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Hydroacoustic observations in the Baltic proper in October 1979.

Preliminary results.

By

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Abstract

This paper informs on preliminary results of the second hydroacoustic survey undertaken by Sweden and the GDR in the Baltic proper during October 1979.

The methods are described and the total biomasses of herring and sprat are calculated. For each ICES square mean integrator values are given as well as total biomasses in tons and the relations of species and their relative density in tons/NM^2. The absolute number of herring and sprat is calculated by age per sub-division.

Enclosed figures show the integration tracks, densities and position of hauls. The results of 1979 and 1978 are compared.

Contents:

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1. Introduction

The decline of fish stocks in the North East Atlantic have resulted in increased importance of the Baltic fisheries. The landings from the Baltic Sea have risen during the last decade from 686 x 10^3 tons in 1967 to 924 x 10^3 tons in 1976 (Anon. 1978). The catches are dominated of three species in term of weight, herring, sprat and cod which together makes up 90 % of the total landings. The herring fishery, with yearly catches of more than 400 x 10^3 ton, has been one of the most important in the North Atlantic during the last years.

This rapid development of the fishery has stressed the need of a better knowledge of basic data about the fish stocks in order to prevent overfishing.

Management of the fish stocks in the Baltic has so far been based on estimates of stock sizes from virtual population analysis (VPA).

During the last years other methods of stock assessment have been used, such as acoustic surveys (Håkansson et al., 1979) and estimates of stock size from egg production of sprat (Shvetsov et al., 1978, Lindquist, 1979).

As pointed out by Håkansson op.cit., conditions in the Baltic Sea are favourable for the use of the acoustic technique. The water body is nearly enclosed and there are only 3 species of importance.

In 1978 a combined acoustic and trawl survey gave estimates of the herring and the sprat stocks. The total quantities in the investigated area of the Baltic proper (42 x 10^3 NM^2) was 1.4 and 0.52 million tons of herring and sprat respectively. The calculated spawning stock of herring was found almost twice as that computed by VPA for Jan. 1979. The opposite proportion was found for the spawning stock of sprat (Håkansson op.cit.).

The differences between the acoustic and the VPA estimates as well as the need to test the reliability in the acoustic estimates demanded a new survey to be carried out in 1979.

A second survey was carried out in October 1979. As in 1978, the survey was a cooperative effort between Institute of Marine Research, Lysekil,

Sweden and the Institute for Deep Sea Fishery and Fish Processing, Rostock, German Democratic Republic, as well as staff members of the Institut für Meereskunde, Kiel, Federal Republic of Germany, who took part in the work on board the R/V "Argos".

The 1979 survey followed the same sampling scheme as the 1978 survey in order to get results as comparative as possible. As in 1978 the participating vessels were the Swedish R/V "Argos" and the GDR R/V "Eisbär". Due to unexpected difficulties to get permission to operate in one fishing zone a minor part of the area could not be covered as planned.

Parts of the findings are used in the WG-report for the Assessment of Pelagic Stocks in the Baltic, see Anon. 1980. In that paper comparisons are made with the results from VPA and herring migrations and mortalities are discussed.

2. Material and methods

2.1. Echo integration

R/V "Argos" was in 1979 equipped with a Simrad EK 120 kHz echosounder and a QM MK II echo integrator. The settings of the instruments are shown in Table 1. The equipment was calibrated 1979-11-29 and the source level (SL) was determined to 116.7dB and the voltage response (VR) to - 7.77dB. A conversion constant (C) of 6 t/NM^2 and mm was used, and alike for all species and fish sizes.

Due to technical problems, only one integrator channel could be used during the last three weeks.

A more comprehensive description of the method is given in Håkansson et al., 1979.

2.2. Biological sampling

To identify echo traces and age groups pelagic trawling was performed, the aim was to carry out at least one haul in each ICES-square. When there were separate echo traces at different depths, hauls were made through each appropriate depth layer. The fishing depth was checked by a net sonde.

Totally 95 hauls (see Fig. 1) were made of which 26 by "Argos" and 69 by "Eisbär". Three hauls were excluded due to insignificant catch. All other hauls were treated as significant single samples of species and age composition.

2.3. Calculation of numbers per year-class

Biomass values for each ICES-square obtained by echo integration were subdivided into herring, sprat and cod biomass according to the species composition in weight of the hauls. Catches of two or more hauls in one square were averaged. Cod is not considered in this paper.

Age-length-keys for herring and sprat were calculated separately for each ICES-square. For those squares in which no samples were taken, data were used from neighbouring squares.

3. Results from the acoustic survey in October 1979

The distribution of total fish densities is given in Fig. 1 and 2. Large areas with high densities were found E and SW Svenska Björn, E Bråviken, E Gotland, SE Öland, SW and NE Bornholm.

Total biomasses and numbers for herring and sprat separately for each ICES-square as well as mean integrator deflection and standard deviations are given in Table 2.

The total biomass of herring is estimated to be in the order of 1 233 x 10^3 t and 28 x 10^9 individuals (Tab. 2 & 3).

Most of the herring was found in the catches around Bornholm, the east of Öland, around Gotland and in the northern parts of sub-division 26 (Fig. 3b).

The 0-group occurred in considerable quantities in sub-division 24, indicating a very strong year-class 1979, cf. Tab. 3. Older herring year-classes are more dispersed over the Baltic but more abundandt in the central parts. The age distributions (Table 3) show that the older herring is stronger represented in the north and the younger in the south.

Age groups 8 and older are found in the Bornholm Basin, in the Basin of Gdansk and around Gotland.

The total biomass of sprat is estimated in the order of 317 x 10^3 t and 22 x 10^9 individuals (Tab. 2 & 3).

Most of the sprat was found in sub-divisions 24 and 26 and in the Eastern Gotland Sea (Fig. 4b).

0-group sprat is found mainly in the Basin of Gdansk and in the north-eastern Baltic. Older sprat are found in sub-division 24 and in the southeastern, eastern and northeastern Baltic. The oldest sprat is most abundant in the open northern Baltic. The age distributions (Table 3) show that the older sprat is stronger represented in the north east Baltic and the younger in the south east Baltic and in sub-division 24.

The very strong year-class 1978 is still recognizable in sub-division 26 (Tab. 3).

4. Discussion

4.1. Echo integrations

General problems and limitations of the acoustic technique are discussed in greater detail by Lindquist et al, 1977, Hagström et al., 1979 and Håkansson et al., 1979.

As pointed out in several publications the conversion constant, C, is one of the most important sources of error in the biomass estimates.

According to the calibrations the sensitivity of the equipment has decreased with 4.77dB from 1976-04-27 to 1979-11-29. This means a corresponding increase of the C-value with a factor of 3.0. The used C-value was established in 1978 and since no calibration was performed during that year it is impossible to say how much the C-value has changed from 1978 to 1979. Since only one integrator channel was available when conditions for determination of the C-value by fish counting here favourable, this was not done. The used value of C = 6 tons/NM^2 and mm corresponds, according to the latest calibration, to a mean target strength per kg of -38dB.

In this report we have used the same value of C for all species and fish

sizes. However, it has been suggested that better estimates could be made if a length dependent C-value was introduced. Nakken and Olsen (1977) have shown that the scattering cross section of the fish and thus also the mean target strength per kilogram is dependent on fish length. This implies increasing C-values by length. Due to lack of data from controlled cage experiments, length dependent conversion constants have not been used in this publication.

A comparison of the standard deviations of the integrated values (Tab. 2) shows generally higher values in 1979 than in 1978 which implies a higher degree of patchiness in 1979. The differences observed between day and night values in 1978 are also found in the 1979 survey. As in 1978 no corrections have been made for these differences.

4.2. Biology

The total number of herring and its biomass is lower in 1979 than in 1978 (Tab. 3). In the sprat this decline in number and biomass is still more dramatic:

		biomass, t x 10^6	numbers x 10^9
herring	Oct. 1978	1.391	29.8
	Oct. 1979	1.233	28.2
sprat	Oct. 1978	0.519	42.7
	Oct. 1979	0.317	22.3
Total herring and sprat	Oct. 1973	1.910	
	Oct. 1979	1.547	

About the same area (about 42 000 NM^2) of the Baltic has been covered during the two surveys, i.e. the entire Baltic proper, with the exception of coastal areas, minor differences cannot possibly account for the reduction of the biomass with about 25 % for the two species together.

The general pattern of distribution of herring during the two surveys is similar, although there was less herring in the eastern side of the

Baltic in October 1979 (Fig. 3). In sprat the distributions are very similar; in October 1978, however, the sprat was abundant in the north-western Baltic (Fig. 4).

The pattern of age distributions of herring and sprat is the same in the two surveys, i.e. in the north there are more "middle aged" herring and sprat than younger ones. This has tentatively been interpreted in the WG for Assessment of Pelagic Stocks in the Baltic as a migration of older herring to the north (Anon. 1980).

Summary

About 42 000 NM^2 of the Baltic proper were surveyed by echointegration and 95 hauls using the same methods as in 1978.

High fish densities were found E and SW of Svenska Björn, E Bråviken, E Gotland, SE Öland, SW and NE Bornholm in large areas.

The total biomass of herring was estimated to be in the order of 1 233 x 10^3 t and 28 x 10^9 individuals and in sprat in the range of 317 x 10^3 t and 22 x 10^9 individuals. This means a reduction of the biomass of herring by about 11 % and 39 % in sprat respectively in comparison to 1978.

Minor differences in the size of the investigated areas between 1979 and 1978 possibly cannot account for the reduction of the biomasses.

In general the distribution pattern of herring and sprat is similar in 1979 and 1978.

Most herring was found around Bornholm, E Öland, around Gotland and in the northern part of sub-division 26.

The 0-group herring occurred in considerable quantities in sub-division 24, indicating av very strong year class 1979. Older herring is more represented in the north and the younger one in the south.

Most sprat was found in sub-divisions 24 and 26 and in the Eastern Gotland Sea. The older age groups were observed in sub-division 24 and in the southeastern, eastern and northeastern Baltic. The oldest sprat were found in the open northern Baltic.

The very strong year class 1978 is still recognizable in sub-division 26.

Litterature

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Håkansson, Nils, Sven Kollberg, Ulrich Falk, Eberhard Goetze, Otto Rechlin, 1979: A Hydroacoustic and Trawl Survey of Herring and Sprat of the Baltic Proper in October 1978. - Fischerei-Forschung, Rostock 17 (2): 7-23.

Lindquist, Armin, 1979: Sprat (Sprattus sprattus) in the Baltic and the Skagerrak/Kattegat: stock sizes calculated from VPA, egg surveys and echointegrations. - ICES C.M. 1979/J:9, 10 pp.

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Nakken, O., K. Olsen, 1977: Target strength measurements of fish. - Rapp. P.-v. Réun. Cons. int. Explor. Mer 170:52-69.

Shvetsov, F.G., A.G. Polivaiko, G.B. Grauman, 1978: Estimations of the Baltic Sprat Absolute Resources. - ICES C.M. 1978/J:9, 6 pp.

Table 1. Technical data and settings of the acoustic equipment on board R/V "Argos"

Echosounder Simrad EK 120 S

Frequency	120 kHz
Output power	1/1
Transducer	10 cm Ø, ceramics
10 log Ψ	- 18 dB
Band with/Pulse length	3 kHz, 0.6 ms
TVG and Gain	20 log R - 0dB
Basic range	0 - 100 m
Discriminator	4 -8 m (varying)
Recorder Gain	9
SL + VR[1)]	108.93 dB/ 1 µbar ref. 1m

Echointegrator QM MK II

	Channel A	Channel B
Gain	10-30 dB	10-30 dB Varying
Threshold	0 -	0 - Depending on Gain
Interval	Varying	Varying
Bottom stop	Off	On

Table 2. Mean integrator value, standard deviation and total covered area, as well as proportion of herring and sprat by ICES square.

ICES square	mm/NM			Area NM^2	Total biomass. tons $(\times 10^{-3})$	Herring		Sprat	
	mean	S.D.	NM			%	tons $(\times 10^{-3})$	%	tons $(\times 10^{-3})$
3759	4.74	2.56	34	360	10.2	78	8.0	22	2.2
3760	14.35	8.09	20	226	19.4	78	15.2	22	4.2
3858	4.24	2.43	35	644	16.4	71	11.7	28	4.6
3859	8.89	20.22	59	1027	54.8	63	34.4	27	14.6
3860	4.22	4.68	78	1027	26.0	80	23.3	-	-
3861	3.30	1.35	5	44	0.9	94	0.8	6	0.05
3957	2.28	1.87	13	169	2.3	39	0.9	60	1.4
3958	13.39	18.53	106	830	66.7	39	25.7	61	40.9
3959	9.35	21.76	109	801	44.9	46	20.6	21	9.4
3960	19.22	26.27	72	1007	116.1	90	104.0	0.2	0.2
3961	15.00	16.67	52	1030	92.7	94	87.4	0.2	0.2
3962	4.94	3.40	38	690	20.4	83	17.0	14	2.9
3963	2.49	1.59	67	1030	15.4	28	4.3	71	10.9
3964	3.26	2.28	65	1030	20.1	39	7.8	58	11.8
3965	0.68	0.52	24	450	2.4	18	0.4	80	1.9
4059	5.45	10.08	49.1	432	14.1	93	13.1	0.5	0.07
4060	6.82	11.25	152	1020	41.7	76	31.6	-	-
4061	3.25	4.80	108	1020	19.9	95	18.9	1.4	0.3
4062	1.90	1.69	69	1020	11.6	97	11.2	-	-
4063	3.17	2.95	63	1020	19.4	95	18.5	0.5	0.1
4064	10.64	16.69	48	1020	65.1	71	46.0	15	9.6
4065	19.68	40.09	22	786	92.8	32	29.8	63	58.8
4161	16.18	36.03	47	480	46.6	92	42.7	-	-
4162	8.46	14.83	112	1000	50.8	97	49.2	-	-
4163	5.91	5.02	72	1000	35.5	81	28.8	-	-
4164	5.96	5.53	71	1000	35.8	88	31.3	6	2.2
4165	2.60	2.76	43	720	11.2	82	9.2	16	1.8
4262	5.38	5.55	68	990	32.0	98	31.4	0.1	0.03
4263	6.93	4.42	39	855	35.6	54	19.4	-	-
4264	9.31	4.70	24	368	20.6	38	7.8	53	10.8
4265	5.88	3.67	28	405	14.3	89	12.7	5	0.7
4362	3.90	4.39	64	870	20.4	91	18.5	-	-
4363	6.22	2.84	16	266	8.1	63	5.1	6	0.5
4364	8.76	8.56	39	970	51.6	72	36.6	13	6.6
4365	3.63	1.68	33	975	21.1	66	13.8	32	6.7
4366	3.25	0.84	12	350	6.8	57	3.9	42	2.9
4462	4.78	4.60	96	960	27.5	97	26.7	0.6	0.2
4463	8.69	3.26	26	345	18.0	88	15.8	-	-
4464	10.18	9.99	43	690	42.1	98	41.3	0.1	0.04
4465	8.21	7.28	35	960	47.3	60	28.3	35	16.6
4466	6.31	6.40	33	525	19.9	48	9.5	51	10.2

(continued)

Table 2. (continued)

ICES square.	mm/NM mean	mm/NM S.D.	mm/NM NM	Area NM^2	Total biomass. tons ($\times 10^{-3}$)	Herring %	Herring tons ($\times 10^{-3}$)	Sprat %	Sprat tons ($\times 10^{-3}$)
4561	2.15	2.31	27	?	?	83	?	15	?
4562	6.82	8.16	61	875	35.8	83	29.8	15	5.5
4563	3.58	2.66	68	950	20.5	86	17.6	7	1.4
4564	8.80	8.96	46	920	48.6	71	34.6	24	11.8
4565	4.50	3.94	74	950	25.6	17	4.3	79	20.2
4566	7.54	5.16	24	475	21.5	85	18.2	14	3.0
4662	14.37	16.58	33	270	23.3	49	11.3	0.5	0.1
4663	3.73	2.02	50	785	17.6	92	16.1	4	0.8
4664	5.06	2.28	45	940	28.5	94	26.7	5	1.3
4665	3.00	1.54	33	940	16.9	45	7.7	50	8.4
4666	2.53	1.53	32	740	11.2	49	5.4	42	4.8
4764	7.77	11.19	62	690	32.2	6	2.0	2	0.7
4765	6.07	4.97	69	920	33.2	64	21.3	11	6.5
4766	4.22	3.32	58	920	23.3	69	16.0	28	6.5
4865	16.90	15.87	34	369	37.4	86	32.1	11	4.1
4866	10.59	6.27	32	369	23.4	75	17.6	12	2.9
4867	6.81	5.02	29	369	15.1	64	9.6	36	5.6
Totally			3008.1	41894	1732.6		1232.9		316.99
Average	6.91	8.17				71		18	

Table 3. Numbers by age groups, October 1978 and 1979

Numbers x 10^6

Herring Age Group	Sub-division													
	24		25		26		27		28		29		Total	
	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
0	1047.5	5449.0	1952.4	2144.0	847.7	324.8	-	-	10.5	62.0	48.7	306.6	3906.8	8286.4
1	932.1	383.2	2151.3	281.9	245.2	311.2	776.5	54.2	377.4	718.7	949.3	592.9	5431.8	2342.1
2	131.7	273.4	1431.9	870.7	367.4	135.5	863.2	337.5	1034.0	717.1	1502.8	1461.2	5331.0	3795.4
3	43.8	34.7	1225.2	894.6	505.6	131.8	681.8	545.8	2273.2	661.8	1352.0	735.7	6081.6	3004.4
4	-	25.1	222.3	847.5	158.0	478.6	511.5	411.3	709.2	1212.4	380.4	791.2	1981.4	3766.1
5	8.4	4.8	336.3	459.7	200.4	182.2	463.9	404.2	659.5	306.7	284.8	157.2	1953.3	1514.8
6	-	3.3	271.7	448.0	438.2	218.8	575.6	327.5	842.5	266.1	109.9	136.6	2237.9	1400.3
7	-	-	105.8	409.9	156.2	264.8	342.0	350.9	406.1	311.2	123.4	78.9	1133.5	1415.7
8	-	1.9	39.4	220.9	166.6	180.1	130.4	226.3	233.5	147.9	72.6	77.6	642.5	854.7
9	3.9	-	57.9	228.8	158.8	129.5	201.4	179.6	191.5	131.9	78.7	60.8	692.2	730.6
≥10	-	-	32.0	295.4	139.5	423.5	95.0	150.0	112.0	153.8	45.8	71.7	424.3	1094.4
Total	2167.4	6175.4	7826.2	7101.4	3383.6	2780.8	4641.3	2987.3	6849.4	4689.6	4948.4	4470.4	29816.3	28204.9

Sprat Age Group	Sub-division													
	24		25		26		27		28		29		Total	
	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
0	13.4	2.6	8.3	-	10456.7	800.7	475.9	0.6	138.5	112.1	43.9	43.3	11136.7	959.3
1	1719.3	2596.0	1015.4	348.1	640.3	4423.1	62.3	46.5	178.3	899.6	27.8	157.8	3644.0	8471.1
2	736.4	1821.0	1019.3	153.4	2622.6	785.0	286.7	10.9	2335.4	767.2	1702.9	216.6	8703.3	3754.1
3	258.7	524.3	528.1	185.6	2787.8	1331.0	1264.9	70.7	2593.0	1944.2	4848.2	900.6	12280.7	4956.4
4	63.6	29.2	174.3	76.1	193.3	530.5	457.9	258.0	571.8	1478.8	1301.5	884.7	2762.4	3257.3
5	6.9	7.9	95.5	12.3	62.3	52.4	493.1	121.6	311.6	189.7	1342.6	215.3	2312.0	599.2
6	11.1	-	17.8	8.7	1.2	34.2	255.0	36.3	197.6	66.8	451.8	24.9	934.5	170.9
7	-	-	4.0	1.5	1.0	19.4	110.5	3.3	13.4	7.5	321.4	60.3	450.3	92.0
8	-	-	31.6	1.5	0.2	-	95.9	38.0	37.2	8.9	130.9	6.4	295.8	54.8
9	1.1	-	-	-	-	-	38.3	15.5	-	4.2	40.5	6.8	79.9	26.5
≥ 10	8.3	-	-	-	-	-	55.4	-	10.6	-	65.0	-	139.3	-
Total	2818.8	4981.0	2894.3	787.2	16765.4	7976.3	3595.9	601.4	6387.4	5479.0	10276.5	2516.7	42738.9	22341.6

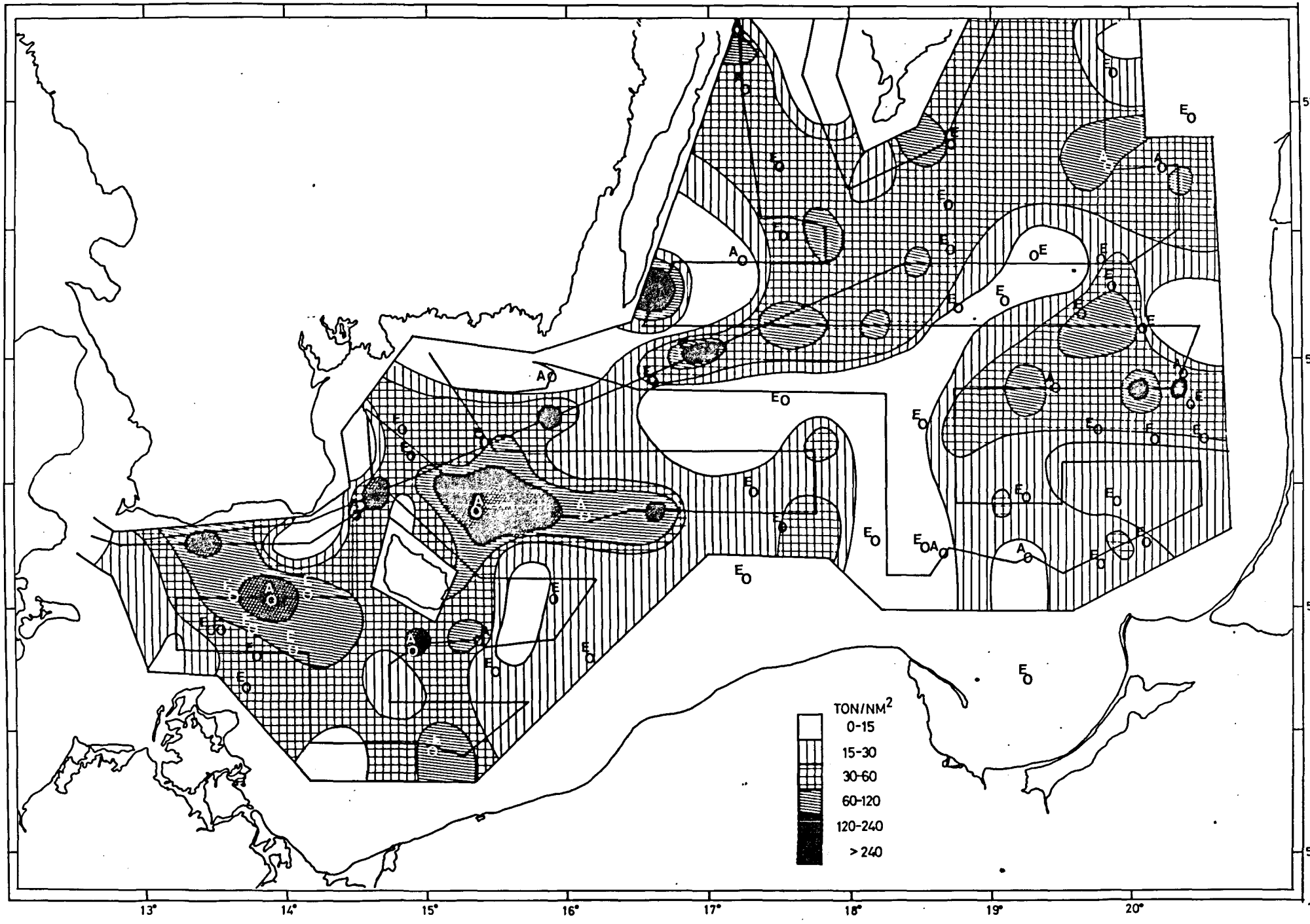


Fig.1. R/V "Argos". Tracks, densities and hauls - Southern Baltic
(A - R/V Argos' hauls; E - R/V Eisbär's hauls)

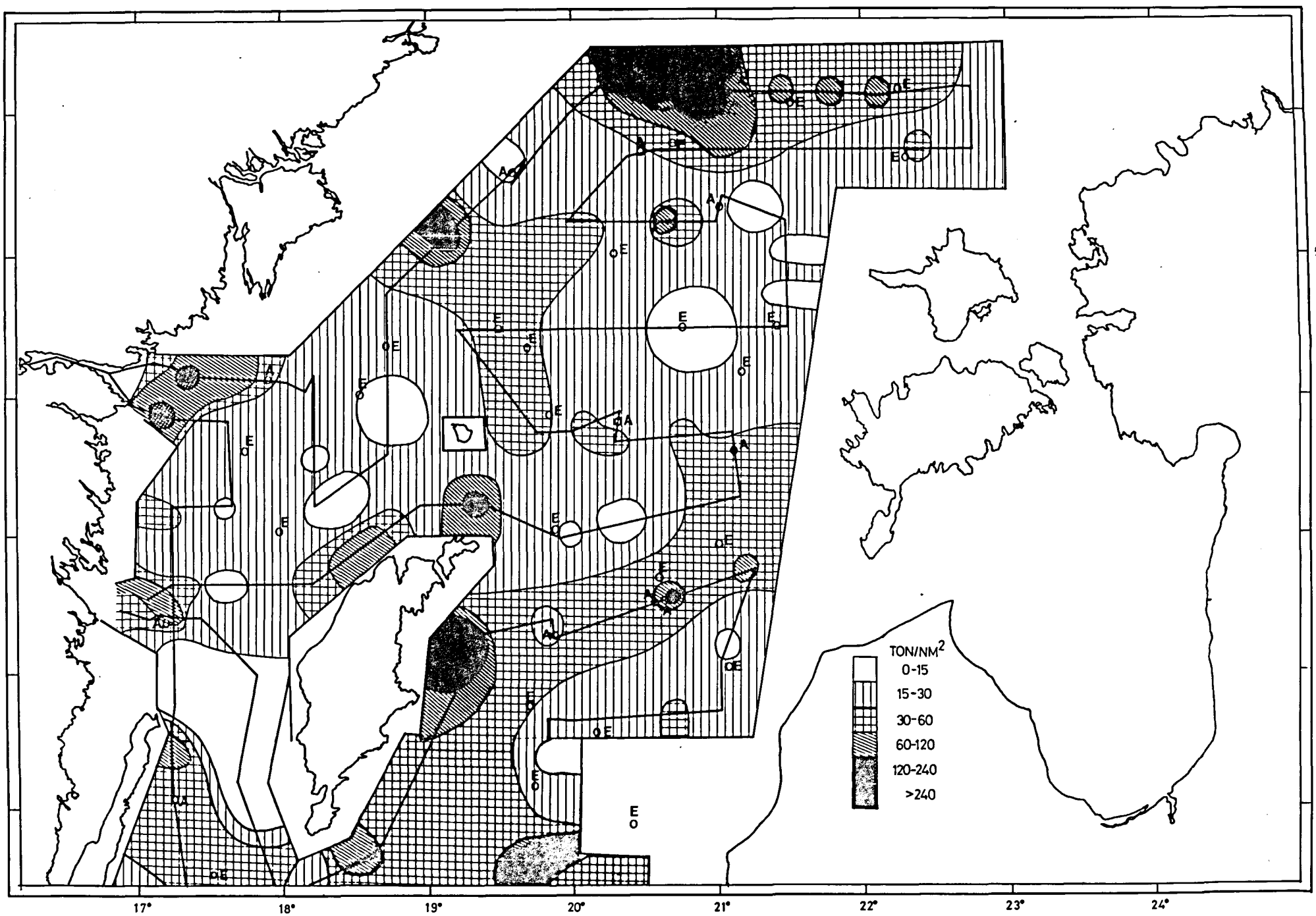
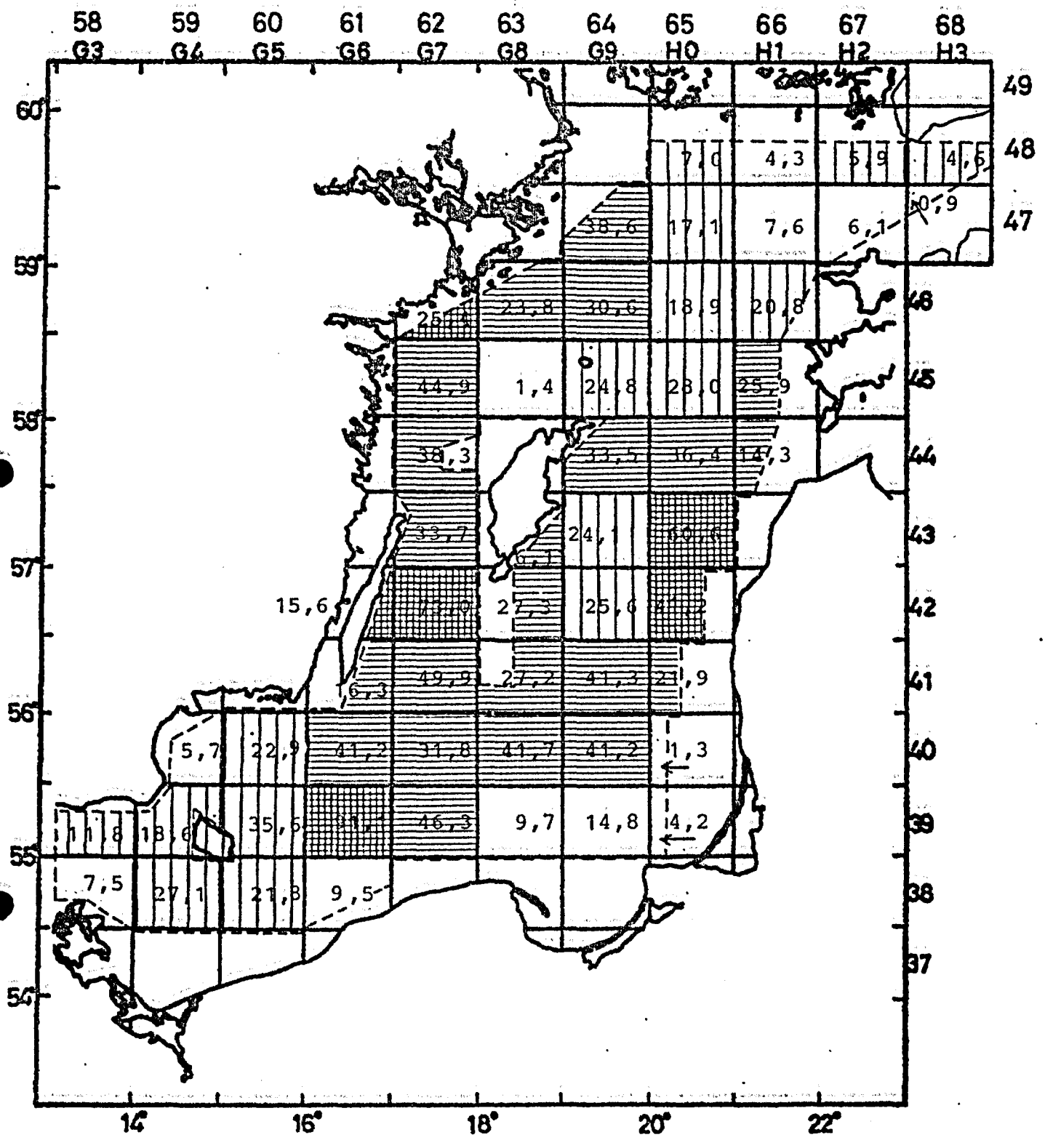


Fig. 2. R/V "Argos". Tracks, densities and hauls – Northern Baltic (A – R/V Argos' hauls; E – R/V Eisbär's hauls)

Fig. 3a

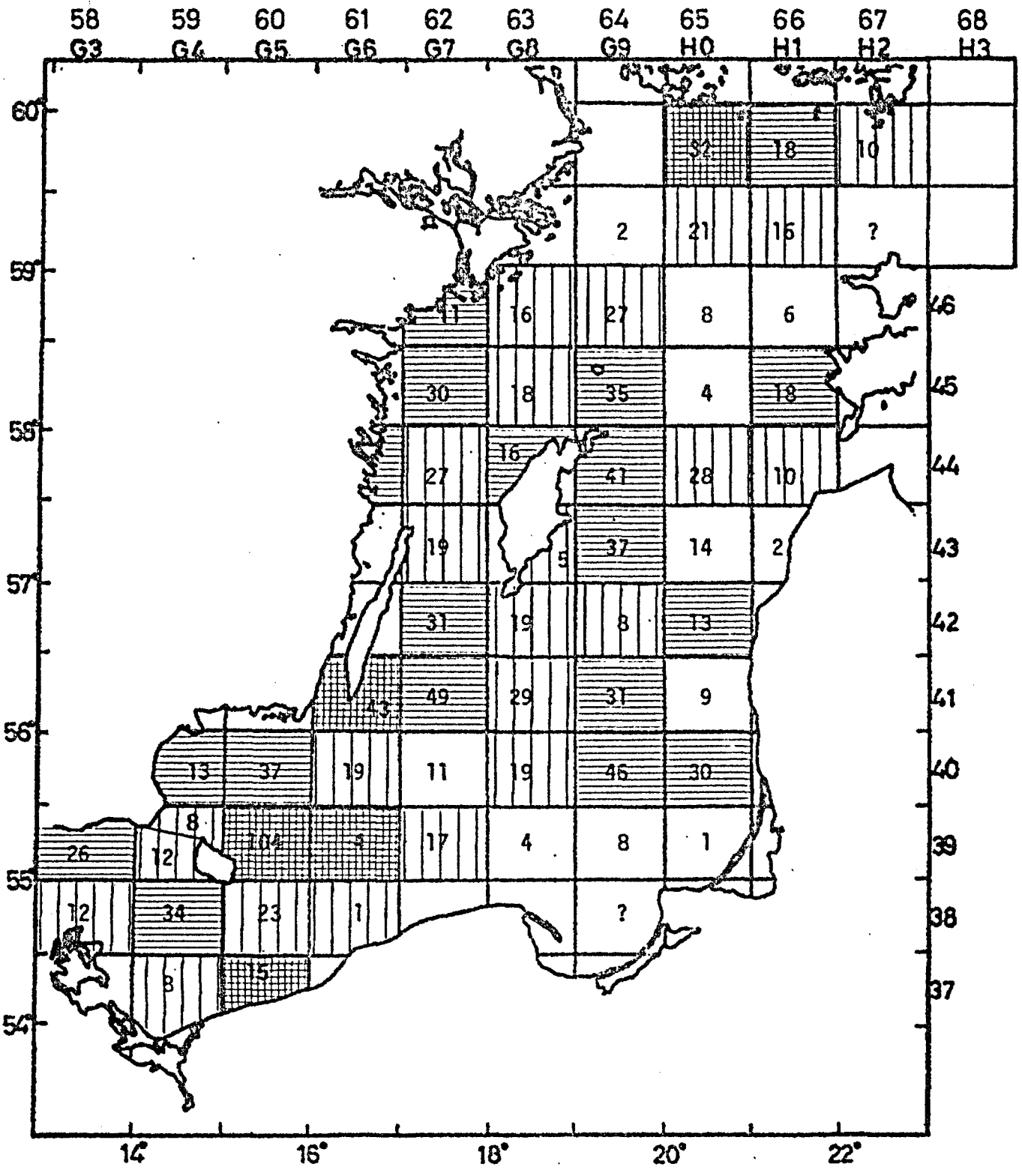


Herring October 1978
Biomass x 10^3 t

Relative density

0 - 15	ton/nm^2
15 - 30	"
30 - 60	"
60 - 120	"

Fig. 3b

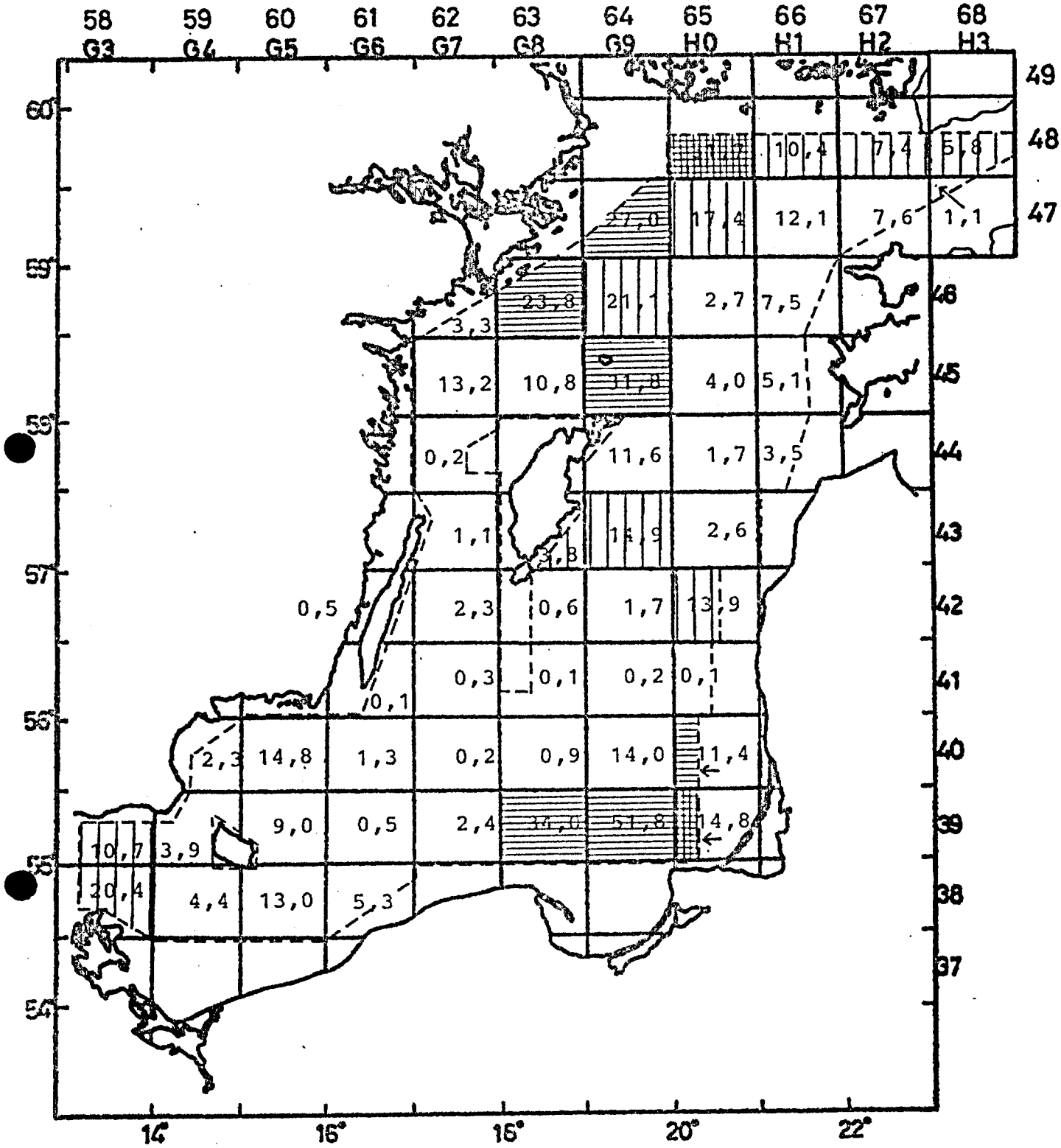


Herring October 1979
Biomass x 10^3 t

Relative density

	0 - 15 ton/nm^2
	15 - 30 "
	30 - 60 "
	60 - 120 "

Fig. 4a

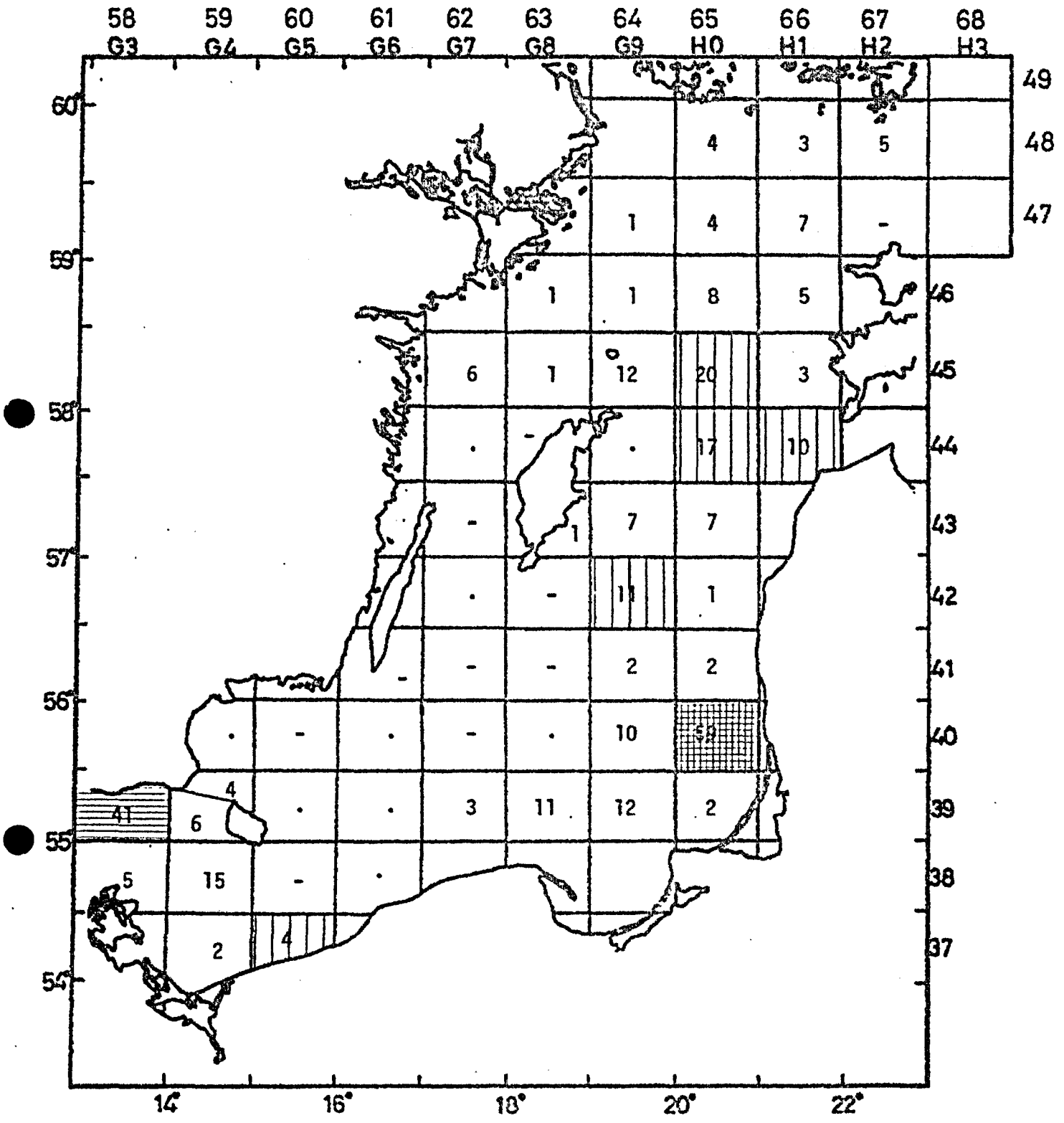


Sprat October 1978
Biomass x 10^3 t

Relative density

0 - 15	ton/nm^2
15 - 30	"
30 - 60	"
60 - 120	"

Fig. 4b



Sprat October 1979
Biomass x 10^3 t

Relative density

	0 - 15 ton/nm^2
	15 - 30 "
	30 - 60 "
	60 - 120 "