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Some considerations concerning the homogeneity of the Atlanto-Scandian herring.

by

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Introduction.

Several attempts have been made to subdivide the Atlanto-Scandian herring race (Broch 1908, Johansen 1919, Schnakenbeck 1931, Otterstad 1934, Runnstrøm 1941). The results obtained in these investigations are partly contradictory. The study of meristic characters has not given any decisive evidence for a distinction of different races. From evidence revealed by the last years tagging experiments and studies of herring migration it is now generally agreed that the Atlanto - Scandian herring is one race.

However, in our studies of the dynamics of the herring population it is of basic importance to know if there exist components which, although they cannot be distinguished by racial criteria, ought to be treated separately.

Different growth types in the Atlanto - Scandian herring.

Through intensive studies of herring scales Lea (1929) observed that the winter rings of scales from young herring taken in northern Norway were sharper than the winter rings of herring scales from the southern west coast.
According to their main distributions Lea termed the two types: northern and southern respectively.

On the basis of samples of young herring ($1\frac{1}{2}$ years old) taken along the Norwegian west coast, Runnstrøm (1936) has given further information with respect to the geographical distributions of the two types. In northern Norway, on the Finnmark coast, 100 per cent of the young herring have the northern scale type. In the intermediate region, between northern Norway and the Møre coast, the two types are mixed. On the south west coast about 90 per cent of the young herring have coastal rings of the southern type. From this evidence Runnstrøm concluded that the northern type of winter rings are formed in coastal waters of northern Norway and the southern type on the south west coast, thus sustaining Lea's theory.

In the older age groups there is an increasing intermixing of the two types and in the spawning shoals both types are always found together. There seems, however, to be a dominance of the northern type on the northernmost spawning banks.

Vertebral counts of the southern and the northern type.

According to Runnstrøm (1941) the mean vertebral number of samples of small herring taken on the south west coast of Norway, is significantly higher than that of herring samples taken from the northern west coast. If this holds true, and the southern type is mainly recruited from the southern spawning grounds, one should expect the mean vertebral counts of this type to be significantly higher than that of the northern type. In Table 1 are shown the mean vertebral counts for the southern and the northern types of the year classes 1934 to 1950.

The means tend to be slightly lower for the southern type, but only within the year classes 1938, 1943 and 1945 there exist a significant difference between the mean vertebral counts of the two types.

From this evidence we must conclude that the two types cannot be separated by the number of vertebrae. This is consistent with the result of analysis of vertebral counts of young herring with different scale types, shown by Runnstrøm (1941).

It is thus reasonable to assume that the two types originate from the same main spawning areas. The differentiation of the types then occurs as a result of a different drift during the pelagic stage.

Growth rate and age at first spawning.

The difference in the structure of the winter rings of the southern and the northern types is related to a different growth - rate (Runnstrøm 1936). Figure 1 shows the growth curves of different year classes for the southern and the northern types of herring. During the first years of life the southern type has a much greater growth increment than the northern type.

The age at first spawning is closely related to the growth of the herring. The fast-growing southern type reaches maturity at a lower age than the slow-growing northern type.

The age at first spawning can be determined by means of the spawning rings of the scales. On the basis of samples of herring taken on the spawning grounds in the years 1946 to 1955 the mean age at first spawning has been calculated for each year class and growth type according to year of sampling. The result is shown in Table 2.

It should be mentioned here that the calculated mean age at first spawning is not the true mean spawning age. The younger spawning groups of a year class have been exposed to fishing mortalities during more fishing seasons than individuals belonging to older spawning groups, and are thus reduced in numbers compared with later incoming spawning groups. The calculated mean age at first spawning must therefore be slightly too high.

When all individuals of a year class have attained sexual maturity one would expect that the calculated mean age at first spawning should be constant, if it is assumed that the mortality is now the same for all spawning groups of the year class. Figure 2 gives the variations in the mean age at first spawning for some year classes. As will be seen the mean age is not constant for any of the year classes. An analysis of variance of the mean age at first spawning for the year classes 1934 to 1945 shows that significant differences exist between the mean ages for the various years of sampling. This may be ascribed to two main sources of errors, sampling methods and mistakes in the interpretation of the spawning rings. It might also be that our presumption of the same mortality- rate for all spawning groups of a year class (when all individuals have attained sexual maturity) does not hold true.

However, if we compare the grand mean ages for the different year classes, shown in Figure 3, we find that for the southern type the mean age at first spawning has been nearly constant at about 4.4, over a long period of years. In contrast to this the year classes of the northern type show a decreasing mean age at first spawning from about 7.4 for the year class 1934 to 5.1 for the year class 1945. As seen from Figure 1 this may be ascribed to the increase in growth rate of the northern type of herring in this period.

Relative abundance of the southern and the northern types.

In Figure 4 the percentage ratios of the two types are shown for each age group and each year class, calculated from samples taken on the spawning grounds. The proportions of the two types show great fluctuations from year class to year class. In the older year classes, 1931 - 1939, the northern type is the dominant component. In the year classes after 1940 the southern type is usually the most abundant one.

In each year class the southern type dominates the younger age groups, in accordance with the difference in age at first spawning. Owing to insignificant number the 3 years old are not included on the figure, but this age group concists almost exclusively of the southern type of herring.

The relative abundance of the two types seems to be related to the strength of the year classes. When comparing this figure with the relative strength of the year classes it is evident that nearly all the strong year classes have a high proportion of the northern type. The year classes 1934, 1937, 1943 and 1947 were especially rich. A rich year class is thus mainly dependent of a strong influx of the northern type of

herring. This is especially noticeable for the year class 1937. The recruitment of the southern type must have been very weak this year compared with the northern type.

Further evidence that the northern type is dominant in the rich year classes is drawn from observations of the growth increment and the geographical distribution of the various year classes. According to Marti (1956) the rich year classes have a smaller growth increment and a more northerly distribution than the poor ones.

Conclusions.

The study of different scale types from the Atlanto-Scandian herring race has shown that we can distinguish between two main groups with different growth - rates.

The difference in rates of growth is an effect of different geographical distributions during the immature stage of life.

The two groups cannot be separated by the number of vertebrae and it seems reasonable to conclude that they are recruited from the same main spawning area.

It is thus evident that the northern and the southern types cannot be defined as different races. However, the existence of these two types complicates our studies of the dynamics of the entire herring population.

Thus, the recruitment of the two types may differ significantly from one year class to another, and the two types attain sexual maturity at different ages. To give any prediction in fluctuations of the size of the mature herring stock, it is important to know the proportion of the two types in all the age groups and particularly those which comprise recruit spawners.

To obtain an accurate estimate of the rates of growth of a year class great care has to be taken to ensure that the proportions of the southern and the northern types in the samples are representative for the year class in question. During the immature stage of life the geographical distributions of the two types are widely different and it may be necessary to treat the two groups separately.

The main exploitation of the Atlanto - Scandian herring race takes place on the mature part of the stock.
As the southern and the northern types are recruited to the spawning stock at different ages, they are subject to different fishing mortalities in early years of life. A change in the fishing intensity will therefore influence the two sub- populations differently. This may provide a mean of study the effect of fishing upon the stock.

Literature.

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Table 1.

Mean vertebral counts of samples of southern and northern types of the year classes 1934–1950.

Year class	Type	Number	Mean	t	P less than
1934	N	753	57.18	0.653	0.5
	S	43	.11		
1935	N	545	57.22		
	S	42	.21		
1936	N	425	57.26		
	S	36	.22		
1937	N	1915	57.13		
	S	53	.09		
1938	N	1312	57.19	2.338	0.02
	S	80	.00		
1939	N	610	57.26		
	S	100	.23		
1940	N	435	57.19		
	S	296	.20		
1941	N	266	57.22	1.217	0.2
	S	275	.15		
1942	N	154	57.14		
	S	373	.12		
1943	N	2837	57.13	2.96	0.01
	S	1153	.20		
1944	N	2030	57.19		
	S	1699	.18		
1945	N	350	57.22	2.89	0.01
	S	876	.09		
1946	N	174	57.20		
	S	925	.23		
1947	N	1436	57.17		
	S	1548	.17		
1948	N	557	57.25		
	S	124	.26		
1949	N	124	57.27		
	S	304	.24		
1950	N	1400	57.15		
	S	1425	.14		

Table 2.

Mean age at first spawning for the northern and the southern types of the year classes 1933 – 1950 according to year of sampling.

Northern type.

Year of sampling	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
1946	6.99	7.38	7.13	6.59	6.30	6.12	5.99											
1947	6.60	7.28	7.03	6.66	6.30	6.20	5.85	5.42										
1948	6.61	7.12	6.92	6.55	6.19	6.20	5.88	5.33	4.97									
1949	6.88	7.63	7.36	6.73	6.39	6.28	6.19	5.68	5.21	5.16								
1950	6.79	7.52	7.35	6.85	6.38	6.33	6.16	5.73	5.35	5.46	5.47							
1951	6.40	7.63	7.65	7.11	6.45	6.32	6.32	5.86	5.44	5.29	5.53	5.06						
1952	6.92	7.09	7.21	6.92	6.31	6.18	6.15	5.80	5.38	5.33	5.50	5.04	5.02					
1953	–	7.79	7.41	6.93	6.33	6.27	6.13	5.72	5.64	5.12	5.45	4.91	5.07	5.13				
1954	–	7.49	7.37	7.36	6.32	6.33	6.10	5.96	5.60	5.48	5.50	5.07	5.25	5.25	5.72			
1955	–	7.71	7.71	7.32	6.47	6.41	6.38	6.01	5.83	5.61	5.58	5.43	5.16	–	5.79	5.92		
Grand mean	6.74	7.46	7.31	6.90	6.34	6.26	6.11	5.72	5.42	5.35	5.50	5.10	5.12	5.19	5.75			
Total number	593	2194	1261	728	4600	2844	1008	666	338	154	2765	1405	192	55	508	177		
F	2.72	9.28	8.85	8.96	5.28	4.98	5.80	7.29	6.59	1.66	2.17	30.80	–	–	–	–		

Southern type.

Year of sampling																		
1946	4.61	4.53	4.55	4.49	4.73	4.55	4.62	4.43	4.93									
1947	4.44	4.41	4.41	4.55	4.42	4.31	4.41	4.37	4.50									
1948	–	–	4.38	–	–	–	4.14	4.19	4.37	4.25								
1949	–	–	–	–	–	–	4.27	4.39	4.80	4.18	4.30	4.36						
1950	–	–	–	–	–	–	–	4.33	4.71	4.12	4.49	4.28	4.33					
1951	–	–	–	–	–	–	–	4.35	4.39	4.57	4.55	4.47	4.10	4.68				
1952	–	–	–	–	–	–	–	4.17	4.33	4.50	4.48	4.38	4.02	4.04	4.15			
1953	–	–	–	–	–	–	–	4.15	4.53	4.47	4.33	4.31	4.07	4.56	4.35	4.64		
1954	–	–	–	–	–	–	–	4.33	4.39	4.45	4.38	4.35	4.22	4.64	4.32	4.31	4.04	
1955	–	–	–	–	–	–	–	4.23	4.38	4.36	4.50	4.45	4.22	4.48	4.52	4.54	4.22	4.58
Grand mean							4.36	4.29	4.53	4.36	4.43	4.37	4.16	4.48	4.33	4.49	4.13	
Total number	63	129	99	73	56	81	215	697	539	653	1673	2066	834	628	959	97	189	
F	–	–	–	–	–	–	–	1.34	13.41	3.49	8.48	6.04	7.70	6.47	–	–	–	

F underlined: not significant heterogeneity between means for years of sampling.

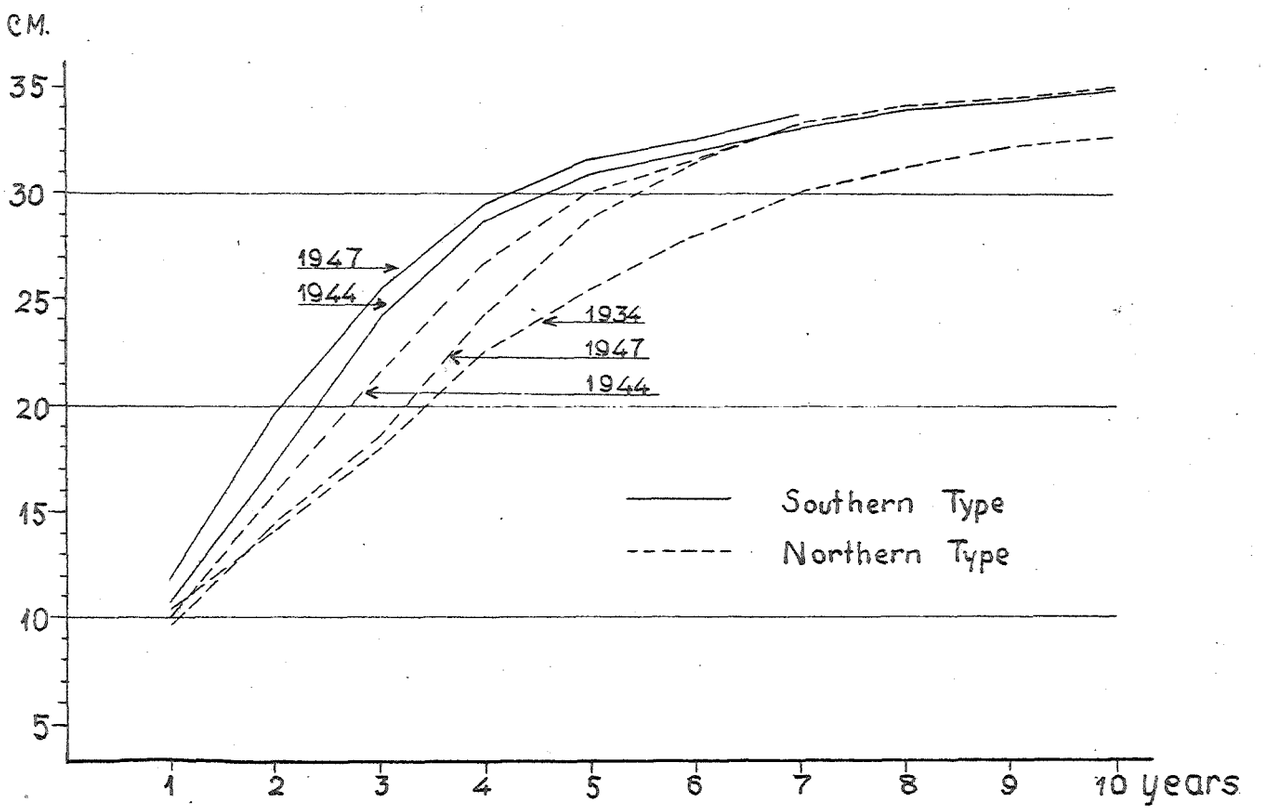

Fig. 1. Growth curves of different year classes for the northern and the southern types of herring.

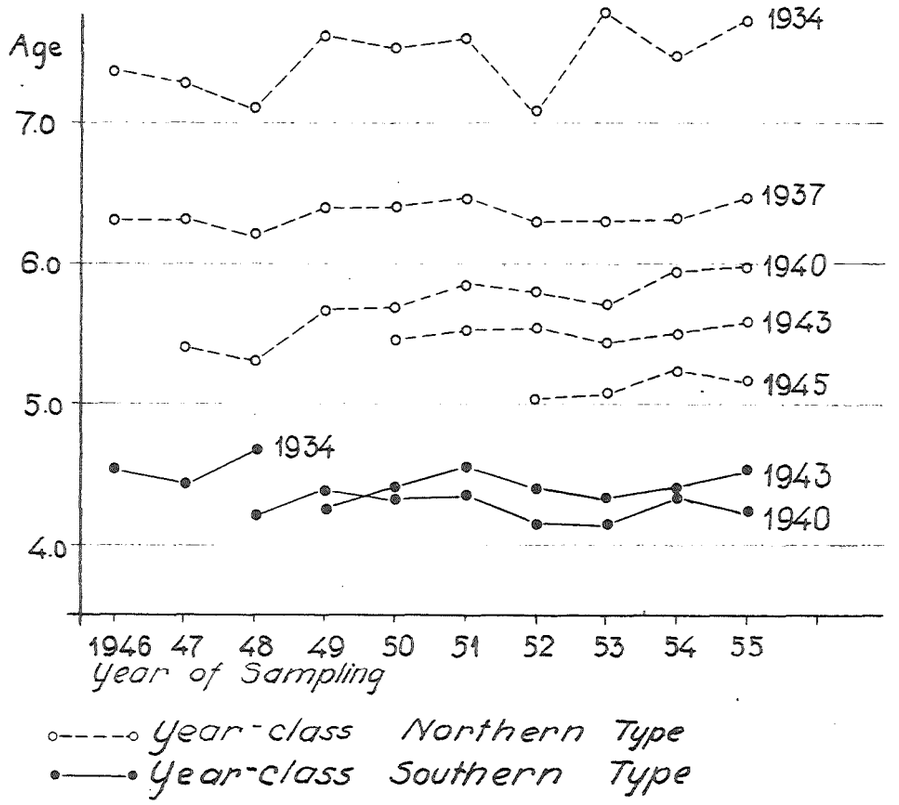

Fig.2. Mean age at first spawning for the northern and the southern types of herring of various year classes, according to year of sampling.

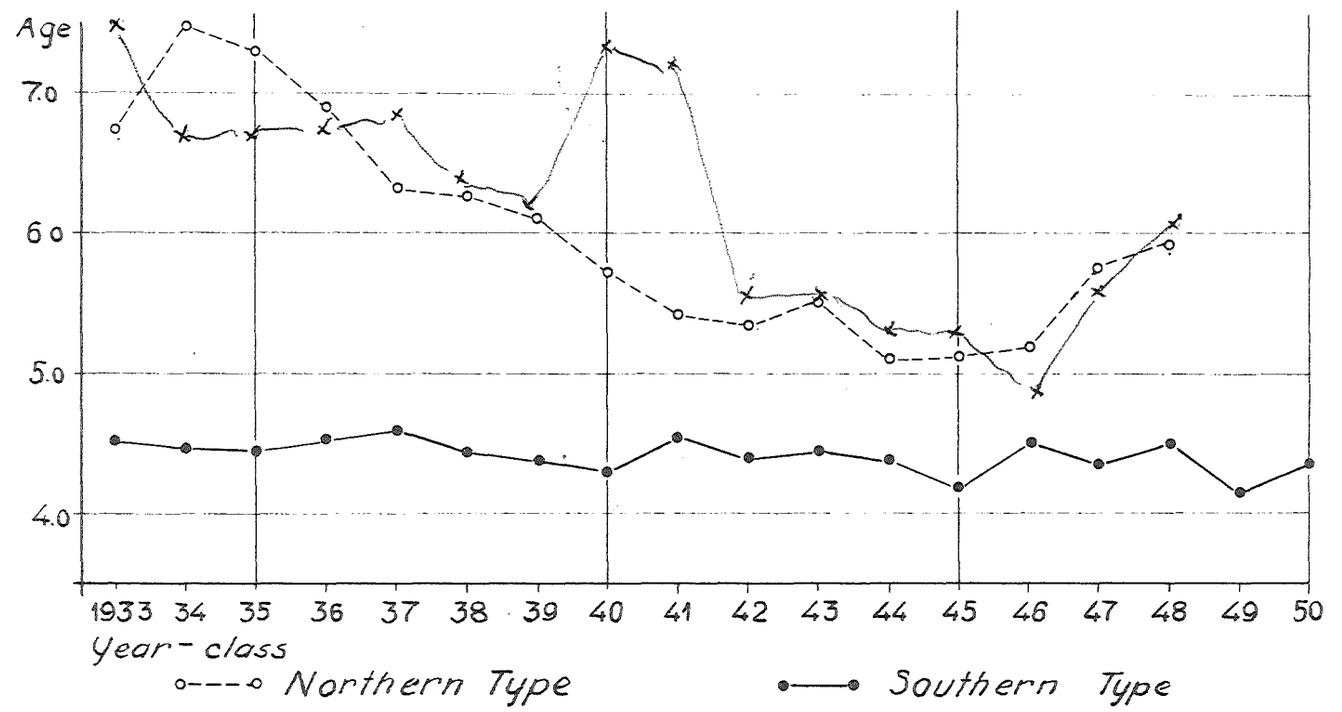

Fig.3. Average of the mean age at first spawning for the northern and the southern types of herring of the year classes 1933 - 1950.

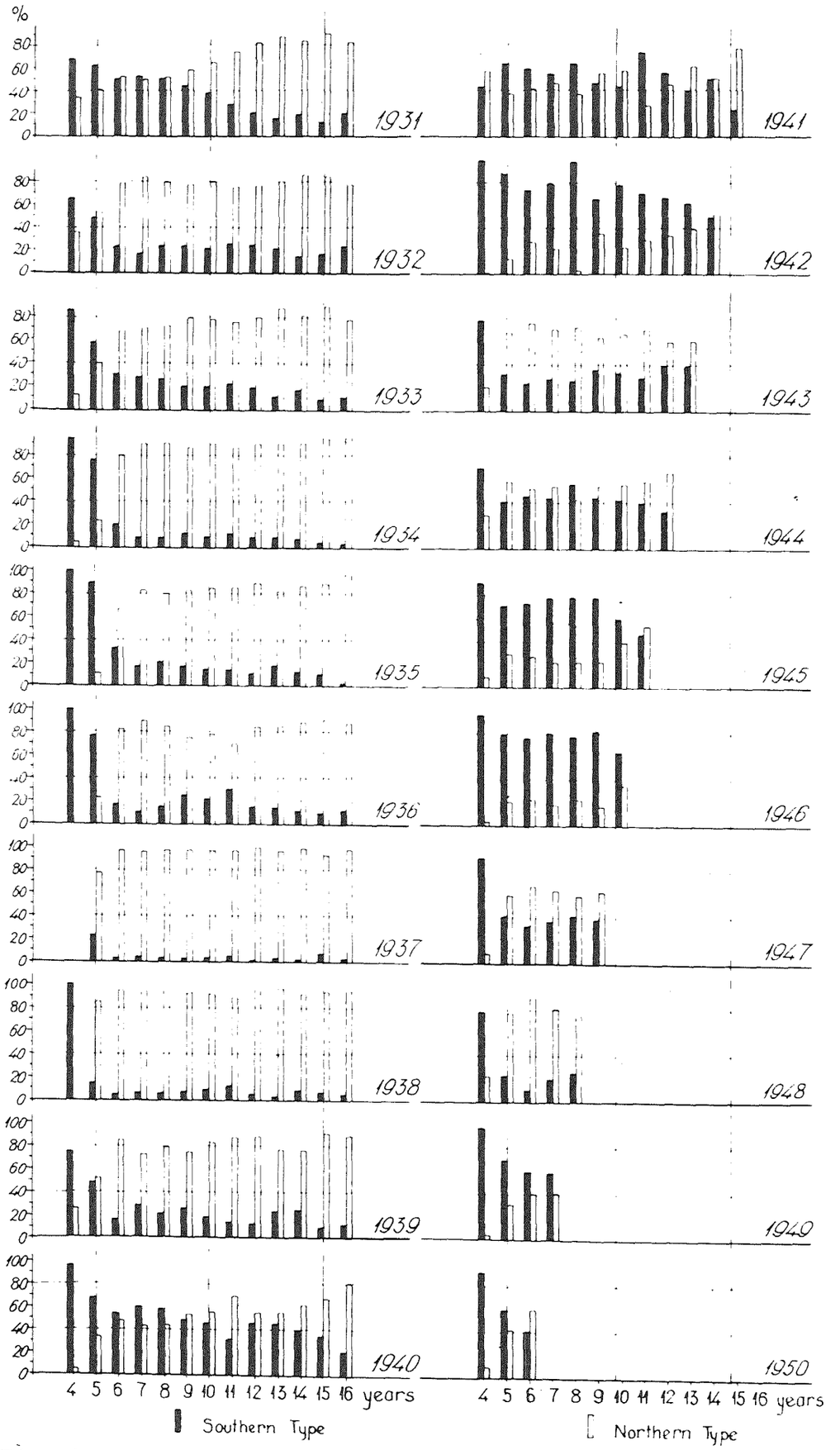

Fig. 4. The ratios of the northern and the southern types of herring for each age group and each year class.