International Council for the
Exploration of the Sea

Demersal Fish Committee
ICES C.M. 1992/G:51

REPORT ON THE ICELANDIC AND RUSSIAN ACOUSTIC SURVEYS ON OCEANIC REDFISH IN THE IRMINGER SEA AND ADJACENT WATERS, IN MAY/JULY 1992

by

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In 1991, Iceland and Russia had decided to conduct acoustic surveys on the oceanic redfish in the Irminger Sea in the following year. One of the main aims of the ICES Study Group on Redfish stocks which met at Copenhagen, May 13-15, 1992, was therefore to coordinate ongoing research on this species (ICES, C.M. 1992/G:14). It was also decided that the two parties that planned to conduct acoustic surveys in the Irminger Sea, in 1992, should meet in Reykjavík, Iceland, after the surveys to prepare a combined report to ICES (Demersal Fish Committee).

Since the planned cooperation during the acoustic surveys did not work out as anticipated it was decided that this report should contain a short description of each survey (Part I: Icelandic report; Part II: Russian report) and joined results (Part III) mainly on the acoustic assessments.

Part I. Report on the Icelandic survey on oceanic redfish in the Irminger Sea, in June and July, 1992

1. Introduction

In June 1991, an acoustic survey on oceanic redfish was conducted by Iceland in the Irminger Sea (ICES/G:64). The positive results led to the decision to continue with this kind of work preferably as a task of international cooperation, regarding the vast distribution area of this stock of redfish. For the current year, two nations, i.e. Iceland and Russia had decided to conduct acoustic surveys mainly in the Irminger Sea. During the meeting of the ICES Study Group on Redfish Stocks at Copenhagen, May 13 to 15, 1992 a detailed combined survey plan was worked out and agreed upon by the representatives of the two nations. However, only Iceland conducted the survey according to the plan agreed upon.

The Icelandic survey was carried out by the Marine Research Institute (MRI) with the research vessel "Bjarni Sæmundsson" during the time period June 16 to July 7. About 82 000 n.m^2 were covered between 64°N and 57°N on 10 latitudinal sections beginning from the north, with 30 n.m. distance (Fig. 1). The planned sections in the southwesternmost part of the survey area had to be altered because of bad weather conditions which also led to time delays in the beginning of the survey. In the area off East Greenland, the transsections had to be curtailed because of ice.

Scientists in charge were:

J. Magnússon
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2. Material and methods

A 38 kHz SIMRAD EK500 split-beam echo sounder and a BI500 postprocessing system was used for the acoustic data collection. The equipment was

thoroughly calibrated prior to the survey, using the standard target method. Instrument settings relevant to the echo integration and target strength analysis are shown in Table 1.

During the survey, the postprocessing system was used for scrutinizing echograms and mean intergrated values of redfish per 1 n.m. were recorded for every 5 n.m. sailed. In order to have values directly comparable to the results of the redfish survey in June 1991, a volume backscattering threshold of -72 dB was used (Sv threshold). This threshold is sufficiently high to exclude to a large extend undesirable echoes from smaller organisms. The target strength distribution of redfish observed during the survey indicates a lower end below -50 dB. In order to incorporate all redfish echoes down to at least 300 m depth, a treshold of -79 to -82 dB is required. The preliminary investigation from the integration using different Sv-thresholds, of echograms consisting almost exclusively of redfish indicates that a correction factor of 1.1 -1.3 should be applied depending on the depth distribution of echoes and the amount of small scatterers. A correction factor of 1.1 was used.

A specially designed pelagic trawl (Gloria type, Hampiðjan, with maximum stretched mesh size of 32 m) with a vertical opening of 75-80 m was used. The codend was lined with a fine-meshed net (36 mm). The duration of the hauls was 1 hour with very few exceptions when it was prolonged to 1.5 hours.

A total of 27 hauls were taken of which 5 were deep-sea hauls (>500 m depth). The biological sampling was carried out according to the survey plan agreed to by ICES.

Zooplankton sampling was regularily carried out by means of bongo net (100 m depth oblique) mostly 40 n.m. apart. The volume was measured by the displacement method and the main components were recorded. The ichthyoplankton was sorted out. Temperature measurements were carried out simultaneously with the zooplankaton sampling by means of a bathythermograph (XBT) down to 760 m depth.

In vivo, chlorophyll *a* was recorded during the survey by a Model 10 Fluorometer Turner Design. Sampling for Chl. *a* extraction measurements were made twice a day.

3. Results

Acoustic measurements

A first analysis of target data obtained in this survey determined the target strength of a single fish as -40.2 dB and -38.1 dB for 1 kg. These values are representative for redfish in the depth interval 100-200 m with mean length 36.4 cm and mean weight 623 g.

According to the Icelandic acoustic estimation, the stock size of oceanic redfish was assessed to be about 1.3 million tonnes, in the area surveyed by the Icelandic r/v "Bjarni Sæmundsson".

The relative distribution based on echo values is shown in Figure 2. Some aspects of the distribution should be pointed out:

1. Oceanic redfish were most abundant in the western part of the Irminger Sea.
2. In a few hauls, oceanic redfish were observed, in small quantities although the acoustic records did not register any values.
3. Oceanic redfish were mainly abundant in 100-200 m depth.

It should be noted that deep sea redfish (*Sebastes mentella*) were caught in all deep-sea hauls.

Temperature and distribution

As stated before, the distribution and abundance of oceanic redfish are closely connected with the temperature. The temperature range in which the species was most abundant was about 3.5°-4.5° (av. 4°) C which is, however, somewhat lower than observed in 1991 (4°-5°C).

The temperature according to depth is demonstrated on a section at 60°N between 33°W and 40°22'W (Fig. 3). It shows that the temperature distribution changes between st. 518 and st. 521, i.e. at approximately 35°W which corresponds to an increased density of oceanic redfish.

The horizontal distribution of the temperature is shown in Figure 4. The relation between the abundance of oceanic redfish and e.g. the 4° isotherm is obvious by comparison of Figures 2 and 4.

Biological information

A total of 6098 oceanic redfish were measured of which 2920 (46%) were males and 3178 (54%) females. The length range was 23-46 cm, av. 36,35 cm. For males, the average was 35.58 cm and for females, 36.98 cm resp.

The maturity stages were almost exclusively stage II for males, i.e. ripening according to the scale of maturity stages applied in Icelandic research and stage IV for females which means newly spent. Some females were also observed with stage II.

A total of 2005 fish in a length range of 23-46 cm were weighed individually. The average weight was 623 g while it was 599 g for males and 646 g for females.

Incidence of abnormalities: According to the sampling procedure agreed upon at the ICES Study Group on Redfish Stocks meeting, observations on the general appearance of the fish were carried out. (Table 2). The infestation rate per tow ranged from 1.0 to 4.4, average 1.8 i.e. about 41% of the observed fish were infested. Males were less frequently infested, the ratio (males versus females) being 0.5. The visual external infestation was grouped into 5 categories: black spots, red spots, mixed spots, remnants (i.e. lesions caused by *Sphyrion lumpi* that had fallen off) and *Sphyrion lumpi*. In most cases, the fish were infested by several spots and/or *Sphyrion lumpi*. On the whole, *Sph. lumpi* and/or remnants of it were observed in over 50% of the infested fish but black spots were also prominent.

Abnormal muscular pigmentation, i.e. gray or black spots in the fillets was observed in 1292 (55%) of the 2000 investigated fish but most of them were only slightly pigmented. About 46% of these 1292 fish also carried external abnormalities but a connection could not be established.

Observation on stomach contents. Most of the investigated specimens (Table 3) had everted (61%) or empty stomachs (20%). Only 19% were with contents but very few specimens had a full stomach. Amphipods were by far most prominent of the food groups. Second and third ranged copepods and euphausids. Fish remnants were only observed in some few cases.

Plankton: The zooplankton was generally very uniform, and the plankton distribution on the whole characterized by phytoplankton and zooplankton tongues stretching in north-south directions (Fig. 5). The most common plankton animals - found nearly everywhere - were Calanus finmarchicus and pteropods. Other typical plankton animals such as Euphausiids and Chaetognaths were more localized to certain areas or water masses.

The volume of the zooplankton was rather poor in comparison to previous zzIcelandic observations in this area. Young animals, i.e. copepodite stages of Calanoids and furcilia stages of Euphausiids were also more frequently met with, most likely indicating a late spring in the area investigated.

Reference

Magnússon, J., J.V. Magnússon, P. Reynisson 1992: Report on the Icelandic survey on oceanic redfish in the Irminger Sea, in June 1991. ICES C.M. 1992/G:64.

Table 1. Instruments and settings in the redfish survey in June/July 1992.
The five last lines in the table refer to criteria used in the EK500 for single-echo selection.
The sound velocity profile was set according to the known general hydrography in the survey area. This affects the time varied gain of the echo sounder.

Echo sounder/Integrator	EK500/BI500
Frequency	38 kHz
Transducer	ES38-B
Absorption coefficient	10dB/km
Transmitted power	2000 W
Pulselength	1.0 ms (medium)
Bandwidth	3.8 kHz (wide)
3 dB beamwidth	7.0 degrees
Equivalent beam angle	-20.6 dB
Calibration constant for integration	26.7 dB
Calibration constant for target strength	26.7 dB
Integration threshold	-72 dB
Target strength threshold	-63 dB
Maximum echo length	0.7 pulsewith
Minimum echo length	1.4 pulsewith
Maximum phase deviation	2.0
Maximum gain compensation	3.0 dB

Table 2
Oceanic redfish
Incidence of abnormalities

	Males	Females	Total	
No. of exam. fish	1004	1001	2005	
No. of fish w. abnorm.	276	544	820	
%	34	66		
external				%
black spots	95	194	289	25
red spots	36	49	85	7
mixed spots	7	120	127	11
remnants	107	170	277	24
Sph.lumpi	87	277	364	32
muscular	No.	%	No.	%
none	708	35		
light	918	46	918	71
medium	285	14	285	22
severe	89	4	89	7
total	2000			
no.w.abnorm.			1292	

Table 3
Oceanic redfish
Observations on the stomach content

	No.	%
Total	2000	
everted	1214	60,7
empty	394	19,7
w.content	392	19,6
little	245	12
medium	120	6
much	27	1
	frequ.	%
Amphip.	278	47
Copep.	90	15
Euphaus.	82	14
Squids	53	9
Gastrop.	28	5
Medusae	24	4
Fish remn.	17	3
Other	15	3

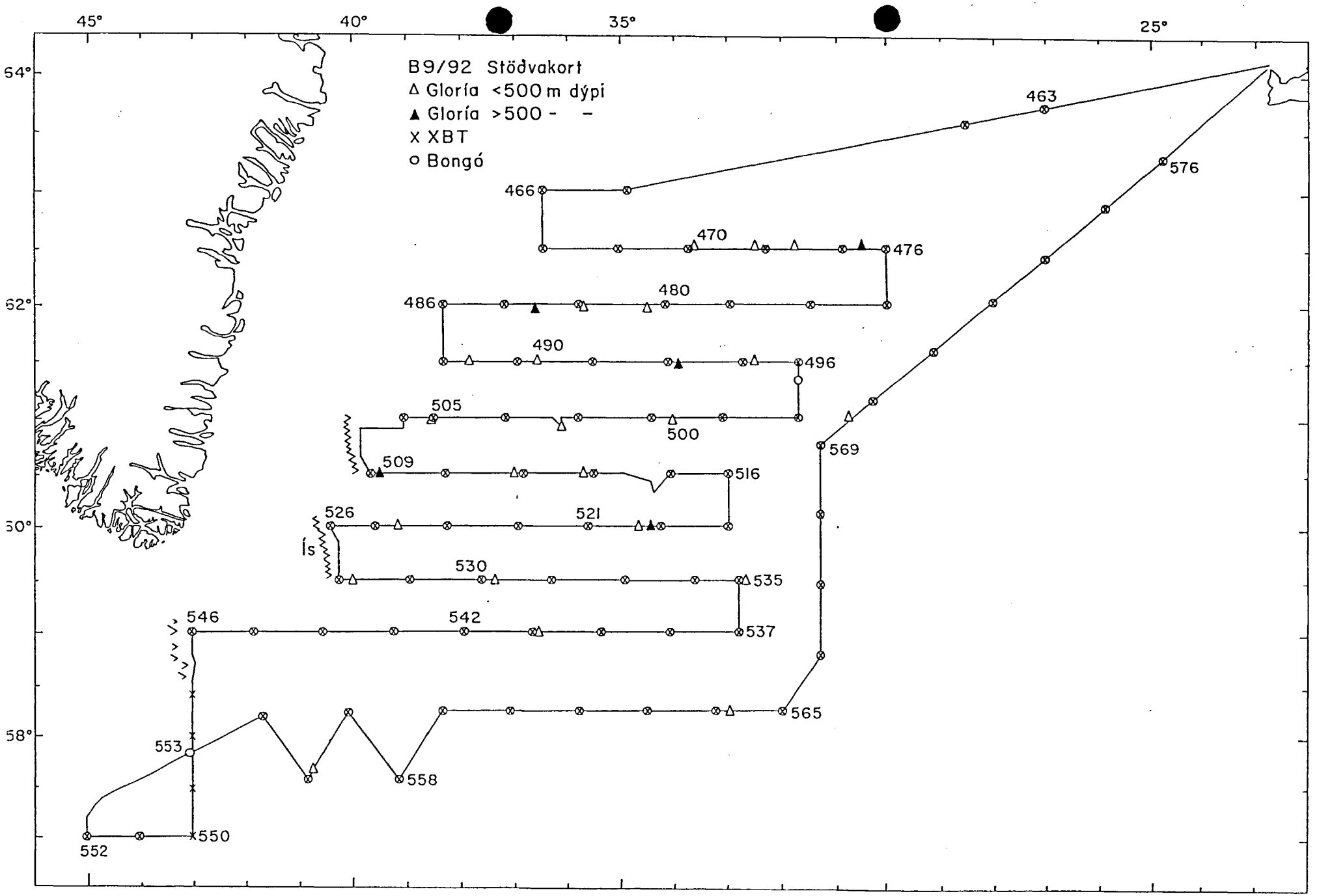

Fig. 1. Cruise tracks

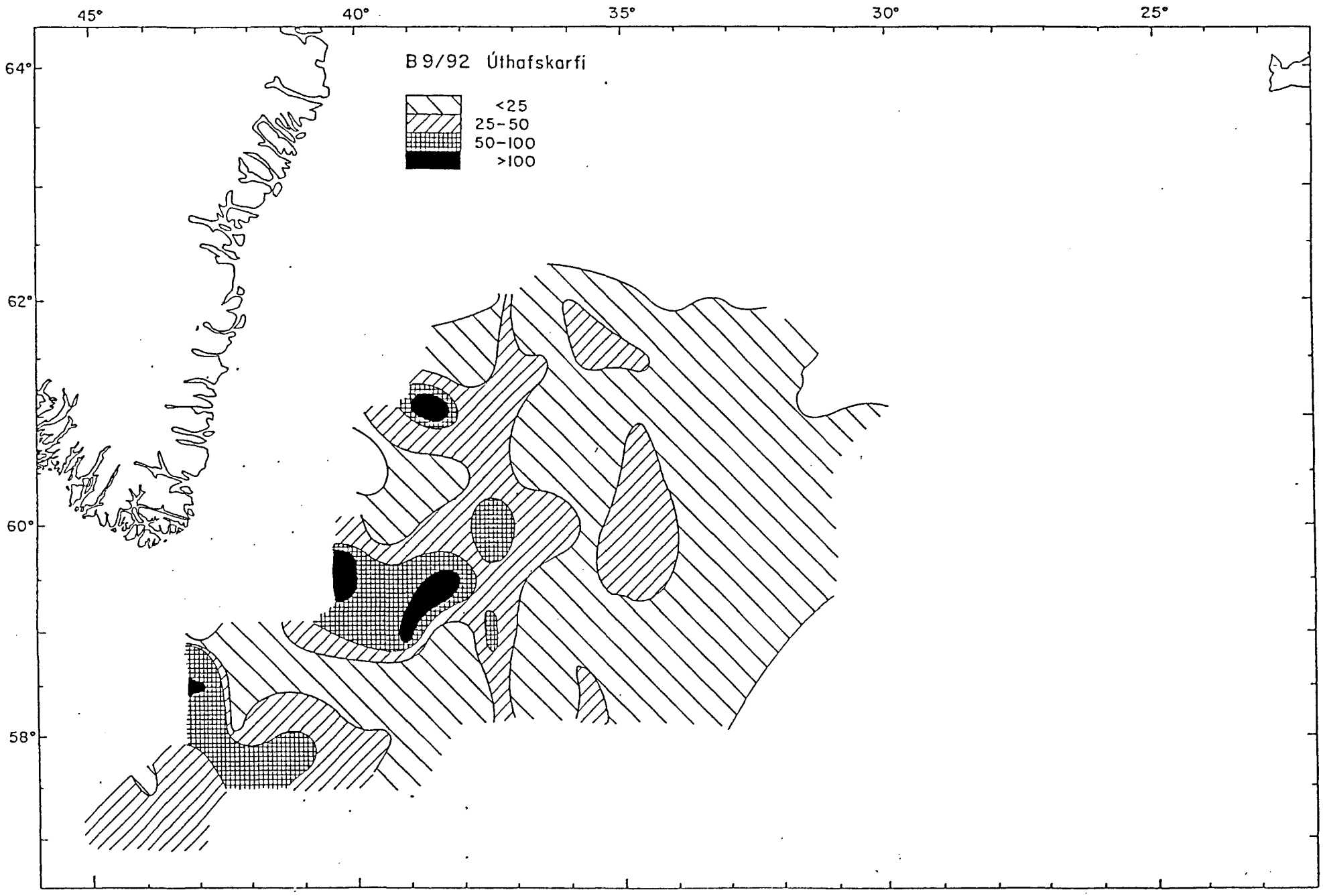

Fig. 2. Relative abundance of oceanic redfish based on echo values.

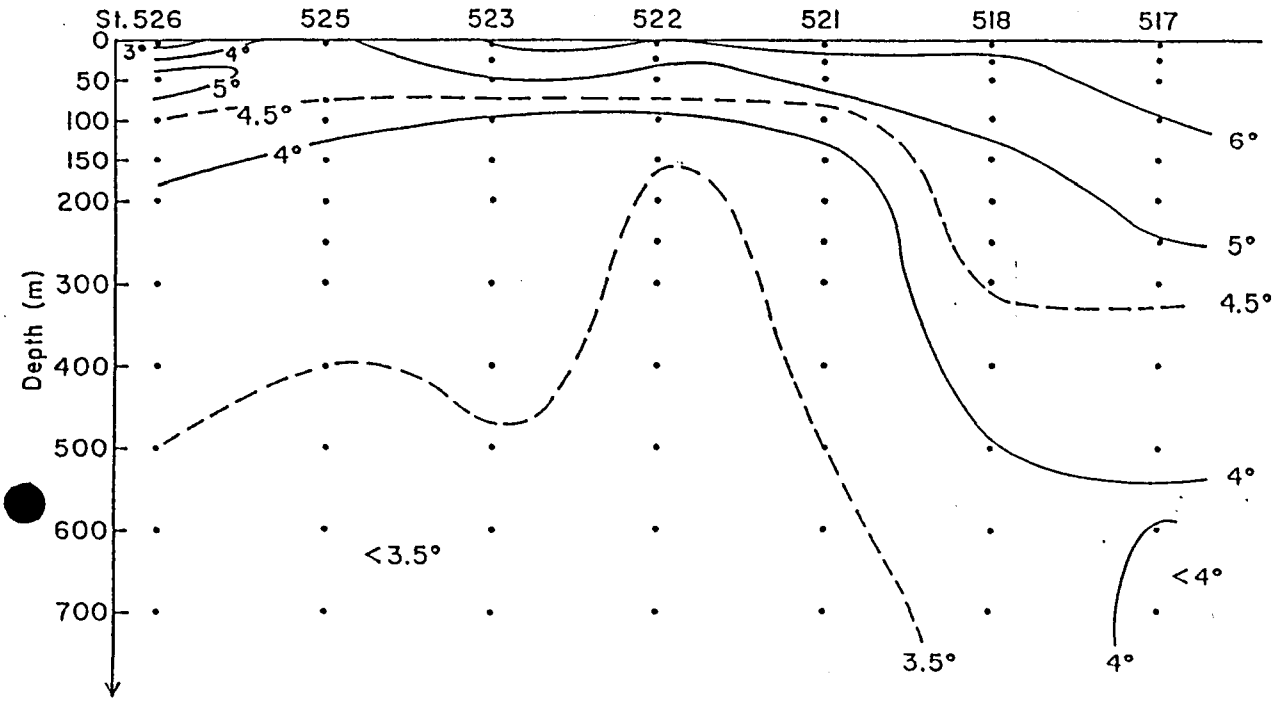

Fig. 3. Vertical temperature distribution (t°C) on a section along the 60°N latitude

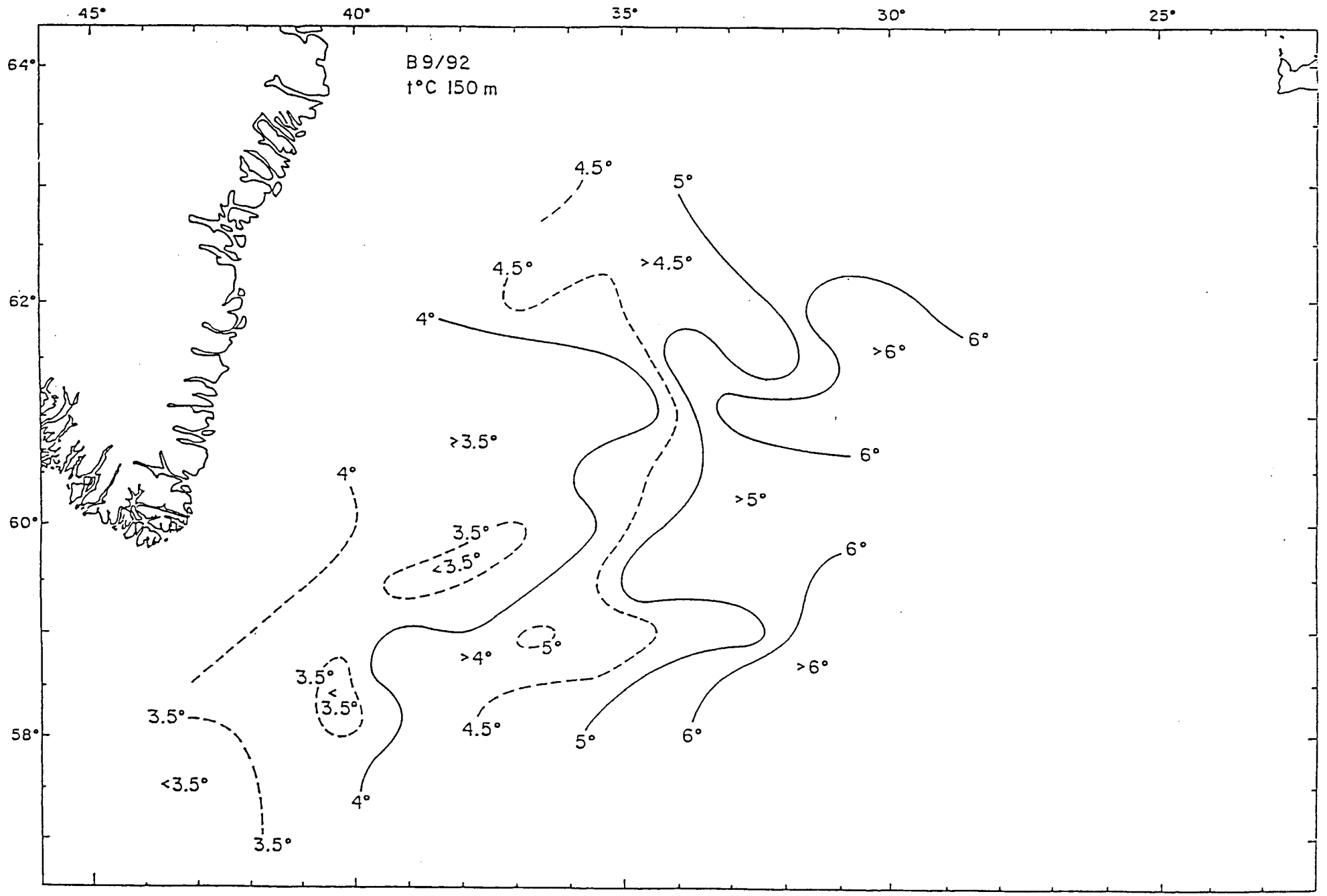

Fig. 4. Horizontal temperature (t°C) distribution in 150 m depth.

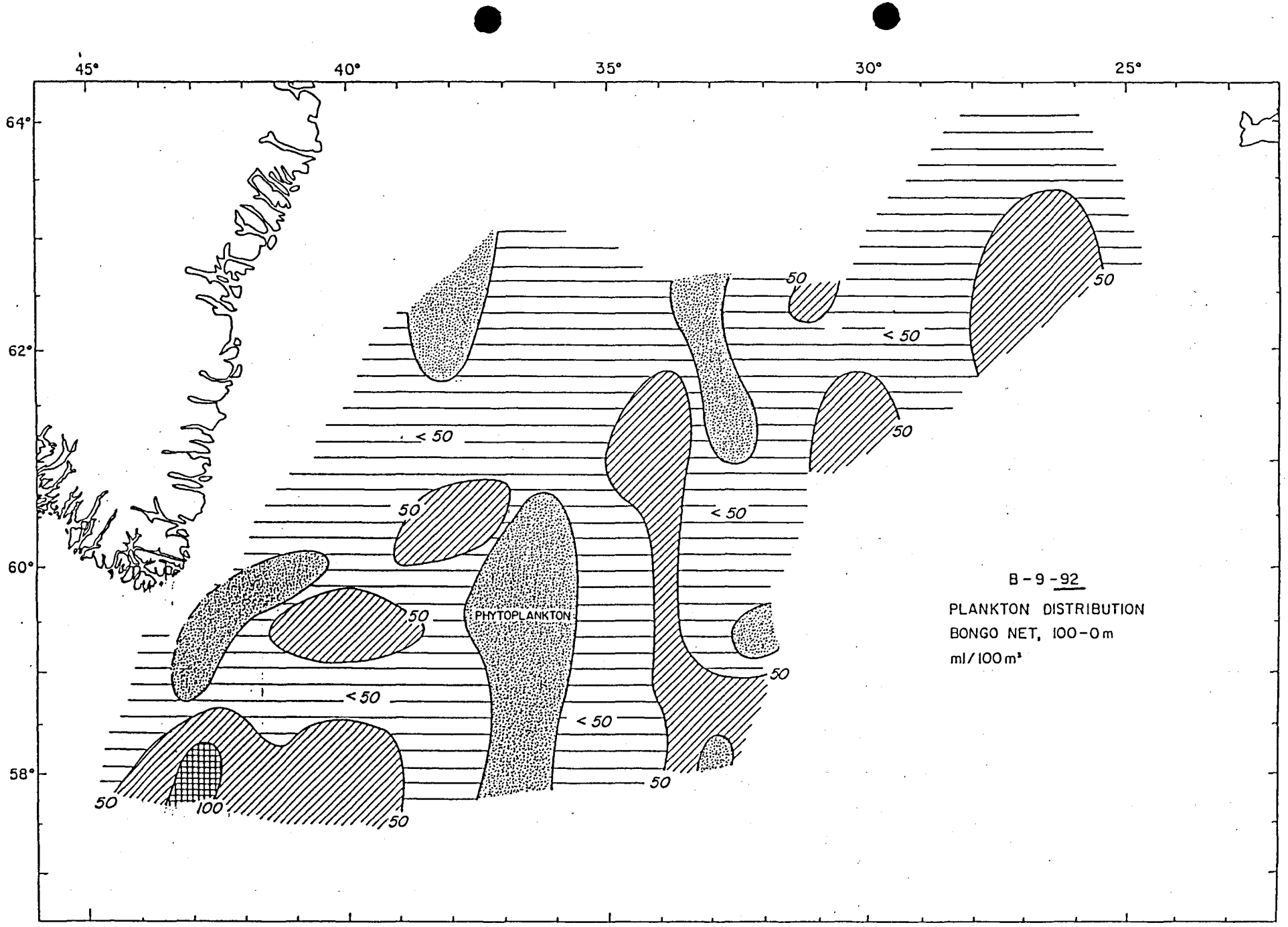

Fig. 5. Plankton distribution

Part II. Report on the Russian survey on oceanic redfish in the Irminger Sea and adjacent waters, May to July 1992.

Introduction

The acoustic survey of the oceanic redfish in the Irminger Sea was conducted during May to July 1992. This survey was carried out in accordance with the traditional Russian program and the Polar Institute (PINRO, Murmansk) plans. The survey started on 26 May, 1992 and finished on 11 July, 1992.

The Russian survey was carried out with the research vessel "F. Nansen" and consisted of two parts: The first one was a survey of the open part of the Irminger Sea, between 26 May and 6 July and the second part, within the Greenland Exclusive Economical Zone (EEZ) from 6 July to 11 July (Fig. 1).

About 134 000 n.m.^{2} were covered during the survey in the open part of the Irminger Sea and more than 40 000 n.m.^{2} during the survey in the EEZ of Greenland. The total distance in the open part of the survey was about 4500 n.m. and the distance of the acoustic transsections in the Greenland EEZ was more than 1200 n.m.

Scientists in charge were:

A. Dorchenkov, acoustics

A. Pedchenko, oceanology and

Y. Bakay, biology, and cruise leader.

Material and methods

For the acoustic data collection, a single-beam echosounder EK-400 with the frequency 38 kHz and an echointegrator SIORS were used. The equipment was calibrated by a standard copper sphere. The instrument settings are shown in Table 1.

A commercial pelagic trawl with a vertical opening of 50-55 m and with the mesh size of 16 mm was used. The duration of all trawl stations was 1 hour.

Temperature and salinity measurements were carried out with a CTD sonde down to 1000 m depth.

The conversion of the acoustic data to biomass and abundance of oceanic redfish were carried out for all size distribution (per cm) by using PINRO TS equation "in situ" 28.2Log(L)-84.5 dB.

Results

The oceanic redfish were distributed in the depth interval of 100-350 m and concentrated along the Greenland EEZ, from 62°N to 56°N (Fig.2). The maximum densities in the open part of the Irminger Sea were about 50-60 tonnes per $n.m^2$ and the mean density was 7.5 tonnes per n.m. The zero-line of the redfish distribution in the southern and western part of the survey area were established. Oceanic redfish were mainly abundant in 100-200 m depth. The total biomass in the open part of the Irminger Sea was about 1 million tonnes and the total abundance was 1600 mill. sps. Accordingly, in the Greenland EEZ, it was about 600 000 tonnes and 1 000 mill.sps., resp.

Temperature and distribution

It should be noted that thermal conditions of the water are determining the characteristical abundance of oceanic redfish in the research area. The surface temperatures were below the average for the period 1976-1991 in the Irminger Sea, in May, June and July 1992 and also in the eastern part of the Labrador Sea. The vertical temperature distribution on section 3-K, carried out during May 28-30, 1992, showed similar trends (Fig. 3).

North of 60°N, oceanic redfish were most abundant in a temperature range of about 3.7-4.7°C. In June and July, our investigations were carried out in the southern open part of the Irminger Sea from 58°30'N. Oceanic redfish were most abundant in the 100-200 m depth layer and in the temperature range of 3.4-4.2°C (average 3.9°C). The vertical temperature distribution on the section at 42°45'W between 52°50'N and 56°19'N is shown in Fig. 4.

The horizontal temperature distribution in 200 m depth for the whole TAS area (Trawl Acoustic Survey) and time period is demonstrated in Figure 5. The reiterated investigation of the area north of 60°N which was carried out in July showed differences in the layer 0-50 m depth of +1.6°C and in the layer 50-200 m, +0.6°C compared to the month May.

Generally, the hydrological conditions in the TAS area, in 1992, were similar to those in 1990.

Biological information

In the open part of the Irminger Sea, a total of 4662 redfish were measured of which 2579 (55.3%) were males and 2083 (44.7%) females. The length range was 24-47 cm and the mean length was 35.6 cm. The mean length for males was 35.1 cm and for females, 36.1 cm. The mean weight of oceanic redfish was 649 g. For males, the mean weight was 626 g. and for females, it was 677 g.

In the Greenland EEZ, a total of 993 specimens of oceanic redfish were measured of which were 613 males ands 380 females. The length range was 26-41 cm and the mean length 34.9 cm. The mean length for males was 34.4 cm and for females 35.6 cm. The mean weights were 625 g. for both sexes combined, 612 g. for males and 645 g. for females.

A detailed analysis of the maturity stages (according to the stages which are applied by PINRO), stomach contents and stomach condition and infestation of the species by the copepod *Sphyrion lumpi* is given in Tables 2-8.

Table 1. Settings of hydroacoustical instruments

EK 400 echo sounder

Frequency	38 kHz
Pulse duration	1.0 mS
Bandwidth	3.3 kHz
TVG/Gain	20logR/0 dB
Absorption coefficient	8.7 dB/km
Equivalent beam angle	-20.1 dB
Threshold	-74 dB//1W

SIOR echo integrator

Gain	10 dB
Threshold	-48 dB//1W
SL+VR	133.1 dB
Instrumental constant	19.5 ref. 0 dB gain

Table 2.

Oceanic redfish. Size distribution in the open part of the Irminger Sea.

Length	Males		Females		Males + Females	
cm	No.	%	No.	%	No.	%
24	1	0,0	1	0,0	2	0,0
25	1	0,0	3	0,1	4	0,1
26	-	-	6	0,3	6	0,1
27	1	0,0	3	0,1	4	0,1
28	2	0,1	8	0,4	10	0,2
29	4	0,2	5	0,2	9	0,2
30	17	0,7	4	0,2	21	0,5
31	39	1,5	19	0,9	58	1,2
32	171	6,6	54	2,6	225	4,8
33	371	14,4	129	6,2	500	10,7
34	439	17,0	195	9,4	634	13,6
35	446	17,3	384	18,4	830	17,8
36	364	14,1	355	17,0	719	15,4
37	351	13,6	370	17,8	721	15,5
38	211	8,2	259	12,4	470	10,1
39	134	5,2	152	7,3	286	6,1
40	20	0,8	101	4,8	121	2,6
41	4	0,2	23	1,1	27	0,6
42	1	0,0	7	0,3	8	0,2
43	1	0,0	1	0,0	2	0,0
44	-	-	3	0,1	3	0,1
45	1	0,0	-	-	1	0,0
46	-	-	-	-	-	-
47	-	-	1	0,0	1	0,0
Total	2579	100,0	2083	100,0	4662	100,0
Length mean, cm	35,1		36,1		35,6	
Weight mean, g		626		677		649

Table 3

Food composition of oceanic redfish in the open part of the Irminger Sea

N	Food objects	Frequency	
n/n		No	%
1	Calanus sp.	360	30,7
2	Themisto sp.	351	30,0
3	Sagitta sp.	196	16,7
4	Euphausiacea	196	16,7
5	Ommastrephidae	23	2,0
6	Myctophidae	15	1,3
7	Digested fish	15	1,3
8	Limacina sp.	9	0,8
9	Digested food	3	0,3
10	Paralepis sp.	1	0,1
11	Gonostomidae	1	0,1
12	Meduses	1	0,1
Total		1171	100,0
Number of observed stomachs		995	
Number of stomachs with content		551	

Table 4

Food composition of oceanic redfish in the Greenland EEZ

N	Food objects	Frequency	
n/n		No.	%
1	Themisto sp.	93	41,0
2	Calanus sp.	51	22,5
3	Bolinopsis sp.	37	16,3
4	Ommastrephidae	16	7,0
5	Euphausiacea	15	6,6
6	Limacina sp.	9	4,0
7	Sagitta sp.	4	1,8
8	Digested food	1	0,4
9	Myctophidae	1	0,4
Total		227	
Number of observed stomachs		133	
Number of stomachs with content		112	

Table 5

Oceanic redfish. Maturity stages in the open part of the Irminger Sea

Sex	Stage of maturity				No. of
	2	3	4	9-2	measurements
Males, spec.	11	1284	13	-	1308
%	0,8	98,2	1,0	-	100
Females, spec.	48	282	-	629	959
%	5,0	29,4	-	65,6	100

Table 6

Food intensity of oceanic redfish in the open part of the Irminger Sea.

Sex	Stomach condition					Total	Mean
	0	1	2	3	4		condition
Males, spec.	253	142	127	75	25	622	1,2
%	40,7	22,8	20,4	12,1	4,0	100	
Females, spec.	191	69	70	33	10	268	0,9
%	51,2	18,5	18,5	8,8	2,7	100	

Table 7

Infestation of oceanic redfish by the copepod *Spyrion lumpi* (Greenland EEZ)

Sex	Living Sph.lumpi		Living Sph.lumpi + old cephalotoraxes		% of Redfish with pigmented lesions
	%	number on 1 investigated redfish	%	number on 1 investigated redfish	
males	11,0	0,18	23,3	0,36	11,0
females	20,3	0.34	33,9	0,65	29,7
males + females	14,5	0.27	27,3	0,48	18,3

Table 8

Infestation of oceanic redfish by the copepod *Sphyrion lumpi* in the open part of the Irminger Sea

Sex	Living Sph.lumpi		Living Sph.lumpi + old cephalotoraxes		% of Redfish with pigmented lesions
	%	number on 1 investigated redfish	%	number on 1 investigated redfish	
males	6,1	0,3	19,3	0,4	15,6
females	24,5	0,7	43,7	1,1	24,8
males + females	13,6	0,5	29,3	0,7	19,4

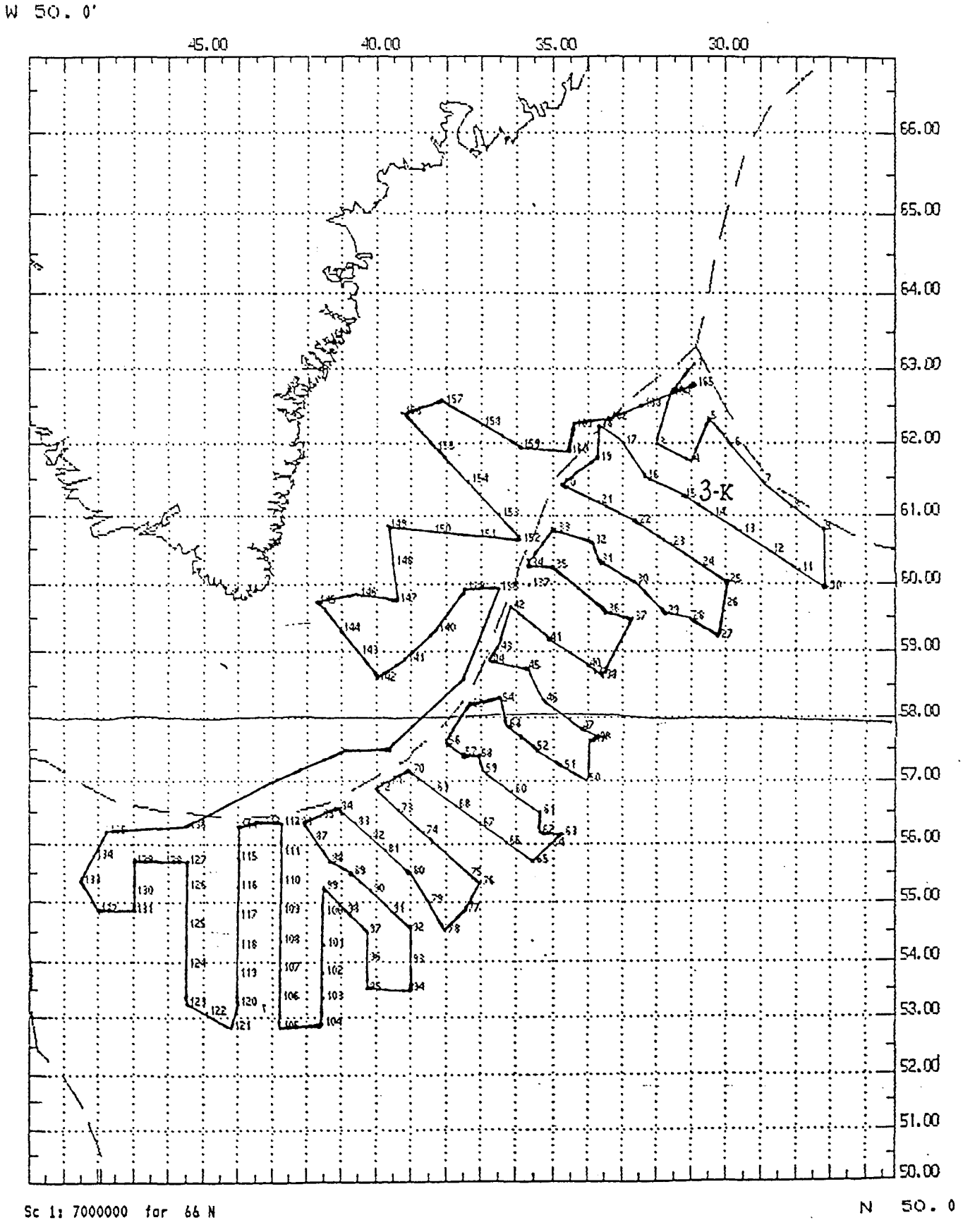

Fig. 1. Fr. Nansen. May/July 1992. Cruise tracks.

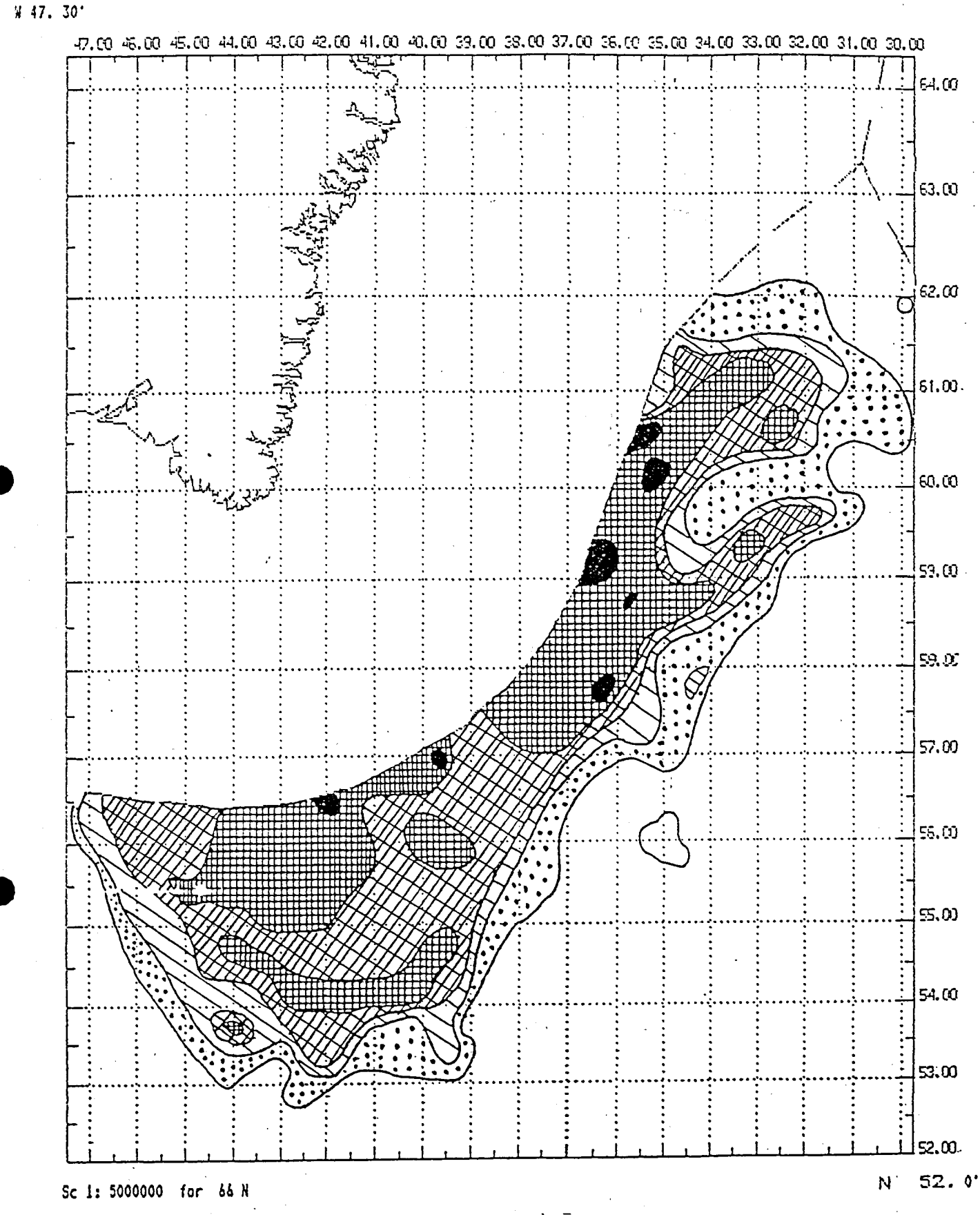

Fig. 2. Redfish integrator values. Distribution in the open part of the Irminger Sea/26.05.-02.07.1992/. (m^2/n.m.^{2}).

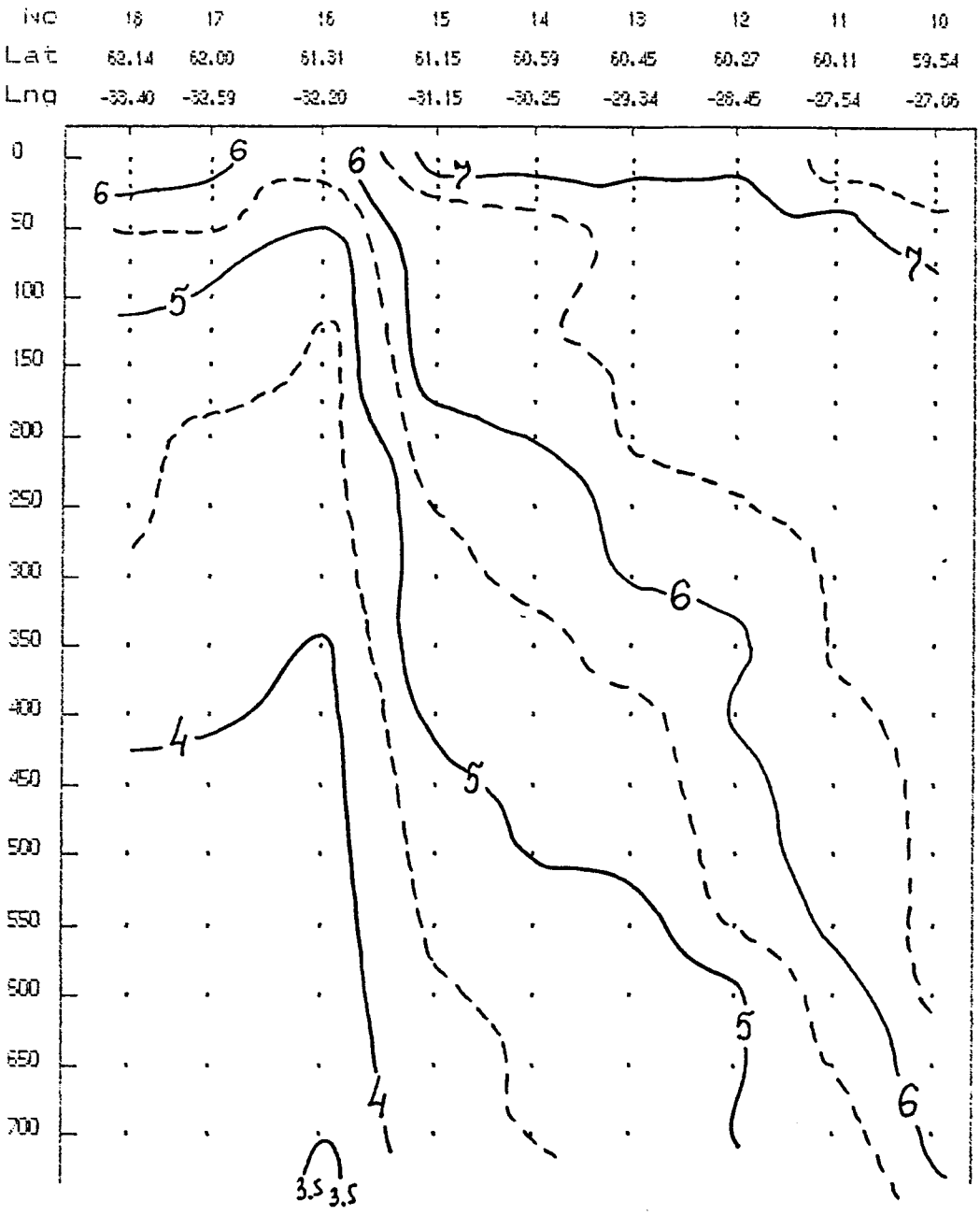

Fig. 3. Vertical temperature distribution on section 3-K (see Fig. 1).

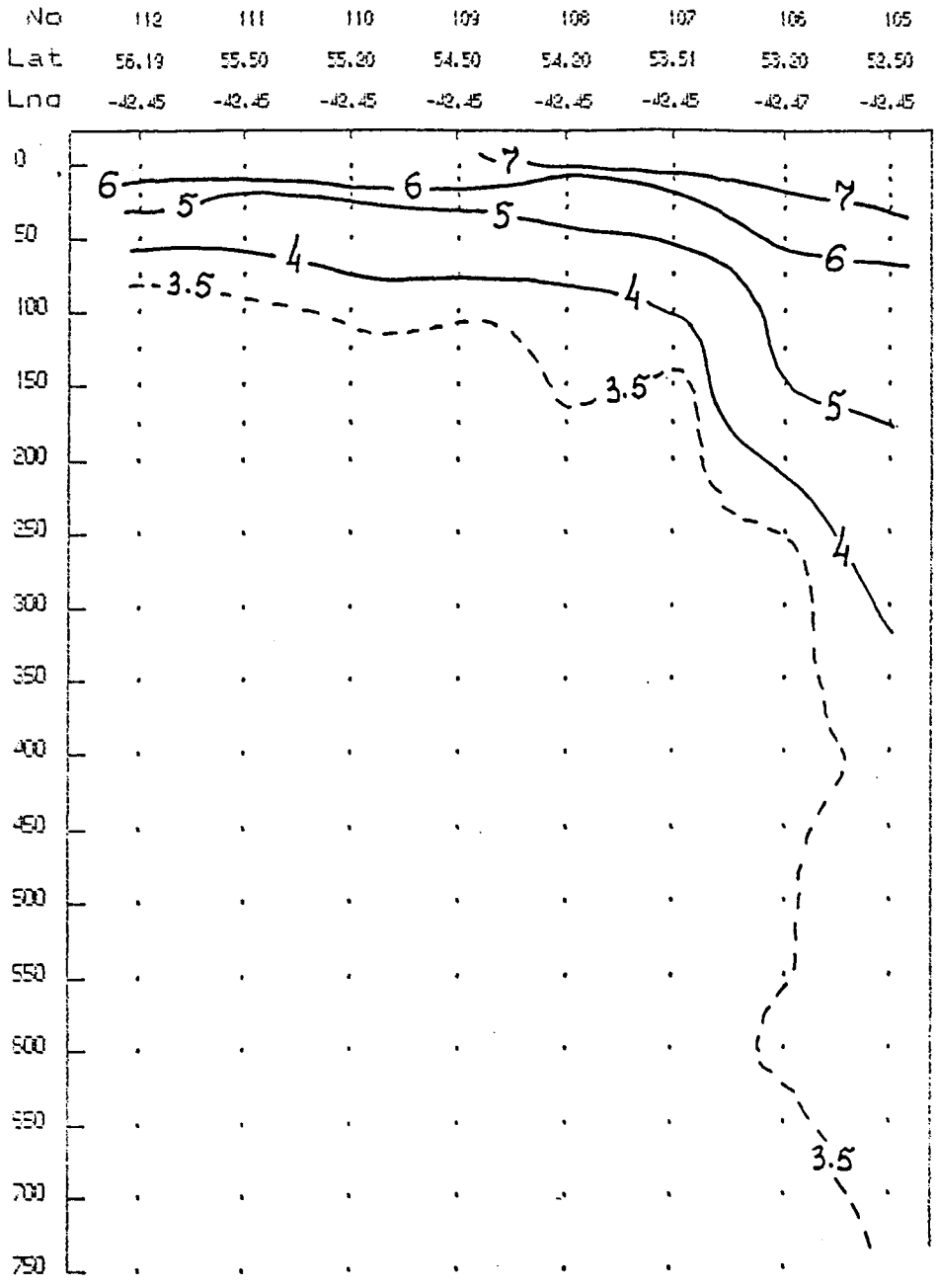

Fig. 4. Vertical temperature distribution on the section at 42°45'W between 52°50'N and 56°19'N.

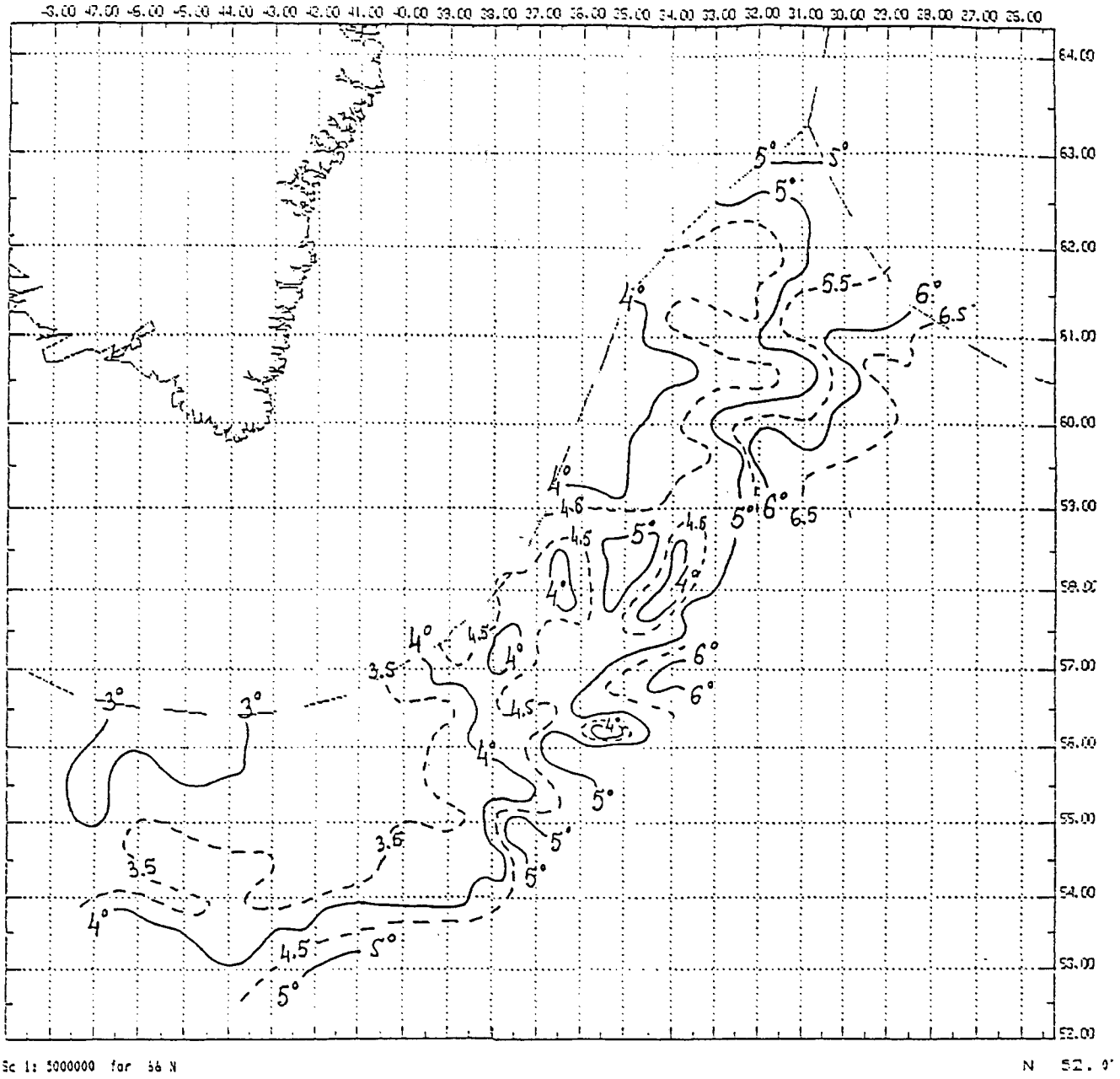

Fig. 5. Horizontal temperatue in 200 m depth in the survey area.

Part III. Joined results

Because of the time differences in the performance of the two surveys it was difficult to combine the results of the acoustic estimation. However, the southern part of the Russian survey (i.e. south of 57°N) was carried out during the same time when the Icelandic vessel operated in the southernmost part of its survey area. The Russian estimate from that particular part of the survey area, i.e. the area between 57°N and 53°N and 48°W and 35°W which is about 80 000 $n.m^2$ in size amounted to about 630 000 tonnes. Adding this amount to the Icelandic acoustic assessment of ca. 1.3 mill. tonnes the total estimate covering an area of about 165 000 $n.m^2$ is resulting in 1.9 mill. tonnes. It should be pointed out that this estimate dos **not** cover the entire area of distribution of the oceanic redfish partly because of ice and also because of bad weather conditions.

Compared to the results of the surveys in 1991, the cold water isotherm (<3.5°C) was higher in the water column in 1992. This is clearly indicated in the vertical temperature distribution along the 60°N latitude (Icelandic report, Fig.3) and along the 42°45'W longitude (Russian report, Fig.4).

Reference

Anon. 1992: Report of the Study Group on Redfish Stocks. ICES. C.M. 1992/G:14