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International Council for the Exploration of the Sea

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International Acoustic Survey on Blue Whiting in the Norwegian Sea, August 1984.

ABSTRACT

Six research vessels from the five nations, USSR, Norway, Faroe Islands, Iceland and GDR participated in the third ICES-coordinated acoustic survey on blue whiting in the Norwegian Sea and adjacent waters.

By use of instrument constants obtained from calibration either against a standard target or with a hydrophone, the integrator values were standardized and combined.

Blue whiting was recorded over the major part of the Norwegian Sea on the warmer side of the Polarfront. The highest concentrations were found in the southern part of the investigated area, especially off the northern coast of Faroe Islands, the southern coast of Iceland and in a limited area between Iceland and Greenland.

The acoustic estimate resulted in a total biomass of 3.8 mill. tonnes of blue whiting, which is an increase of 1 mill. tonnes since August 1983.

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RÈSUMÈ:

La troisième campagne coordonnée par le CIEM d'échoprospection acoustique du stock de merlan bleu de la Mer Norvégienne et des mers adjacentes a été réalisée par six bateaux de recherche appartenant aux nations suivantes: URSS, Norvège, Iles Féroé, Islande et RDA.

Grace à l'utilisation des constantes instrumentales obtenves par calibration sur cible standard ou par hydrophone, les valeurs intégrées ont été standardisées et combinées.

Du merlan bleu fut localisé dans la plus grande partie de la Mer Norvégienne, dans le secteur chavd du front polaire - les plus importantes concentrations furent trouvées dans le nord de la zone prospectée, plus particulièrement au large de la côte est des Iles Féroé, au sud de l'Islande et dans une zone limitée entre l'Islande et le Groenland.

L'estimation acoustique de la biomasse du merlan bleu s'élève à 3.8 millions de tonnes, ce qui est supérieur de 1 million de tonnes à l'estimation de août 1983.

INTRODUCTION

For several years acoustic surveys have been conducted on the main spawning ground west of the British Isles. The congregation of the adult "northern" stock during the spawning period has allowed the area to be covered within a reasonable period of time. However, due to the fast migrating fish and the extented spawning season from February to May, the complete spawning stock can not be recorded within the area at the same time. Hence the corresponding assessments of the stock size have been underestimates only.

In the summer half of the year the blue whiting stock is spread over greater parts of the Norwegian Sea and adjacent waters. To make an acoustic assessment of the "total" stock one have to survey these areas.

In 1982 the first ICES-coordinated international acoustic survey on blue whithing in the Norwegian Sea took place according to the recommendation by the Blue Whiting Assessment Working Croup (Anon. 1982,). In 1983 a similar survey was carried out (Anon. 1983, a), both years showing the necessity of such assessment for monitoring the stock and its status.

For the summer season of 1984 the Working Group also recommended a joint survey to take place in the Norwegian Sea and adjacent waters to estimate the abundance of blue whiting in the "northern" areas. The terms of reference were set by ICES' resolution passed at its 71 Statutory Meeting (C. Res. 1983/-2:15).

The third ICES-coordinated international acoustic survey on blue whiting in the Norwegian Sea and adjacent waters was then conducted from 26 July to 5 September 1984.

MATERIAL AND METHODS

From five countries the following research vessels participated:

Research vessel	Nation	Survey period	Instrument constant $C_I \cdot 10$	Vertical opening of pelagi trawl (m)
"Persey III"	USSR	26 July-20 Aug.	2.26	60
"Eldjarn"	Norway	1 Aug.- 5 Sept.	1.04	45
"Eisbaer"	GDR	1 Aug.-27 Aug.	3.35	20
"Bjarni Sæmundsson"	Iceland	8 Aug.-25 Aug.	2.00	15
"Arni Fridriksson"	"	9 Aug.-29.Aug.	2.06	17
"Magnus Heinason"	Faroes	20 Aug.-1 Sept.	1.06	40

In Appendix are also given the names of the institutes and personell of the scientific staff participating the cruises.

The total area surveyed is illustrated on Fig. 1 and 2 with the cruise tracks and trawl stations and hydrographical stations plotted. In the area around Iceland and off the northern Norwegian Coast, as well as in the Spitsbergen area, the blue whiting survey was combined with 0-group fish investigations.

The planned cruise tracks of the various vessels were agreed upon through correspondence and telephone contacts. They were taken as guidelines, open for adjustment in accordance with the actual situation. The expected most important areas were tried to be covered properly and hence a great deal of overlapping occured.

The practical procedure of operation at sea, with conveyance of the collected data to the "central" vessel by use of standard forms and radio-communication was followed as suggested in the Planning Group Report of 1983 (Anon. 1983, b).

The vessels were all equipped with echo integrator connected to 38 kHz echo sounders. Prior to the survey the acoustic systems of each vessel were calibrated, either against a standard target (coppersphere) or by use of a hydrophone. The obtained instrument constants ($C_I \cdot 10$) for standardizing the integrator values into comparable units, are listed in the above text-table.

The echo intensity recorded was expressed as numbers of square metres reflected per square nautical mile. It was integrated and averaged for each five nautical miles sailed. Identification of the recordings and collection of biological samples were done with a pelagic trawl mainly, the size expressed by the vertical opening given in the above text-table. Catch compositions together with the corresponding echo paper recordings were used as a basis for portioning the integrator values on different fish groups or species.

The method for estimation of the blue whiting biomass was the same as in 1982 and -83 (Anon 1983). The area surveyed was divided into rectangels of 1^{o} latitude and $2^{o}30'$ longitude.

Within each rectangle the average integrator value was calculated and the blue whiting distribution area measured according to zero-line.

Representative length- and weight distributions of blue whiting were established for each rectangle. These were based on the trawl catches within the rectangle or from neighbouring rectangles.

The integrated echo intensities were converted into biomass values by use of a length dependent density coefficient. Within an area the number of fish is given as the product of the size of the area (square nautical miles) and the fish density (nos. of fish per square nautical mile). As described in Appendix II of Anon. (1982) the fish density can be written as

$$\bar{P}_A = \frac{1}{\bar{\sigma}_{b.s}} \cdot \overline{C_I \cdot M}$$

where
P_A is the number of fish per square nautical mile,
$\bar{\sigma}_{b.s}$ is the mean backscattering cross section of the fish, [$\bar{T}S=10 \log \bar{\sigma}_{b.s}$],
C_I is the instrument constant, and M is the echo integrator value.

The density coeffiscent (C-value) is the same as used for young cod. The value corresponds to a target strength of -40.5dB for a 30 cm fish, which leads to the expression of:

$$\frac{1}{\sigma_{b.s}} = 1.87 \cdot 10^7 \cdot 1^{-2.18}$$

where 1 is the fish length in cm.

The calculations were made by computer that weighted the length distribution in each rectangle by the integrator values. The number of specimens and corresponding weight in each length-

group were calculated for each rectangle, and summed up for the subareas and total.

During the survey a great number of hydrographical stations were made, by use of either bathythermograph, CTD-sonde or "Nansen-bottles" with reversing thermometers (Fig. 2).

RESULTS

Hydrography

The temperature distributions at sea surface, 200 m and 400 m are presented in Figs. 3, 4 and 5 respectively. Compared to the situation during the corresponding survey in previous years, the water masses were found somewhat warmer than in 1983 and more like the situation in 1982.

Blue whiting

The recorded distribution and relative densities of blue whiting are shown on Fig. 6. The stock was found mostly as scattered recordings over larger parts of the area surveyed. It was distributed on the warmer side of the polarfront, from the Norwegian Trench at Skagerak in the south, to approximately 73^{o}N in the north.

As observed during the previous three years, the highest concentrations were located in the southern part of the investigated area, especially off the northern coast of Faroe Islands, the southern coast of Iceland and within a limited area midway between Iceland and Greenland.

Estimation of the total blue whiting biomass observed gave the result of 3.8 mill tonnes which represents 49.2×10^{9} specimens. In Fig. 7 the biomass is given for each of the rectangles within the distribution area. The area is further divided into subareas which are marked on Fig. 7.

Structure of the stock is illustrated on Fig. 8 which shows the total length distribution weighted by the abundance, and on Fig. 9 which shows the length distribution for each of the subareas. It is clearly demonstrated that young fish made up the bulk of the stock, while bigger and older fish were only scarcely represented.

The length distribution clearly show peaks of the three youngest year classes, and this was used to split the biomass into year-groups. Not demanding absolute accuracy, and cutting through overlapping areas, the ranges were set as follows; 0-group fish: below 19 cm, I-group: between 19 and 23 cm, II-group: between 23 and 29 cm and older above 29 cm.

The 1982- and 1983- year classes dominated in all areas. 0-group blue whiting was found in area III, between Faroes and Iceland and to a minor extent also in area I and II, at Shetland and near the Norwegian coast. In the Icelandic area the 1983- year class made up most of the recordings, while in the north, area I and VI, the 1982- year class dominated.

Table 1 gives the biomass of the three youngest year classes, older fish and the total, the size of the distribution area and the density. The 1983- and 1982 year classes contributed to the total biomass with 1,8 mill. tonnes, and 1.6 mill. tonnes, respectively.

The 1981- year class and older fish together contributed with 0.4 mill tonnes, and the 1984- year class with 0.1 mill tonnes. The total mean weight in each length group to the whole area investigated, are plotted on Fig. 10.

DISCUSSION

Six research vessels, compared to eight in 1982 and -83, participated in the survey, and hence a smaller area was covered. The important parts of it were, however, surveyed properly enough, and the resulting estimate represents the biomass of the total "northern" blue whiting stock.

The estimated biomass was 1 mill. tonnes higher in 1984 than in 1983. This is shown in the text-table below.

years	1983 $t \cdot 10^{-6}$	1983 $N \cdot 10^{-9}$	years	1984 $t \cdot 10^{-6}$	1984 $N \cdot 10^{-9}$
0	0.2	8.5	0	0.1	2.1
1	1.5	22.7	1	1.8	30.6
2+	1.1	5.3	2	1.5	14.6
			3+	0.4	1.9
Sum	2.8	36.5	Sum	3.8	49.2

The rich 1982-year class was measured to 1.5 mill. tonnes both in August 1983 and 1984, representing 22.7 x 10^{-9} and 14.6 x 10^{-9} specimens in the two years respectively. Two year old fish and older were measured to 1.9 mill. tonnes in 1984 against 1.1 mill. tonnes of same age groups in 1983.

The 1983- year class which contributed with 1.8 mill tonnes representing 30,6 x 10^{-9} specimens. It is obvious that only a small part of this year class was represented in the 1983-estimate.

The estimated total biomass of 3.8 mill. tonnes in August 1984 is somewhat higher than the three different estimates obtained by Norway with 2.8 mill. tonnes, The Faroes with 2.4 mill. tonnes, and USSR with 3.4 mill. tonnes, during the spawning season in the areas west of The British Isles and Irland.

From 1982, when the total stock was measured to 4.6 mill. tonnes, there was an unexpected drop to 2.8 mill. tonnes in 1983. Regarding the adult fish only, the difference was about 3 mill. tonnes (Anon. 1983, a). However, thanks to succesfull recruitment both in 1982 and in 1983, these two year classes of blue whiting seems to rebuild the stock.

References.

Anon. 1982. Report of the International Acoustic Survey on Blue Whiting in the Norwegian Sea, July/August 1982, ICES, C.M. 1982/H:5, 1-21 [Mimeo].

Anon 1983, a). Report of the International Acoustic Survey on Blue Whiting in the Norwegian Sea, Agust 1983. ICES, C.M. 1983/H:5, 1-20 [Mimeo].

Anon 1983, b) Report of the Blue Whiting Planning Group for the Coordinated Acoustic Survey 1983, Copenhagen, 2-3 March 1983. ICES, C.M. 1983/ H:4 [Mimeo].

Jakupsstovu i H. and Thomsen B. 1984. Report of an acoustic survey on blue whiting to the spawning areas west of the British Isles in April 1984. Working Paper to the Blue Whiting Assessment Working Group, 1984.

Monstad, T. 1984. Norwegian Blue Whiting Investigation in March/April 1984. Working Paper to the Blue Whiting Assessment Working Group, 1984.

Ermolchev, et al., 1984. USSR-results from blue whiting assessment survey west of the British Isles and Irland March/April 1984. Working Paper to the Blue Whiting Assessment Working Group, 1984.

Table 1. Biomass (1000 tonnes) and density (tonnes) of blue whiting in the Norwegian Sea, by area (as marked on Fig. 7) and year classes, August 1984.

Area / Year class	I	II	III	IV	V	VI	VII	Total
1984	2,1	9,2	34,9	-	-	-	-	46,1
1983	172,3	523,9	447,9	528,0	0,5	2,4	92,6	1767,5
1982	216,0	616,1	257,9	45,2	58,1	197,8	164,7	1555,8
1981+	45,6	77,7	115,6	27,4	35,0	30,7	73,3	405,6
Sum	436,0	1226,9	856,3	600,6	93,6	230,9	330,6	3774,0
$(n.mile)^2$	41.836	110.890	68.958	19.040	36.697	40.291	19.900	337.612
$t/(n.mile^2)$	10,4	11,1	12,4	31,5	2,6	5,7	16,6	11,2

APPENDIX

Survey period	Research vessel	Research Institute	Participants
26.7-20.8	"Persey III"	"Polar Research Institute of Marine Fisheries and Oceanography" - PINRO-Murmansk, U.S.S.R.	Dorchenkov A.E.,Galkin A.S., Gavrukhov A.A., Konforkin J.N., Korol L.N., Mukhin A.A., Novikov J.V., Ozhigin V.K., Vanukhina N.V., Vlasov V.V.
1.8-19.8 and 20.8-5.9	"Eldjarn"	Havforskningsinstituttet, Bergen, Norway	Hofstad B., Kvinge B., Lauvås K., Monstad T. (coordinator), Romslo A., Senneset H., Sælen E.
1.8.-27.8	"Eisbaer"	Institut für Hochseefischerei und Fischverarbeitung, Rostock, G.D.R.	Bleil W., Buck W., Hoffmann U., Stein H., Vaske B.
8.-25.8	"Bjarni Sæmundsson"	Hafrannsoknastofnunin, Reykjarvik, Iceland	Astthorsson O., Halldórsson O., Magnusson J.V., Malmberg S.Aa., Olafsson J., Reynisson P.
9.8.-29.8	"Arni Fridriksson"	Hafrannsoknastofnunin, Reykjarvik, Iceland	Sveinbjørnsson S., Vilhjalmsson H.
20.8-1.9	"Magnus Heinason"	Fiskirannsoknarstovan, Torshavn, Faroe, Islands	Jakupsstovu H.i, Thomsen B.

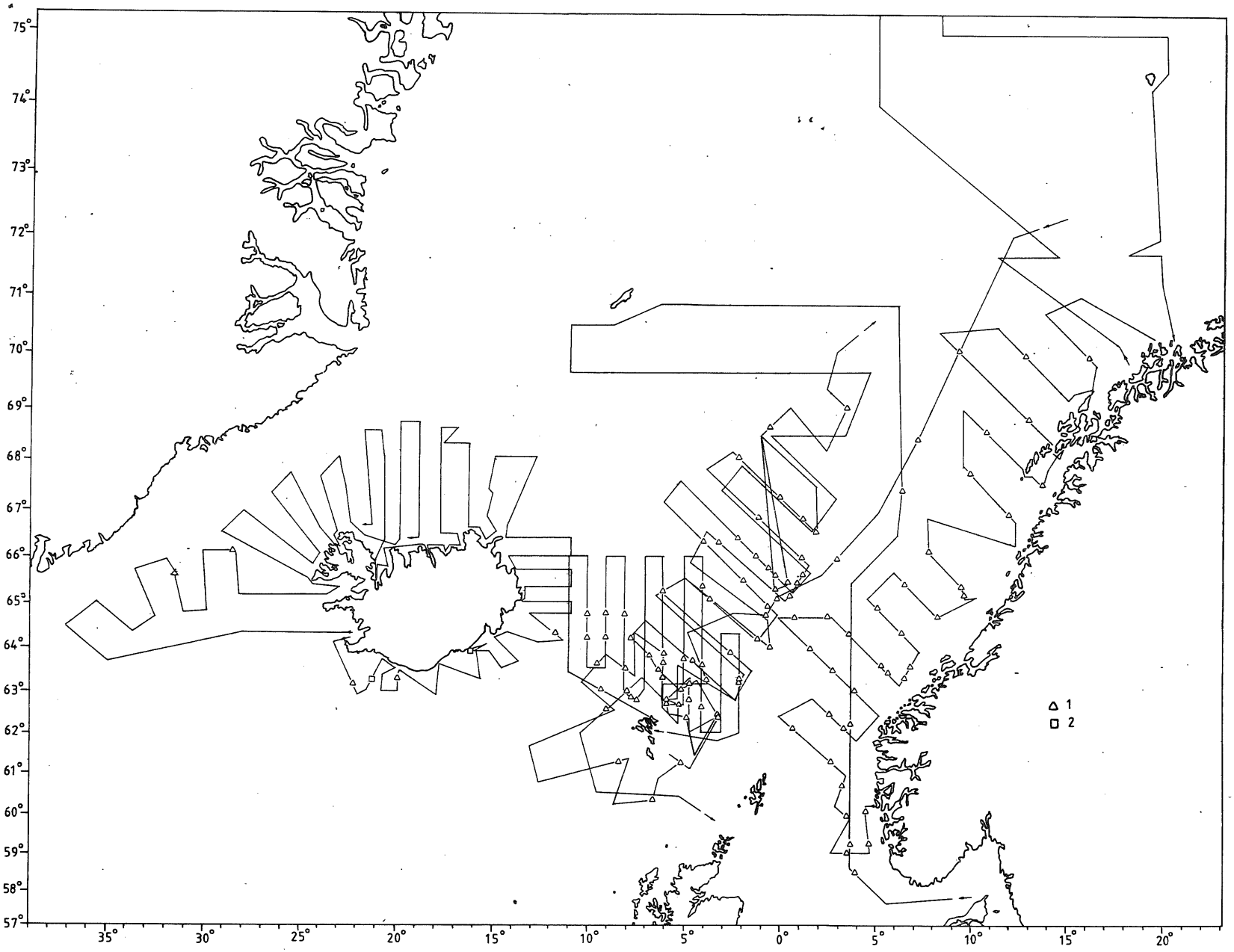

Fig. 1. Cruise tracks and trawl sta ns of the six research vessels, August (26 ly - 5 September 1984) 1984. 1) Pelagic trawl, 2) bottom trawl.

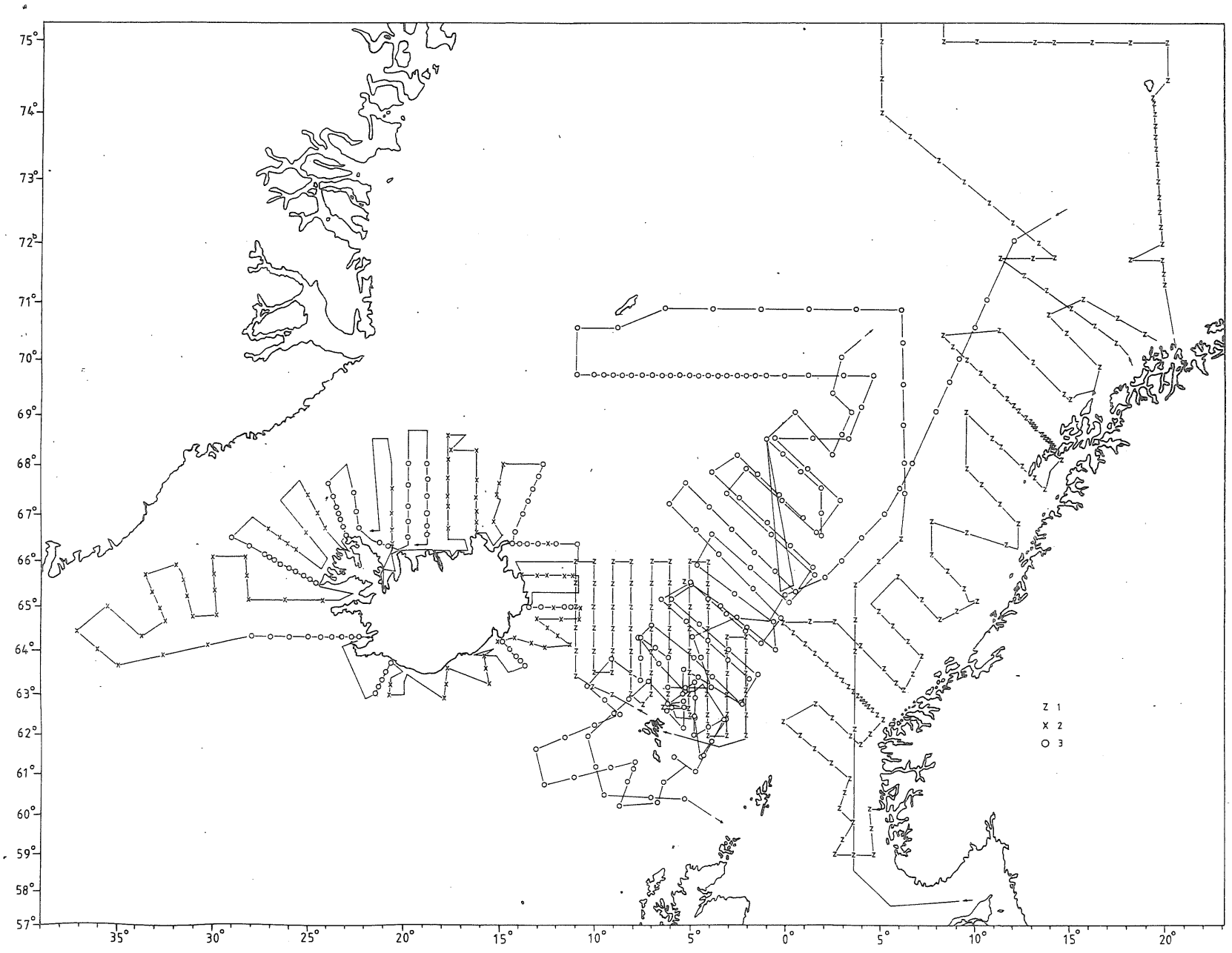

Fig. 2. Cruise tracks and hydrographical stations, August 1984. 1) CTD-sonde, 2) Bathythemograph and XBT, 3) "Nansen-bottles" with reversing thermometer.

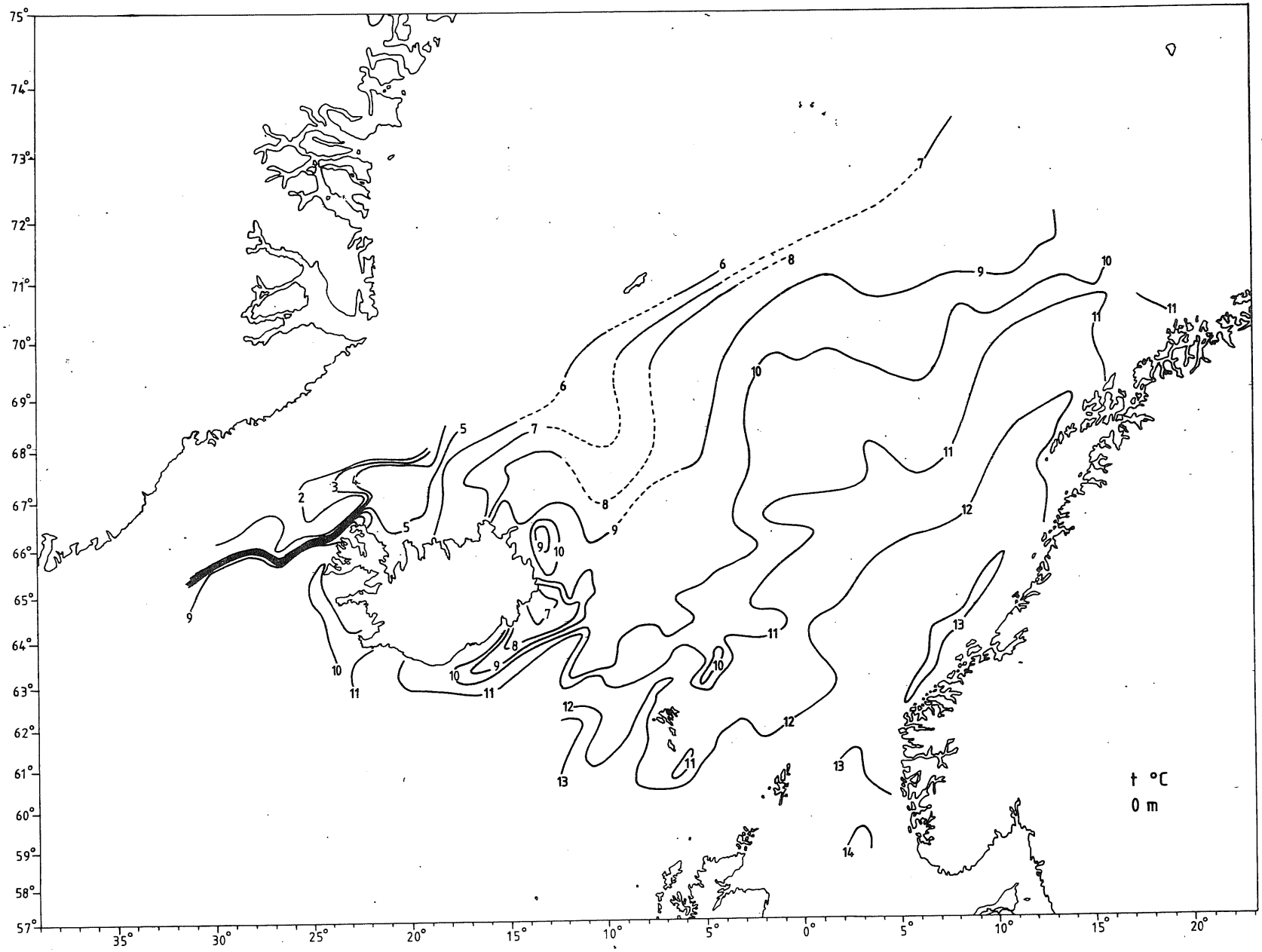

Fig. 3. Temperature at sea surface ugust 1984.

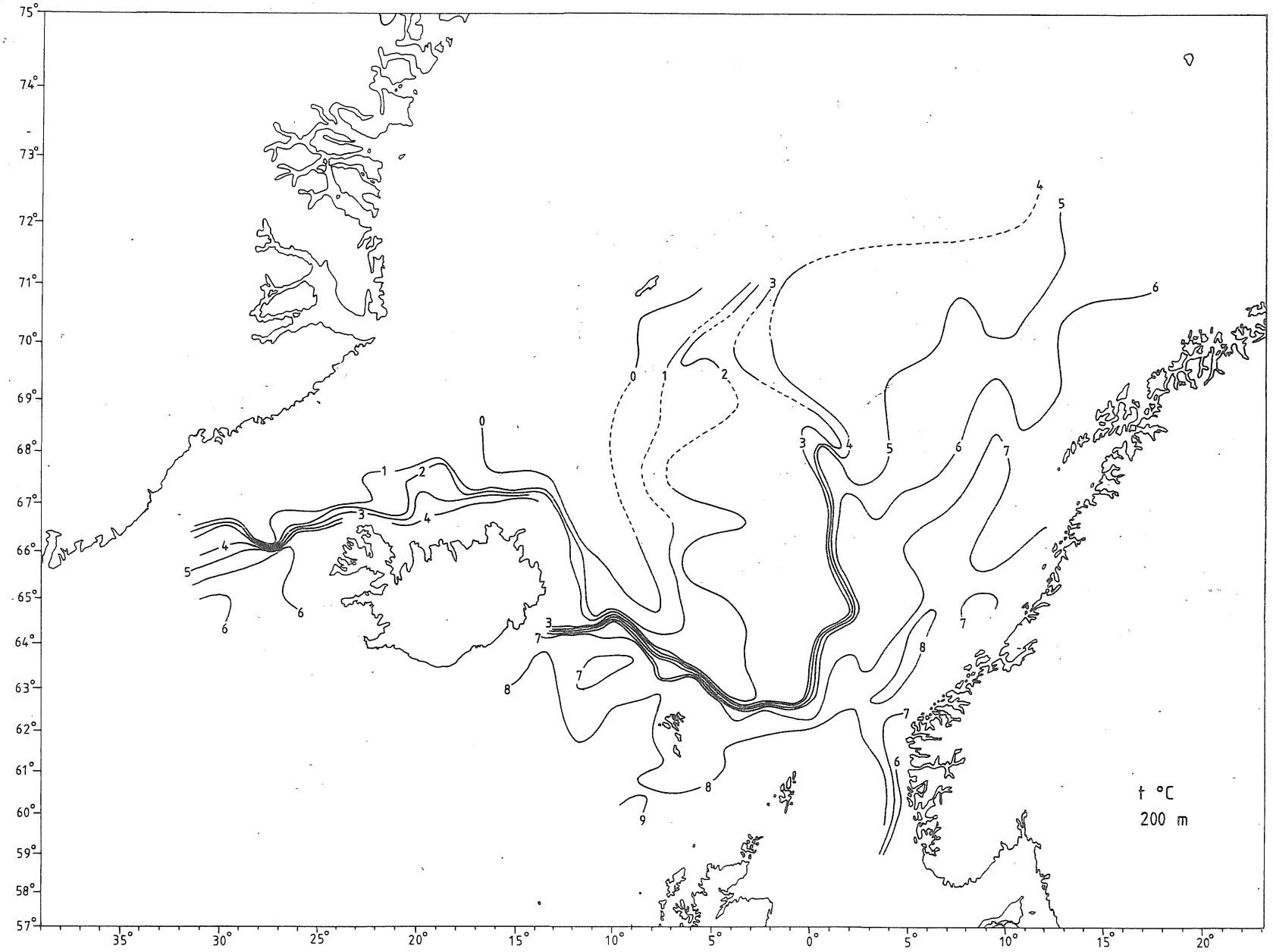

Fig. 4. Temperature at 200 m depth, August 1984.

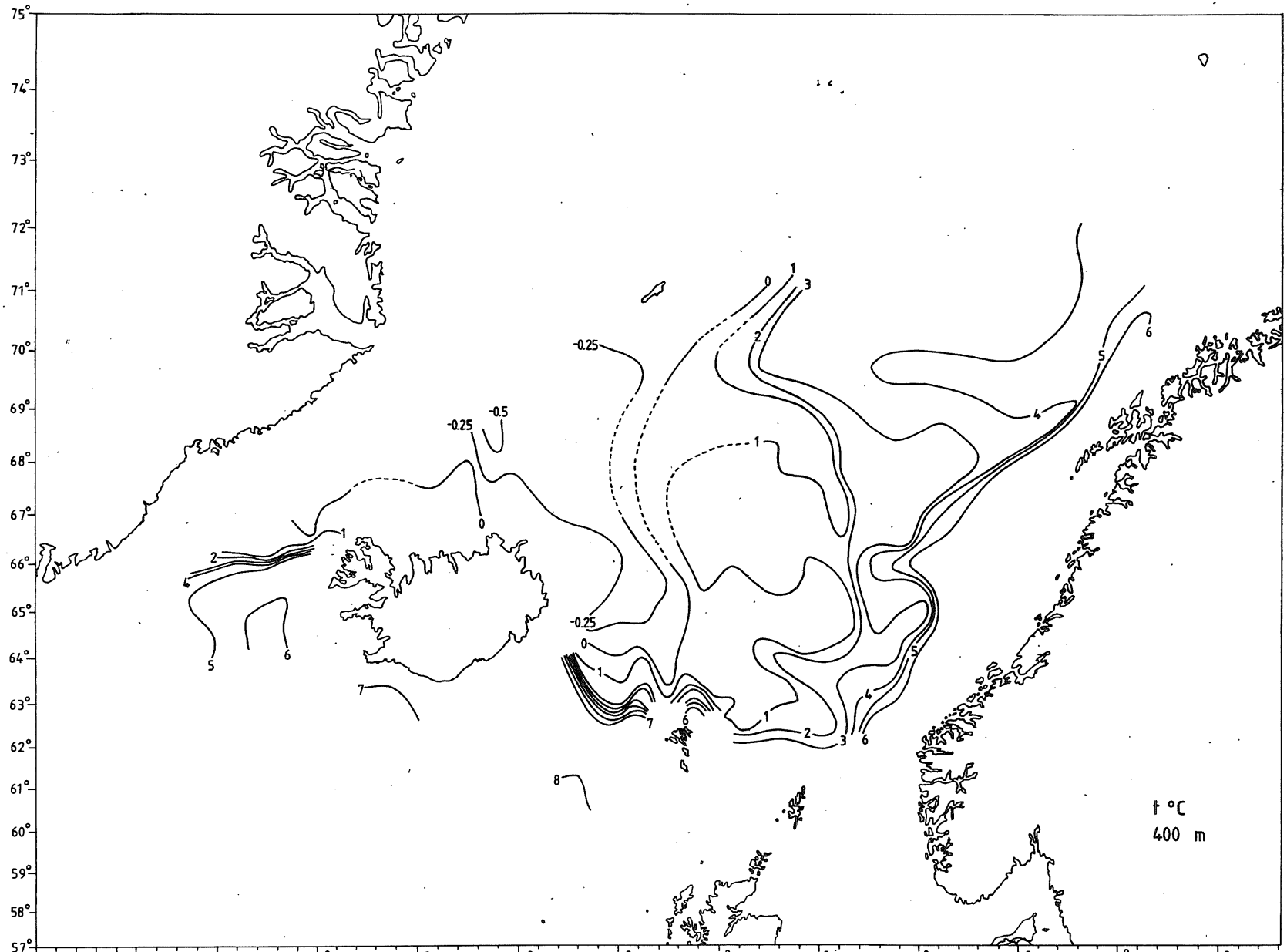

Fig. 5. Temperature at 400 m depth, August 1984.

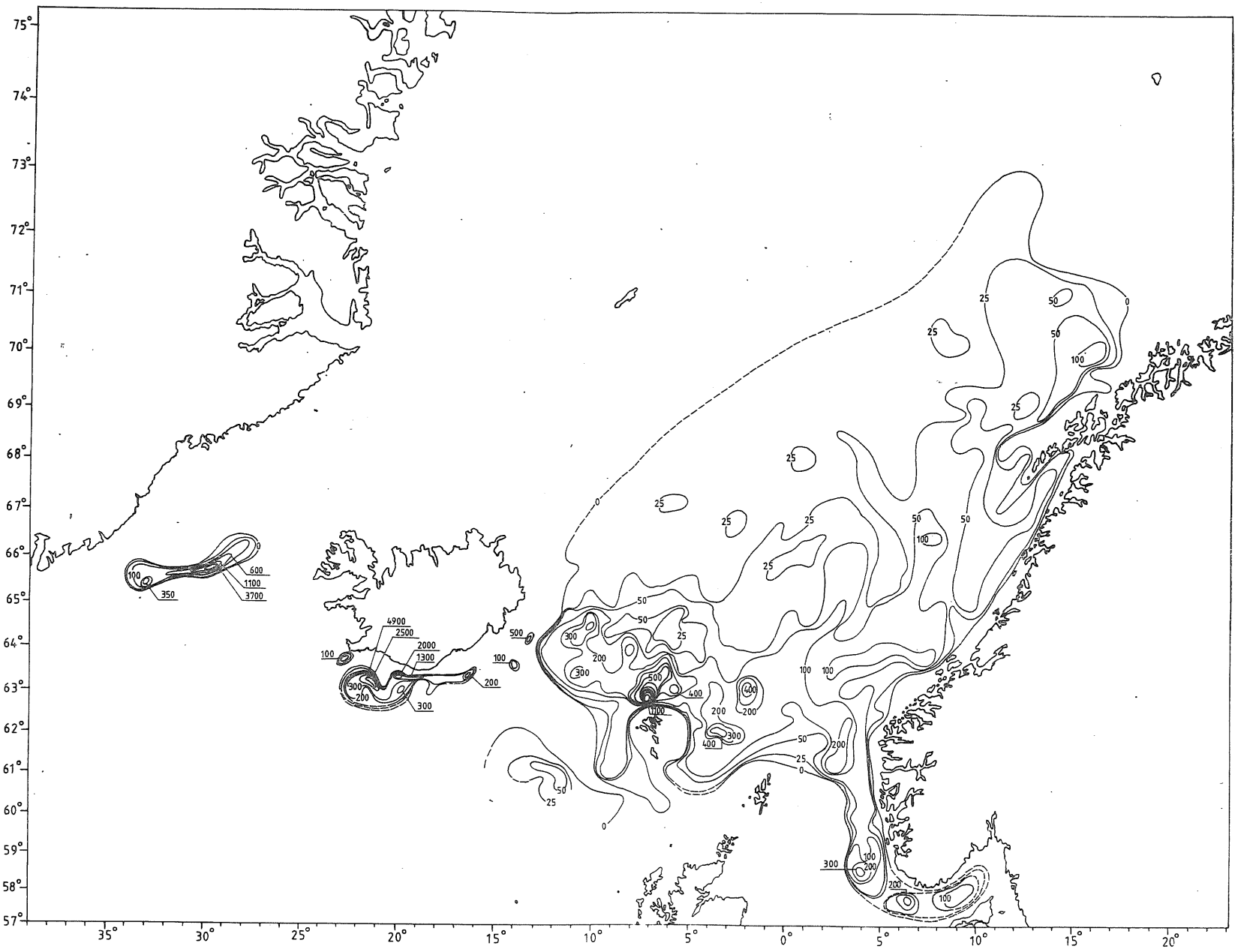

Fig. 6. Distribution and relative abundance of blue whiting, August 1984. Echo intensity in $m^2/(n.\ mile)^2 \times 10$.

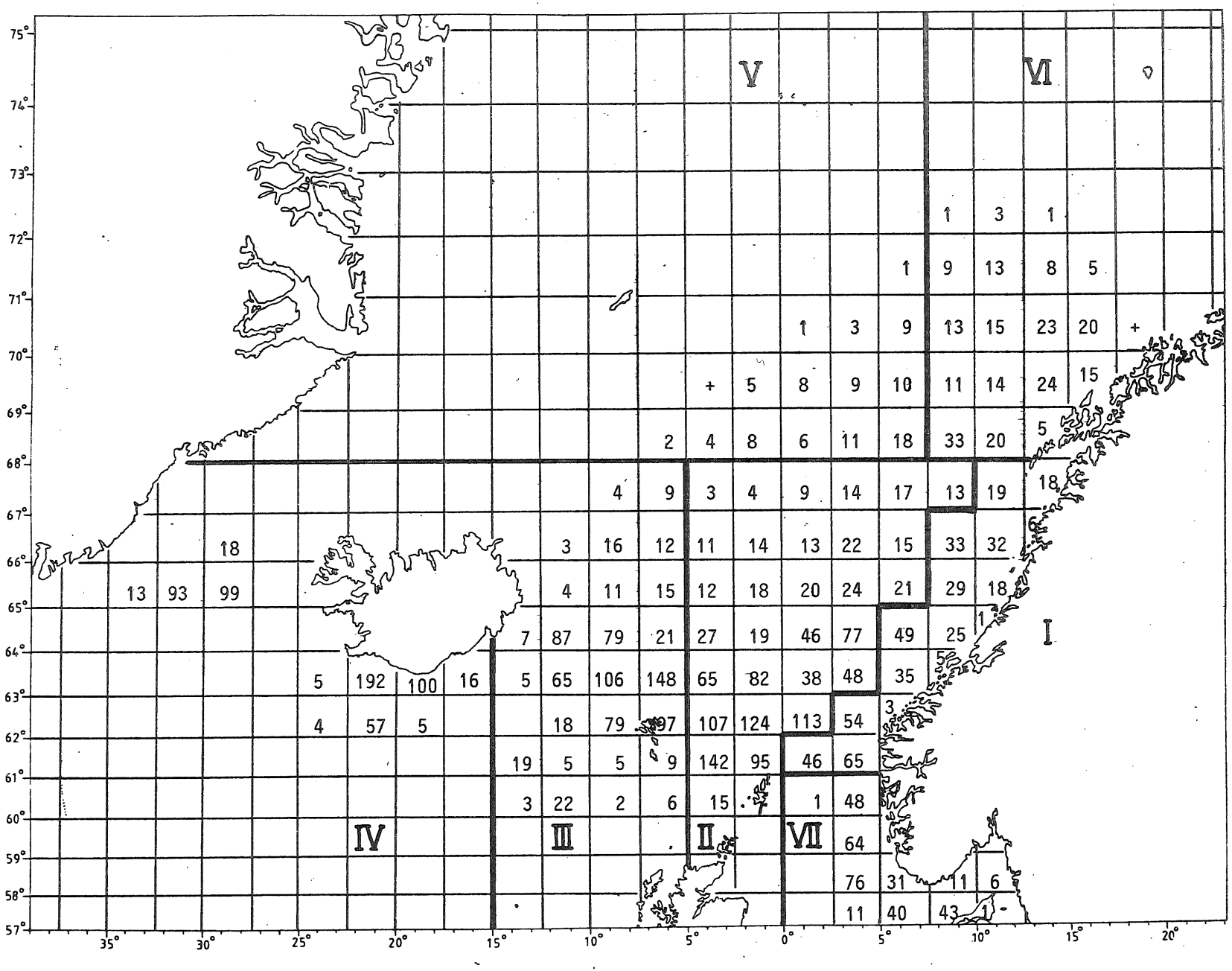

Fig. 7. Estimated biomass of blue whiting in thousands of tonnes, and mar gs of the subareas I-VII.

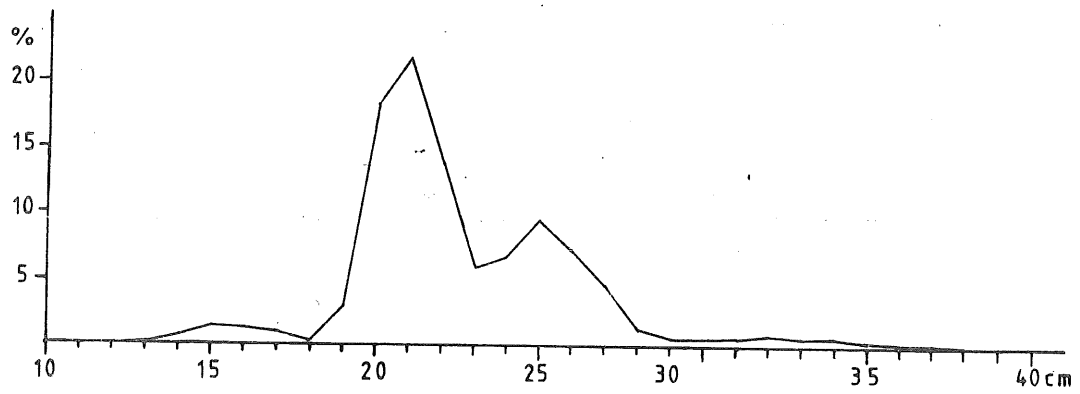

Fig. 8. Total length distribution (N) of blue whiting weighted by abundance in the Norwegian Sea and adjacent waters, August 1984. N in 49,2 x 10^9 specimens.

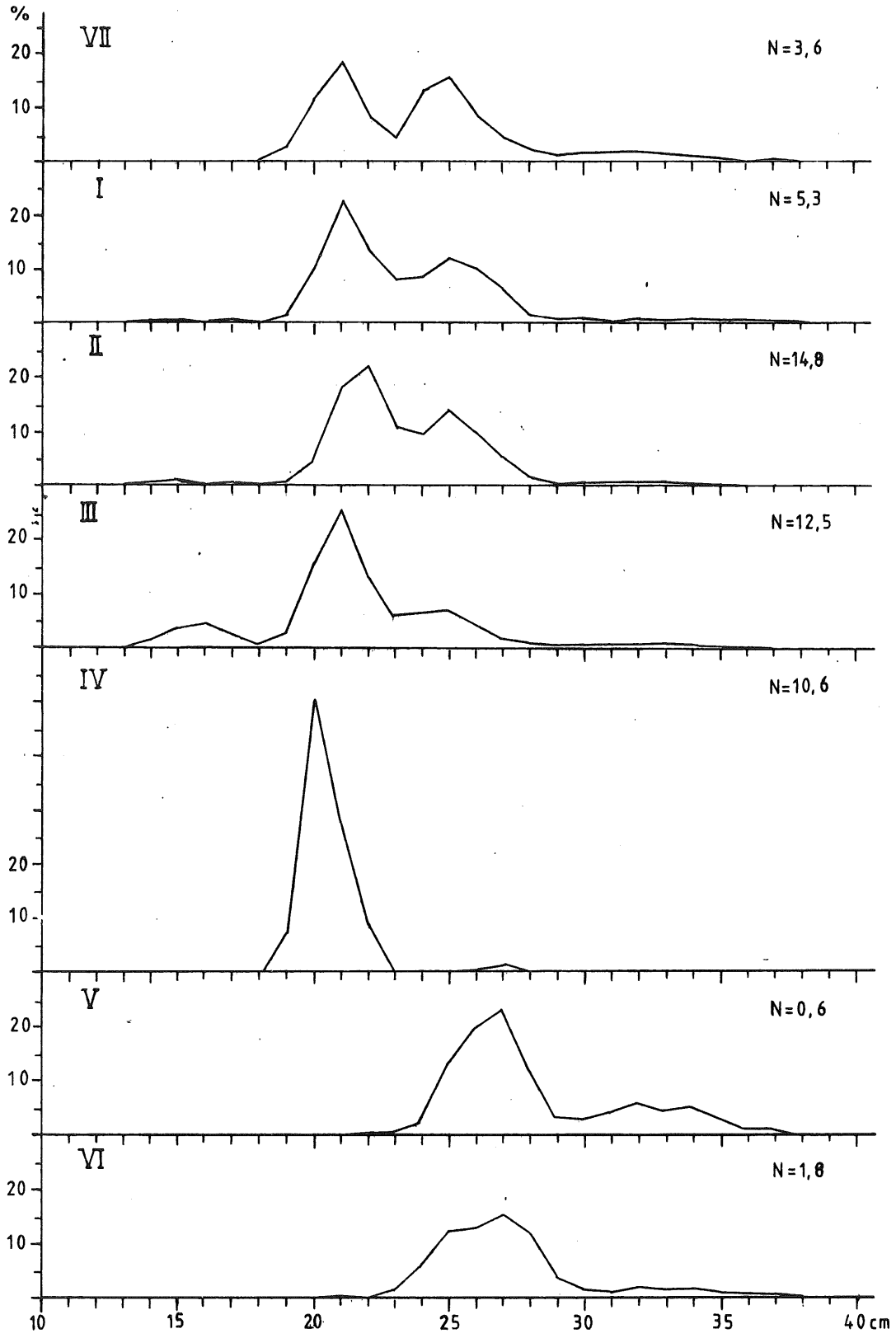

Fig. 9. Length distributions (N) of blue whiting weighted by abundance in subareas I-VII (see Fig. 7). N in 10^9 specimens.

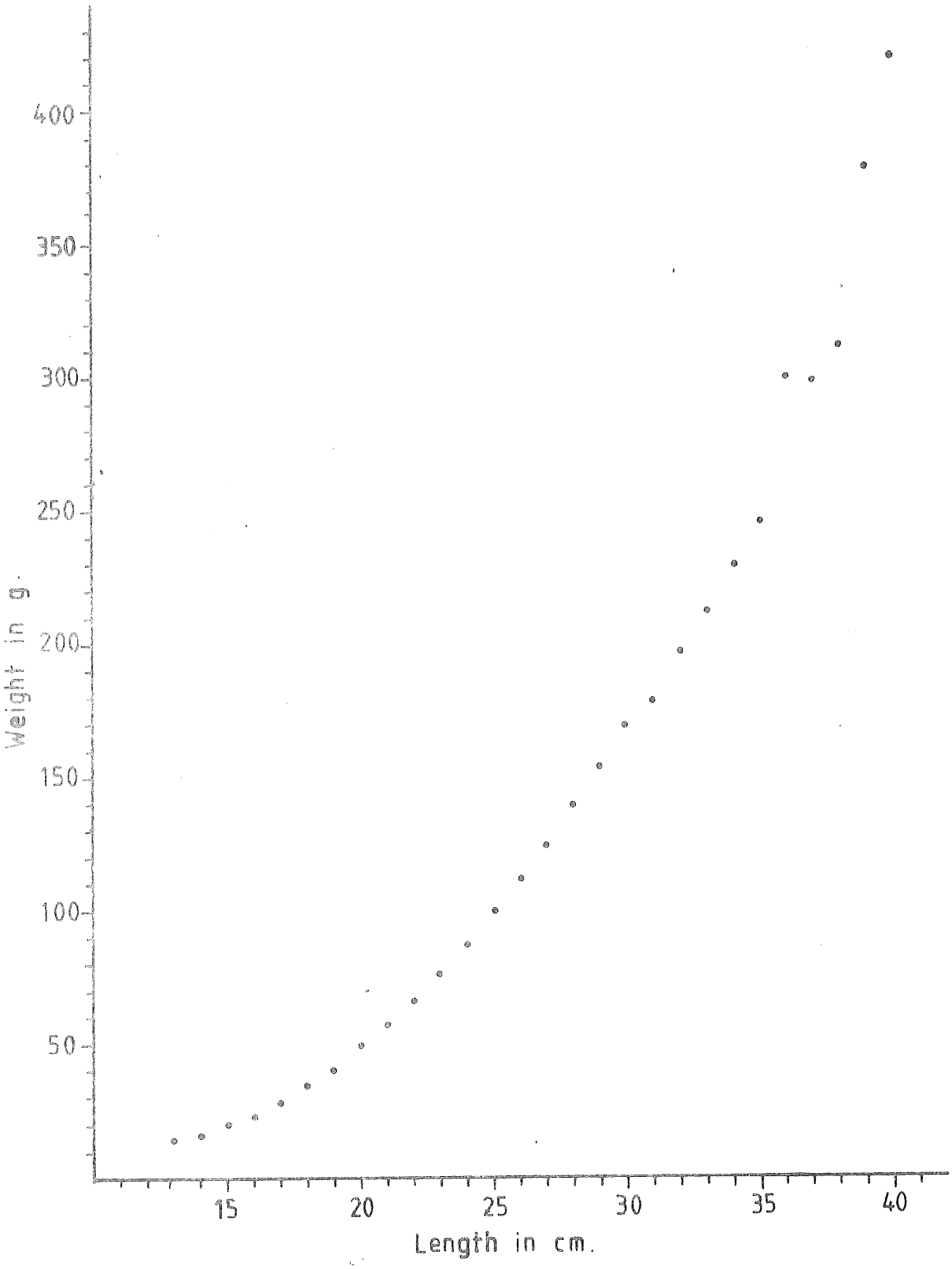

Fig. 10. Total length/weight relationship of blue whiting in the Norwegian Sea, August 1984.