danish Waters.

For this area we have to rely on the quantitative data of catch of pelagic larvae and young fish referred to above. (E. P o u l s e n, 1931).

V. The North Sea.

For this region the data supplied by G r a h a m (1933) referred to above suffer from lack of observations during the war years, the brood-years 1913—1920 being left out of consideration. This defect is in some measure made good by the statistical data regarding the Aberdeen trawl catches of large codling quoted by d'A r c y T h o m p s o n (1929) suggesting 1917 as a good brood in the North Sea also. (See Tables, Ser. 25). If this could be substantiated, we should possess an instance of a good brood year affecting all European cod areas.

VI. The Faroes.

The data kindly supplied by Dr. T å n i n g are not expressed in figures but still allow of combining the facts from the different sampling years so as to bring out the interesting fact that this region has its cod stock renewed in the same years as the North Sea, the Danish waters, and the Norwegian south coast, and *not* in the same years as Iceland or Northern Norway.

VII. The Norwegian Skagerak coast.

The data have been kindly supplied by Dr. A l f D a n n e v i g and are interesting also in showing the variation in breeding conditions observed in small local stocks. In spite of the local differences between the several series in Dr. D a n n e v i g's material the predominant character of the years 1923 and 1925 appears sufficiently warranted.

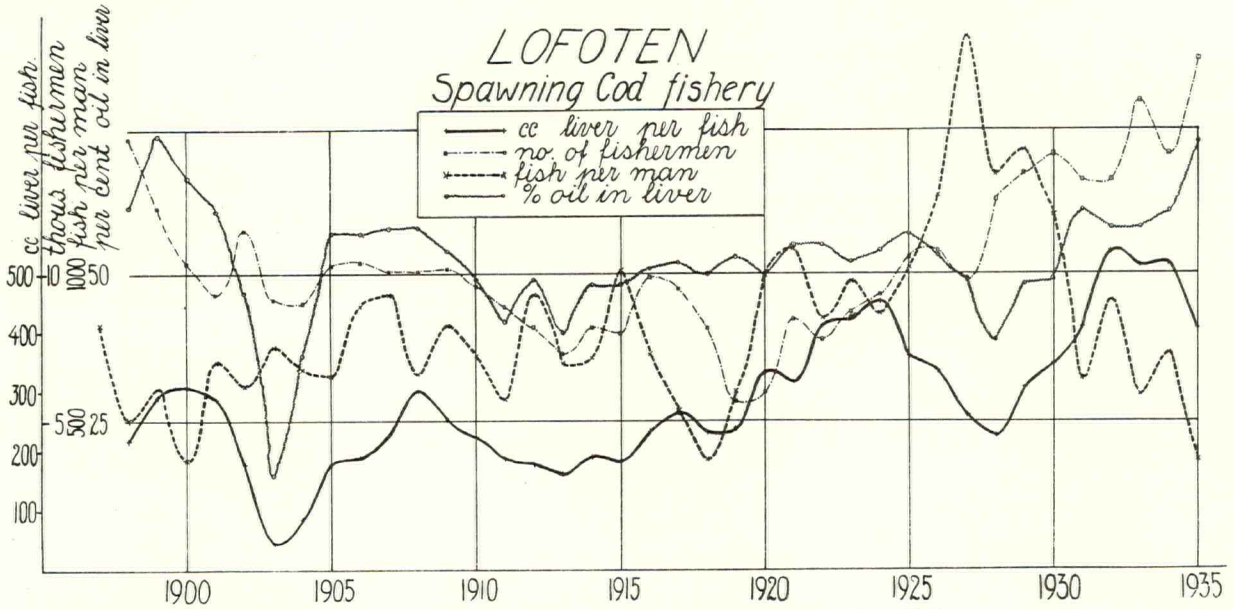


Fig. 4. Fluctuations in various elements at Lofoten (which is the main scene of cod-fishing in N. Norway, besides Finnmark). There is a close correlation between the amount of liver per fish and the fatness of the liver, and some degree of correlation between the amount of liver and the output per man. The amount of liver depends mainly on the size of the fish.

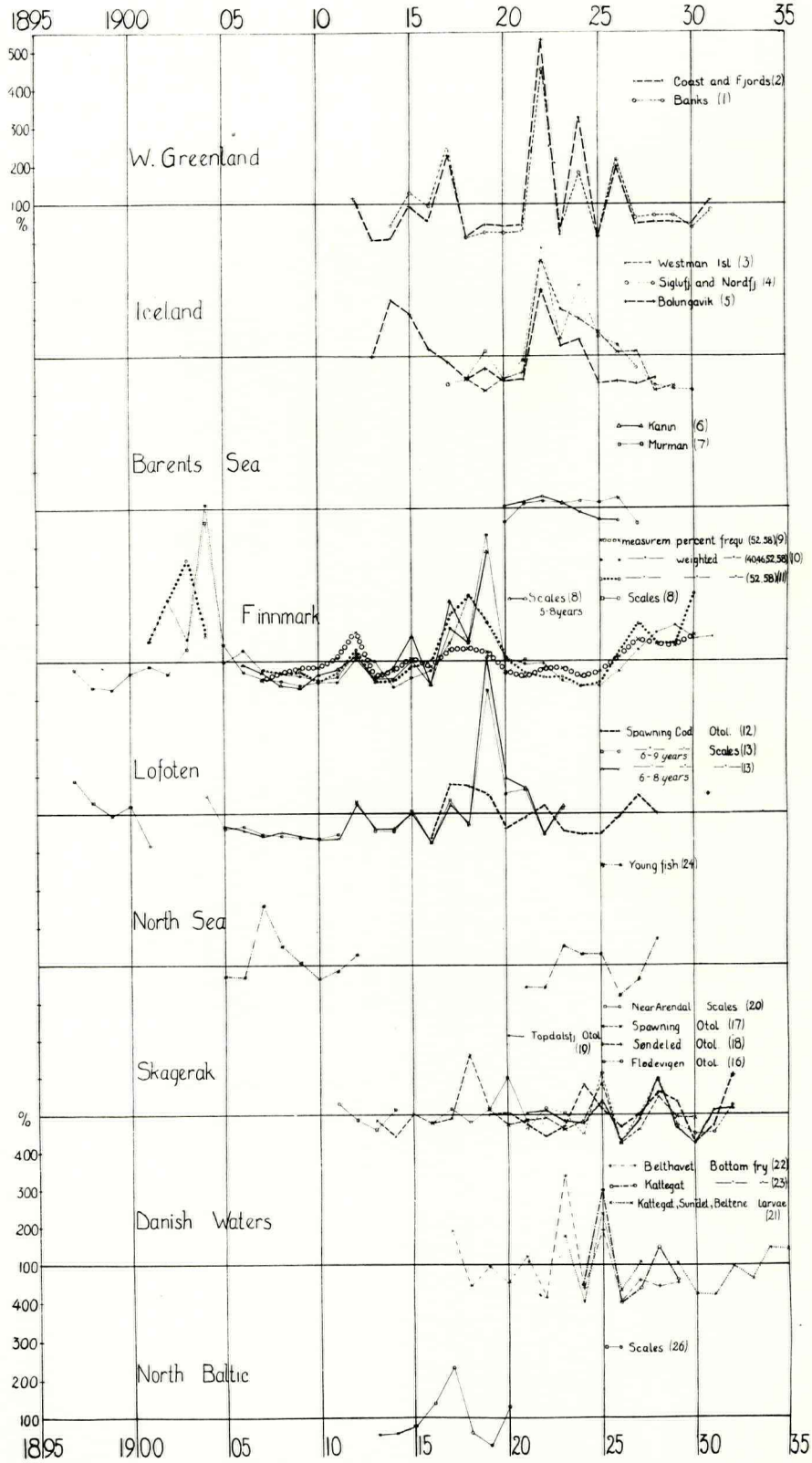


Fig. 5. Graphical rendering of figures in synoptical Table of calculated Brood Strength. Brood Strength expressed as percentage of average.

Conclusions.

The results of our calculations are set out in the first appendix in a synoptical table where all the main facts about each series of calculated brood strength are entered, but the table does not give any indication as to the relative certainty of each series or, indeed as to each figure. That will have to be judged from the details given in the tables rendering the original data, also from the length of each series and from the nature of the original material. The figures of this table, such as they are, have also been given in the form of curves as Fig. 5. As these figures and curves may appear somewhat confusing, it has been tried to extract their general purport and render it in a simpler form; this resulted in the "Simplified view of brood years, classified", Fig. 6.

The periods covered by material from the different areas are very uneven, the earliest records going back as far as 1897 but only in respect of the Arcto-Norwegian stock. This longest series of observations demonstrates the very irregular nature of the variation in the recruitment, — the intervals between the maxima can in no way be termed "periods".

It is only with the year 1912 that data are available from several other areas and thus enable a comparison. This may, perhaps, be best done if the brood strength for each of the comparable years is entered on a chart comprising the region within our purview. For our purpose very simple charts (drawn with a pair of compasses) will suffice, such as those given in Fig. 7.

Although in most cases one or more of the sectors, representing regions, had to be marked with an interrogation sign, we note, however, that some years are marked out by extensive success of the breeding of the cod, namely, above all, 1912 and especially 1917, other years are notable for the poor recruitment nearly everywhere, especially 1916 and 1920.

In certain other years we note that the favourable conditions, whatever they may be, have been limited to one region or stock, thus the North-Western Area apparently had successful broods also in 1922, 1924 and 1926, the North-Eastern Area in 1918, 1919, 1927 and 1928, the "South-Western Areas" (North Sea and Skagerak) also in 1923, 1925 and 1928, the Danish Waters in 1925 and 1928.

If we consider the broods only which are known to have been of outstanding importance but include the whole period covered by our material, we may condense the matter into the following table:

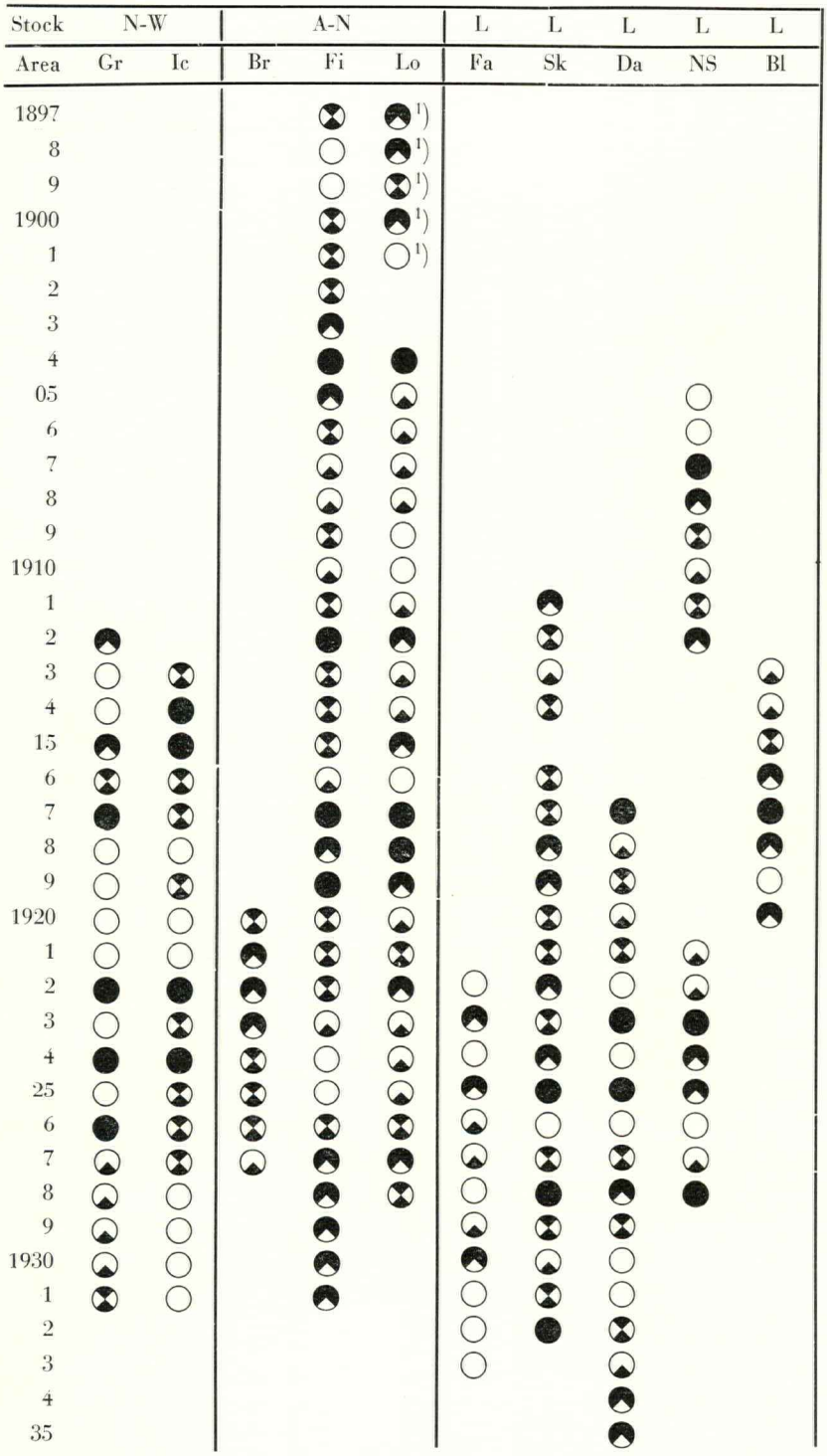
Areas affected by outstanding broods:

1904		NE.				
1907	NW.					
1912	NW.	NE.				
1917	NW.	NE.	N.SEA		DAN.	BALT.
1918		NE.				
1919		NE.				
1922	NW.					
1923			N.SEA		DAN.	
1924	NW.					
1925				SK.	DAN.	
1928			N.SEA	SK.		

Thus we can assert the occurrence of very good broods but the evidence is too fragmentary to allow a verdict of "generally bad" to be given to any year.

The question which we have been striving to formulate might therefore be worded thus: *what sort of influence occurred with extreme values and affecting the NW. Area (Iceland) ind 1907, 12, 17, 22 and 23, affecting the Norwegian coast in 1912, 17, 18, 19, the southern regions in 1917, 23, 25 and 28?*

Simplified view of brood years, classified.



Areas thus:

Gr = W. Greenland
Ic = Iceland
Br = Barents Sea
Fi = Finnmark coast
Lo = Lofoten
Fa = Faroe
Sk = Skagerak
Da = Danish waters
NS = North Sea
Bl = Midd. Baltic

Symbols

= very rich
= rich
= medium
= lean
= very lean

Stocks thus:

N-W = Iceland - Greenland
A-N = Arcto-Norwegian
L = Local

Fig. 6.

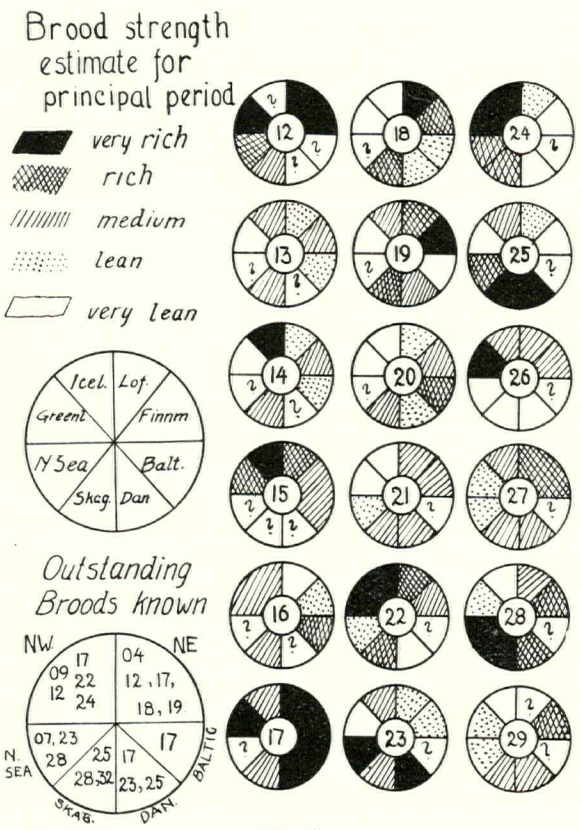


Fig. 7.

Methods thus: ot. = otolith readings, sc. = scale readings, ms. = from measurement frequencies, lar. = from relative quantity of larvae, y. f. = from No. of young fish pr. standard haul, sml. = from relative catch of Grimsby "smalls".

"Weight" refers to whether commercial statistics (sta) were considered or not, exp. = experimental hauls.

Appendix I.

Synopsis of calculated brood-

Stock	NW-Area				
Region	W. Greenl		Iceland		
Locality	Bank	C. F.	Wm.	N. S.	Bol.
Method	ot	ot	ot	ot	ot
Weigth	not	not	not	not	not
Series	1	2	3	4	5
Broods: 1897					
8					
9					
1900					
1					
2					
3					
4					
05					
6					
7					
8					
9	RR				
1910					
1					
2	RR	114			
3		3	98		
4	43	7	247		
15	128	92	210		
6	94	52	118		
7	247	225	84	24	
8	9	12	37	36	38
9	24	43	66	111	9
1920	22	38	32	37	38
1	25	41	39	88	55
2	452	528	273	382	347
3	35	18	127	144	220
4	180	325	142	287	195
25	12	10	26	150	165
6	215	196	33	126	106
7	61	45	26	68	109
8	67	50	42	21	9
9	68	49		14	20
1930	36	44		8	
1	81	108			
2					
3					
4					
35					
No. of sampl. years	9 (7)	11	8	7	6

Synopsis of Material.

strengths. "Series" refers to "List of Data".

Arcto—Norwegian								Faroe		Nor. S. coast local					Dan. Waters			North Sea	Balt. Midd.	
Bar. Sea		Finmark				Lofoten		S	N	Norw. S. E. coast					Belt Kat.	Belt	Kat.			
Kan.	Mur.	—	—	—	—	—	—	—	—	Fl.	—	Søn.	Top.	Am.				—	—	
sc	sc	sc	ms	ms	ms	ot.	sc.	ot	ot	ot	ot	ot	ot	sc.	lar.	y. f.	y. f.	sml.	sc	
not	not	sta	not	sta	sta	sta	sta	not	not	not	not	not	not	not	exp.	exp	exp.	sta	sta	
6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	26	
		77	(2	(4	(2		189													
		33	year	year	year		130													
		26	gr.)	gr.)	gr.)		97													
		69					122													1900
		86		153	153		16													
		67		260	260															
		131		156	362															
		468		510	165		147													
		139		99			59											22		
		72		128			66											22		
		53	49	76	76		47											264		
		48	68	66	66		42											154		
		37	80	61	71		35											110		
		48	78	50	46		35											66		1910
		45	108	60	68		45							133				88		
		108	177	123	127		134							90				132		
		55	59	99	45		54				88			63					57	
		54	73	32	46		53				45			116					63	
		100	108	57	85		107				105			–					79	
		41	85	75	100	36	24				80			82					140	
		185	129	149	220	176	135				91			119		194			238	
		147	132	273	268	171	67				262			82		48			61	
		432	125	200	200	151	424				119	102		118		99			29	
107	65	69	71	108	109	61	152				76	107		101		56			130	1920
117	113	104	56	92	68	89	163			65	87	79	107	80		126		44		
131	120	18	78	94	57	122	44			122	94	45	115			19		44		
114	113		80	48	57	55	115	●●	●●	109	64	71	86		179	340		154		
88	120		59	35	35	46				48	85	184	80		6	44	50	132		
71	115		71	35	44	47		●●	●●	215	185	119	140		236	194	300	132		
68	128		111	74	124	91				27	25	69	33		36	10	5	22		
	61		155	129	198	148		●		107	63	102	94		111	65	45	66		
			143	174	147	102				195	149	161	199			48	150	176		
			139	191	147			+	+	75	96	137	69		109	58	65			
			167	157	275			●●	●●	52	93	23	27		29					1930
				162						56		71	114		27					
										129		208	120		101					
															66					
															147					
															145					
3	3	15	25	25	25	4	19	11	10	12	11	13	11(10)	6 (5)	13	11	5	16	4	

List of Data

Year	No. of ind.	Per mille frequencies, Age, determined by otoliths. 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Series 1. W. Greenland Offshore Banks (Hand lines and long lines) (Paul M. Hansen)																								
1924	41	—	—	—	—	—	—	—	73	49	98	—	—	512	—	—	268	—	—	—	—	—	—	—
25	108	—	—	—	—	—	9	9	19	351	130	93	28	—	185	—	—	176	—	—	—	—	—	—
28	34	—	—	—	—	—	59	589	—	88	88	—	147	—	29	—	—	—	—	—	—	—	—	—
30	113	—	—	—	—	88	9	186	18	522	35	—	—	—	142	—	—	—	—	—	—	—	—	—
31	172	—	—	—	—	12	151	23	233	46	430	41	6	23	12	23	—	—	—	—	—	—	—	—
32	577	—	—	—	—	9	54	222	3	156	73	313	29	28	35	3	69	3	3	—	—	—	—	—
33	691	—	—	—	—	12	41	32	184	9	303	16	374	6	7	3	—	10	—	3	—	—	—	—
34	348	—	—	—	—	6	78	143	132	296	9	181	14	114	6	14	—	—	—	—	—	—	—	—
35	298	—	—	—	—	27	44	77	64	70	322	17	188	23	128	3	3	27	—	7	—	—	—	—
Series 2. W. Greenland Coast and fjords (Hand lines and long lines) (Paul M. Hansen)																								
1924	697	—	—	—	—	169	185	9	463	92	27	7	1	21	1	9	16	—	—	—	—	—	—	—
26	317	—	—	—	—	875	66	9	13	3	25	6	3	—	—	—	—	—	—	—	—	—	—	—
27	260	—	—	—	—	12	576	50	27	31	15	177	27	42	—	—	31	—	4	4	4	—	—	—
28	271	—	—	—	—	113	34	647	71	15	27	—	75	7	—	—	—	4	—	—	7	—	—	—
29	1000	—	—	—	—	18	190	20	652	31	14	16	7	45	2	3	1	—	—	—	—	—	1	—
30	1947	—	—	—	—	24	7	355	16	506	17	7	2	4	50	1	7	—	—	4	—	—	—	—
31	1438	—	—	—	—	59	244	7	311	14	273	8	7	5	1	65	1	1	—	—	4	—	—	—
32	1315	—	—	—	—	33	58	212	14	384	11	200	8	4	7	—	58	—	3	—	—	8	—	—
33	1600	—	—	—	—	—	23	40	235	7	324	4	212	3	2	29	2	103	1	—	—	—	8	—
34	4018	—	—	—	—	12	77	88	50	287	8	292	7	110	6	6	17	—	33	—	—	—	—	1
35	3001	—	—	—	—	114	87	90	102	50	227	5	168	7	95	4	7	17	—	—	—	—	—	—
Series 3. Iceland SW. Coast, Westman Islands (Tåning and Fridriksson)																								
1928	306	—	—	—	—	—	—	23	46	134	294	147	141	78	39	36	26	36						
29	403	—	—	—	—	—	—	7	20	20	47	181	156	137	124	102	97	109						
30	450	—	—	—	—	—	—	4	78	607	80	60	104	20	18	9	11	9						
31	3370	—	—	—	—	—	3	—	36	380	428	28	49	37	—	30	3	6						
32	8680	—	—	—	—	—	—	15	11	118	420	341	33	14	25	6	10	7						
33	5820	—	—	—	—	—	12	16	12	14	238	134	519	27	8	8	4	8						
34	3830	—	—	—	—	5	16	15	10	33	81	409	113	269	20	6	15	8						
35	2000	—	—	—	—	—	22	14	14	44	69	65	418	77	228	5	14	30						

(The last column includes also the fish older than 16 years.)

Series 4 a. Iceland E. Coast, Nordfjord (Tåning and Fridriksson)																								
1928	408	—	—	—	108	316	118	352	49	32	10	7	3	5	—	—	—	—						
29	511	—	—	—	8	78	372	131	115	72	37	22	31	31	20	18	14	51						
30	457	—	—	—	9	39	85	219	72	512	42	7	4	7	2	2	—	—						
31	—	—	—	—	—	—	11	50	84	128	265	54	32	177	35	51	28	85						
32	—	—	—	—	1	10	33	47	67	273	71	304	16	25	79	7	33	34						
33	—	—	—	—	—	—	43	160	85	96	308	32	202	43	21	10	—	—						

(The last column includes also the fish older than 16 years.)

Year	No. of ind.	Per mille frequencies. Age, determined by otoliths. 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
Series 4 b. Iceland N. Coast, Siglufjord (Tåning and Fridriksson)																		
1928	309	—	—	—	3	74	110	454	210	26	29	32	23	13	—	7	3	16
29	463	—	—	—	167	309	184	93	147	48	26	9	15	—	2	—	—	—
30	407	—	—	—	3	10	17	52	57	805	32	15	3	3	—	—	3	—
31	—	—	—	—	7	81	94	73	87	226	302	18	12	38	5	27	11	19
32	—	—	—	—	3	8	31	33	64	264	310	265	8	4	5	—	1	4
33	—	—	—	—	—	10	10	20	20	102	338	184	214	31	41	20	—	10
34	—	—	—	—	25	15	25	10	5	75	65	546	60	139	—	5	15	15
Series 5. Iceland W. Coast, Isafjord (Tåning and Fridriksson)																		
1928	321	—	—	6	59	75	171	368	181	62	28	22	13	6	—	—	6	3
29	548	—	—	4	75	239	186	272	188	22	6	—	6	2	—	—	—	—
30	425	—	—	2	125	115	111	125	108	389	5	5	2	2	—	2	2	7
31	4550	—	—	—	—	6	23	70	121	365	234	21	37	71	27	—	—	25
32	4650	—	—	—	7	5	20	20	130	264	332	166	6	6	26	2	11	5
33	2500	—	—	—	20	12	12	52	61	46	425	70	272	3	9	12	6	—
Series 6 and 7. Barents Sea Murman (J. Lundbeck)																		
1928/29		‰	—	—	27	29	47	121	202	237	278	59	—	—	—	—	—	— — — — — — —
1929/30	H.	‰	—	—	—	11	19	33	65	77	160	418	193	24	—	—	—	— — — — — — —
—	F.	‰	—	—	—	62	209	237	124	156	85	62	56	9	—	—	—	— — — — — — —
1930/31	H.	‰	—	—	—	8	53	64	80	172	183	194	158	54	28	3	3	— — — — — — —
	F.	‰	—	—	—	20	97	166	209	205	142	108	32	16	2	2	—	— — — — — — —
1931/32	F.	‰	—	—	—	16	67	197	111	135	137	126	71	65	40	16	9	10 — — — — — —
(F.=Spring, S.=Summer, H.=Autumn)																		
Skolpenbank (J. Lundbeck)																		
1929/30	S.	‰	—	—	—	—	—	25	59	114	202	242	260	98	—	—	—	— — — — — — —
—	H.	‰	—	—	—	121	181	158	145	143	113	73	49	17	—	—	—	— — — — — — —
1930/31		‰	—	—	—	5	47	91	111	189	168	173	138	47	25	3	3	— — — — — — —
Kanin (J. Lundbeck)																		
1929/30		‰	—	—	—	—	49	97	230	368	155	86	15	—	—	—	—	— — — — — — —
1930/31		‰	—	—	—	—	5	19	55	171	348	225	121	33	17	3	3	— — — — — — —
1931/32		‰	—	—	—	4	83	101	96	206	205	135	101	37	16	16	—	— — — — — — —
Bear Island (J. Lundbeck)																		
1930/31		‰	—	—	—	1	95	65	172	328	174	99	52	7	5	1	1	— — — — — — —
1931/32		‰	—	—	—	14	153	232	52	129	212	138	47	6	14	1	1	1 — — — — — —

Series 8. Finnmark (Scale determinations by O. Sund; 1913: ‰, other years: numbers) Immature fish. (long lines and jig)																						No. of fish per man-day
1907	629	—	—	—	42	90	90	128	125	60	35	36	15	6	2	—	—	—	—	—	—	28
09	948	—	—	—	—	26	305	310	91	134	29	3	—	—	—	—	—	—	—	—	—	41
13	‰	—	—	—	1	8	35	110	95	247	405	52	35	10	5	—	—	—	—	—	—	53
14	381	—	—	—	—	6	9	25	24	68	70	96	39	18	4	—	—	—	—	—	—	35
15	545	—	—	—	—	5	14	47	65	106	108	72	105	20	3	—	—	—	—	—	—	24
16	736	—	—	—	9	134	114	78	78	65	75	68	51	45	12	4	2	—	—	—	—	20
17	648	—	—	—	2	15	153	176	223	60	34	9	6	2	3	1	—	—	—	—	—	26
18	935	—	—	—	—	1	32	252	127	202	136	89	46	26	13	4	5	2	1	—	—	26
19	602	—	—	—	5	27	64	86	190	112	59	23	11	14	7	2	2	—	—	—	—	30
20	358	—	—	—	1	3	41	86	54	115	20	25	5	5	1	2	—	—	—	—	—	19
21	239	—	—	—	1	16	12	79	59	29	34	4	4	—	1	—	—	—	—	—	—	41
22	415	—	—	—	7	45	107	30	153	23	23	26	1	—	—	—	—	—	—	—	—	59
23	377	—	—	—	2	104	64	111	16	49	10	10	10	1	—	—	—	—	—	—	—	62
25	207	—	—	—	—	16	8	102	37	40	1	3	—	—	—	—	—	—	—	—	—	49
26	270	—	—	—	—	2	14	18	155	23	50	6	2	—	—	—	—	—	—	—	—	63

Series 9, 10, 11. Finnmark.

Length-frequencies corresponding to Mean Sizes of Year-Classes 3 to 6 (40, 46, 52 and 58 cm. respectively).

A: Per mille (unweighted).

B: Weighted by mean catch as percentages of mean weighted distribution 1913—1932.

	A		B			
Age	5	6	3	4	5	6
Size cm:	52	58	40	46	52	58
1907	37	31	855	251	260	153
09	22	70	128	99	165	362
13	6	14	61	41	46	76
14	8	23	21	48	102	86
15	14	16	97	85	52	41
16	19	19	191	142	60	40
17	34	27	36	117	140	76
18	7	41	—	1	30	114
19	10	18	59	58	49	59
20	20	21	31	43	57	42
21	14	26	335	126	92	113
22	27	22	141	223	195	108
23	28	35	73	260	271	245
24	28	34	123	140	228	264
25	15	31	192	107	117	172
26	15	34	26	70	76	100
27	11	16	34	54	60	60
28	15	22	27	35	51	53
29	9	19	22	26	43	63
30	9	16	26	26	22	27
31	47	22	119	92	80	65
32	29	30	301	282	233	168
33	30	37	143	173	186	163
34	24	31	102	104	115	108
35	32	35	114	223	225	178

Series 14 and 15. Faroes. (Å. Vedel Tåning).

"Dana" catches 1925—27. Southern Area: S. and E. of Sudarø. Autumn.

	Age: 1	2	3	4	5
1925	...	3	...	...	...
26	3	...	3	...	...
27	...	2	...	3	...
28	...	...	3	1	2
29	...	...	1	3	...
30	...	...	3	...	1
31	...	1	...	3	...
32	...	3	1	...	...
33	...	...	3	2	...
34	...	3	2	3	...
35	...	3	...	1	3

Commercial catches 1927—35. Northern Area: Northern Sea and around Vaagø. Spring.

	Age: 1	2	3	4	5	6	7
1925	...	3	...	...	...	...	...
26	3	...	...	...	...	...	...
27	...	2	...	3	1	1	...
28	...	...	1	1	3	1	...
29	—	—	—	—	—	—	—
30	...	...	...	1	3	...	1
31	...	...	...	...	1	3	...
32	...	3	1	...	...	...	...
33	...	...	3	1	1	...	...
34	...	...	2	3	1	2	...
35	...	...	...	1	3	2	...

Strength of brood expressed as:
1: important,
2: very important,
3: dominant.

Year	No. of ind.	Per mille frequencies. Age, determined by otoliths. 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	No. of fish per man-day.
Series 12. Lofoten Spawning fish (Long lines. Otolith determinations by G. Rollefsen).																									
1932	1000	—	—	—	—	—	—	2	3	20	45	186	181	120	226	160	41	9	3	4	—	—	—	—	27.4
33	800	—	—	—	—	—	—	5	12	34	67	109	256	163	76	126	100	34	9	5	1	—	—	—	15.5
34	1200	—	—	—	—	—	—	6	56	123	118	129	109	175	88	47	81	45	14	3	3	—	—	—	19.8
35	521	—	—	—	—	—	—	2	61	220	264	126	55	81	69	27	13	50	21	2	4	—	—	—	10.9
Series 13. Lofoten Spawning fish (Long lines—scale determinations by O. Sund; in numbers)																									catch per man
1906[1])	164	—	—	—	—	1	2	13	18	32	81	7	9	1	—	—	—	—	—	—	—	—	—	—	895
07	‰	—	—	—	—	—	5	5	18	195	436	250	77	13	—	—	—	—	—	—	—	—	—	—	927
13	207	—	—	—	—	—	—	—	13	37	103	29	14	6	5	—	—	—	—	—	—	—	—	—	695
14	267	—	—	—	—	—	—	3	20	41	48	102	22	22	6	3	—	—	—	—	—	—	—	—	715
15	603	—	—	—	—	—	1	9	36	77	132	97	128	91	15	14	2	—	1	—	—	—	—	—	1015
16	1077	—	—	—	—	—	2	24	71	157	240	279	156	118	22	3	4	1	—	—	—	—	—	—	729
17	1725	—	—	—	—	2	12	19	27	99	192	311	370	325	216	85	46	14	5	—	—	—	—	—	538
18	1711	—	—	—	—	1	6	30	46	191	282	436	326	223	109	50	9	1	1	—	—	—	—	—	373
19	850	—	—	—	—	—	2	17	130	179	190	171	106	41	11	2	1	—	—	—	—	—	—	—	606
20	420	—	—	—	—	—	1	8	27	203	83	78	12	6	2	—	—	—	—	—	—	—	—	—	1000
21	543	—	—	—	—	—	—	13	31	65	186	94	100	39	11	2	1	—	1	—	—	—	—	—	1088
22	371	—	—	—	—	—	—	2	25	41	45	154	21	56	8	12	5	1	1	—	—	—	—	—	847
23	238	—	—	—	—	—	—	5	3	74	47	35	64	6	3	—	1	—	—	—	—	—	—	—	978
24	849	—	—	—	—	—	11	14	125	66	304	90	61	138	24	8	7	—	1	—	—	—	—	—	862
25	255	—	—	—	—	—	3	45	29	79	21	54	10	6	7	1	—	—	—	—	—	—	—	—	1020
26	233	—	—	—	—	—	1	14	82	15	77	9	28	1	1	5	—	—	—	—	—	—	—	—	1276
27	647	—	—	—	—	—	—	24	79	311	52	144	9	26	1	1	—	—	—	—	—	—	—	—	1825
28	203	—	—	—	—	—	—	—	28	22	74	18	47	5	7	2	—	—	—	—	—	—	—	—	1348
29	187	—	—	—	—	—	2	9	21	39	31	71	5	8	—	1	—	—	—	—	—	—	—	—	745

[1]) 1906-samples (2) from SW. and W. coast (Lat. 59°20′ and 61°50′ N.).

Series 16—20. Norwegian Skagerak Coast (investigated by A. Dannevig).

Series 16. Flødevigen codling (traps)

Year	No. of ind.	0	1	2	3	4	5	6	7	8	9	10	11	12
1922	116	—	84	30	2	—	—	—	—	—	—	—	—	—
23	114	—	56	48	8	2	—	—	—	—	—	—	—	—
24	190	—	51	119	18	2	—	—	—	—	—	—	—	—
25	82	—	53	19	6	2	1	1	—	—	—	—	—	—
26	197	—	26	165	6	—	—	—	—	—	—	—	—	—
27	126	—	67	21	36	2	—	—	—	—	—	—	—	—
28	65	—	14	46	1	3	—	1	—	—	—	—	—	—
29	112	—	11	96	5	—	—	—	—	—	—	—	—	—
30	121	—	22	60	39	—	—	—	—	—	—	—	—	—
31	121	—	53	55	11	1	1	—	—	—	—	—	—	—
32	121	—	80	37	2	2	—	—	—	—	—	—	—	—
33	106	—	54	51	—	—	1	—	—	—	—	—	—	—
(1922-33)	(1471)	—	(571)	(747)	(134)	(14)	(3)	(2)	—	—	—	—	—	—

Series 17. Flødevigen hatchery, spawning fish

1920	230	—	—	—	14	53	101	18	19	7	15	2	—	1
21	225	—	—	—	4	61	58	79	11	10	—	2	—	—
25	191	—	—	—	—	27	43	55	47	12	2	5	—	—
26	53	—	—	—	2	11	21	8	5	4	2	—	—	—
27	111	—	—	—	2	21	42	30	9	4	2	—	1	—
28	291	—	—	—	18	116	72	60	13	4	5	1	1	—
29	151	—	—	—	2	90	27	15	12	3	2	—	—	—
30	384	—	—	—	9	24	255	51	25	16	3	1	—	—
31	268	—	—	—	17	74	30	110	22	13	1	1	—	—
32	528	—	—	7	42	267	94	21	67	16	10	3	1	—
34	671	—	—	2	67	186	205	162	26	15	6	1	1	—
(1920-34)	(3103)	—	—	(9)	(177)	(930)	(949)	(609)	(256)	(104)	(48)	(16)	(4)	(1)

Series 18. Søndeled fjord (traps)

1922	158	—	30	92	16	9	9	2	—	—	—	—	—	—
23	87	—	6	47	16	9	6	1	2	—	—	—	—	—
24	187	—	39	80	56	12	—	—	—	—	—	—	—	—
25	355	—	219	107	13	10	5	—	1	—	—	—	—	—
26	807	—	97	532	126	21	26	5	—	—	—	—	—	—
27	453	—	86	287	65	10	2	3	—	—	—	—	—	—
28	523	—	134	162	116	89	11	6	3	2	—	—	—	—
29	566	—	101	318	55	63	21	5	1	2	—	—	—	—
30	1033	—	208	508	171	50	58	28	8	2	—	—	—	—
31	776	—	23	462	218	42	15	14	—	2	—	—	—	—
32	396	—	93	54	143	84	12	7	3	—	—	—	—	—
33	440	—	245	112	25	36	17	2	2	1	—	—	—	—
34	188	—	20	143	16	2	3	4	—	—	—	—	—	—
(1922-34)	(5969)	—	(1301)	(2904)	(1036)	(437)	(185)	(77)	(20)	(9)	—	—	—	—

Series 19. Topdalsfjord (traps)

1924	50	—	3	35	11	1	—	—	—	—
25	487	—	112	203	123	43	1	3	2	—
26	654	—	290	192	105	40	9	4	5	—
27	258	—	23	145	42	33	11	3	1	—
28	166	—	65	29	51	12	3	4	2	—
29	126	—	55	57	1	12	—	—	1	—
30	192	—	3	140	23	9	11	3	1	2
31	161	—	19	49	70	9	10	2	1	1
32	159	—	55	32	34	34	3	—	—	1
33	128	—	35	67	5	11	8	2	—	—
34	144	—	25	90	28	—	1	—	—	—
(1924-34)	(2516)	—	(685)	(1039)	(493)	(204)	(57)	(21)	(13)	(4)

Series 20. Environs of Arendal (traps)

Year	No. of ind.	Age by scales 0	1	2	3	4	5	6	7
1914	141	2	30	69	32	7	—	1	—
15	556	—	333	139	41	23	15	3	2
16	32	—	67	2	1	1	1	—	—
1920	259	11	123	67	36	9	7	3	3
21	244	22	55	119	30	14	2	—	2
22	163	—	45	87	20	6	5	—	—
	(1395)	(35)	(653)	(483)	(160)	(60)	(30)	(7)	(7)

Series 21. Danish Waters (E. M. Poulsen)

Number of cod-larvae in April per 30 min. haul with Ring-trawl or Petersen's Young-fish-trawl.

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
Kattegat	—	—	—	—	30	2	46	5	6	—	39	15	10	70	29	70	41
The Sound	—	—	—	—	36	—	118	18	—	—	52	1	4	6	29	41	42
The Belts	—	—	—	—	110	2	67	—	67	—	16	12	12	23	7	33	62
(No. of hauls)	—	—	—	—	(49)	(7)	(49)	(24)	(29)	—	(33)	—	—	—	—	—	—

Series 22. Danish Waters Belt-Sea (E. M. Poulsen)

Number of Bottom Young-fish per 30 min. haul with "eel-tog", summer and autumn.

0-group	55	30	49	4	113	4	40	1	15	14	18	—	—	—	—	—	—
1-group	17	21	9	18	1	54	4	45	1	12	9	—	—	—	—	—	—
2-group	10	—	—	1	6	2	18	5	10	1	4	—	—	—	—	—	—
3-group	—	—	—	—	1	2	—	10	1	6	—	—	—	—	—	—	—
(hours fishing)	(9)	(5)	(5)	(7)	(8)	(10)	(13)	(21)	(14)	(33)	(14)	—	—	—	—	—	—

Series 23. Danish Waters Kattegat (E. M. Poulsen)

Bottom Young-Fish, as in Ser. 22.

0-group	—	—	—	—	—	—	44	—	3	43	12	—	—	—	—	—	—
1-group	—	—	—	—	—	—	5	31	1	7	7	—	—	—	—	—	—
2-group	—	—	—	—	—	—	2	2	3	—	1	—	—	—	—	—	—
3-group	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
(hours fishing)	—	—	—	—	—	—	(33)	(53)	(21)	(116)	(235)	—	—	—	—	—	—

Series 24. North Sea

Brood strength, calculated by Michael Graham (1933, p. 62) from trawler landings of "small" at Grimsby.

Brood:	1905	1906	1907	1908	1909	1910	1911	1912	—	1921	1922	1923	1924	1925	1926	1927	1928
Rel. strength:	1	1	12	7	5	3	4	6	—	2	2	7	6	6	1	3	8

Series 25. North Sea, large codling

Mean annual catch by Aberdeen trawlers in Area X (Shetland) per 100 hours fishing (D'Arcy Thompson, 1930, p. 25).

Year:	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927
% of mean:	90	79	79	85	121	142	170	149	105	54	59	87	98	93

Series 26. Baltic Isle of Øland to Gävle (Hessle, 1923, p. 47)

Catches (by trawl and long lines) referring to the Gotland fishery.

	Brood years								Total No. of ind.	Total catch in tons.
	1913	1914	1915	1916	1917	1918	1919	1920		
1919	2	13	60	100	29	—	—	—	204	380
20	—	—	—	35	93	9	—	—	137	737
21	2	7	19	124	479	129	54	8	822	480
22	5	13	21	52	158	26	9	6	290	171

Appendix II.

Review of the Fluctuations in the Stock of Cod at Greenland, Iceland, the Faroes and in Danish Waters.

By Dr. Á. Vedel Tåning.

Greenland.

West Greenland.

Age determinations have been carried out in West Greenland waters during the years 1924—1935; about 18,250 specimens have been analysed by the otolith method, and the results are given in the annexed lists, which have been prepared by Mr. Paul M. Hansen, the bank fishery and the coastal fishery separately. The list of literature includes the different publications in which particulars are given. The material from the first years of investigations has been revised and some new material included.

Prior to the systematic collection of material, inaugurated in 1924, a few samples were obtained by Prof. Ad. S. Jensen (in 1908 and 1917) these show (Jensen and Hansen, 1931 p. 22) the broods of 1903 and 1912 as dominating year-classes.

During the years 1924—35 the following year-classes have been predominant in the catches: *1909, 1912, 1917, 1922, 1924* and *1926.*

A transport with the currents from West Iceland to *West Greenland* of post-larval cod has been made possible during cruises in the area by the "Dana" in 1931, 1932 and 1933, but has not yet been definitely proved; the question is of outstanding importance however to the interpretation of the causes of coincidence of dominant year-classes in the Icelandic and West Greenlandic area. Differences from year to year in the transport of fry from Iceland to Greenland may possibly account for the differences between the two areas as to dominating year-classes.

East Greenland.

Very few samples from the East Greenlandic waters have been analysed; the few samples so far seen supplemented with informations attained through the cod-marking experiments show however that cod from this area chiefly belong to the same year-classes as we have found dominant at Iceland (1922 and 1924 year-classes), which is in accordance with the demonstrated drift of post-larval stages from West Iceland to East Greenland.

Iceland.

The papers by Sæmundsson, Tåning and Fridriksson have shown that in this area the year-classes *1917, 1919, 1922* and *1924* have been dominating during a period out of which the year-classes *1922* and *1924* have been by far the best during the years 1928—1934.

After the very good year-class 1924 no specially rich year-class has appeared in the commercial catches; so far it is not possible to determine the value of the year-classes 1926, 1927 and 1929, which are better probably than the broods of 1925 and 1928. Prior to 1917, it seems as if the year-classes 1912, 1913 and 1915 have been the best ones; the material at hand is, however, too scanty to define this question.

In the first paper published on fluctuations in the stock of cod in Icelandic waters (Tåning, 1931 pp. 35—36) a certain coincidence as to dominant year-classes of cod in the waters of Norway, Iceland and Greenland has been pointed out (see also Rapp. et Proc. Verb., Vol. LXXXV, III, p. 8 and Vol. LXXXIX, III 2, p. 11).

Otolith material has been used exclusively in this area. A cooperative work has been carried out to reach the best possible agreement between the age determinations made by the different persons engaged in the determination of the otolith material.

In a paper in Rapp. et Proc.-Verb., Vol. LXXXVI, V, 1934, the results of such an investigation carried out in 1933 have been given, showing that some difference was present particularly as to one year-class, namely that of 1923. The results obtained by the cooperative work mentioned has been confirmed by age determinations carried out in subsequent years, showing that the year-class 1923 has been as unimportant at Iceland as at Greenland.

The papers by Fridriksson from 1932 and onwards give a rich and detailed material for the studies of the year-classes at the various coasts of Iceland.

The Faroes.

The age distribution of the year-classes in this area shows no special coincidence with that known from Icelandic waters; the area may probably be considered as an independent one; a certain coincidence with Danish waters is however not excluded.

The otolith method has been used, and during the years 1925—1935 about 7000 age determinations have been carried out; 60,000 measurements supplement this material. A paper on these investigations will soon be published.

The dominant year-classes during recent years will be seen from the table annexed; the most prominent year-classes being: 1923, 1925, 1927, 1930, 1932? and 1933?, with *1923*, *1925* and *1930* as the most important ones.

It is necessary to point out some facts of interest concerning the Faroese cod fishery and the probable effect of this on the composition of the stock.

The trawl fishery in the area as well as the fishery of the natives is very effective, marking experiments having shown that at least 35 % of the cod marked are recaptured (against 8 % in the Icelandic area); supposing that some marking buttons are lost and that the enemies of the cod take their part of the stock also, it will be seen that a special year-class will diminish rapidly.

The cod of the area have a rapid growth, we do not know however whether this is original or caused by the intense fishery; e. g. the III-group on the different banks reach an average size of 50—74 cm. in June; in November many commercial Faroese catches include very high numbers of cod belonging to the II-group; cod of the VII-group and older individuals are of rather small importance in the catches. In the southern area of the islands the catches are composed of younger age-groups than in the northern area, mainly age-groups II—IV, against II—VI in the north. The stock is obviously renewed every few years.

Considering these facts it is at present rather difficult to compare the fluctuations shown in the table with those in more northern waters; primarily because sufficient commercial material is not at hand from the years prior to 1927, secondly because we know too little about the possible influence of the fishery in this area on the stock of spawning fish, which in some probably good survival years for the brood may be present in too small numbers to produce sufficient spawn.

Danish Waters.

From the Danish waters within Skagen we owe all recent information on fluctuations in the stock of cod to Dr. E. M. Poulsen's paper of 1931 (e. g. p. 89—91); in the annexed table (Ser. 21) he gives some further results (years 1930—35) not yet published.

The investigations show that the broods of the following years have been best:

....1906 .... 1908 .... 1917, 1919, 1921, 1923, 1925, 1927, 1929, 1932, (1933?), 1934 and 1935.

In a note to the table Dr. Poulsen concludes:—

"In the period 1923—30 good and bad survival years have alternated regularly: 1923, 1925, 1927 and 1929 being rich brood years, 1924, 1926, 1928 and 1930 bad brood years. 1931 too was a bad brood year, whereas 1932, 1934, 1935 and in a minor degree 1933 were good brood years."

In the North Sea Danish investigations have not been carried out as to this question prior to 1932, and the material from recent years has not yet been worked up.

Literature concerning Fluctuations in the Stocks of Cod.

1) In the North-Western Area.

A. Fridriksson, 1929: Age-composition of the Stock of Cod in East Iceland Fjords during the Years 1925—27. Rapp. et Proc.-Verb., LVII, Copenhague, 1929.

— 1929: Fiskirannsóknir Fiskifélags Islands.

— 1932: I. 1931. Skyrsla Fiskifélag Islands 1930—31. Reykjavik, 1932.

— 1933: II. 1932 Ärsrit Fiskifélag Islands 1932. Reykjavik, 1933.

— 1934: III. 1933. Ibid. Reykjavik, 1934.

— 1935: IV. 1934. Ibid. Reykjavik, 1935.

A. Fridriksson, P. M. Hansen, A. F. Bruun and Å. V. Tåning: Report concerning the Analysis of Cod Otoliths from Iceland. Rapp. et Proc.-Verb., LXXXVI, No. V, Copenhague, 1934.

Paul M. Hansen, 1931: Undersøgelser over den grønlandske Torsk. Beretninger og Kundgjørelser vedr. Styrelsen af Grønland, 4, pp. 705—711, København, 1931.

— 1932: Fiskeriundersøgelser ved Vestgrønland i 1931. Beretninger og Kundgjørelser vedr. Styrelsen af Grønland, 2, pp. 902—906, København, 1932.

Paul M. Hansen, 1933: Fiskeriundersøgelser ved Vestgrønland i 1932. Beretninger og Kundgjørelser vedr. Styrelsen af Grønland, 1, pp. 32—43, København, 1933.

— 1934 a: Fiskeriundersøgelser ved Vestgrønland i 1933. Beretninger og Kundgjørelser vedr. Styrelsen af Grønland, 2, pp. 226—247, København, 1934.

— 1934 b: Synopsis of Investigations into Fluctuations in the Stock of Cod at Greenland during the Years 1930—33. Rapp. et Proc.-Verb., LXXXVI, pp. 1—11, Copenhague, 1934.

Paul M. Hansen, 1935: Fiskeriundersøgelser ved Vest-Grønland i 1934. Beretninger og Kundgjørelser vedr. Styrelsen af Grønland 2, pp. 2—16, København, 1935.
Ad. S. Jensen and Paul M. Hansen, 1930: Undersøgelser over den grønlandske Torsk (*Gadus callarias* L.). Med en Indledning om de grønlandske Torskefiskeriers Historie. København, 1930.
— 1931: Investigations on the Greenland Cod (*Gadus callarias* L.). With an Introduction on the History of the Greenland Cod Fisheries. Rapp. et Proc.-Verb., LXXII, pp. 1—37, Copenhague, 1931.
Johs. Schmidt, 1926: The Frequency of young Cod etc. on the North and East Coasts of Iceland. Rapp. et Proc.-Verb., XXXIX, Copenhague, 1926.
— 1931: On the Occurrence of the Cod (*Gadus callarias* L.) at East Greenland. Rapp. et Proc.-Verb., LXXII, (IV), Copenhague, 1931.
Bjarni Sæmundsson, 1923: On the Age and Growth of the Cod (*Gadus callarias* L.) in Icelandic Waters. Medd. Komm. Danmarks Fiskeri- og Havundersøgelser, Ser. Fiskeri, VII, 3, København, 1923.
Å. Vedel Tåning, 1931: Fluctuations in the Stock of Cod in Icelandic Waters. Medd. Komm. Danmarks Fiskeri- og Havundersøgelser, Ser. Fiskeri, IX, 3, København, 1931.
— 1932: Investigations on the Icelandic and Greenland Stock of Cod in 1932. Rapp. et Proc.-Verb., LXXXV, III, pp. 7—8, Copenhague, 1933.

2) Danish Waters.

E. M. Poulsen: 1931: Biol. Invest. upon the Cod in Danish Waters. Medd. Komm. Danmarks Fiskeri- og Havundersøgelser, Ser. Fiskeri, IX, 1, 1931.

3) On the Arcto-Norwegian Stock.

Johan Hjort, 1914: Fluctuations in the Great Fisheries of Northern Europe. Rapp. et Proc.-Verb., XX, Copenhague, 1914.
G. Rollefsen, 1933: The Otoliths of the Cod. Rep. Norw. Fish. and Mar. Invest., IV, 3, Bergen, 1933.
— 1934 a: The Cod Otolith as a Guide to Race, sexual Development and Mortality. Rapp. et Proc.-Verb.. LXXXVIII, Copenhague, 1934.
— 1934 b: Skreiens Alder. Rep. Norw. Fish. and Mar. Invest., IV, 7, Bergen, 1934.
— 1934 c: Skreiens Alderssammensetning i 1934. Lofotber. 1934, Bergen, 1934.
G. Rollefsen, 1935 a: The Spawning Zone in Cod Otoliths and Prognosis of Stock. Rep. Norw. Fish. and Mar. Invest., IV, 11, Bergen, 1935.
— 1935 b: Aldersundersøkelser. Lofotber. 1935, Bergen, 1936.
Oscar Sund, 1927: The Arcto-Norwegian Cod Stock. Journ. du Conseil, II, 2, Copenhague, 1927.
— 1930: The Renewal of a Fish Population studied by Means of Commercial Catches. Example: The Arcto-Norwegian Cod Stock. Rapp. et Proc.-Verb. LXV, Copenhague, 1930.
— 1934: Cod Measurements during 21 Years etc. Rapp. et Proc.-Verb., LXXXVIII, Copenhague, 1934.
— 1920—1934: Annual statements (in Norwegian, sometimes with English summary) in the reports of the Director of Fisheries — "Aarsber. vedk. Norges Fiskerier".

4) The North Sea Cod.

Michael Graham, 1928: Studies in Age-determination in Fish. Part I. Min. Agric. and Fish., Fish. Invest., II, XI, 2, London, 1928.
— 1930: Notes for Discussion of the Fluctuations in Abundance of Year-Classes of Cod (*Gadus callarias* L.) in European Waters. Rapp. et Proc.-Verb., LXVIII, Copenhague, 1930.
— 1934: Report on the North Sea Cod. Min. Agric. and Fish., Fish. Invest., II, XIII, 4, London, 1934.
E. S. Russell, 1922: Market Measurements in Relation to the English Cod Fishery. Min. Agric. and Fish., Fish. Invest., II, V, 1, London, 1922.
D'Arcy W. Thompson, 1930: On Fluctuations in the Abundance of Cod. Rapp. et Proc.-Verb., LXV, Copenhague, 1930.

5) On the Skagerak coastal Cod.

A. Dannevig, 1933: On the Age and Growth of the Cod of the Norwegian Skagerrak Coast. Rep. Norw. Fish. and Mar. Invest., IV, 1, Bergen, 1934.

6) On the Baltic Cod.

C. Hessle, 1923: Undersökningar rörande Torsken (*Gadus callarias* L.) i Mellersta Östersjön och Bottenhavet. Medd. Kungl. Lantbruksstyrelsen, 243, Stockholm, 1923.