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REPORT OF THE NORWEGIAN SURVEYS ON BLUE WHITING DURING SPRING 1986

by

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ABSTRACT

During the period 12 March-19 April 1986 the blue whiting stock was surveyed by two research vessels in the shelf area from west of Ireland to Lofoten in northern Norway. Maturing blue whiting was still migrating southwards to the shelf edge area west of the British Isle and the survey covered only part of the spawning stock. A total of 2.6 mill. tonnes blue whiting were measured, of which 2.1 mill. tonnes were mature. Particularly in the main spawning area west of the British Isles the stock was dominated by the strong 1982- and 1983-year classes. In the Norwegian waters these year classes were strongly supported by the 1985-year class.

INTRODUCTION

The blue whiting stock in the Northeast Atlantic congregates in spring to spawn in the area along the shelf edge to the west of the British Isles. Since the beginning of the 1970-ies the spawning stock has been annually surveyed acoustically by one or more nations, resulting in estimates of great variety (Anon., 1983). Migration of fish to and from the spawning area lasts from early March to late May, and hence surveys at different time periods covering different parts of the area, records only parts of the stock. To a lesser extent, spawning also take place in other areas than west to the British Isles, i.e. in the Norwegian Sea at various localities, for example along the western Norwegian Coast (Lahn-Johannessen, 1968).

In spring 1986 two Norwegian research vessels surveyed the area from west of Ireland to Lofoten in North-Norway. The R.V. "Eldjarn" covered the shelf edge area from the Porcupine Bank north to the Faroe Isles in the period 12 March-6 April and the R.V. "Michael Sars" covered the area further north along the Norwegian shelf up to Lofoten in the period 1-19 April. While the southern survey had blue whiting as main objective, the northern survey had other main target with blue whiting observations as additional informations. The complete cruise tracks and the stations worked are shown in Fig. 1.

During the first part of the survey a period of very rough weather conditions spoiled much of the cruise programme, and consequently the area surveyed was rather strictly limited.

MATERIAL AND METHODS

For identification of the recordings and collection of biological samples both bottom trawl and pelagic trawls with vertical openings of 15, 20 and 45 m were used.

For the acoustic assessment the area surveyed were divided into 10 subareas using the distribution pattern as guidance and these again into rectangles of 30 minutes latitude and 60

minutes longitude (Fig. 3). Within each rectangle the size of the blue whiting distribution area was measured, the mean integrator value calculated and the weighted combination of representative biological samples with length, age and weight established. The calculations were done by a computer with a programme based on relations described in Appendix II of Anon. (1982). The density coeffisient (C_F) of blue whiting is the same as used for young cod. For a 30 cm fish with target strength of ÷40,5 dB, and using 4π in expressing the integrator values the coeffisient will be:

$$C_F = 1.488 \times 10^6 \times l^{-2.18} \text{ no of fish/m}^2\text{/n.mile}^2$$

where l is fish length.

This value was used in the calculation of blue whiting abundance and biomass within each of the rectangles.

For establishing age-length and length-weight keys in each of the 10 sub-areas and for calculations of length, age and maturity compositions, the different biological samples used in the combinations were weighted in accordance to the consideration of their representativeties.

The vessels worked with 38 kHz echosounders connected to integrators. Calibration of the acoustic equipment against a standard target coppersphere (Foote, 1981) gave the following instrument constants, C_I:

R/V "Eldjarn": 0.57 m^2/n.$mile^2$
R/V "Michael Sars": 1.20 - " -

These standardizing of the integrator values then theoretically give comparable units. Nevertheless, ship to ship-calibration in the field may show practical differences due to various threshold levels.

In the late July R.V "Eldjarn" made a ship to ship-calibration with R.V. "G.O. Sars" (C_I : 0.46) in the Norwegian Sea.

Recordings were made within the whole water column, showing plankton uppermost, mesopelagic fish intermediate and blue whiting from approximately 200 to 500 m depth. The total regression obtained was:

$$M_{\text{G.O. Sars}} : 1.04 \times M_{\text{Eldjarn}} + 20.5$$

with $r = 0.96$

(M = integrator values, r = correlation coefficient).

The threshold effect has been discussed in Anon. (1985b), showing that most vessels have problems with single-fish integration at depths below 100 m, even at ideal threshold levels. While in 1986 the maximum range for proper single-fish integration was 79 m for "G.O. Sars", it was found to be only 35 m for "Eldjarn" (Aglen, not published).

Using the blue whiting recordings only, during the ship to ship-calibration, i.e., the recordings between 200 and 500 m, the estimation within a rectangle of 4016 n. mile^2 gave 43 152 tonnes for "G.O. Sars" separate and 23 674 tonnes for "Eldjarn" separate. Based on this the results of the blue whiting biomass and abundance estimation obtained from "Eldjarn" west of the British Isles in March/April were recalculated by using the relation:

$$\frac{\text{"G.O. Sars"}}{\text{"Eldjarn"}} = 1.82$$

RESULTS

Blue whiting concentrations of various densities were recorded along the whole shelf edge area from west of Ireland northwards to the Lofoten Islands (Fig. 2). To the west and to the south the zero-line of the distributions was not defined, and particularly to the south the concentrations clearly extented further off the shelf edge.

The highest concentrations were found in the Porcupine bank area at longitude 54°N, west of Shetland at the shelf edge at 60°70'N and west of Mid-Norway at the shelf edge at 65°N. The other observations of blue whiting were rather scattered and considered as weak recordings.

The assessment of the total blue whiting biomass recorded during the survey was 2.6 mill. tonnes. Of this 2.1 mill. tonnes were mature or maturing and the rest, 0.5 mill. tonnes, were immature. In the southern part, i.e. from the Faroe-Shetland area and southwards, the biomass recorded was assessed to 1.6 mill. tonnes of which 1.4 mill. tonnes were mature blue whiting. In the northern part, i.e. west of the Norwegian coast, the assessment gave 1.0 mill. tonnes, where 0.6 mill. tonnes of it were mature (Table 1).

The length- and age compositions of the blue whiting from the north (subareas E-J) and from the south (subareas A-D) are illustrated in Figs. 4 and 5 respectively. The 1982- and the 1983-yearclasses were dominating and in the south they made up the bulk of the stock with 30% and 44% respectively. In the north the 1985-yearclass were also found to be of significant abundance and had a contribution of nearly 35%, the same as the 1982-yearclass. In Figs. 6 and 7 the length and age composition respectively are shown for each of the subareas.

The distribution of the maturity stages of the blue whiting from each of the subareas is presented in Table 2. At the Porcupine bank (subarea A) the spawning had started in mid March and 70% were found to have either spent or running gonads. Lesser than 2% of the specimen were immature in this area. In the area west of the Hebrides (subarea C) only 18% were spent or running, indicating that the process were just in the starting phase in this "peak-area" of spawning. The contribution of immature fish increased northwards up to subarea G where it was found to be 61%. Spawning of blue whiting did also take place also along the Norwegian shelf area, and contributions of specimen with ripe, running or spent gonads were found in all of the subareas.

The male blue whiting seems to start maturing somewhat earlier than female, and for the southern area surveyed (A-D) also maturing specimen of the 1985-yearclass were found (Fig. 8). Near 100% of the 1982-yearclass and older were mature in the southern area, when in the northern area this percentage were valid for the 1980-yearclass and older. The maturity ogive of blue whiting from each of the subareas are shown in Fig. 9.

The temperature conditions in the sea surface layer and at 300 m depth are shown in Figs. 10 and 11 respectively, and no significant differences were observed from previous years.

DISCUSSION

The result of 1.4 mill. tonnes of adult blue whiting in the spawning area along the shelf edge west of the British Isles is clearly an underestimate of the spawning stock size. Due to much rough weather, the area planned to be surveyed was considerable amputated. It seems possible that concentrations of blue whiting were still far off the shelf edge and only later migrated nearer to the edge. The survey of the area from the Faroe Islands and Shetland and northwards, demonstrated that blue whiting were maturing and thus expected to migrate southwards to the main spawning area. As spawning also took place at the Norwegian shelf, not all of the observed adults, however, would likely pass beyond Norwegian waters.

Due to the maturing progress of the gonads it is reasonably to believe that the survey west of the British Isles would have met significantly more blue whiting 2 weeks later. Assuming that the majority of the mature blue whiting in the subareas E, F and G migrated southward, would increase the spawning part in the main spawning area to 2.0 mill. tonnes, and leaving 0.1 mill. tonnes in the northernmost subareas.

In spring 1984 a Norwegian assessment gave 2.1 mill. tonnes mature blue whiting (Monstad, 1984 as ref. in Anon., 1985a), and in 1985 a Faroese assessment gave 1.7 mill. tonnes of the 1981-yearclass and older (Jakupsstovu and Thomsen, 1985). An

USSR estimate in 1985, which covered a bigger area, gave 2,7 mill. tonnes of mature blue whiting (Belikov et al., 1985 as ref. in Anon., 1986).

The present total estimate of 2.1 mill. tonnes of mature blue whiting is an underestimate and does not represent the total spawning stock. The estimate, however, seems to be representative for the abundance of mature blue whiting being inside the area covered during the survey.

The survey clearly confirmed the strength of the 1982- and 1983-yearclasses (Anon., 1986) and demonstrated their recruitment to the spawning stock.

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Table 1. Blue whiting observations in different subareas west of Norway and west of the British Isles (see Fig 3), March/April 1986.

Subarea	Abundance - N in millions			Biomass - thousand tonnes			$\bar{w}$ (g)	$\bar{l}$ (cm)	Area size $n.m^2$	Density $t/n.m^2$
	imm.	mat.	sum	imm.	mat.	sum				
J	1.0	12.0	13.0	0.2	2.3	2.5	192.0	31.2	2446	1
I	259.0	737.0	996.0	25.5	72.5	98.4	98.4	25.1	11638	8
H	69.9	186.1	256.0	11.1	29.7	40.8	159.4	28.8	13187	3
G	2344.3	1473.7	3818.0	200.9	126.4	327.3	85.7	24.2	13705	24
F	561.9	1146.1	1708.0	51.2	104.5	155.7	91.1	24.2	20522	8
E	1373.6	3251.4	4625.0	105.4	249.7	355.1	76.8	22.9	24706	14
SUM OFF NORWAY	4609.7	6806.3	11416.0	394.3	585.1	979.4	85.8	23.9	86204	11
D	923.6	3453.4	4377.0	100.2	374.9	475.1	108.5	26.1	14696	32
C	38.0	1482.0	1520.0	6.2	244.7	250.9	165.1	29.6	5734	44
B	6.9	690.1	697.0	0.9	97.8	98.7	141.6	28.8	4919	20
A	118.0	6822.0	6940.0	13.0	745.8	758.8	109.3	26.8	12599	60
SUM OFF THE BRIT.ISL.	1086.5	12447.5	13534.0	120.3	1463.2	1583.5	117.0	27.0	37948	42
TOTAL	5696.2	19253.8	24950.0	514.6	2048.3	2562.9	98.1	25.1	124152	21

Table 2. Maturity stages (%) of blue whiting in the areas west of Norway and The British Isles, March/April 1986.

STAGE / AREA	1 IMMATURE	2 MAT./REC.	3 MATURING	4 MATURING	5 RIPE	6 RUNNING	7 SPENT	N
J	7.9	82.9	1.0	4.9	1.0	-	2.7	304
I	26.0	67.7	2.1	4.1	0.1	-	-	677
H	27.3	60.4	7.3	1.8	0.4	0.9	1.8	1028
G	61.4	35.2	1.2	0.6	0.2	0.4	1.0	497
F	32.9	64.0	-	-	-	0.4	2.7	450
E	29.7	68.5	-	-	-	0.2	1.7	650
D	21.1	63.3	1.2	0.5	1.6	0.2	12.1	1000
C	2.5	26.4	4.9	7.7	40.1	11.3	7.0	284
B	1.3	26.0	2.3	4.7	11.0	14.3	40.3	300
A	1.7	9.4	7.0	10.1	2.3	36.6	32.9	700

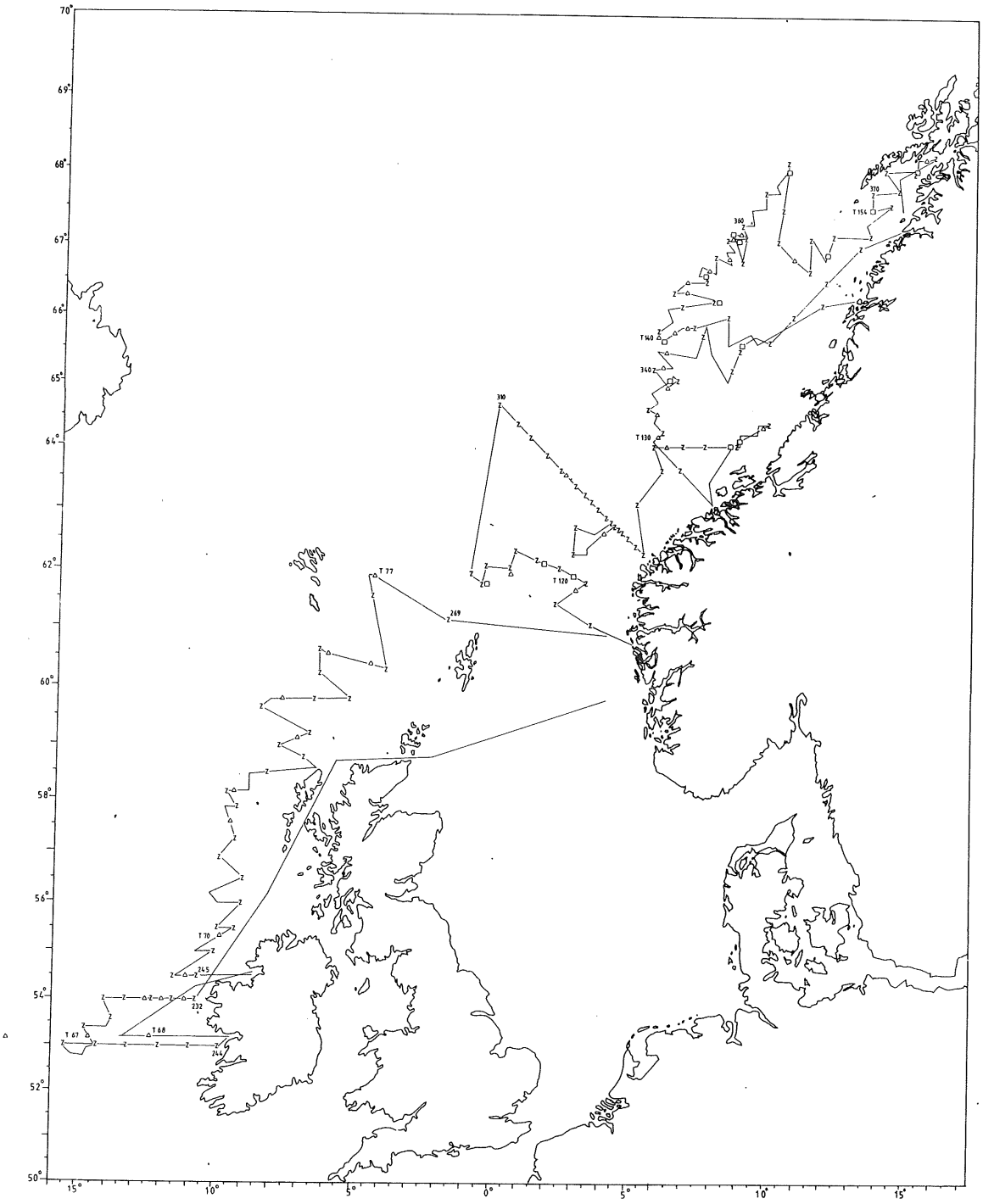

Fig. 1. Cruise tracks and stations of R.V. "Eldjarn" 12 March-6 April and R.V. "Michael Sars" 1-19 April 1986. Symbols: z) PTD-sonde, triangle) palgic trawl, square) bottom trawl.

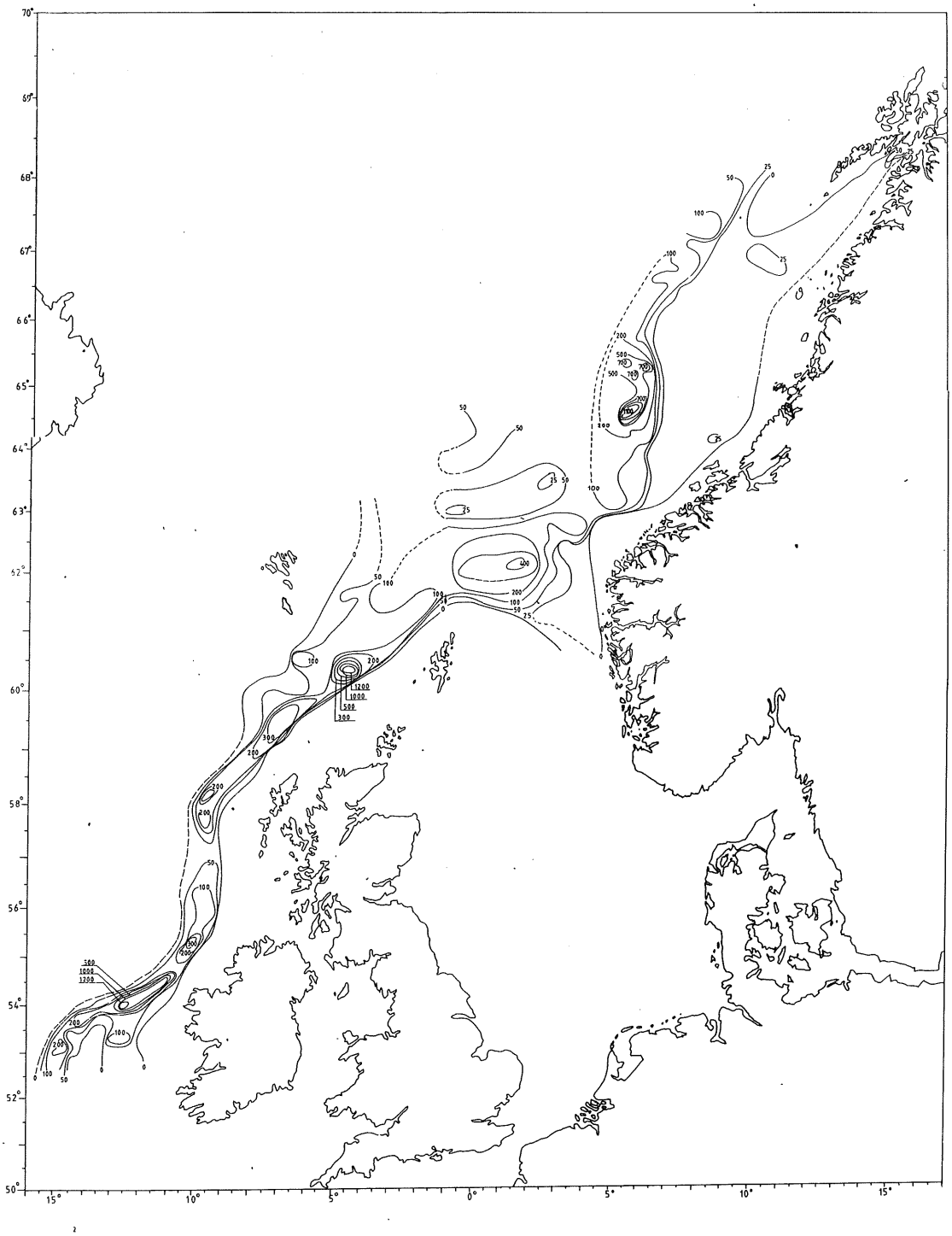

Fig. 2. Blue whiting observations, spring 1986. Echo intensity in $m^2/n.mile^2$.

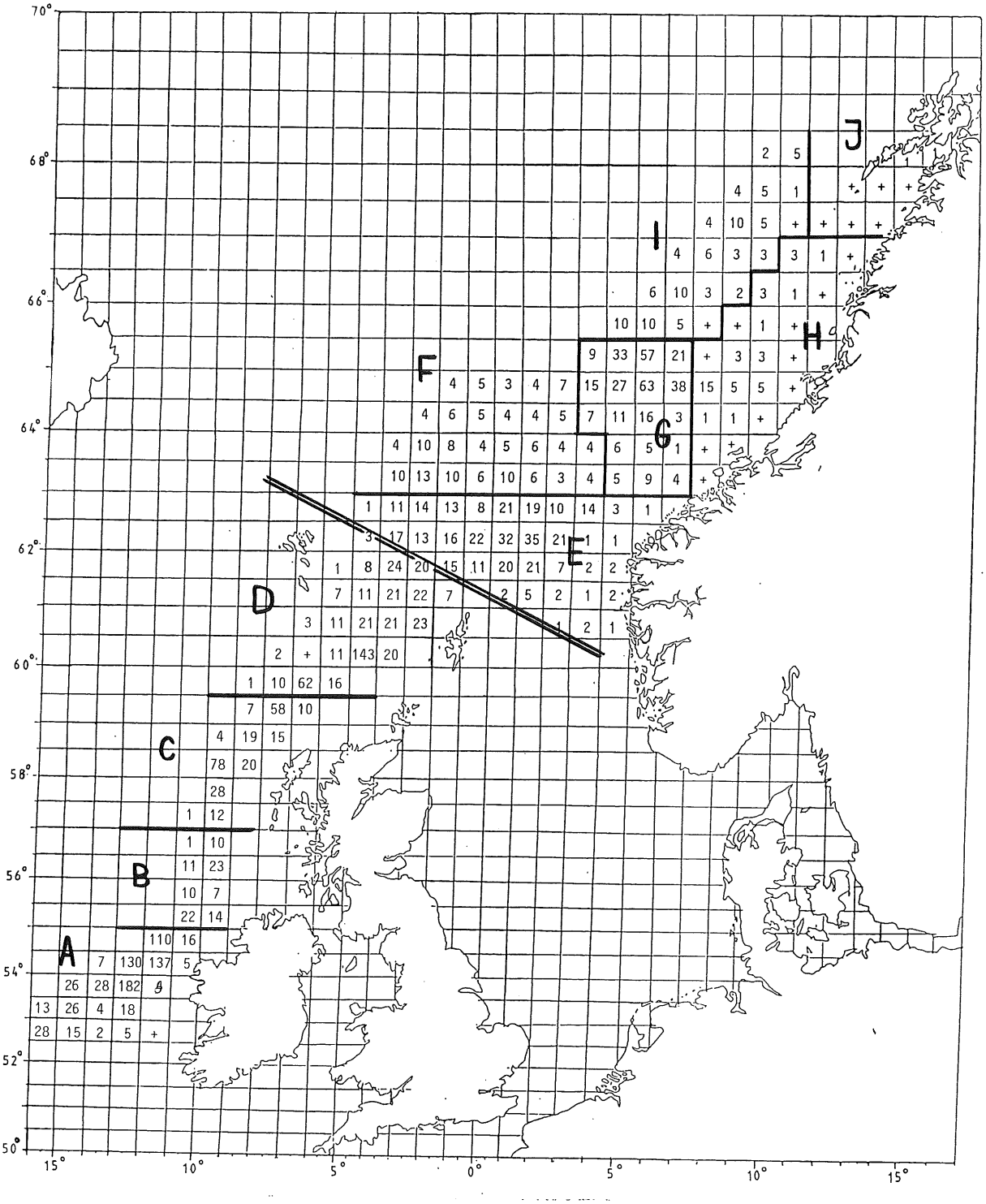

Fig. 3. Blue whiting biomass in thousand tonnes, spring 1986.
A-J : subareas used for the calculations.

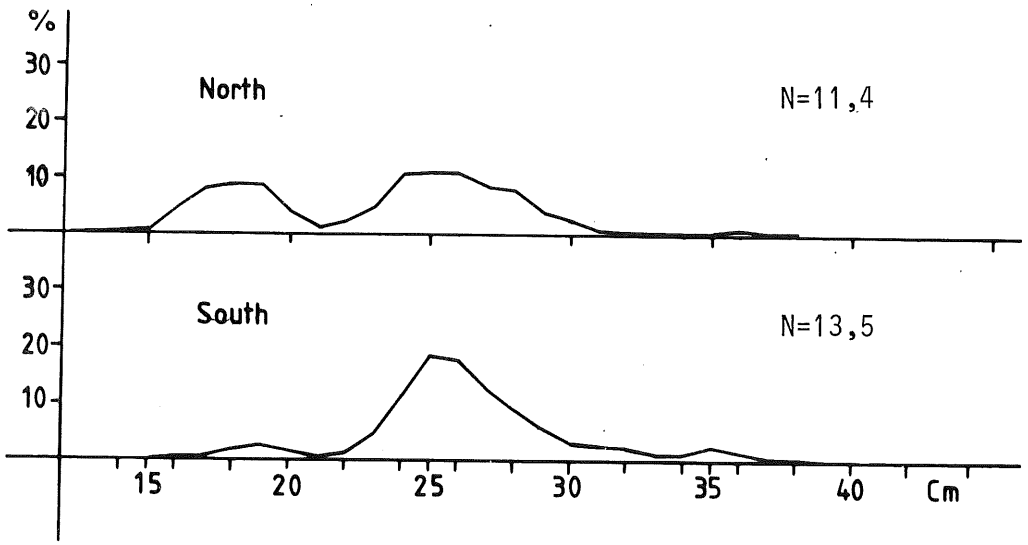

Fig. 4. Length distribution of blue whiting weighted by abundance. North: The area west of Norway (subareas E-J). South: The area west of The British Isles (subareas A-D). N in 10^9 specimen. (See Fig. 3).

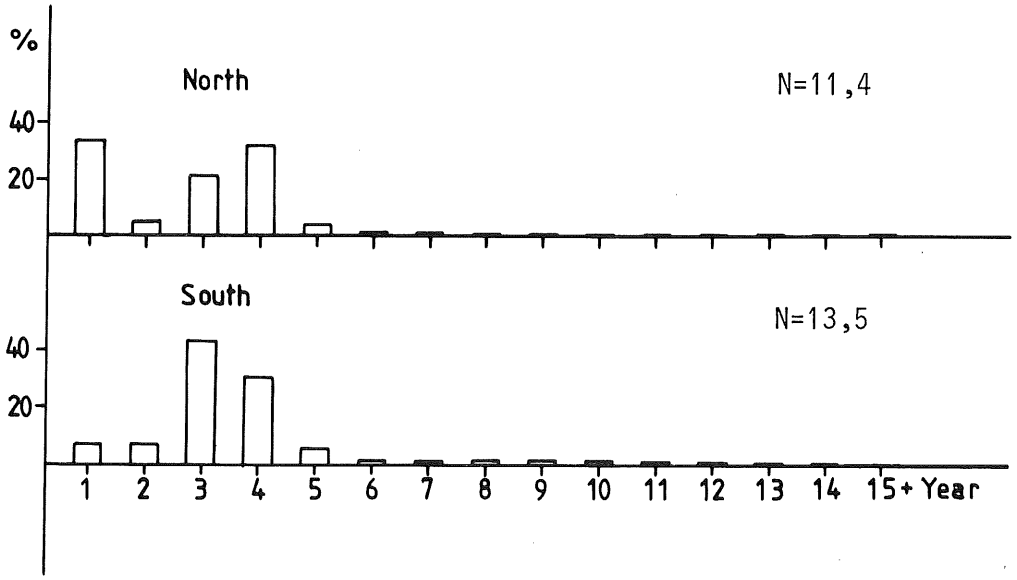

Fig. 5. Age distribution of blue whiting weighted by abundance, from west of Norway (North), west of The British Isles (South). N in 10^9.

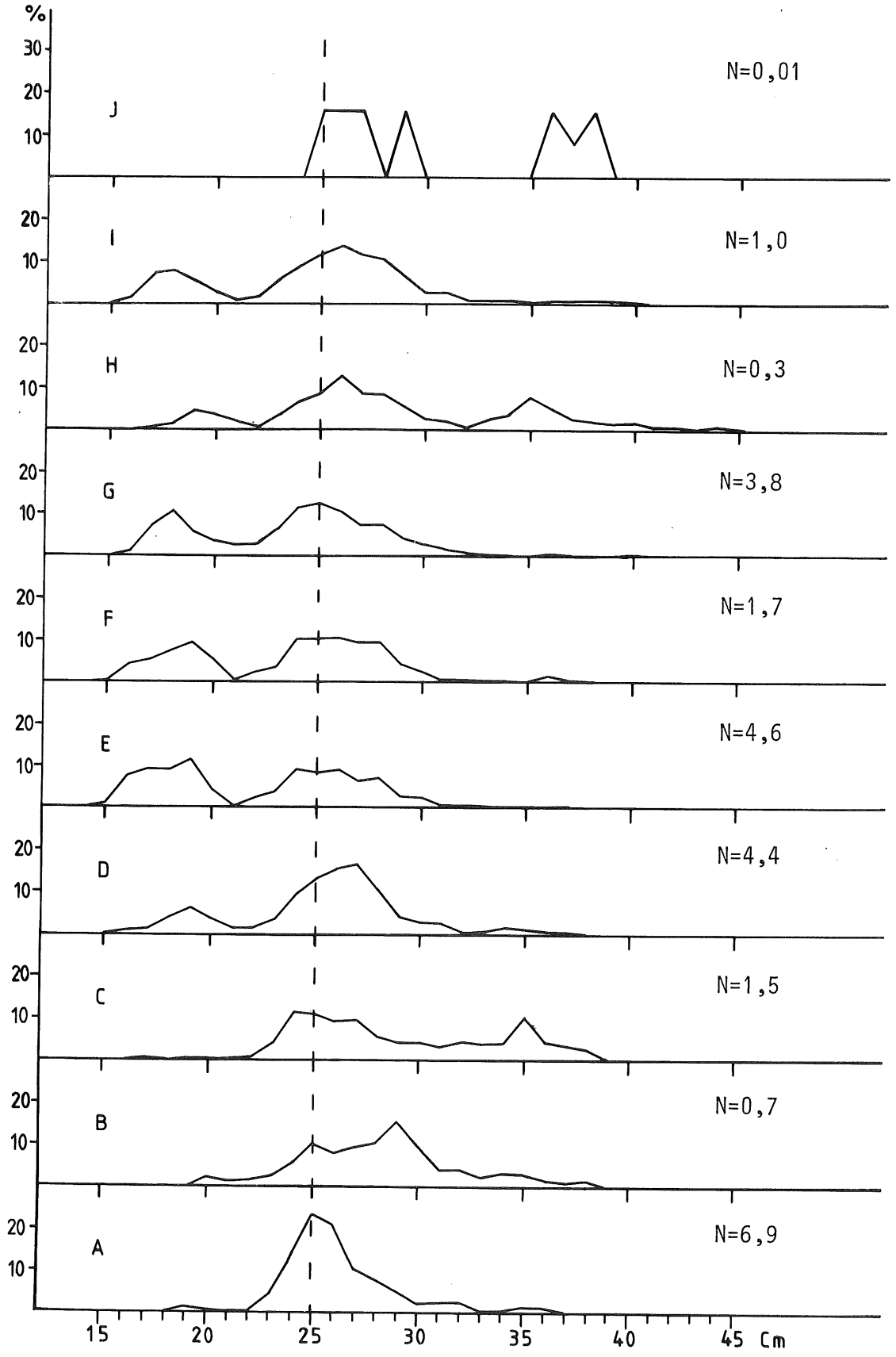

Fig. 6. Length distribution of blue whiting weighted by abundance in the subareas A-J west of Norway and west of The British Isles. N in 10^9. (See Fig. 3).

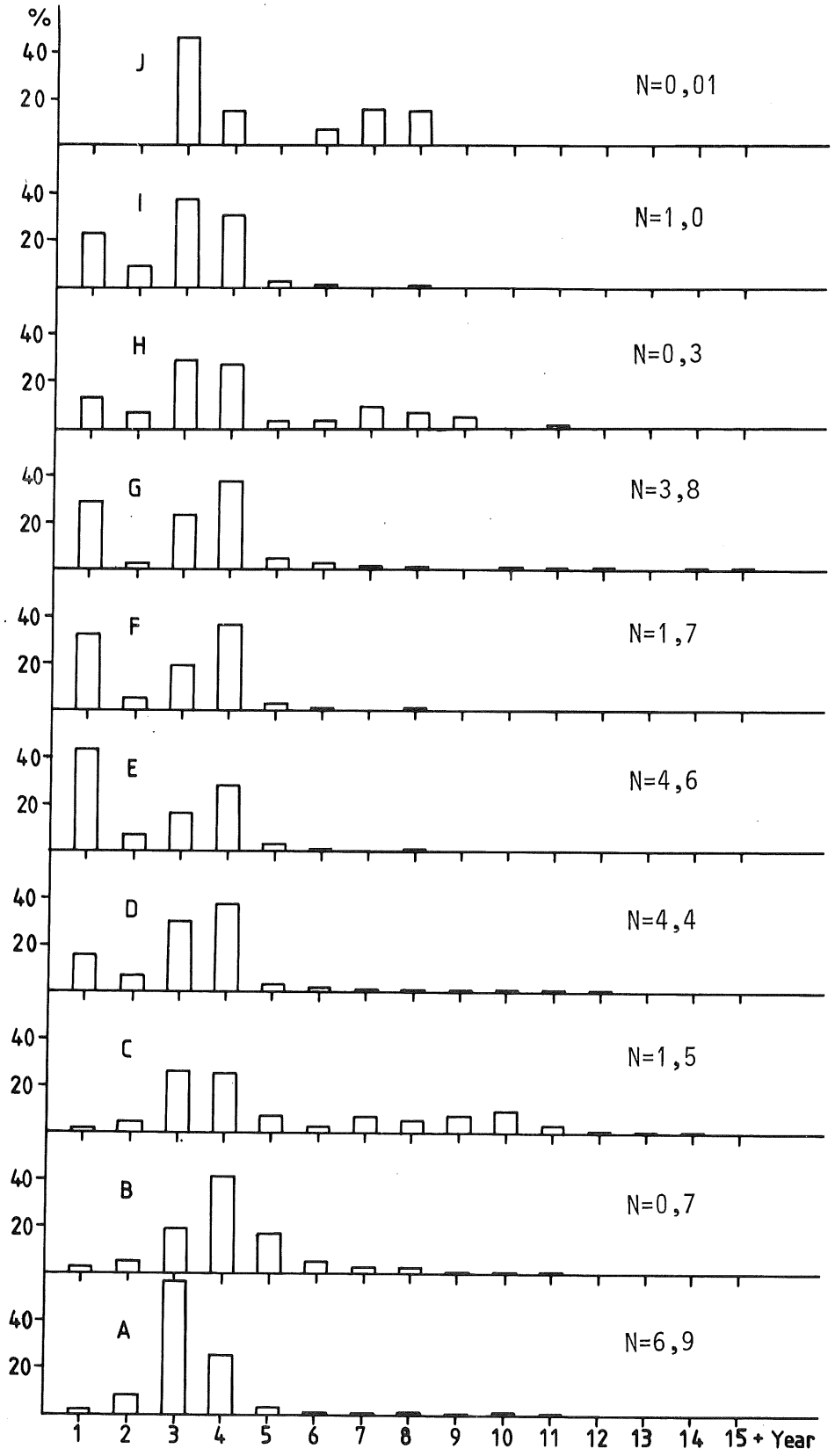

Fig. 7. Age distribution of blue whiting weighted by abundance in the subareas A-J west of Norway and west of the British Isles. N in 10^9. (See Fig. 3).

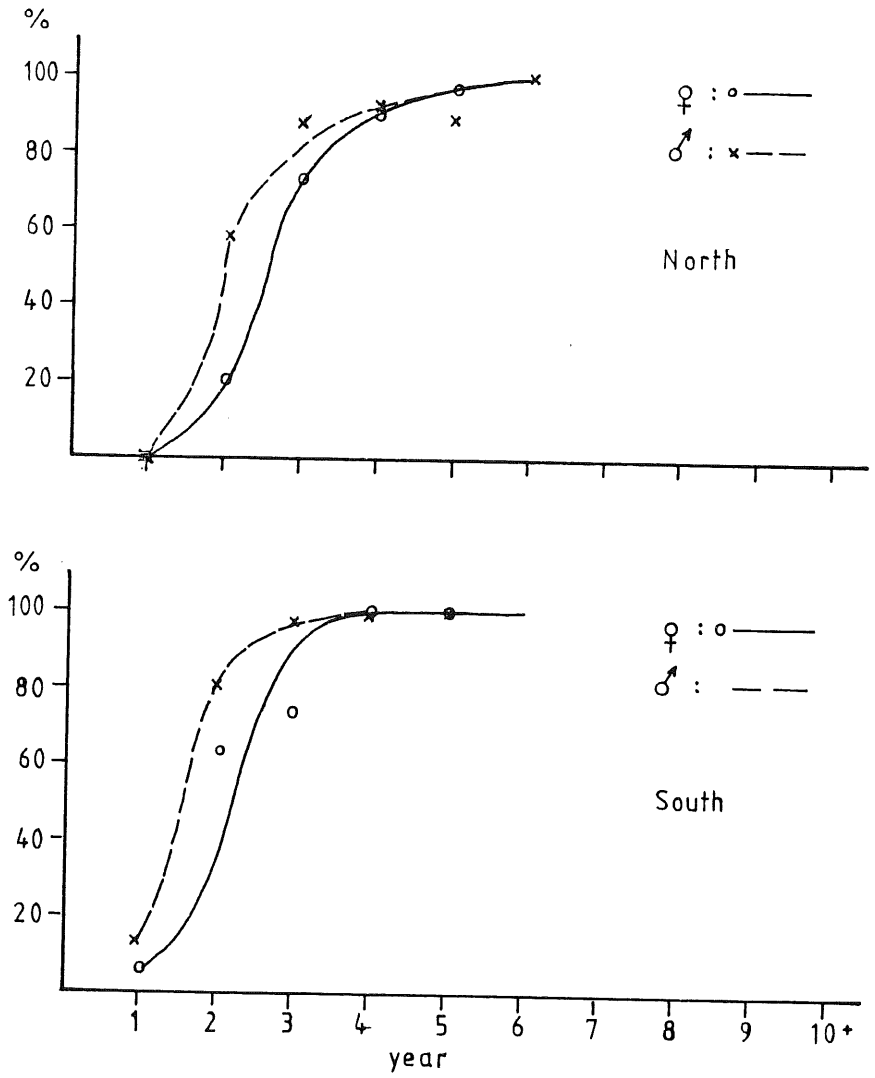

Fig. 8. Percentage of mature or maturing blue whiting in each yearclass from the areas west of Norway (North) and west of The British Isles (South), spring 1986.

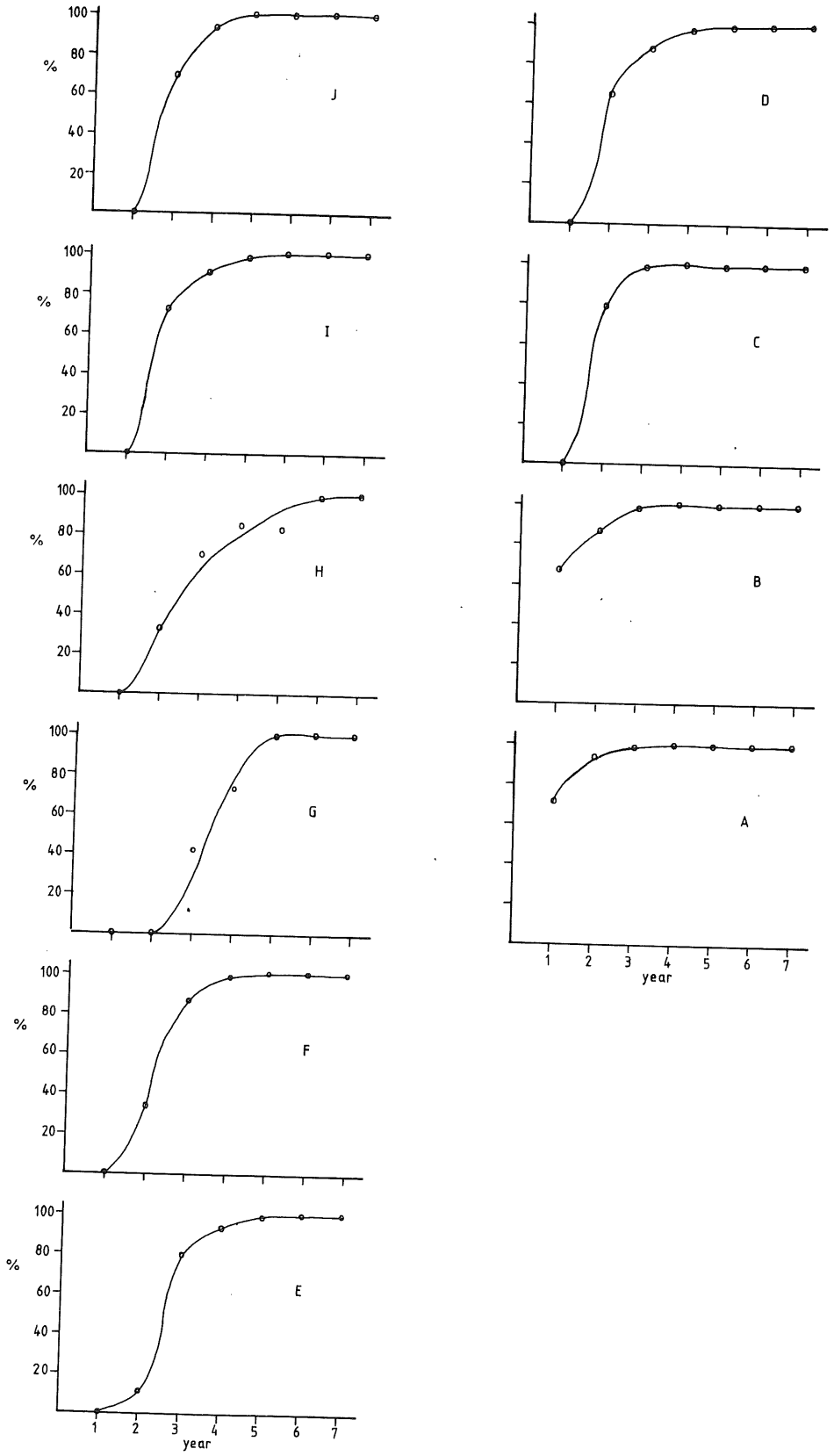

Fig. 9. Percentage of mature or maturing blue whiting in each yearclass from the subareas A-J, spring 1986. (See Fig. 3).

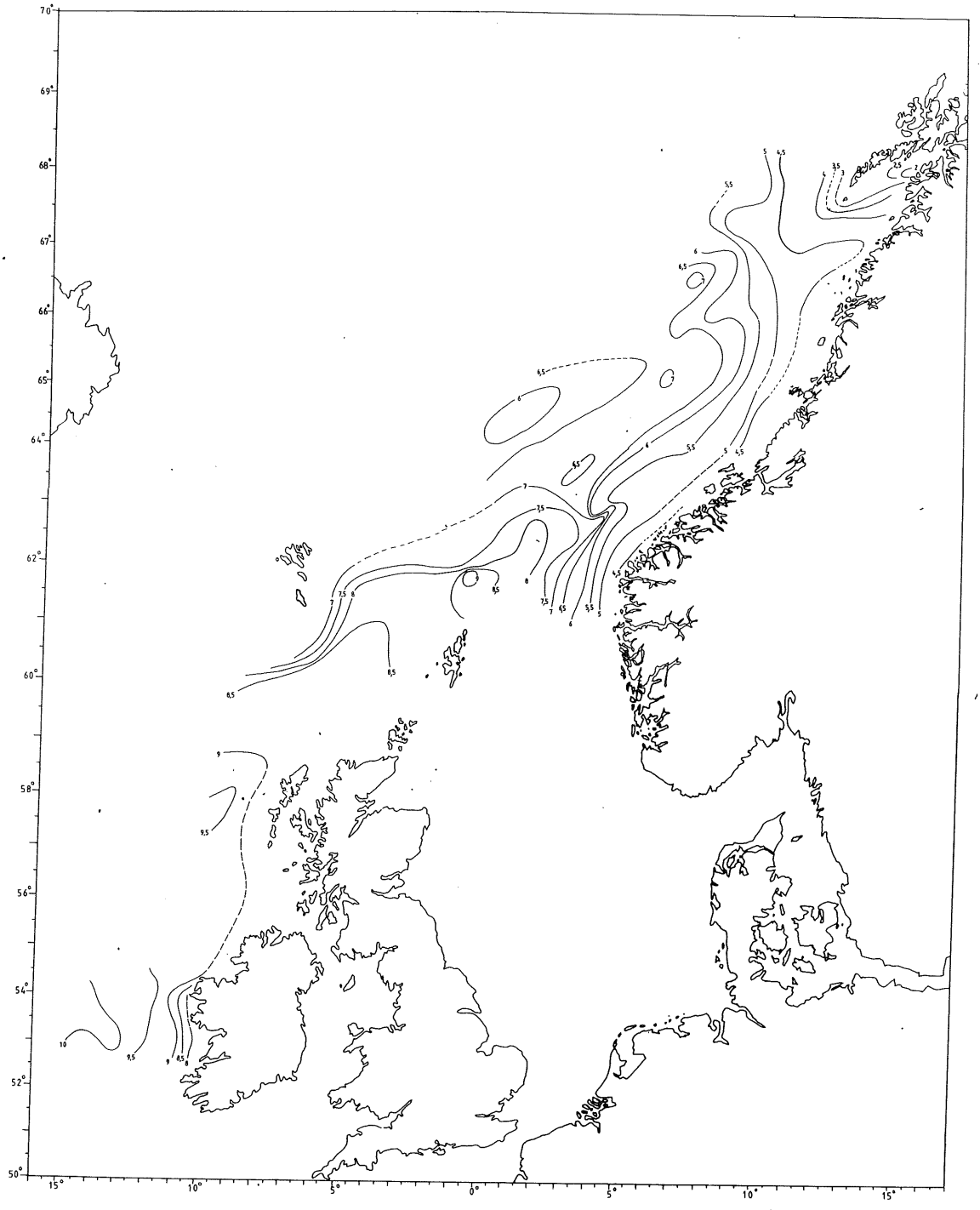

Fig. 10. Temperature, t°C, in the sea surface March/April 1986.

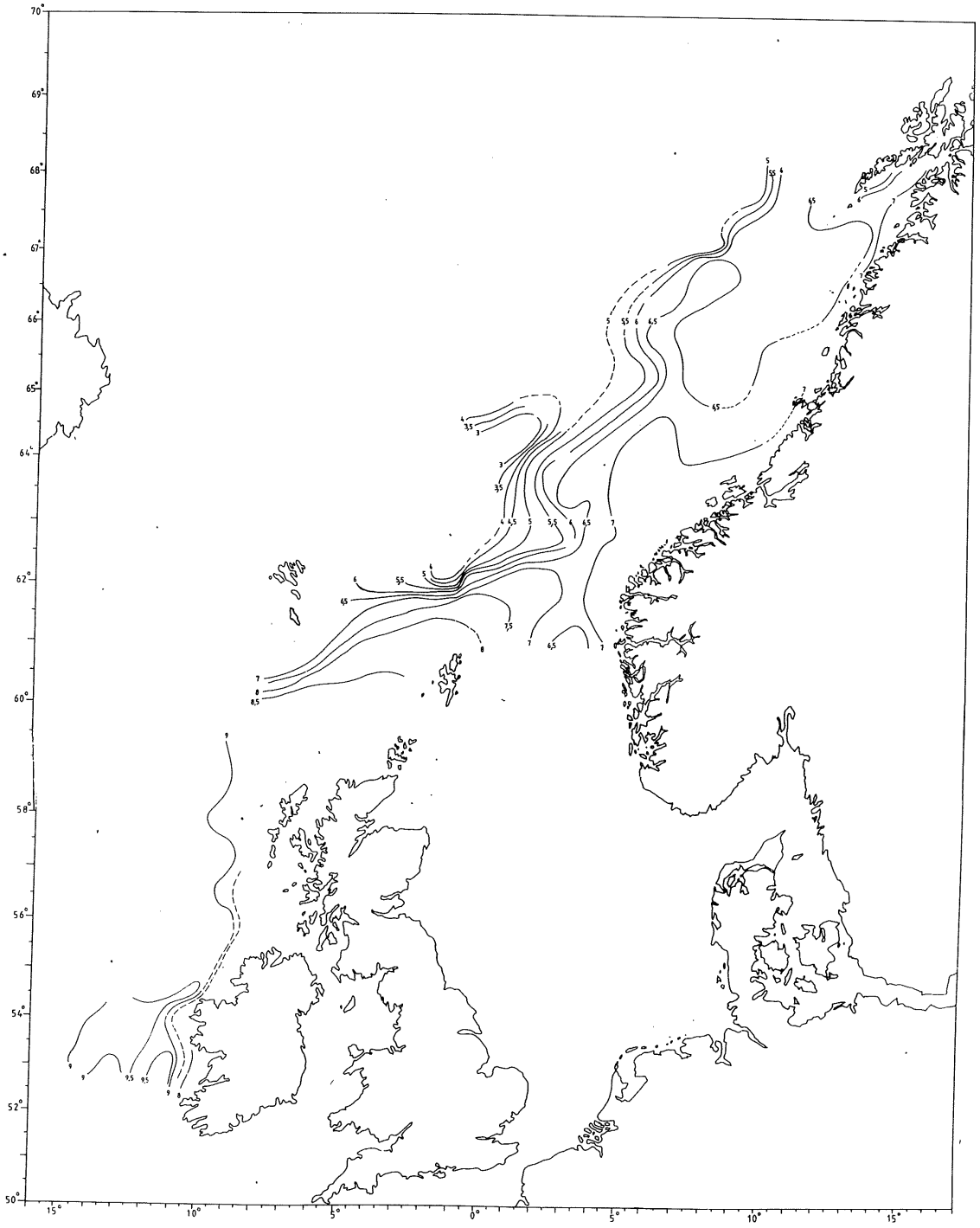

Fig. 11. Temperature, t°C, at 300 m depth March/April 1986.