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The Problem of Determination of Abundance of the Barents Sea Population of the 1950 Year-Class of the Atlanto-Scandian Herring Stock in the Norwegian Sea (According to Data of 1954-1958)

by

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The purpose of the present paper is to single out the Barents Sea herring according to growth-rate, and to define their quota in the Atlanto-Scandian herring stock in the Norwegian Sea.

Differences in environmental conditions during the first years of herring life determine the growth-rate, the term of their first maturity, and also cause the features of their scale structure (Marty, 1941 and 1956).

Investigations carried out by Lea (1929) stated that there are coastal, oceanic, and spawning rings on the scale of Atlanto-Scandian herring; coastal rings can be of the northern type (N) or of the southern one (S). The number of specimens having the northern type of the scale increases from south to north in the Norwegian Sea (Runnström, 1936).

The Barents Sea herring have annual (winter) rings on their scale only of the northern type (Murashkintseva, 1938). The different conditions under which the herring live cause different types of growth (Ottestad, 1934).

During our investigations on the growth-rate of the 1950 herring year-class in the Norwegian Sea 6 types of growth were determined: A, B, C types, which are described by Ottestad; D type, described by Shutova-Korzh (1960) for the Barents Sea herring; and also the types B-C and C-D (Figure 1).

Table 1. The ratio of different growth types of the 1950 herring year-class in the Norwegian Sea in 1954-1958 (%).

Year	Type						n
	A	B	C	B-C	D	C-D	
1954	14,6	47,0	19,4	15,3	2,8	0,9	1343
1955	9,6	40,6	26,5	13,9	4,8	4,6	834
1956	7,3	33,6	26,1	12,5	12,5	8,0	1580
1957	6,7	25,2	28,4	9,3	15,4	15,0	2180
1958	6,9	28,0	26,7	9,4	15,6	13,4	1782

For the 1950 herring year-class in the Barents Sea C and D growth types are characteristic (Shutova-Korzh, 1960).

First type B and then type C are characteristic for the Atlanto-Scandian 1950 herring year-class. Types A, B-C, D and C-D are in the third place, though their value changes considerably in some years. This is connected with extermination of large specimens of these types which have matured at an age of 4-5 years, and with recruitment to the stock of herring with a low growth-rate which have matured only at an age of 6-7 years.

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On material collected in the Norwegian Sea in 1954-1958 the following scale data were determined for each herring: the type of the scale (northern or southern), the number of coastal, oceanic or spawning rings, and the age at first spawning.

The growth-rate was calculated by years with the help of the angular variable scale by Aleev (1937) and the type of growth was determined. Later on only herring having the northern type of scale was investigated.

Types of growth and formulas of the scale of the 1950 herring year-class

The analysis of the scales of the 1950 herring year-class revealed that certain formulas of the scale are characteristic for different types of growth.

Table 2. Scale formulas characteristic for herring of the 1950 year-class of different growth types.

Growth type	A	B	C	B-C	D	C-D
The age at the first spawning	4-5 7-8	4-5	5-6 7-8	4-5 6	6 7-8	6 7-8
The scale formula	N 2+1 N 2+2 N 6+0+1 N 6+1	N 2+1 N 2+2	N 3+1 N 3+2 N 6+0+1 N 6+1	N 2+1 N 2+2 N 3+1 N 3+2	N 4+1 N 4+2 N 6+0+1 N 6+1	N 4+1 N 4+2 N 6+0+1 N 6+1

The northern type of the scale is marked by the letter N; the Figure 2 shows that the herring was dwelling in the coastal waters for two years; the Figure 1 shows that there is one oceanic ring. Table 2 and Figure 2 show that A, B and B-C type herring recruit the spawning stock at an age of 4-5 years, and a small part of herring of type A at an age of 7-8 years. Herring of C, D and C-D type mature mainly at an age of 6-7 years.

In the formula N 6+0+1, 0 means that there is no oceanic ring, and the Figure 1 shows that there is one spawning ring.

Investigations by Marty (1956) and Yudanov (1939) show that the Barents Sea herring begin to mature in bulk at the age of 5 years, the mean length L_5 being not less than 22,5-24 cm.

The 1950 herring year-class in the Barents Sea began to mature in bulk at the age of 6, the mean length L_6 being 23,2 cm (Shutova-Korzh, 1960). In this case the length, less than 25 cm, at the age of not only 5 but also 6 complete years, can serve as a distinguishing feature of the Barents Sea herring, as compared with the Norwegian Sea herring.

Type A. The size structure of the type A 1950 herring year-class in the Norwegian Sea had one peak in 1954 and 1955 (Figure 3).

In 1956 it became bimodal in connection with the origination of specimens having a low growth-rate. The value of L_5 of specimens having a low growth-rate and the scale formula of N 6+0, N 6+1 are 20,7-21,7 cm, whereas L_5 of herring having the scale formula of N 2+1, N 2+2 is 28,1-28,7 cm.

Do specimens of type A having a low growth-rate belong to the Barents Sea herring?

The type A herring was not in samples in the Barents Sea from 1953 on. The data from 1953, however, are not completely referred to type A, because some part of these herring could pass into type D in 1954.

The possibility that one type of growth may pass into another was shown by Ottestad (1934).

In 1954 the type A herring in the Barents Sea had the reproductive products of the maturity stages II-III and III. In July 1955 there was an equal number of herring with gonads in maturity stages II and III. In October specimens were observed with reproductive products at the IInd stage of maturity. In 1956 single herrings of type A were found in catches in the Barents Sea (Table 3).

In the Norwegian Sea herring with 6 coastal scale rings appeared in July-August 1956, they were mainly in maturity stage III, and a small part of them in stage II.

The growth-rate of herring which came into the Norwegian Sea in 1956, and whose reproductive products were in stage II, coincides with the growth-rate of the herring in the Barents Sea in 1955 and whose reproductive products were in the same stage.

Herring having coastal scale rings and spawning for the first time in 1958 (the scale formula is N 6+1) are like immature Barents Sea herring in their growth-rate. (Tables 3 and 4).

This correspondence in growth-rate, stages of maturity, time of herring leaving the Barents Sea and time of their coming into the Norwegian Sea makes it possible to consider herring of type A with 6 coastal scale rings as the Barents Sea ones. Herring with scale formulas N 2+1 and N 2+2 are the Norwegian Sea ones.

Type B. Large, fastgrowing herring, L_5 of which makes up 27,2-28 cm, are referred to this type. The size-frequency of herring of this type is one-peaked. No specimens have L_6 less than 25 cm (Figure 4). Therefore, herring of this type can be regarded as herring staying in the Norwegian Sea from the first years of their life.

Type C. Herring which have been living in the coastal zone for 3 and 6 years are characteristic for this type. According to the time of their coming into the Norwegian Sea and their growth-rate (L_5 makes up 25,7-27,0 cm), herring having 3 coastal rings are not those from the Barents Sea, though the areas where these herring stay are situated further north than the areas of type A and B herring.

Herring having 6 coastal rings appeared in the Norwegian Sea in 1956 and their size-frequency turned from one-peaked into two-peaked (Figure 5). The growth-rate of these herring is considerably lower thanthat of specimens with 3 coastal rings L_5 of herring with the scale formula N 6+0+1, makes up 21,2 cm; and L_5 of herring with the scale formula N 6+1 makes up 20,5 cm.

The comparison of growth-rates of herring spawning for the first time without the oceanic ring (N 6+0+1), and the most mature part of the Barents Sea herring (the II-III, and III maturity stages as stated by the 1954 and 1955 samples) show that herring of type C with 6 coastal scale rings in the Norwegian Sea are from the Barents Sea (Tables 3 and 4).

The growth-rate of the Norwegian Sea herring spawning a year later (the scale formula N 6+1) coincides with that of immature Barents Sea herring in 1955 (Tables 3 and 4).

In this type, as well as in type A, the value of L_6 of 25 cm is the size where sharp differentiation of the two groups of herring is observed.

Type B-C. In his investigations on the life-cycle of the herring, Ottestad (1934) noted that there are A, B and C types of herring. In our research of the 1950 Atlanto-Scandian herring year-class the existence of type B-C was recognised. This type combines the features of the B and C types. It is presented by large herring which mature at the age of 4-5 years. Their L_5 makes up 27,1-27,9 cm. Specimens of this type of growth have scale formulas which are characteristic for the Norwegian Sea herring.

The size-frequency of type B-C herring is one-peaked in all years (Figure 6). There are no specimens with a slow growth-rate, therefore it is possible to say that the B-C type is represented only in Norwegian Sea herring.

Type D, determined for the 1950 Barents Sea herring year-class by Shutova-Korzh (1960), is characteristic for this year-class as well as type C.

The herring of type D differ sharply from the herring of other growth types in their growth-rate. L_5 of the type D herring fluctuates between 20,1 and 24,4. Our opinion is that herring of type D with 4 coastal scale rings, which came into the Norwegian Sea in 1954 are those from the Barents Sea. In 1953 this herring was of growth type A. In July, 1953 on Rybachya Bank and in September 1953 in the western coastal area the largest herring of growth type A were observed (Table 3). Most probably, after reaching by the 1953 autumn the sizes when the Barents Sea specimens begin to migrate actively, this herring moved into

the most western areas of the Barents Sea. They wintered there and came again into the Norwegian Sea in the summer of 1954. The migration into regions with more favourable conditions caused a great increment in the fifth year. This is characteristic for type D. That is, a passing of a part of herring with growth type A into growth type D took place.

Comparison between the growth-rate of type D specimens with 4 coastal scale rings (these specimens appeared in the Norwegian Sea in 1954) and the growth-rate of type A herring in the Barents Sea in 1953 shows a complete coincidence of these groups of herring in their growth-rate and in the stages of their maturity (Tables 3 and 5). Type D herring with 6 coastal rings were first met in the Norwegian Sea in 1956. Their growth-rate coincides with that of herring of the same growth type in the Barents Sea (Tables 5 and 6).

Type C-D combines features of C and D types. At the end of the fifth summer, specimens of type C-D reach 20,0-24,3 cm in size. Herring with the scale formula N 4+1 are the largest. They came into the Norwegian Sea in 1954 together with specimens of type D with the same scale formula.

Our opinion is that in herring of growth type C-D also the passing of herring of one growth type into another takes place, namely, some part of the largest herring of growth type C passed into growth type C-D.

To my mind the third and the fourth summer of the life of the herring in the Barents Sea is the period when the formation of their type of growth is not yet completed.

The coincidence of the growth-rates of herring with 4 coastal rings of growth type C-D in the Norwegian Sea, and these of Barents Sea herring of growth type C from the 1953 catches make it possible to regard them all as Barents Sea ones. (Tables 3 and 7). Besides in the open regions of the Barents Sea in 1954 and 1955 such large growth type C herring as in 1953 were not found.

The growth-rate of herring of type C-D with scale formula N 6+1 in the Norwegian Sea is identical to the growth-rate of herring of the same type in the Barents Sea (Tables 6 and 7).

Size structure of type D and C-D herring in 1954 and 1955 is expressed by a one-peaked curve which is formed by the largest specimens (Figures 7 and 8). After herring with 6 coastal scale rings of slow growth-rate migrated into the Norwegian Sea in 1956, the curve became two-peaked.

In herring of growth type A the size-frequency is two-peaked from their second year of life and in growth type C herring it is two-peaked from the 4th one. This is confirmed by presence of 2 groups of herring in growth type A and C specimens. These groups have grown up under different conditions in different areas: one of them in the Norwegian Sea, the other one in the Barents Sea.

The formation of two peaks in growth types D and C-D in their 5th and 6th year of life is not caused by the existence of two herring groups. It is caused by presence in these types of herring with slow growth-rate (N 6+0, N 6+1), of herring of larger size (N 4+1, N 4+2), which begin their back migration at different times.

Specimens, which have a natural mark, named by Vykhristyuk (1966) "a narrow ring", belong to herring of growth types A, C, D and C-D with scale formulas N 6+0 and N 6+1. Herring having the "narrow ring" were regarded by her as that from the Barents Sea. The natural mark "a narrow ring", or - to be more precise - a narrow summer zone of growth, corresponds to 1955.

In accordance with information by Sarynina, unfavourable hydrographical conditions were observed in the Barents Sea in 1955 (insignificant radiant heating, negative temperature anomalies in the whole of the 200 m water column in the sections in the North Cape - Bear Island area and in the whole south-eastern part of the sea during the whole summer). This must have caused the slowing down of the growth-rate to almost the half, and the origination of a narrow summer zone of growth (Table 8).

1956 was also very cold due to the hard 1955-1956 winter and some weakening of the heating which is usually brought by the North Cape Current. But the growth-rate of herring was not in the least influenced by this cold year, as nearly all the herring of the 1950 year-class left the Barents Sea.

An extremely small quantity of herring of all growth types in the 1956 catches in the Barents Sea, and the presence of Barents Sea herring of all growth types, immature and at the II-III, III stages of maturity in the Norwegian Sea in the 1956 summer samples are indicative of that.

Marty and Yudanov (1962) informed that, "herring with a slow growth-rate (L_5 is less than 25 cm) which have dwelled as young ones in the Barents Sea make up only a very small part of adult herring catches in the Norwegian Sea".

After the difference between the Barents Sea herring and the Norwegian Sea one in types of growth and the scale formula is stated, an attempt is made to determine the quota of these herring in the abundance of the 1950 year-class and also in the total stock of herring in the Norwegian Sea.

The calculations were carried out on the basis of data on Atlanto-Scandian adult herring abundance in the Norwegian Sea (Dragesund and Jakobsson, 1963) and also the data on the 1950 herring year-class.

As a result it was stated that from 1954 to 1958 the abundance of the Barents Sea herring in the total stock of the Atlanto-Scandian herring in the Norwegian Sea gradually increased and in 1957 it made up about 1,3 million tons (Table 9).

Conclusions

The wide area of Atlanto-Scandian herring and essential differences in the environmental conditions in the regions where the herring stay, cause the formation of different groups of herring which differ from each other in their scale type, growth-rate, and the time of first maturity.

Predominance of herring with the "northern" type of scale is characteristic for the abundant 1950 year-class. Specimens with the "northern" type of scale of this year-class show 6 types of growth: A, B, C, B-C, D, and C-D. Types B and C prevail in quantity.

Specimens of A and C types of growth belong to two groups, with geographically separated areas: one group stays in the Norwegian Sea, the other in the Barents Sea. Herring of B and B-C types of growth belong to one group (The Norwegian Sea group), which grew up in the Norwegian Sea. Specimens of D and C-D types of growth belong to the Barents Sea herring.

The first maturity of the Norwegian Sea 1950 year-class of A, B, C, B-C growth type came at the age of 4-6 years. Main scale formulas of the growth type A herring are N 2+1 and N 2+2; those of type B are N 2+1 and N 2+2; those of type C are N 3+1 and N 3+2; and of B-C N 2+1, N 2+2 and N 3+1.

A, C, D, C-D types of growth are characteristic for the Barents Sea herring of the 1950 year-class. The main types are C, D, C-D. The time of first maturity of the herring in bulk comes at an age of 6-7 years, and a small part of them matures at the age of 8 years. The scale formulas of herring of A and C types of growth are N 6+0 and N 6+1, those of D and C-D types are N 4+1, N 4+2, N 6+0 and N 6+1.

The formation of the narrow summer zone of growth of the Barents Sea herring with scale formulas N 6+0 and N 6+1 is caused by the unfavourable hydrographical conditions in 1955 due to which the slowing down of the growth-rate to a half took place.

Determination of the Barents Sea 1950 year-class in the Norwegian Sea according to types of growth and scale formulas made it possible to calculate their abundance in the total Atlanto-Scandian herring stock.

In 1954 the abundance of the Barents Sea herring in the Norwegian Sea was 0,1 million tons, in 1955 they made up 0,4 million tons, in 1956 0,9 million tons, in 1957 1,3 million tons, and in 1958 0,8 million tons.

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Table 3. Growth-rate of herring of types A and C of the 1950 year-class in the Barents Sea[x].

Type of growth	Year	Month	Stage of maturity	Growth-rate							n
				$^1_1$	$^1_2$	$^1_3$	$^1_4$	$^1_5$	$^1_6$	$^1_7$	
A	1953	July	II	7,8	12,3	15,5	16,9				40
			II-III	7,8	12,4	15,6	17,1				123
		September	II-III	7,7	12,3	15,9	18,8				53
	1954	September	II-III,III	7,7	12,2	15,7	18,3	30,5			23
		October	II-III,III	7,3	12,6	16,0	19,0	20,7			7
	1955	July	II	7,7	12,0	15,2	18,1	21,0	21,8		28
			III	8,0	12,6	16,0	19,0	21,4	22,4		30
		October	II	7,4	12,0	15,2	18,0	20,5	21,8		50
	1956	March	II,II-III,III	8,3	12,8	16,2	18,9	21,3	22,5		8
		September	II,III	7,5	11,5	15,0	17,5	20,0	21,5	23,0	2
C	1953	September	II-III	7,7	12,2	14,9	18,6				115
	1954	September	II-III,III	7,5	11,9	14,3	18,1	21,1			47
		October	II-III,III	7,5	12,3	14,3	17,7	20,6			13
	1955	July	II	7,4	11,7	14,1	17,7	20,6	21,6		79
			III	7,6	12,1	14,6	18,3	21,2	22,3		75
		October	II	7,4	11,7	14,2	17,9	20,8	22,1		93
			II-III,III	7,5	12,5	14,7	18,7	21,7	23,2		6
	1956	March	II	7,4	11,3	14,0	18,0	21,1	22,5		17
		July August September	II-III,III	7,6	11,7	14,0	17,7	20,7	22,0	23,5	7

x) Collection of data and determination of the age were carried out by Shutova-Korzh in waters of the Rybachy Peninsula - Kanin Noss region and in the area up to 72°N.

Table 4. Growth-rate of the Barents Sea herring of types A and C of the 1950 year-class with scale formulas N 6+0, N 6+1 (according to data obtained in the Norwegian Sea).

Type of growth	Scale formula	Year	Growth-rate									N
			$^1_1$	$^1_2$	$^1_3$	$^1_4$	$^1_5$	$^1_6$	$^1_7$	$^1_8$	$^1_9$	
A	N 6+0	1956	8,5	13,3	16,6	19,5	21,7	23,7	26,5			14
		1957	7,7	12,1	15,6	18,5	21,2	22,7	26,8	28,8		24
		1958	7,3	11,6	15,0	18,0	20,7	22,5	26,7	28,5	29,3	35
	N 6+1	1957	7,8	12,1	15,3	17,9	20,1	21,7	26,1	28,1		14
		1958	7,0	11,7	15,0	17,5	19,9	21,2	25,7	28,5	29,4	6
C	N 6+0	1956	7,9	12,6	14,9	18,4	21,1	22,5	25,9			37
		1957	7,5	11,9	14,5	18,1	21,2	22,9	26,9	28,5		91
		1958	7,7	11,9	14,4	18,1	21,1	22,6	26,7	28,5	29,5	97
	N 6+1	1957	7,5	11,9	14,3	17,6	20,5	22,1	26,2	28,1		30
		1958	7,5	11,5	13,9	17,2	19,8	20,9	25,2	27,6	29,0	9

Table 5. Growth-rate of the Barents Sea herring of type D of the 1950 year-class with different scale formulas (according to data collected in the Norwegian Sea).

Type of growth	Scale formula	Year	Growth-rate									N
			$^1_1$	$^1_2$	$^1_3$	$^1_4$	$^1_5$	$^1_6$	$^1_7$	$^1_8$	$^1_9$	
D	N 4+1	1954	7,8	12,6	16,0	18,7	23,2					36
		1955	8,2	12,7	16,1	18,8	24,1	26,0				38
		1956	7,9	12,5	16,0	18,6	24,4	27,6	28,8			57
		1957	7,8	12,4	15,7	18,3	23,9	27,3	29,0	29,9		114
		1958	7,7	12,2	15,5	18,3	23,8	27,2	29,1	30,1	30,6	93
	N 4+2	1956	7,8	12,1	15,4	18,1	23,0	25,6	27,7			81
		1957	7,6	12,0	15,1	17,6	22,2	24,6	27,8	29,1		69
		1958	7,3	11,8	14,7	17,2	22,0	24,7	28,0	29,4	30,0	52
	N 6+0	1956	7,2	11,8	14,7	17,0	20,5	22,1	25,8			48
		1957	7,5	11,9	15,0	17,4	20,9	22,4	26,6	28,3		96
		1958	7,3	11,8	15,1	17,3	20,8	22,5	26,6	28,4	29,5	114
	N 6+1	1957	7,4	11,8	14,7	17,0	20,6	22,2	26,2	28,0		52
		1958	7,7	12,0	14,6	16,5	20,1	21,7	26,0	28,4	29,7	14

Table 6. Growth-rate of herring of types D and C-D of the 1950 year-class in the Barents Sea[x].

Type of growth	Year	Stage of maturity	Growth-rate							N
			1_1	1_2	1_3	1_4	1_5	1_6	1_7	
D	1954	II-III,III	7,7	12,1	14,9	17,1	20,5			32
		II-III,III	7,5	12,1	14,9	16,9	20,5			11
	1955	II	7,6	12,1	15,0	17,2	20,5	21,4		68
		III	7,8	12,4	15,3	17,7	21,1	22,1		66
		II	7,6	11,9	14,6	16,9	20,2	21,7		116
		II-III,III	7,8	12,3	15,1	17,7	21,4	22,6		10
	1956	II,II-III	7,5	11,7	15,1	17,3	21,0	22,4		16
		II	7,2	11,2	13,8	15,9	19,4	21,0	22,3	12
C-D	1954	II-III,III	7,5	11,7	14,0	17,0	20,4			24
		II-III,III	7,8	12,1	14,4	17,2	20,8			19
	1955	II	7,2	11,6	13,9	16,8	20,5	21,4		54
		III	7,5	11,9	14,2	17,2	21,1	22,0		55
		II	7,3	11,5	13,7	16,5	20,3	21,7		66
		III	7,7	11,9	14,2	17,2	21,9	22,5		6
	1956	II	7,3	11,6	13,8	16,9	21,0	22,3		14
		II	7,5	11,2	13,2	16,4	19,9	20,9	22,2	6

x) Collection of data and determination of the age were conducted by Shutova-Korzh in water of the Rybachy Peninsula - Kanin Noss region and in the area up to 72°N.

Table 7. Growth-rate of the Barents Sea herring of type C-D of the 1950 year-class with different scale formulas (according to data obtained in the Norwegian Sea).

Type of growth	Scale formula	Year	Growth-rate									N
			$^1_1$	$^1_2$	$^1_3$	$^1_4$	$^1_5$	$^1_6$	$^1_7$	$^1_8$	$^1_9$	
C-D	N 4+1	1954	8,1	12,3	14,4	17,7	22,5					12
		1955	8,1	12,7	15,5	19,0	24,2	26,0				34
		1956	7,6	12,1	14,9	18,8	24,3	27,0	28,7			43
		1957	7,7	12,1	14,8	18,3	23,8	27,2	29,1	29,9		123
		1958	7,5	12,1	14,7	18,2	23,8	27,3	29,2	30,2	30,8	93
	N 4+2	1956	7,6	11,9	14,4	17,7	22,6	25,5	27,6			48
		1957	7,6	11,9	14,4	17,6	22,4	25,1	28,0	29,1		74
		1958	7,4	11,6	14,0	17,1	21,7	24,3	27,6	29,0	30,0	54
	N 6+0	1956	7,9	12,2	14,3	17,4	21,2	22,5	26,1			26
		1957	7,6	12,0	14,3	17,4	21,2	22,9	26,9	28,4		77
		1958	7,4	11,8	14,2	17,3	21,0	22,7	26,8	28,6	29,6	62
	N 6+1	1957	7,6	11,8	14,0	17,0	20,7	22,4	26,3	28,1		37
		1958	7,0	11,4	13,5	16,2	20,0	21,5	26,2	28,6	30,0	9

Table 8. Increments of the Barents Sea herring of different growth types of the 1950 year-class for the 5th, 6th and 7th summer of their life.

Types of growth	Scale formula	1954	1955	1956
A	6+0	2,2-2,7	1,5-2,0	2,8-4,1
	6+1	2,4-2,2	1,3-1,6	4,4-4,5
C	6+0	2,7-3,1	1,4-1,7	3,4-4,1
	6+1	2,6-2,9	1,1-1,6	4,1-4,3
D	6+0	3,5-3,5	1,5-1,6	3,7-4,2
	6+1	3,6-3,6	1,6-1,7	4,0-4,3
C-D	6+0	3,7-3,8	1,3-1,8	3,6-4,1
	6+1	3,7-3,8	1,5-1,7	3,9-4,7

Table 9. Abundance of the Barents Sea herring of the 1950 year-class in the Norwegian Sea in 1954-1958.

	Abundance of the Atlanto-Scandian herring stock in the Norwegian Sea		Abundance of the 1950 year-class of herring with "southern" and "northern" types of scale		Abundance of the Barents Sea herring of the 1950 year-class in the Norwegian Sea
Year	Total (mln t)	Including 1950 year-class	S	N	
1954	12,2	21,9 2,7	5,5 0,2	94,5 2,5	0,8 (3,5) 0,1
1955	13,9	31,9 4,4	8,5 0,4	91,5 4,0	2,7 (8,4) 0,4
1956	12,0	35,4 4,3	6,0 0,3	94,0 4,0	7,4 (21,0) 0,9
1957	9,4	39,2 3,7	4,4 0,2	95,6 3,5	13,9 (35,4) 1,3
1958	6,6	39,2 2,6	6,6 0,2	93,4 2,4	12,8 (32,5) 0,8

Note: 1. in the numerator - %
in the denominator - million tons.

2. in brackets - the portion of the Barents Sea herring of the total herring abundance of the 1950 year-class.

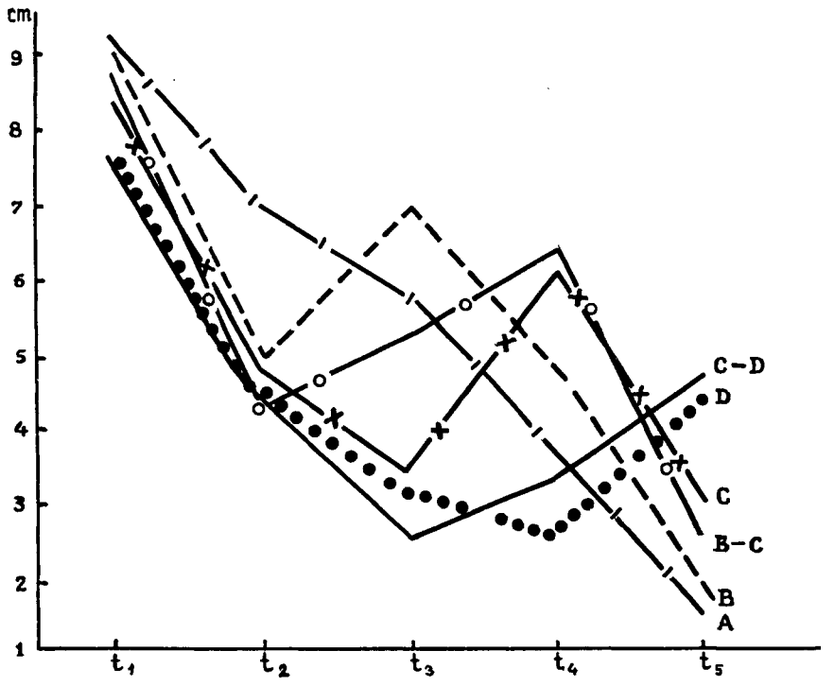

Figure 1. Types of growth of the Atlanto-Scandian herring of the 1950 year-class in the Norwegian Sea.

Figure 2. Ratio of the 1950 year-class with different scale formulas within each type of growth in the Norwegian Sea (in %).

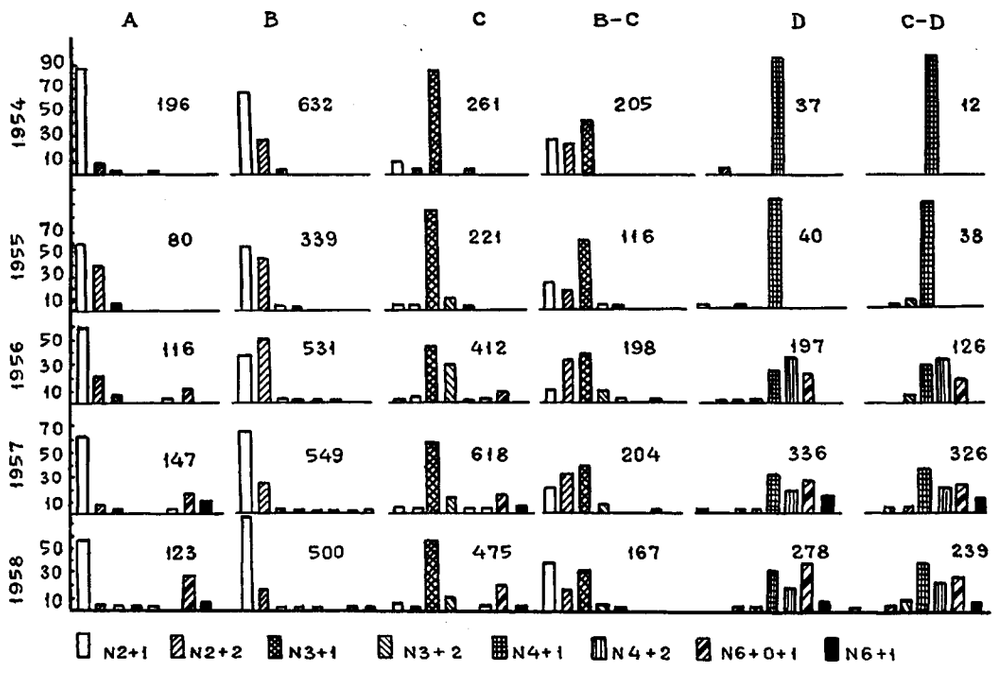

Figure 3. Size frequencies of herring of the 1950 year-class belonging to growth type A in the Norwegian Sea (data calculated and observed).

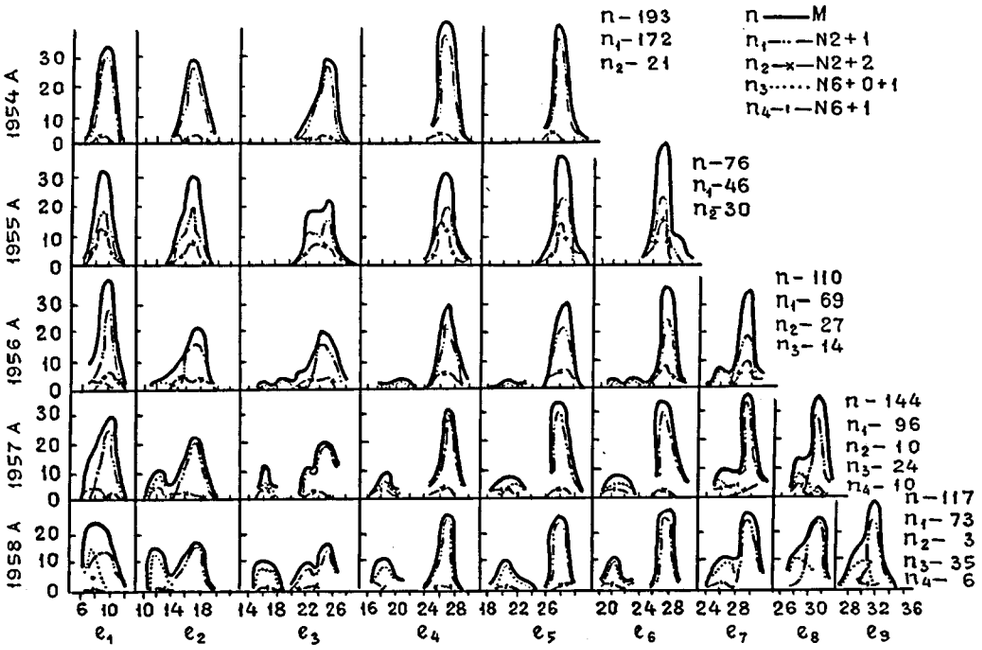

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Figure 4. Size frequencies of herring of the 1950 year-class belonging to growth type B in the Norwegian Sea (calculated and observed data).

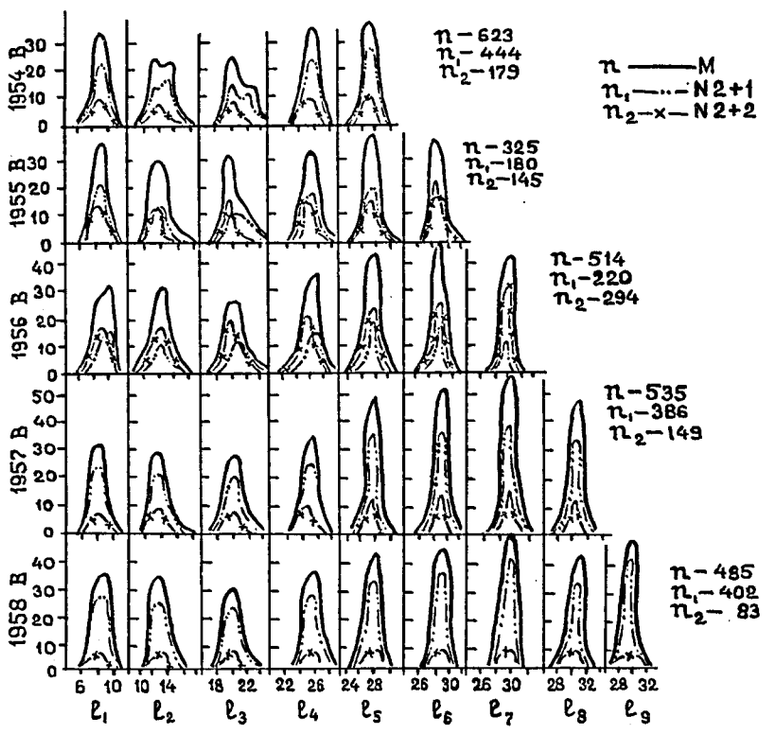

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Figure 5. Size frequencies of herring of the 1950 year-class belonging to growth type C in the Norwegian Sea (calculated and observed data).

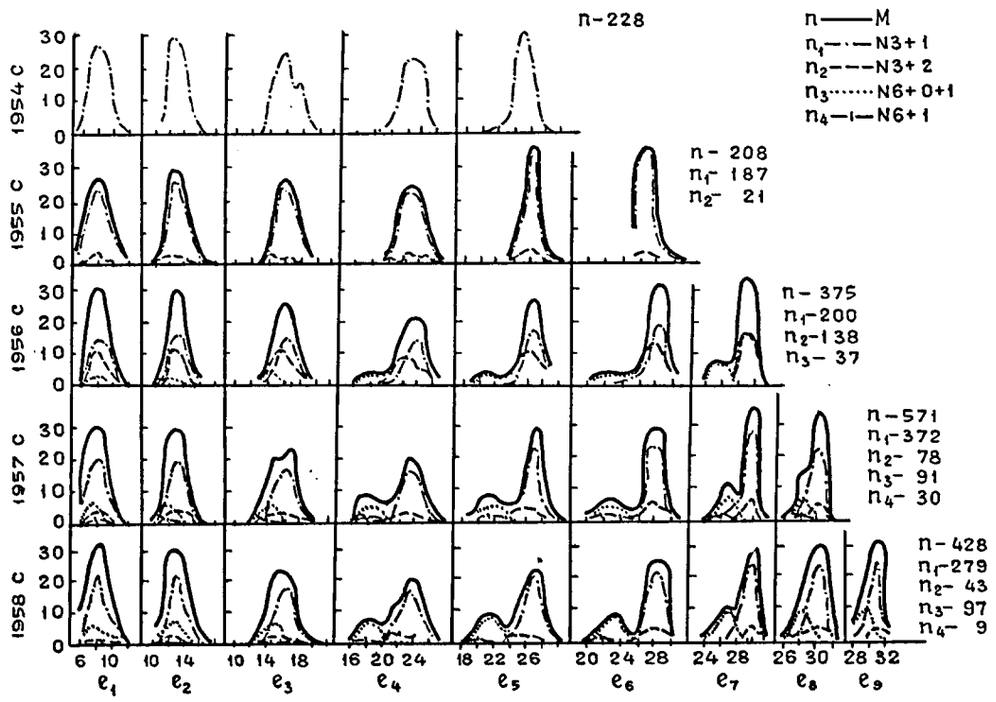

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Figure 6. Size frequencies of herring of the 1950 year-class belonging to growth type B-C in the Norwegian Sea (calculated and observed data).

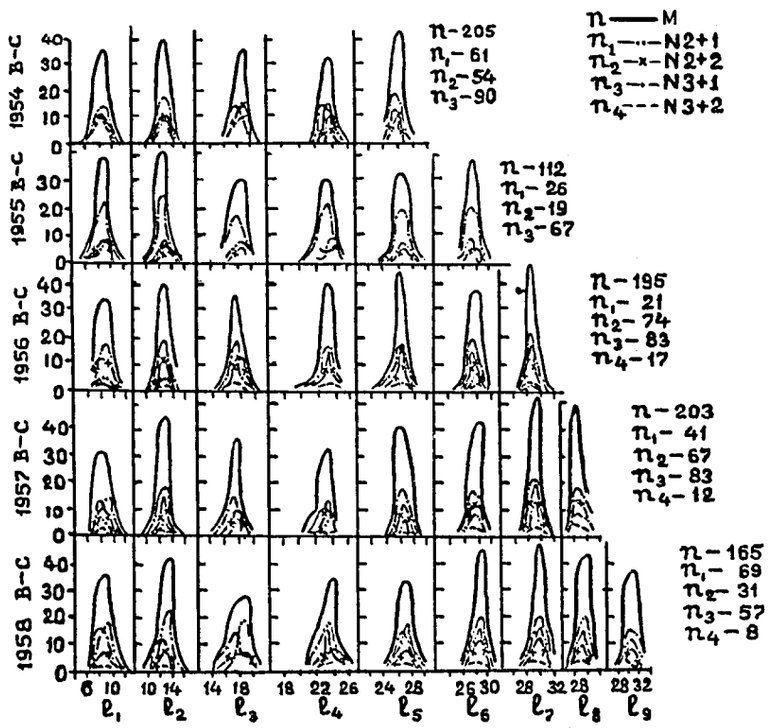

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Figure 7. Size frequencies of herring of the 1950 year-class belonging to growth type D in the Norwegian Sea (calculated and observed data).

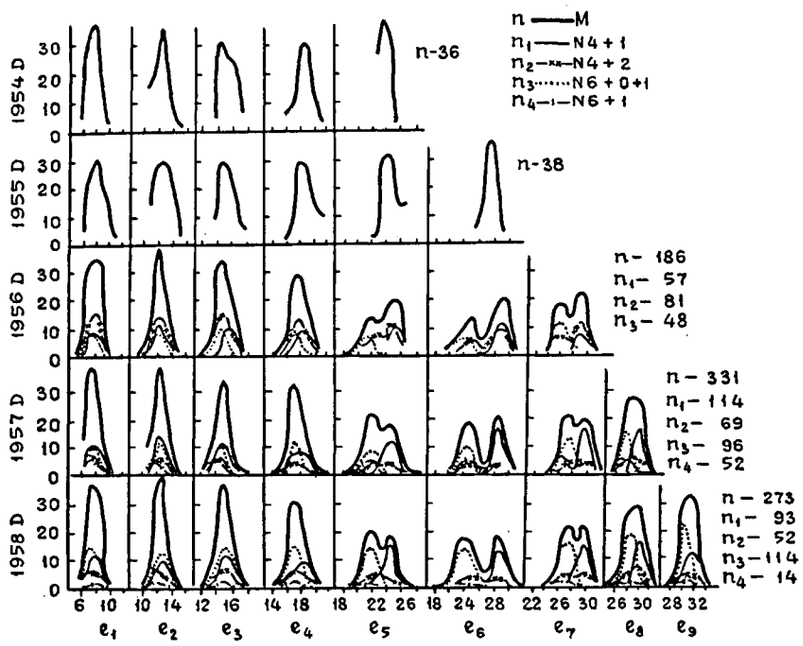

Figure 8. Size frequencies of herring of the 1950 year-class belonging to growth type C-D in the Norwegian Sea (calculated and observed data).