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Observations on the Haemoglobin Types of Cod in Norwegian Coastal Waters

by

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The haemoglobin type of approximately 3000 specimens of cod, collected at 18 different localities in Norwegian coastal waters, has been determined. All the samples were shipped to Copenhagen, where the electrophoresis has been carried out. The technique employed for the analysis and the terminology used in the following account have been described in paper No. 128 presented to the ICES' Gadoid Fish Committee in 1961.

The data are shown in Table 1. The geographical distribution of the stations appears from Figure 1, which also shows the gene frequencies observed.

It is worth while to note from the table, which gives the Hardy-Weinberg expectations for each sample, that all samples, with the possible exception of nos. 11 and 12, exhibit an extremely good fit to the geneotypic distribution expected on the basis of a theory of monomeric inheritance, such as proposed by one of us (Sick, "Nature", 192, 894, 1961). The data presented here add further support to the proposed mode of inheritance, which we now consider proved beyond reasonable doubt.

In spite of the fact that the number of stations investigated remains rather modest, the data nevertheless reveal a clear main trend in the Hb^1 gene frequency along the Norwegian coast. Going from south to north we witness a steady and significant decrease in the Hb^1 frequency. The frequency along the southern Norwegian shore compares well to that found in Danish waters, i.e., the Hb^1 allele occupies some 60% of the available loci. This frequency drops apparently steadily northwards along the coast, until a value of approximately 10% is reached in the Arctic Sea. Though there is no doubt that a conspicuous trend occurs in the frequencies, it is premature to discuss whether this trend really represents a truly continuous cline or whether it is discontinuous and step-wise. The apparent continuity in the data collected may very well reflect the sparsity of the stations studied rather than a true continuity in nature. To settle this important question all that is needed is the collection of further data on a chain of stations along the coast. Work along these lines is in progress.

Two samples, nos. 11 and 12 from the waters outside Ålesund, need special consideration. No. 12 does not concur with the general trend discussed above, but shows a Hb^1 frequency which is lower, i.e., more northern, than expected on the basis of the trend. These two neighbouring samples, nos. 11 and 12, deviate from the Hardy-Weinberg expectations in the same direction, both having a conspicuous excess of homozygotes. The most obvious reason for such a deviation, is that the samples represent a mixture of specimens from two (or more) populations with different frequencies. The data available are compatible with the working hypothesis, that the samples represent mixtures of local fish and migrant spawners from the north. It should be noted that these samples, as opposed to most of the other samples from southern and middle Norway, were not collected inshore, and that they were collected within the spawning season of the "skrei" (the Arctic cod). It is obvious that it would be very desirable to investigate the gene frequency pattern along a line perpendicular to the coast at Ålesund and at a few other selected stations.

Apart from continuing the collection of blood samples for haemoglobin determination, we hope in the near future to be able to extract a greatly increased amount of information from each sample, by including testing for variation in erythrocyte antigens and serum proteins in the standard procedure. Development of useable antibodies is in promising progress in Bergen (Dag Møller), and auspicious results with serum proteins have been obtained in Copenhagen (K. Sick).

Table 1. The distribution of haemoglobin types observed in samples of cod from Norwegian waters (Stations 1-2o on Figure 1), compared with the distribution expected according to the Hardy-Weinberg law of genotype frequencies.

Haemoglobin type								
Station	Date		HbI-1	HbI-1-2	HbI-2	Other types	Total	Frequency of HbI^1 allele
1	12/1/62	obs.	24	43	1o		77	o.59
		exp.	26.9	37.2	12.9			
2	13/1/62	obs.	34	36	1o		8o	o.65
		exp.	33.8	36.4	9.8			
3	15/3/61	obs.	3o	37	11		78	o.62
		exp.	3o.2	36.7	11.2			
4	31/1/62	obs.	78	62	18		158	o.69
		exp.	75.2	67.6	15.2			
5	1/2/62	obs.	49	5o	19		118	o.63
		exp.	46.4	55.2	16.4			
6	19/2/62	obs.	32	68	2o		12o	o.55
		exp.	36.3	59.4	24.3			
7	22/3/62	obs.	32	65	33		13o	o.5o
		exp.	32.o	65.o	33.o			
8	12/2-9/3/62	obs.	54	117	45	1	217	o.52
		exp.	58.6	1o7.8	49.6			
9	29/1/62	obs.	32	53	33	1	119	o.5o
		exp.	29.o	59.o	3o.o			
1o	29-31/3/62	obs.	2o	52	41	5	118	o.41
		exp.	18.7	54.5	39.7			
11	2-3/4/62	obs.	43	86	9o	4	223	o.39
		exp.	33.8	1o4.5	8o.8			
12	27-28/2/62	obs.	14	44	1o6		164	o.22
		exp.	7.9	56.2	99.9			
13	2/4/62	obs.	9	41	44	3	97	o.31
		exp.	9.3	4o.5	44.3			
14	15/9/61	obs.	16	39	25		8o	o.44
		exp.	15.8	39.5	24.8			
15	19-2o/1/62	obs.	3o	98	71		199	o.4o
		exp.	31.4	95.3	72.4			
16	6/2/62	obs.		1o	33	1	44	o.12
		exp.	o.6	8.8	33.6			
17	26/3/62	obs.	1	17	62		8o	o.12
		exp.	1.1	16.7	62.1			
18	16-24/3/62	obs.	17	121	379	2	519	o.15
		exp.	11.6	131.8	373.6			
19	5-9/3/62	obs.	1	3o	129		16o	o.1o
		exp.	1.6	28.8	129.6			
2o	1o/3/62	obs.		25	124	1	15o	o.o8
		exp.	1.o	22.9	125.o			

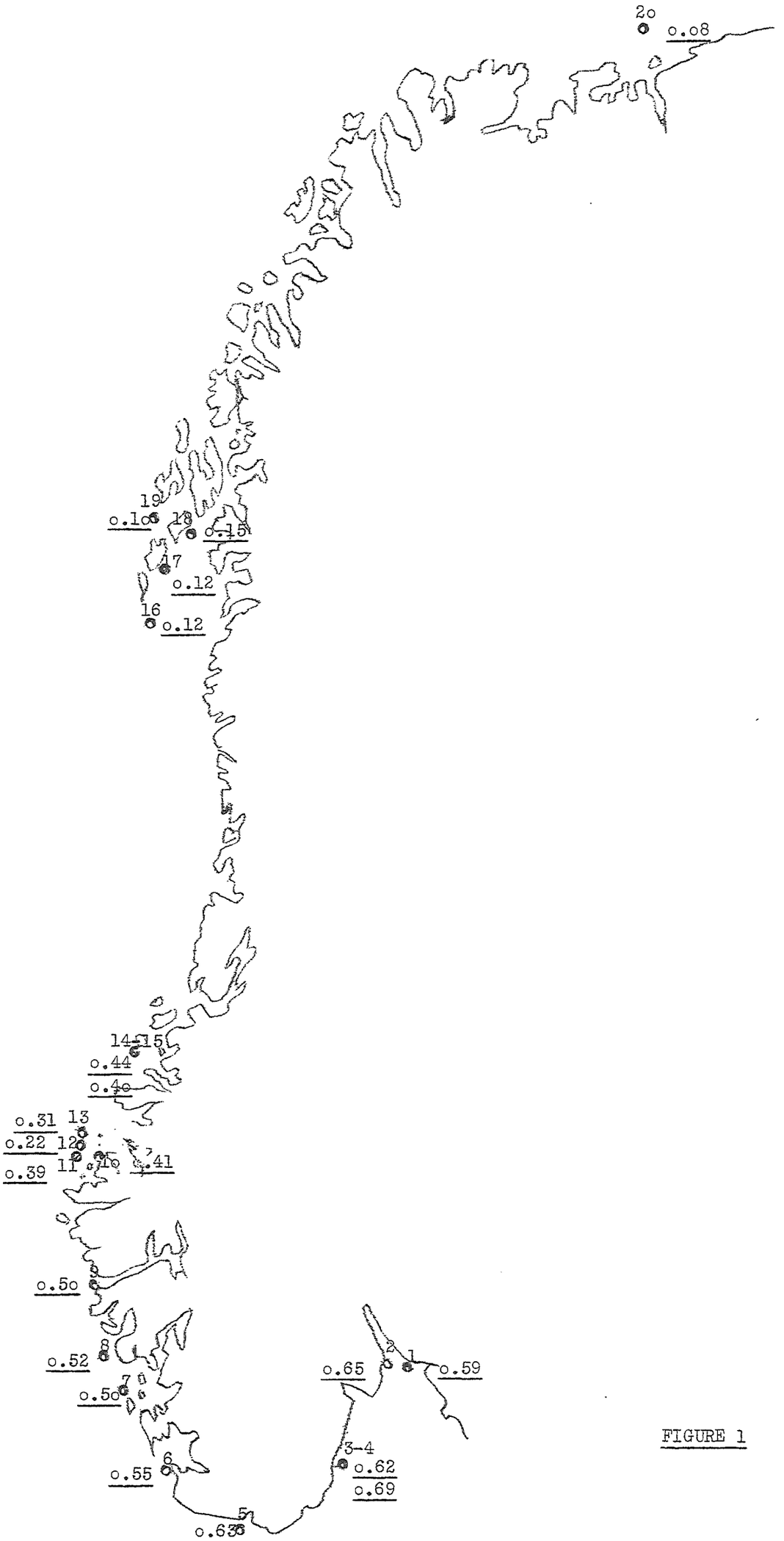
20
0.08
19
0.10
18
0.15
17
0.12
16
0.12
14-15
0.44
0.40
0.31
13
0.22
12
0.39
11
10
0.41
0.50
8
0.52
7
0.50
6
0.55
5
0.63
3-4
0.62
0.69
2
1
0.65
0.59

FIGURE 1