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Report on Groundfish Survey Carried out by the RV *Ernst Haeckel* in Statistical Area 0, Subarea 2 and Div. 3K during autumn 1978

by

U. Berth, N. Schultz and B. Vaske
Institut fur Hochseefischerei und Fischverarbeitung
251 Rostock-Marienehe, German Democratic Republic

Introduction

In the fall of 1978 the RV *Ernst Haeckel* conducted a random survey in Stat. Area 0, and Div. 2G, 2H, 2J and 3K mainly to study the roundnose grenadier and Greenland halibut stocks. The program was coordinated with the staff of the St. John's Biological Station, from which two members stayed on board the *Ernst Haeckel* for 10 days. Work began in Div. 2J on 23 September 1978. Following the completion of work there, the ship steamed northward to Stat. Area 0 and worked southward to Div. 3K (except 2J), finishing on 29 October. The original log records were loaned to the St. John's Biological Station for copying.

Methods

Stratification and Selection of Stations

The survey was planned and carried out as a stratified random survey, as this method ensures efficiency of sampling and allows the calculation of sample variance. In Stat. Area 0 and Div. 2G and 2H, a stratification scheme following that of Messtorff (1974, 1975) was used. The overall depth range was divided into two strata (301-500 m and 501-1000 m) only. In Div. 2J and 3K, the Canadian stratification scheme in the depth range of 300-1000 m (divided as 301-400 m, 401-500 m, 501-750 m, and 751-1000 m) was adopted. It was estimated that a total of 160 stations could be occupied in the time available. This initial estimate was divided among the divisions in rough proportion to the area of each and further subdivided by strata in each division, with the requirement that at least two stations per stratum be fished. Four additional stations were added to meet the minimum requirement, making a total of 164 stations in the planned coverage, as follows:

Area	Number of strata	Area of strata[1]	Number of tows	Stratum area per tow[1]
0	13	20,078	35	574
2G	8	4,914	22	223
2H	5	4,381	15	292
2J	18	6,666	42	159
3K	18	16,308	50	326
Total	62	52,347	164	319

[1] Square nautical miles

The actual geographical positions of the stations in Statistical Area 0 and Div. 2G and 2H were randomly selected for each stratum which was subdivided into 10' × 10' unit areas and numbered. In Div. 2J and 3K, the actual subunits of the Canadian stratification scheme were used as the basis for the random selection of stations within each stratum.

Fishing operations

In general, the tows were of 30 min duration and made at a speed of 3.5-4.0 knots. In the deepest strata (751-1000 m), the warps were too short to fish in depths near 1000 m, and, depending on local conditions, 800-850 m were the maximum fishable depths. Premature discontinuation of a tow sometimes occurred due to rough bottom, but tows lasting more than 15 min were defined as valuable if gear damage did not occur. In some cases, the towing speed had to be reduced below 3.5 knots (due to strong currents) in order to keep the net close to the bottom, and such tows were also considered as valuable. Fishing was carried out around the clock, and a tow was made if suitable bottom was found within a 5-mile radius of the pre-selection station. Positions were determined by satellite navigation and the towing speed was measured by a Doppler log.

Fishing Gear

The bottom trawl (RG 470) had the following specifications: headrope length 32.80 m, footrope length 25.00 m, vertical height 5.00 m, and distance between wings 18.00 m. The codend (mesh size 11 mm) was covered with a modified Polish-type chafer.

Biological Sampling

Greenland halibut, redfish, roundnose and roughhead grenadiers and a few cod were sampled for length, weight and stomach contents, and both otoliths and scales were taken for ageing. For some commercially less- or non-important species, only length measurements and total weight of samples were recorded. Sex was also recorded, if required, in accordance with the ICNAF sampling program. The fish were measured as total length to the centimeter below with the tail fin brought into the natural position. Large catches were subsampled to a reasonable number. Total weight of catches by species and individual weights were determined by using two coupled dynamometers (50 kg max. each, accuracy 5 kg) or steelyards of max. 20 kg and 5 kg respectively.

Hydrography

Each tow was followed by a hydrographic station at which temperature and salinity measurements (surface to bottom) were made using Nansen bottles and reversing thermometers. The ICNAF standard sections at Cumberland, Ryans Bay and Seal Island were worked at standard depths within the depth range fished.

Comment on Random Surveys

The method of random surveys is in our experience a useful way to get low biased quantitative information on groundfish stocks. Its goodness depends on:

a) The number of evaluable stations per unit area;

b) The constancy of (and knowledge on) catchability of the gear-vessel system with respect to different conditions (weather, currents) and fish species;

c) The knowledge on changes in availability of different species.

There are two ways to maximize (within the cost frame) the number of valuable stations. The first is shown by an analyses of sampling effectiveness (values for this cruise are in parentheses):

number of planned stations (164)
↓
worked (157) → remained 7 (shortage of time)
↓
fishable (133) → non fishable (24) (rough bottom) (sought depth range not found)
↓
evaluable (121) → non evaluable (12) (net not hard on bottom) (break off) (net damaged)

Evidently 15% of the worked stations could not be fished because of lacking information on bottom conditions during the planning process. Therefore, it is important that an up-to-date catalogue of all available information on non-fishable stations be maintained, in order to avoid repetition of searching for suitable bottom on subsequent cruises.

The second way to maximize the usefulness of the survey is to pre-select randomly some replacement stations in each stratum to avoid the loss of one or more primary stations due to unsuitable bottom. In this way, the minimum number of evaluable stations would be ensured. The additional time necessary to fish the additional stations (if required) may be taken from a planned buffer period.

The problem of constancy in catchability of the gear-ship system with respect to hydrometeorological conditions, as well as the different avoidance capabilities of the fish species is very hard to quantify and should not be further discussed here.

It is evident that fluctuations in availability occur for diurnal migrating species (e.g. see redfish in Fig. 13 below). Such changes may result in under-estimation of the biomass.

Results

Sampling Effort and Success

Tables 1-4 give the distribution of fishing effort as well as of the quality and quantity of biological and hydrographical material collected. The length distributions of the main species by divisions (Fig, 1-5) roughly characterize the composition of the stocks in the areas fished. Tables 5-7 show the fishing success and catch composition by area and species with respect to the main species. The quantitative and qualitative distributions within areas are shown in Fig. 6-10. More detailed information on distribution of catches of the three main species by environmental factors (depth, bottom temperature, and diurnal phase) are given in Tables 8-10, and plotted in Fig. 11-13.

Mean Trawlable Biomass

A mean trawlable biomass (MTB) of redfish and Greenland halibut for the fished strata was calculated using the areal method. "Mean" implies catches at mean catchability of gear-ship system and mean availability of fish. "Trawlable" implies minimum biomass (catchability <1, availability <1). The applied formula are

$$B = \bar{Y}_{st} \cdot \frac{A}{\bar{a}}$$

where B = MTB (per division)

$\bar{Y}_{st}$ = stratified mean catch per tow

A = sum of stratum areas

$\bar{a}$ = average area swept per tow

$$\bar{Y}_{st} = \frac{1}{A} \sum_{1}^{n} A_h \bar{Y}_h$$

where A_h = area of the h-th stratum

$\bar{Y}_h$ = mean catch per tow in h-th stratum

and $\bar{a} = w.\bar{v}.t$

where w = distance between wings

$\bar{v}$ = mean towing speed

t = towing time.

Additionally, the standard deviation of the estimated MTB and the coefficient of variation were calculated, taking $\bar{a}$ as being constant in the statistical sense. The formula applied here is

$$s(B) = \frac{A}{\bar{a}} \cdot s(\bar{Y}_{st})$$

$$= \frac{A}{\bar{a}} \sqrt{\frac{1}{A^2} \sum_{1}^{h} \frac{A_h \cdot s_h^2}{n_h}}$$

$$= \frac{1}{a} \sqrt{\sum_{1}^{h} \frac{A_h \cdot s_h^2}{n_h}}$$

where $s(B)$ = standard deviation of B

$s(\bar{Y}_{st})$ = standard deviation of $\bar{Y}_{st}$

n_h = number of tows in the h-th stratum

s_h^2 = variance of mean catch in h-th stratum

where $$s_h^2 = \frac{1}{n_h - 1} \sum_{1}^{n_h} (Y_{h_i} - \bar{Y}_h)^2$$

The coefficient of variation is $C_v = s(B)/B$.

The calculated MTB values are given in Table 11, based on the information listed in Table 12.

Discussion

Roughly characterizing the length compositions by using the terms "young" and "old", some trends may be seen with respect to the latitude at which the fish were caught (Fig. 14 and 15). Two types of trends seem to be apparent.

The first relative to the distributions of Greenland halibut, roundnose grenadier and redfish, indicating a northern spawning. Partly settling to the bottom at the spawning locations and partly during their southerly drift, the young fish increase in abundance with increasing distance from the northern spawning areas. This may explain the scarcity of young fish in bottom trawl catches near their origin by assuming that they are still in the pelagic phase. The differences for species shown in Fig. 14 possibly indicate different levels of affinity to the bottom during early development. Greenland halibut, having the strongest affinity to the bottom settles first, followed by roundnose grenadier, which tends to be a bathypelagic and even sometimes a pelagic dwelling species. Redfish is well known as a diurnal migrating species with a relatively low affinity to the bottom. Consequently, only few young redfish were caught as shown in Fig. 14.

The less abundant species may form the second group with a weak tendency to increase (roughhead grenadier) or decrease (cod) with latitude, substituting one another geographically with respect to the spawning locations.

Looking at Fig. 11-13, the following statements can be made:

- The mutual substitution depending on depth and temperature is clearly seen (see Fig. 16).
- Temperature obviously influence fish concentrations as expected (although depth and temperature are closely correlated positively they also act independently to some extent; for example, when redfish data are grouped by depth, redfish concentrations drop with increasing temperature; similarly, when grouped by temperature the redfish concentrations increase with increasing depth).
- Fig. 13 shows a strong dependence of redfish catch on diurnal phase. The reason may be that the availability of redfish decreases during darkness because of its vertical movement.

The calculated biomasses are of the correct order of magnitude, indicating the possible usefulness of stratified random surveys. The biomass values are absolute minimum estimates for two basic reasons: firstly the survey did not cover the total area of distribution of all of the species under consideration, and secondly the catchability and availability factors are both less than 1.

References

J. MESSTORFF. Revised stratification scheme for groundfish surveys in Subarea 2 and Division 3K. ICNAF Res. Doc. 74/4, Serial No. 3147.

J. MESSTORFF. Design of a Stratification Scheme for the Baffin Island Area. ICNAF Res. Doc. 75/75, Serial No. 3502.

Table 1. Distribution of fishing and hydrographic stations by area.

ICNAF division	Fishing stations			Hydrography	
	Worked	Fished	Evaluable	Stations	T-S
0	35	33	27	38	145
2G	22	17	15	19	86
2H	15	12	12	12	23
2J	42	34	32	37	109
3K	43	37	35	34	68
Total	157	133	121	140	431

Table 2. Distribution of samples by area.

ICNAF division	No. of species	Length measurements		Analyzed	
		Samples	Specimens	Samples	Specimens
0	39	305	8401	21	1402
2G	30	150	5787	17	1323
2H	30	126	4558	16	1224
2J	45	391	12283	26	1968
3K	42	470	14495	21	2182
Total	61	1442	45524	111	8099

Table 3. Distribution of samples by species.

Species	Length measurements		Analyzed	
	Samples	Specimens	Samples	Specimens
Reinhardtius hippoglossoids	129	8587	47	3168
Sebastes mentella	117	24636	34	3142
Macrourus rupestris	23	3647	13	1100
Macrourus berglax	113	1731	11	457
Gadus morhua	39	738	6	232

Table 4. Distribution of samples by species

Nr.	species	length meas. samples	length meas. pieces	pres. in Area 0	2G	2H	2J	3K
1	Centroscyllium fabr.	27	220	•	•	•	•	•
2	Raja radiata	72	198	•	•	•	•	•
3	Raja senta	27	127	•		•	•	•
4	Raja spinicauda	28	37	•	•	•	•	•
5	Raja hyperborea	16	28	•	•	•		•
6	Alepocephalus baird.	3	35	•			•	
7	Argentina silus	1	1				•	
8	Mallotus villosus	2	4	•				•
9	Chauliodus sloani	3	3			•		•
10	Myctophidae gen. sp.	46	263	•	•	•	•	•
11	Paralepis brevis	28	54	•	•	•	•	•
12	Paralepis Krøyeri	18	24				•	•
13	Nemichthyes scolop.	1	1					•
14	Serrivomer beani	2	2				•	
15	Synaphobranch. spec.	12	66	•	•		•	
16	Macdonaldia rostrata	1	1	•				
17	Notacanthus nasus	26	95	•	•	•	•	•
18	Antimora rostrata	16	140	•		•	•	•
19	Boreogadus saida	14	227	•		•	•	
20	Brosme brosme	2	2				•	
21	Onos cimbrius	3	3					•
22	Onos ensis	35	81	•	•	•	•	•
23	Micromesistius pout.	1	1				•	
24	Pollachius virens	1	1				•	
25	Urophycis chesteri	4	12				•	•
26	Nezumia bairdi	47	337		•	•	•	•
27	Trachyrhynchus mur.	3	5	•				•
28	Cryptacanthodes mac.	1	1				•	
29	Anarrhichas latifr.	90	323	•	•	•	•	•
30	Anarrhichas lupus	40	390		•	•	•	•
31	Anarrhichas minor	34	70	•	•	•	•	•
32	Lycodes vahli	60	323	•	•	•	•	•
33	Lycodes esmarki	27	57	•	•	•	•	•
34	Lycodes reticulatus	9	22		•		•	•
35	Lycodes turneri	1	1	•				
36	Artediellus uncinat.	30	128	•	•	•	•	•
37	Cottunculus microps	67	175	•	•	•	•	•
38	Cottunculus thomps.	8	11	•		•	•	•
39	Triglops nybelini	12	47	•	•	•	•	
40	Triglops murrayi	1	1				•	
41	Agonus decagonus	19	136	•			•	•
42	Aspidophoroides mon.	10	19	•	•		•	•
43	Cyclopterus lumpus	5	6		•	•	•	•
44	Liparis koefoedi	11	60	•				
45	Liparis gelatinosus	10	20	•	•			
46	Sebastes marinus	18	40	•	•		•	•
47	Glyptocephalus cynogl.	40	906				•	•
48	Hippoglossoides plat.	67	1487	•	•	•	•	•
49	Hippoglossus hippogl.	12	17		•	•	•	•
50	Ceratias holboelli	1	1					•
51	non identified 1	1	2	•				
52	" 2	2	3	•				
53	" 3	1	15	•				
54	" 4	1	1					•
55	" 5	1	1					•
56	" 6	3	3	•			•	
	ICNAF 0-3K Σ	1442	45538					

Table 5. Distribution of total catches (kg) by area and species.

ICNAF division	*Reinhardtius hippoglossoides*	*Sebastes mentella*	*Macrourus rupestris*	*Macrourus berglax*	*Gadus morhua*	No. of tows
0	1920	878	201	170	-	27
2G	4868	1367	549	157	58	15
2H	1796	1115	365	137	297	12
2J	4069	16791	846	405	643	32
3K	1141	7443	363	282	292	35
Total	13794	27594	2324	1151	1290	121

Table 6. Distribution of mean catches (kg) per 30 min tow by area and species.

ICNAF division	*Reinhardtius hippoglossoides*	*Sebastes mentella*	*Macrourus rupestris*	*Macrourus berglax*	*Gadus morhua*	No. of tows
0	71	33	7	6	-	27
2G	325	91	37	10	4	15
2H	150	93	30	11	25	12
2J	127	525	26	13	20	32
3K	33	213	10	8	8	35
Total	114	228	19	9	11	121

Table 7. Percentage distribution of catches by area and species.

ICNAF division	*Reinhardtius hippoglossoides*	*Sebastes mentella*	*Macrourus rupestris*	*Macrourus berglax*	*Gadus morhua*	Total catch
0	53	24	6	5	-	3623
2G	65	18	7	2	1	7468
2H	43	26	9	3	7	4217
2J	17	69	3	2	3	24509
3K	10	62	3	2	2	11946
Total	27	53	4	2	2	51763

Table 8. Mean values grouped by depth.

mean \ group m	325	375	425	475	525	575	625	675	725	775	825
temp. °C	2.65	2.33	3.40	3.08	3.33	3.47	3.23	4.01	—	3.38	3.23
f (t)	1.23	1.17	0.79	1.02	0.96	0.74	0.96	1.78	—	0.26	1.60
S. ment. (kg)	237	348	318	177	161	83	283	185	—	118	1
R. hipp. (kg)	85	104	99	206	120	141	100	127	—	44	45
M. rup. (kg)	0	0	23	2	48	30	17	91	—	93	145
n	32	20	15	17	10	10	7	1	0	4	4

Table 9. Mean values grouped by temperature.

mean \ group °C	-0.75	-0.25	0.25	0.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	...	5.75
depth (m)	351	409	359	373	434	410	466	512	415	470	511		446
f (t)	0.27	1.24	0.68	1.60	1.27	1.23	1.16	0.89	0.94	1.05	1.06		1.31
S. ment. (kg)	9	0	3	8	36	3	72	82	118	226	663		337
R. hipp. (kg)	22	44	145	76	107	203	145	101	68	130	142		2
M. rup. (kg)	0	0	0	0	0	0	2	11	0	34	51		0
n	2	4	3	3	10	4	7	9	23	30	24	...	1

Table 10. Mean values grouped by f(t).

mean \ group	0.125	0.375	0.625	0.875	1.125	1.375	1.625	1.875
temp. °C	2.92	2.97	3.03	3.79	2.52	3.46	2.75	2.85
depth (m)	491	514	458	498	394	454	399	456
S. ment. (kg)	124	403	174	84	161	301	389	333
R. hipp. (kg)	93	120	113	131	64	143	89	134
M. rup. (kg)	18	40	3	74	0	8	0	30
n	21	14	17	5	7	12	15	29

Table 11. Biomass calculations.

ICNAF division	$\bar{Y}_{st}$ (kg)	Biomass (m. tons)	s(B) (tons)	C_v
Greenland halibut				
0	87.72	90,342	4,989	0.11
2G	295.43	74,963	16,953	0.23
2H	148.63	29,862	10,323	0.35
2J	137.19	43,015	5,363	0.12
3K	38.07	30,360	7,647	0.25
Redfish				
0	35.54	40,787	11,611	0.28
2G	58.17	14,760	5,195	0.35
2H	62.80	12,617	4,822	0.38
2J	489.23	153,385	51,992	0.34
3K	164.23	130,971	32,658	0.25

Table 12. Total area of strata by division and mean area fished per tow.

ICNAF division	Total area of strata A (nm^2)	Mean area per tow $\bar{a}$ (nm^2)
0	20,078	0.017495
2G	4,661	0.018369
2H	4,003	0.019924
2J	6,125	0.019536
3K	14,649	0.018369

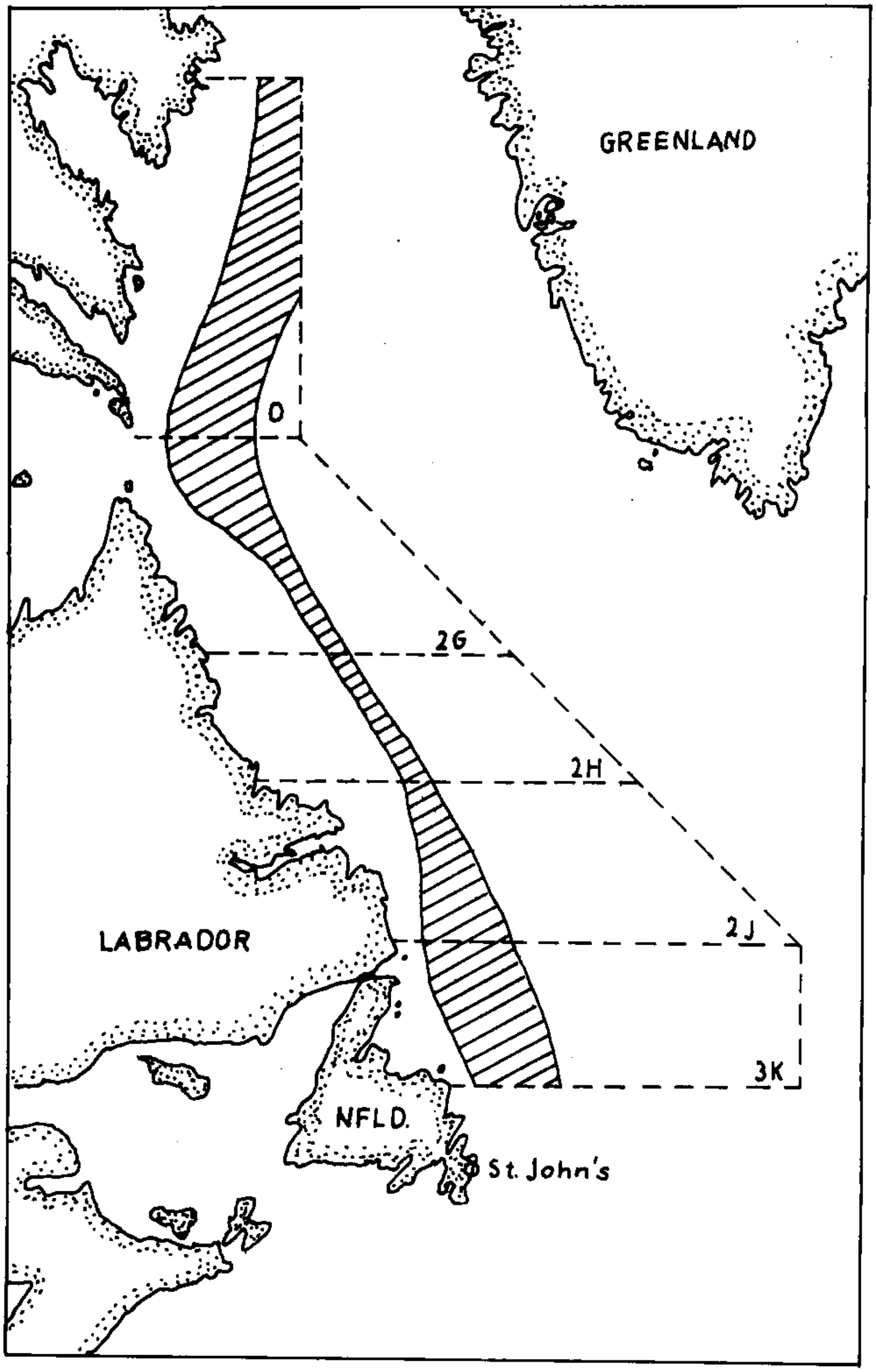

Fig. Ø Worked area (shaded)

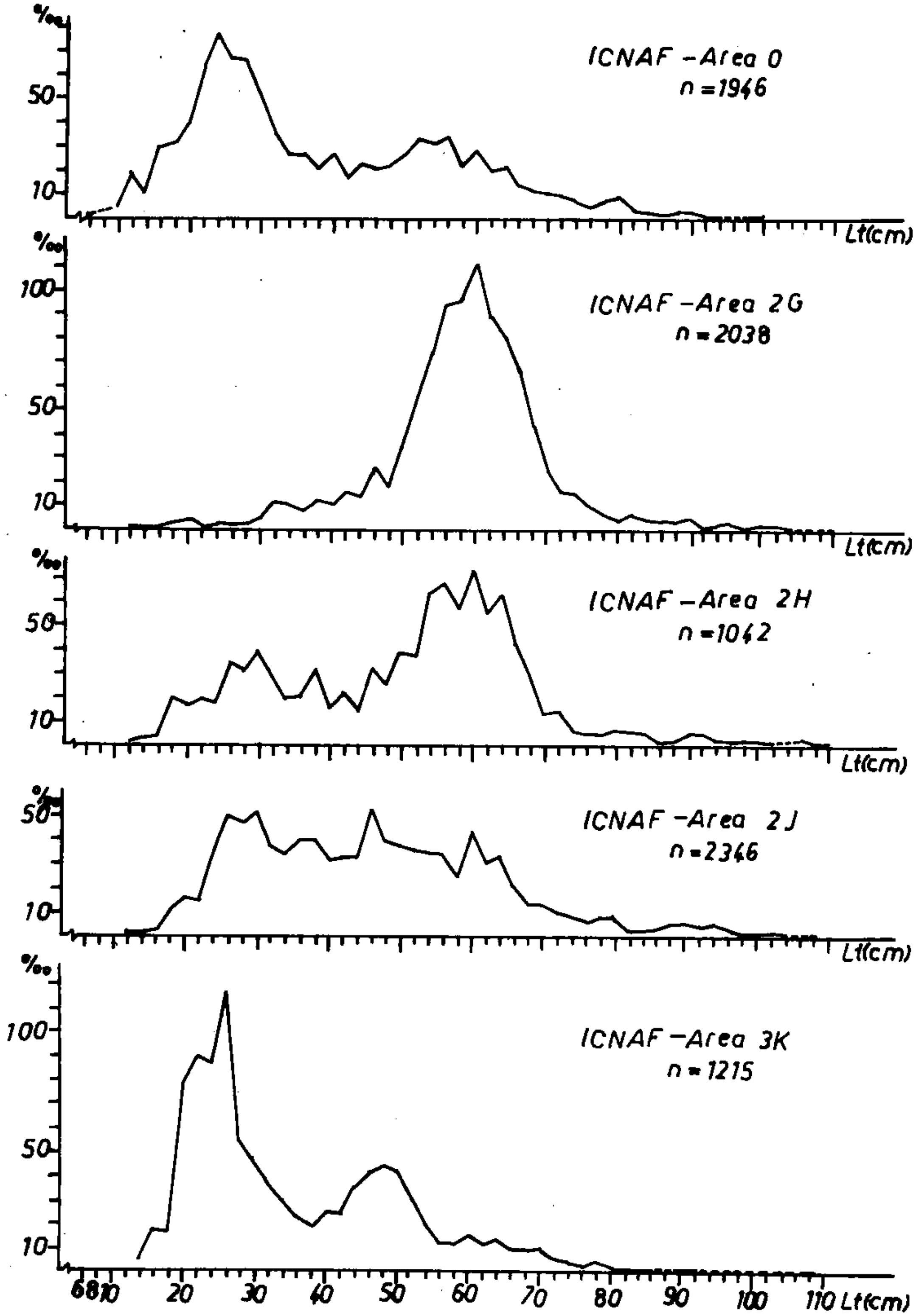

Fig.1 Length composition—Reinhardtius hippoglossoides (♂+♀)

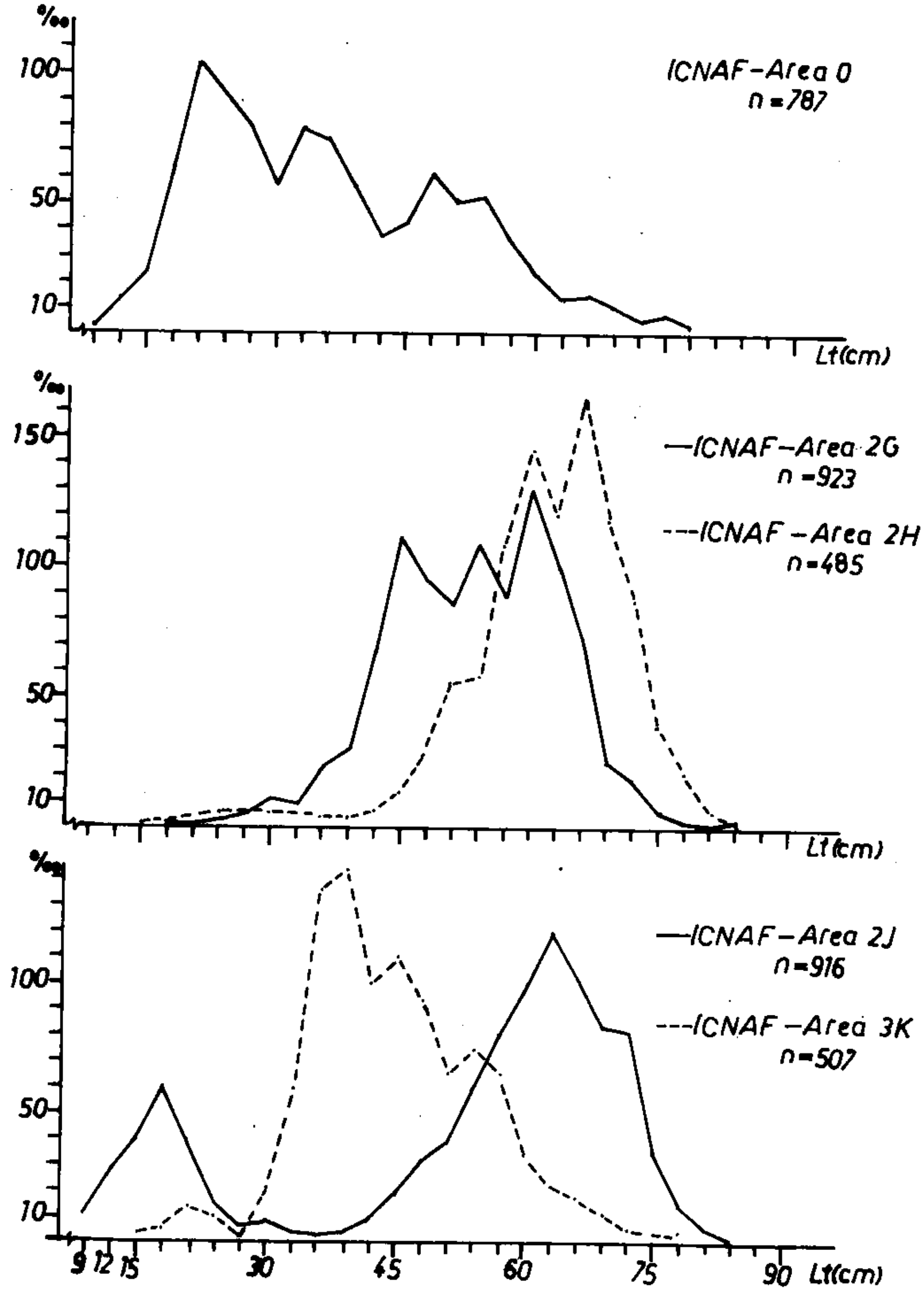

Fig. 2 Length composition – Macrurus rupestris

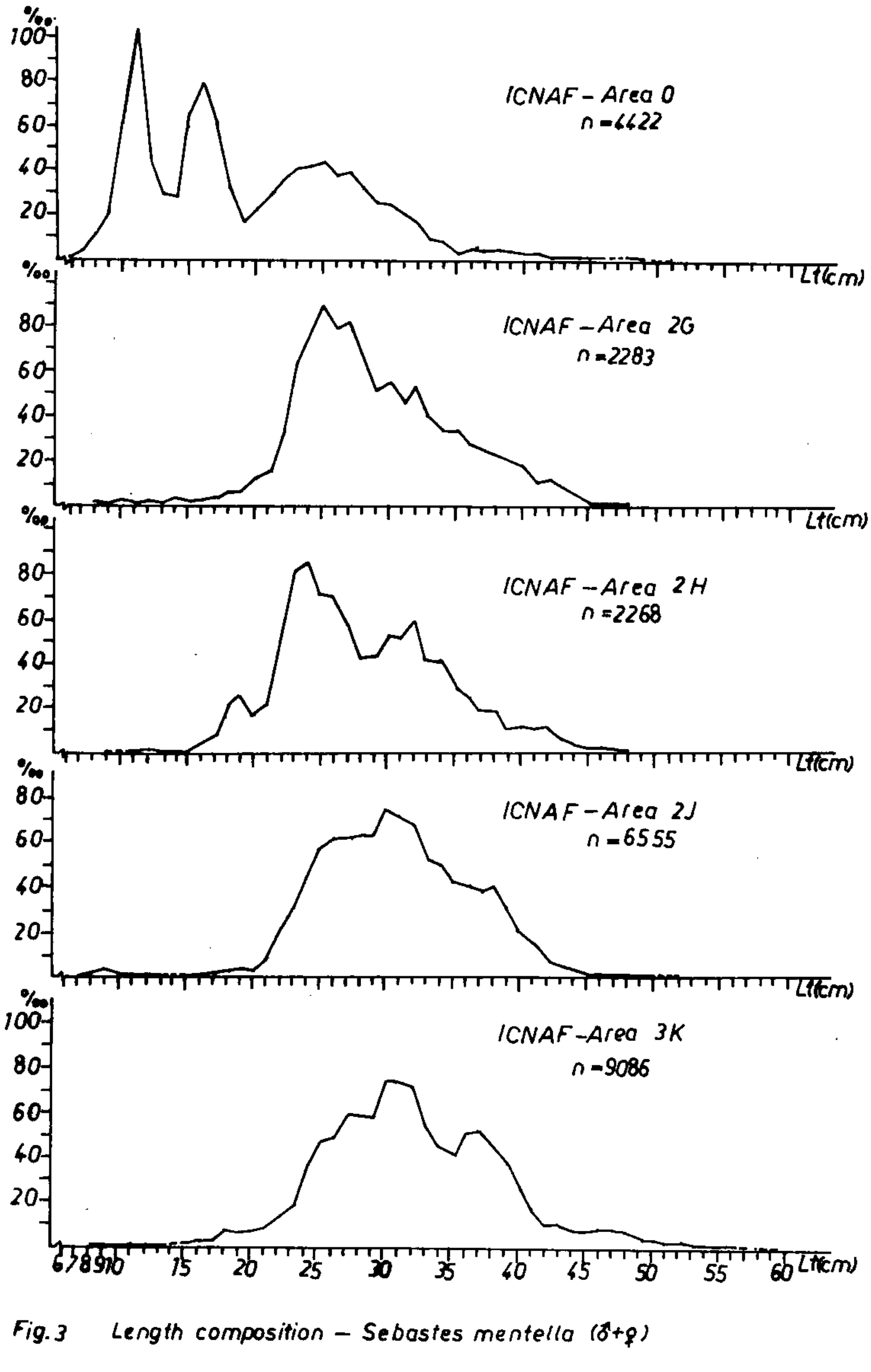

Fig. 3 Length composition – Sebastes mentella (♂+♀)

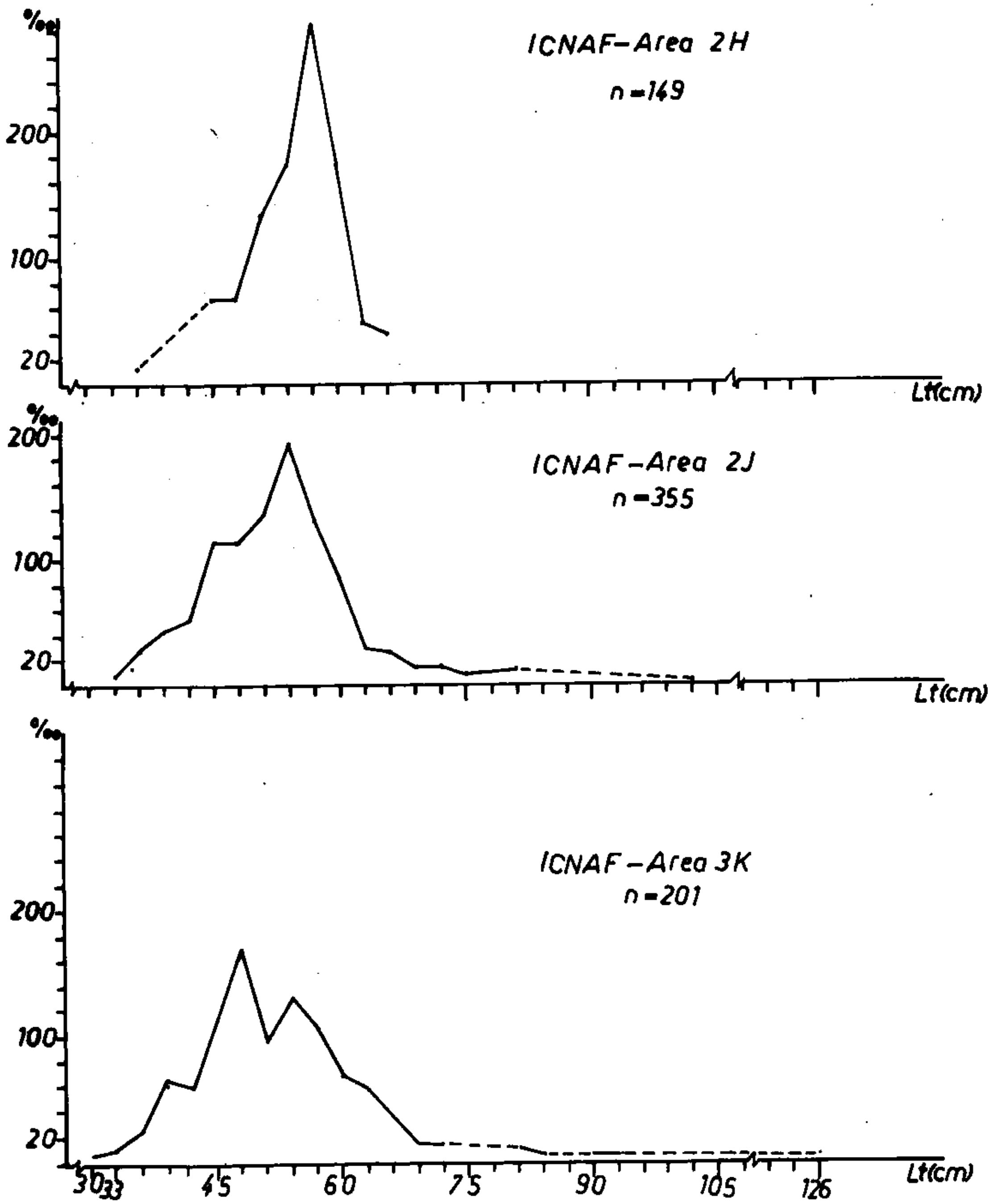

Fig.4 Length composition – Gadus morrhua

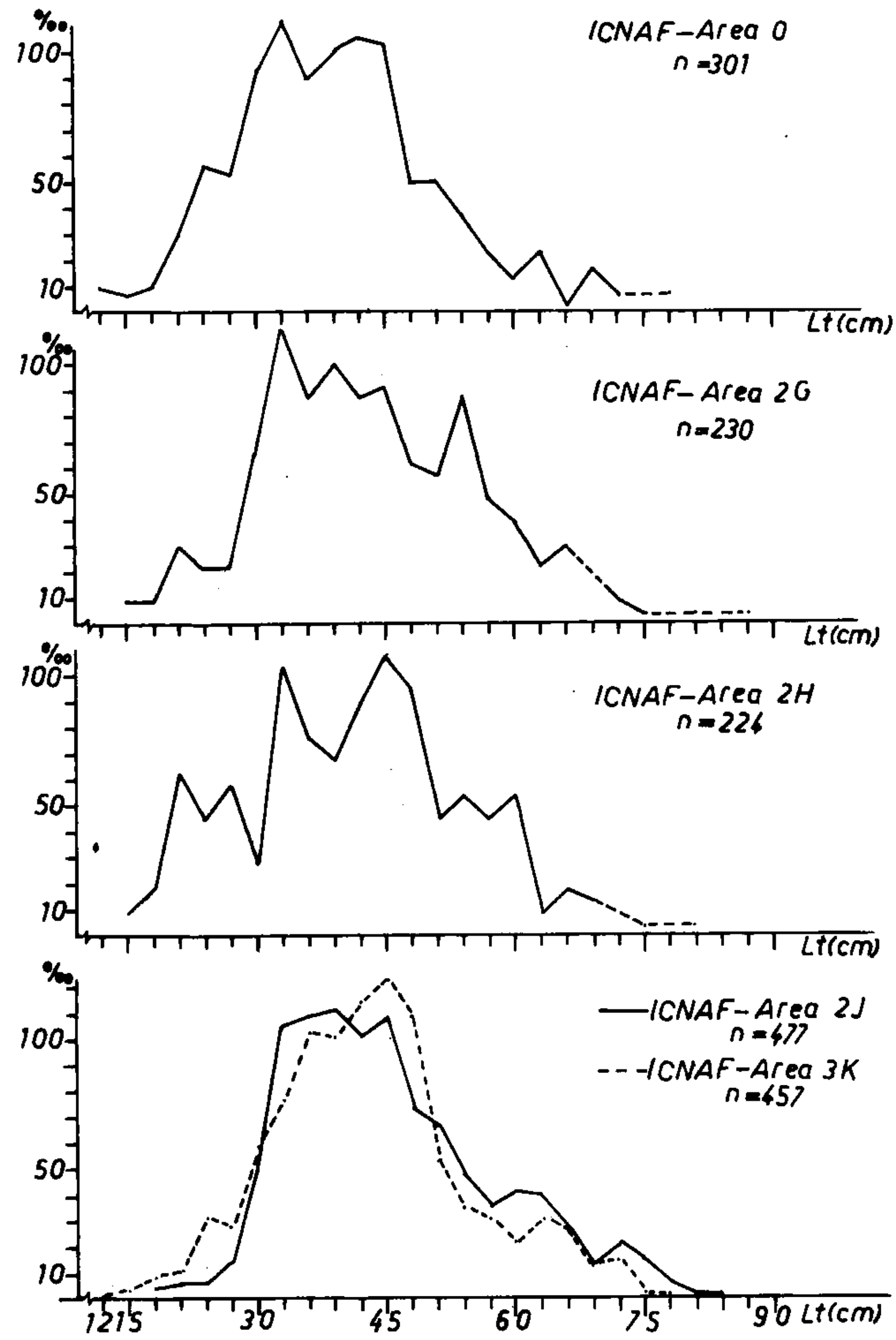

Fig.5 Length composition – Macrurus berglax (♂+♀)

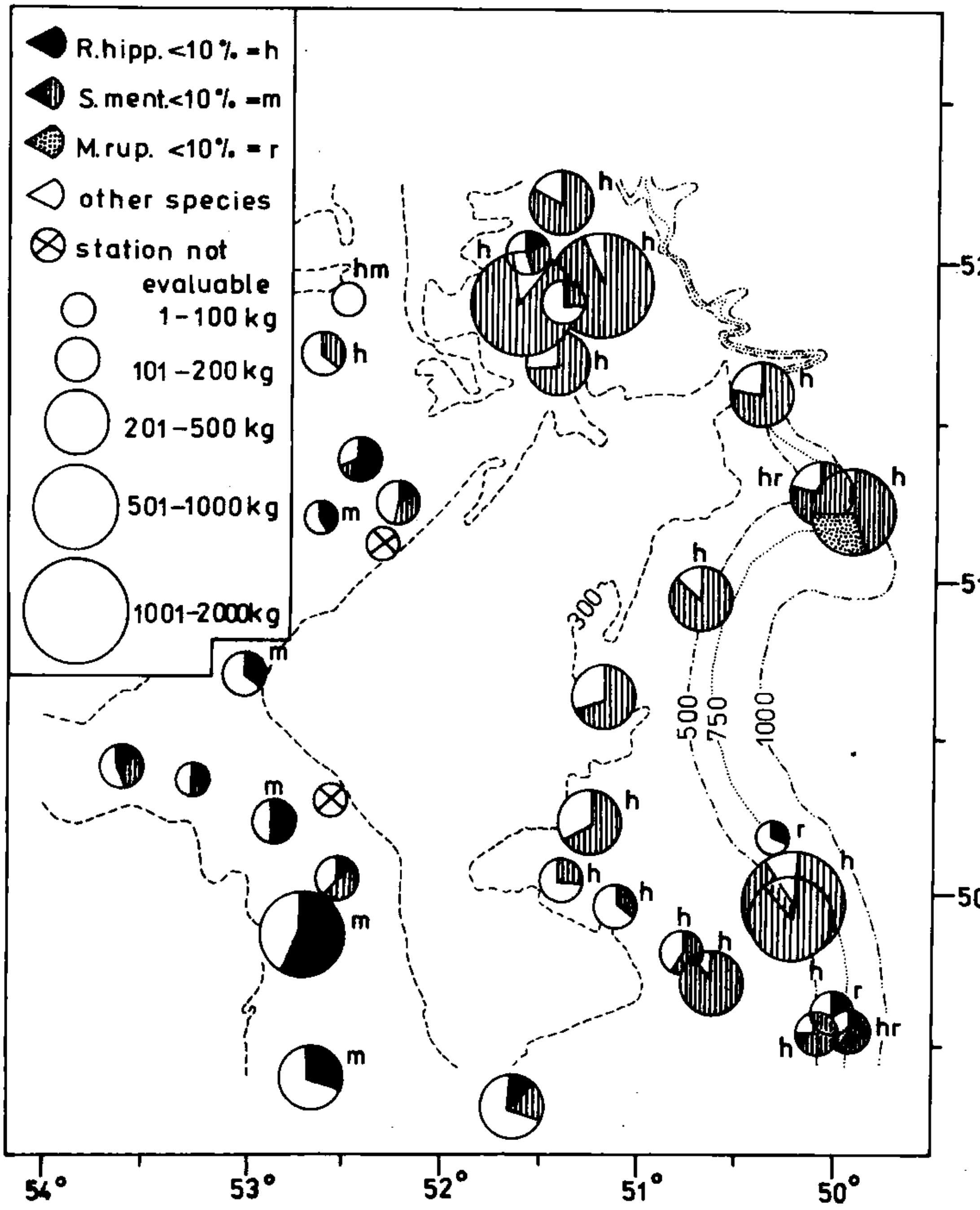

Fig. 6 catch/30'-tow (distribution and composition) in Area 3K

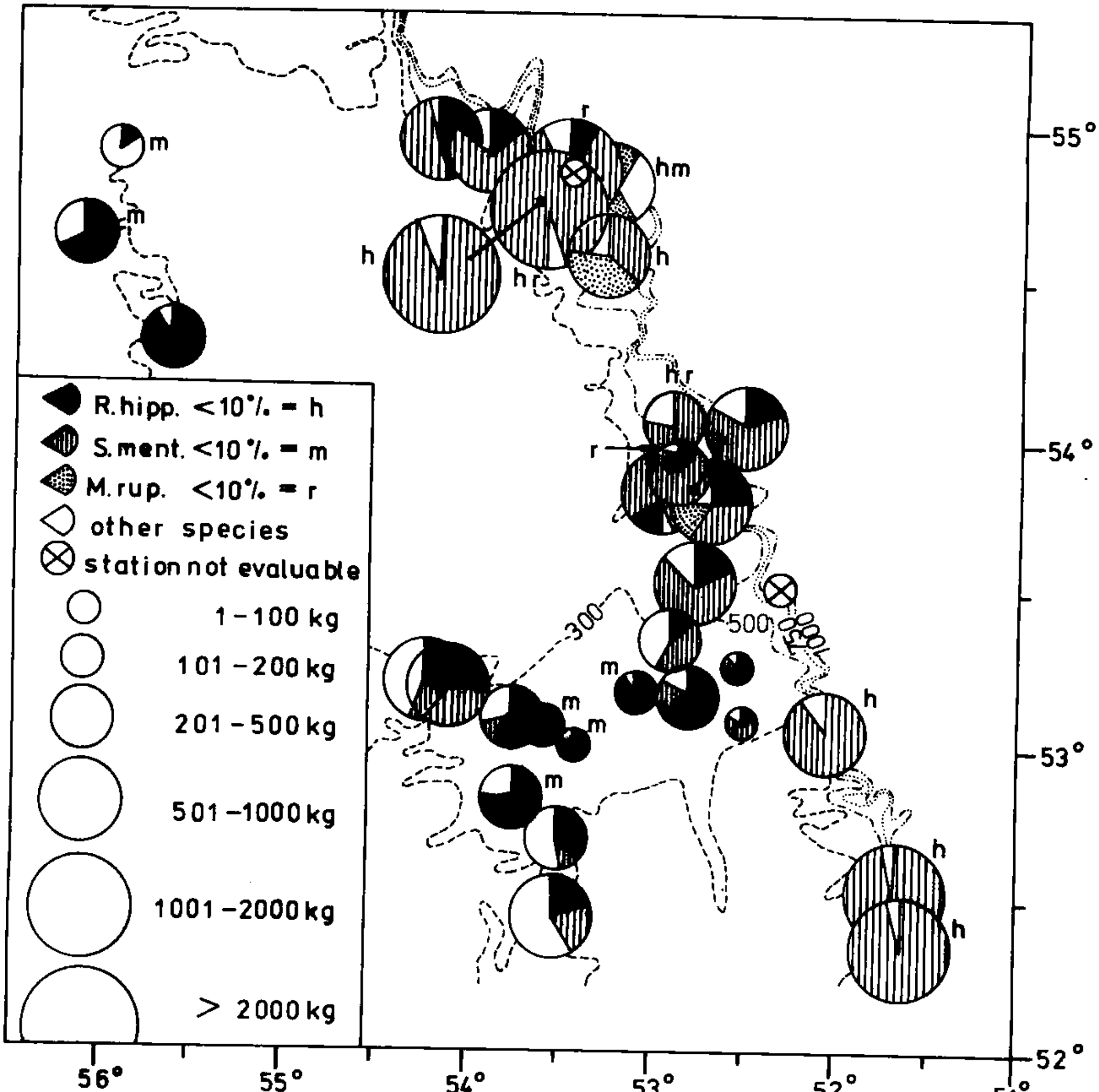

Fig. 7 catch/30'-tow (distribution and composition) in Area 2J

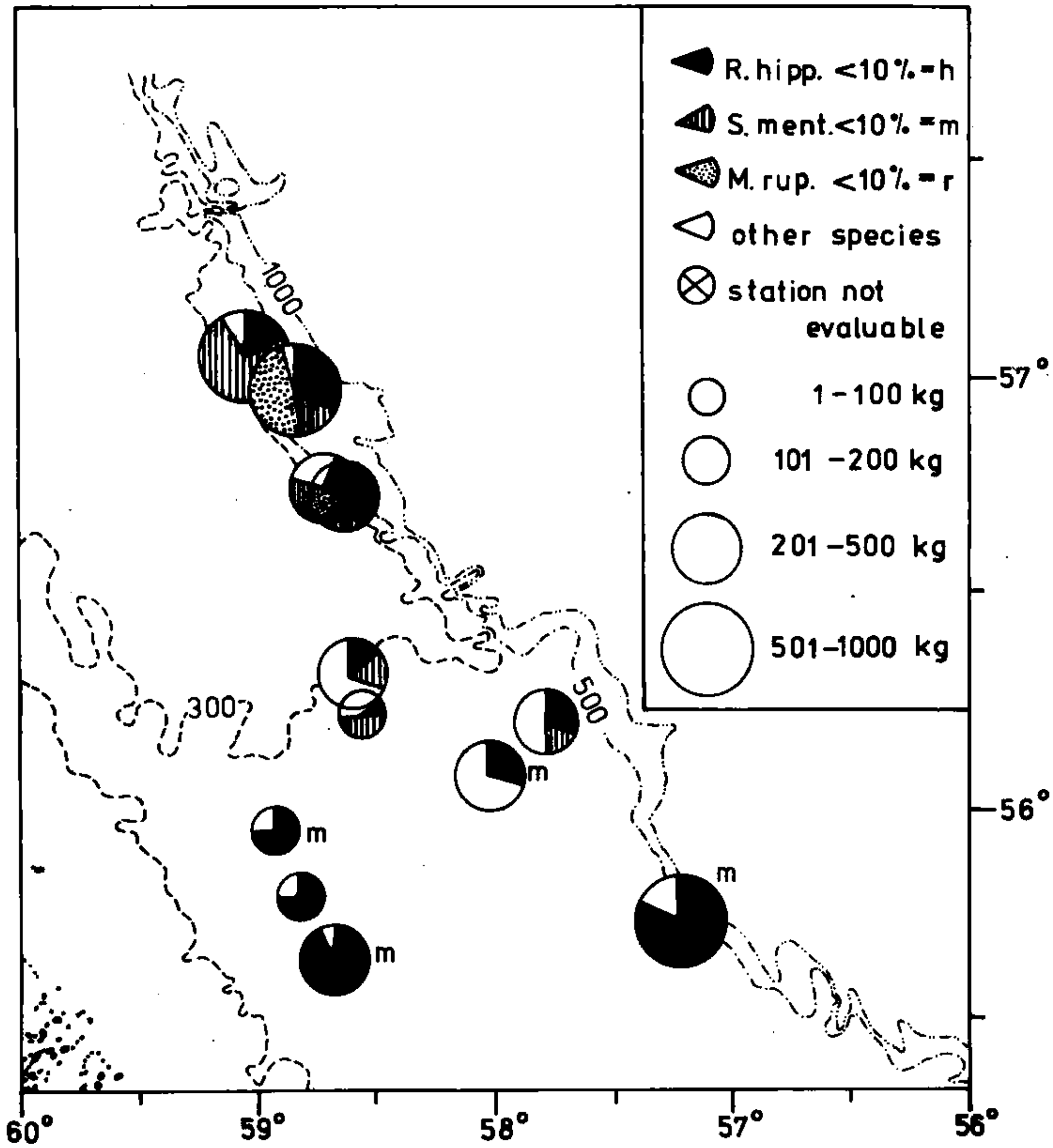

Fig. 8 catch/30'-tow (distribution and composition) in Area 2H

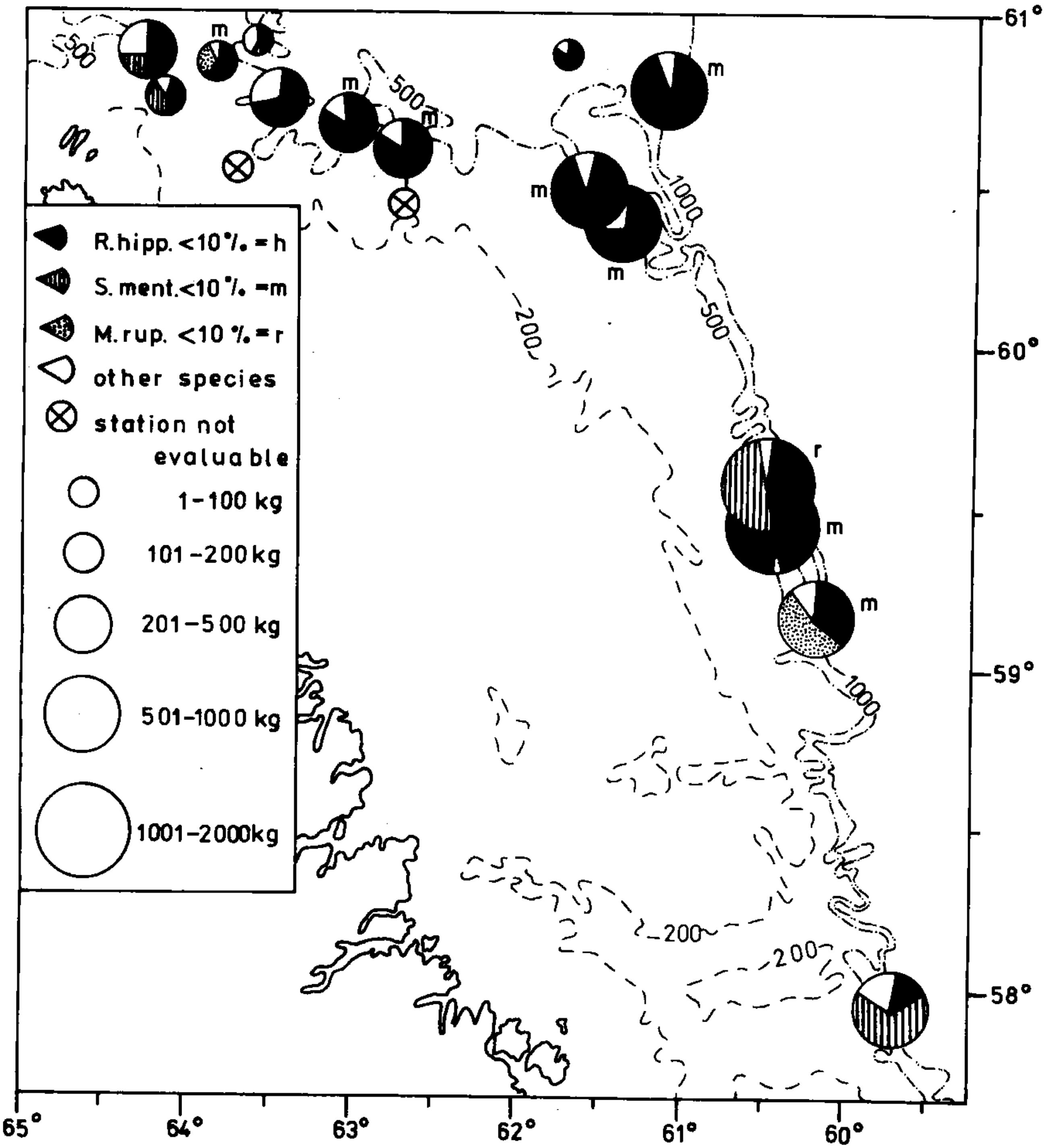

Fig. 9 catch / 30'-tow (distribution and composition) in Area 2G

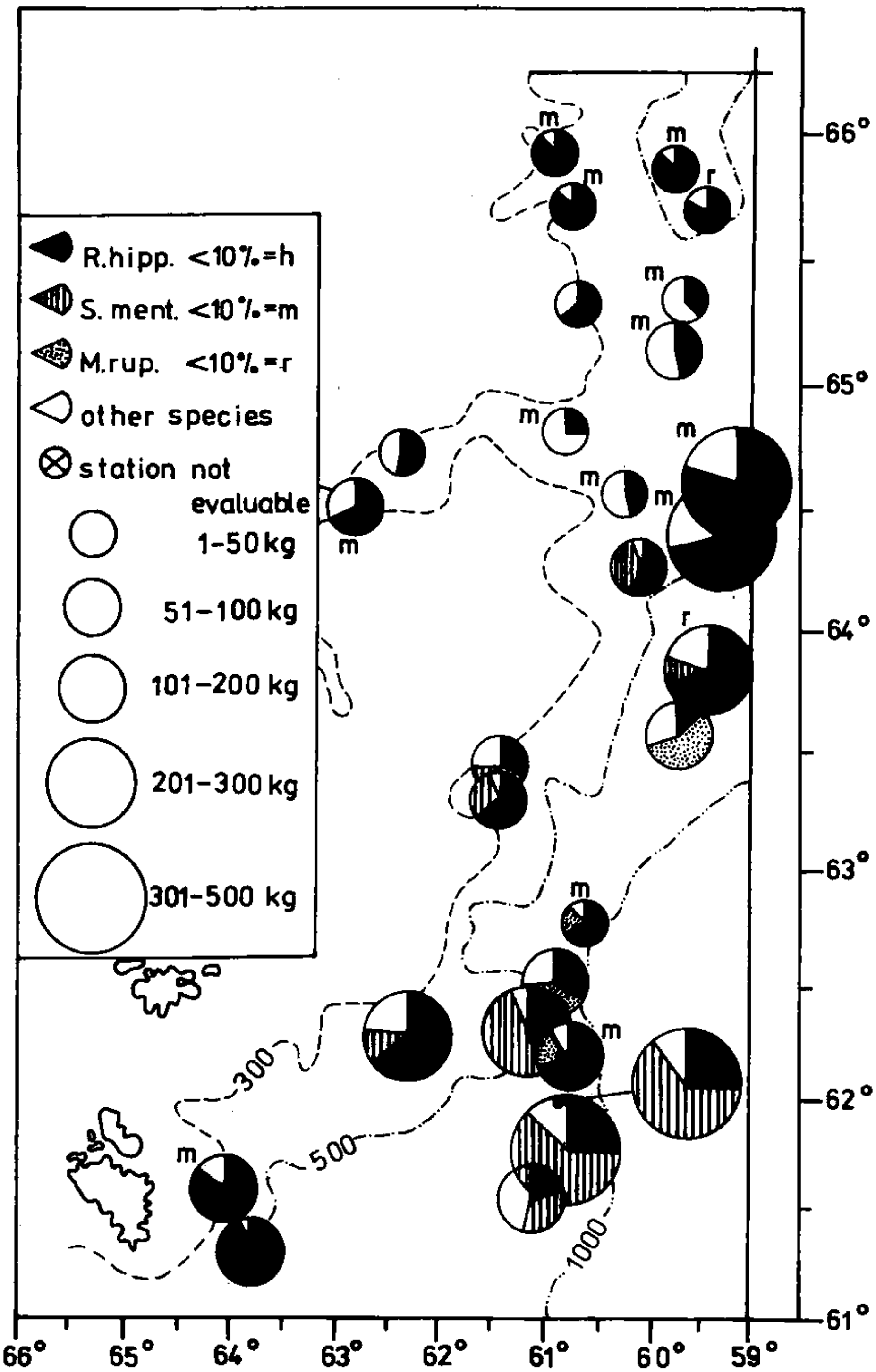

Fig.10 catch/ 30' - tow (distribution and composition)

in Area 0

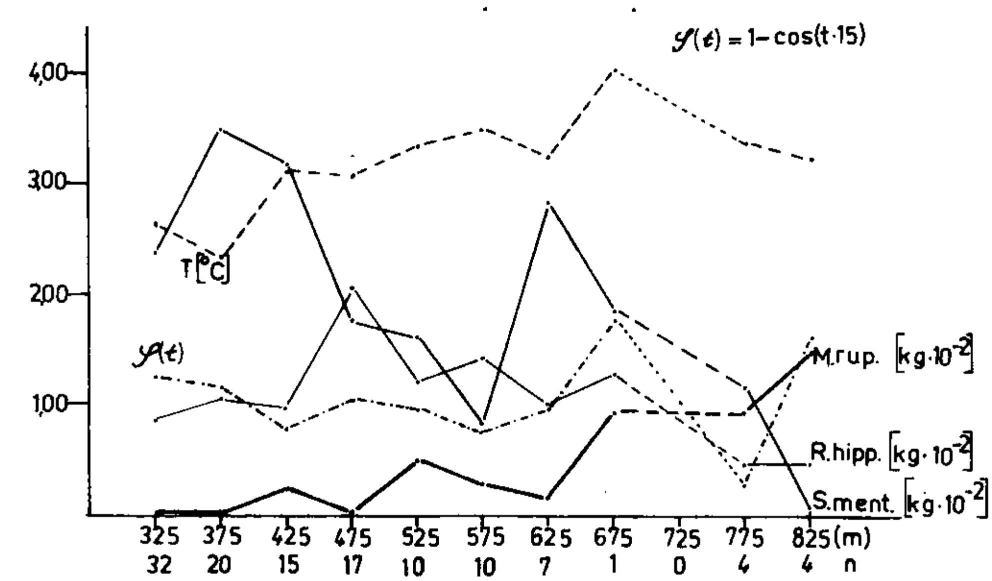

Fig. 11. Distribution of catch per tow by environmental factors (values grouped by depth).

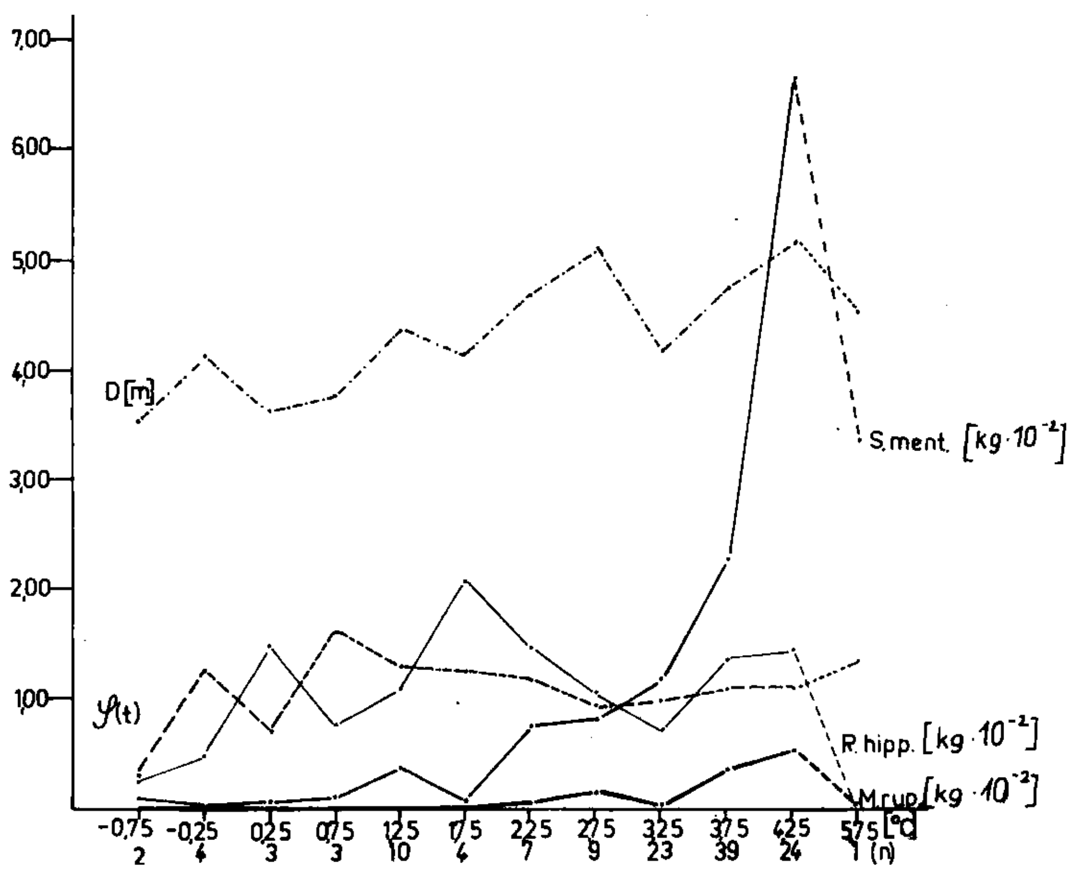

Fig. 12. Distribution of catch per tow by environmental factors (values grouped by temperature).

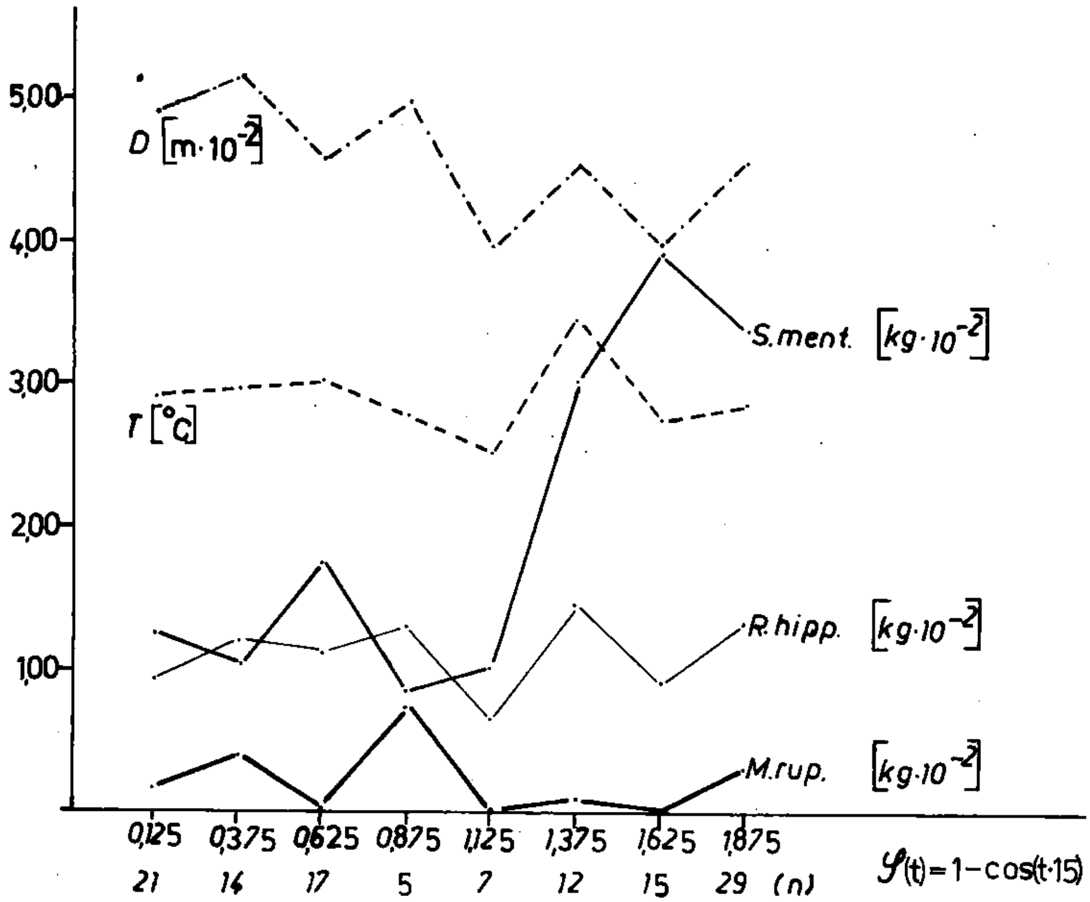

Fig. 13 Distribution of Catch per tow by environmental factors (values grouped by a function of local time)

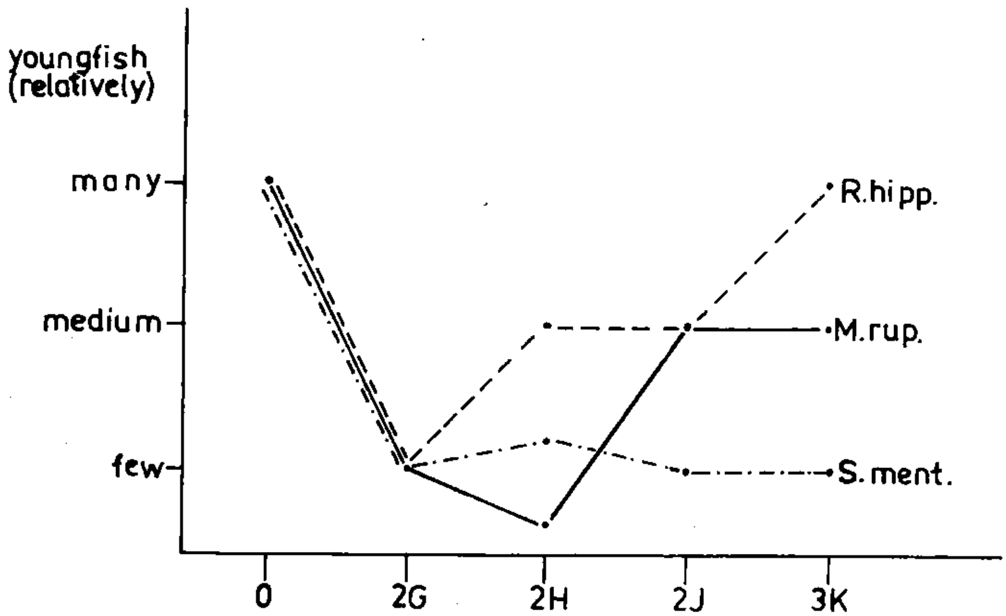

Fig. 14. Geographical distribution of young Greenland halibut, roundnose grenadier and mentella redfish.

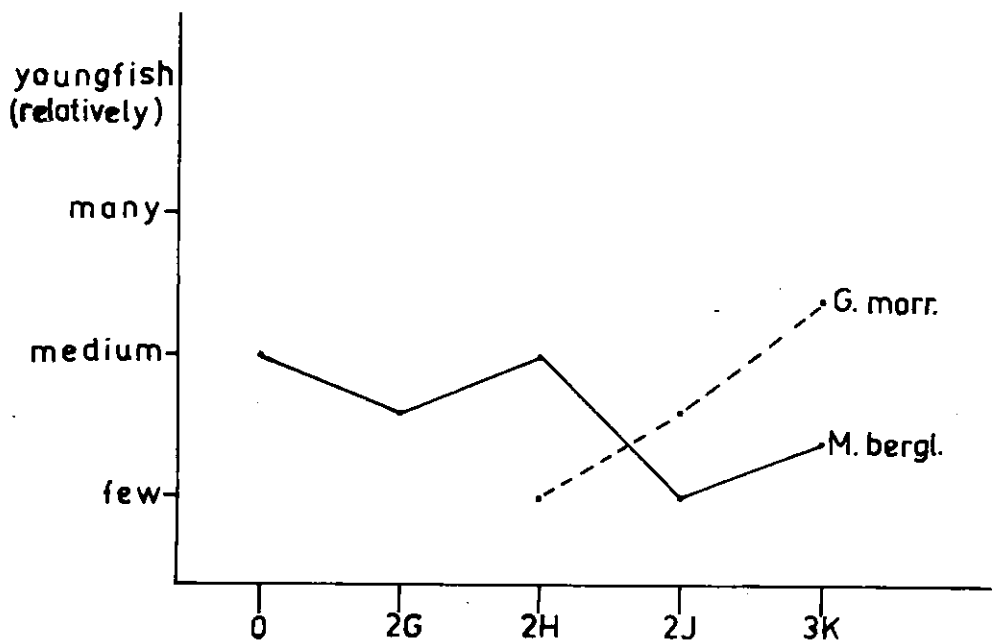

Fig. 15. Geographical distribution of young cod and roughhead grenadier.

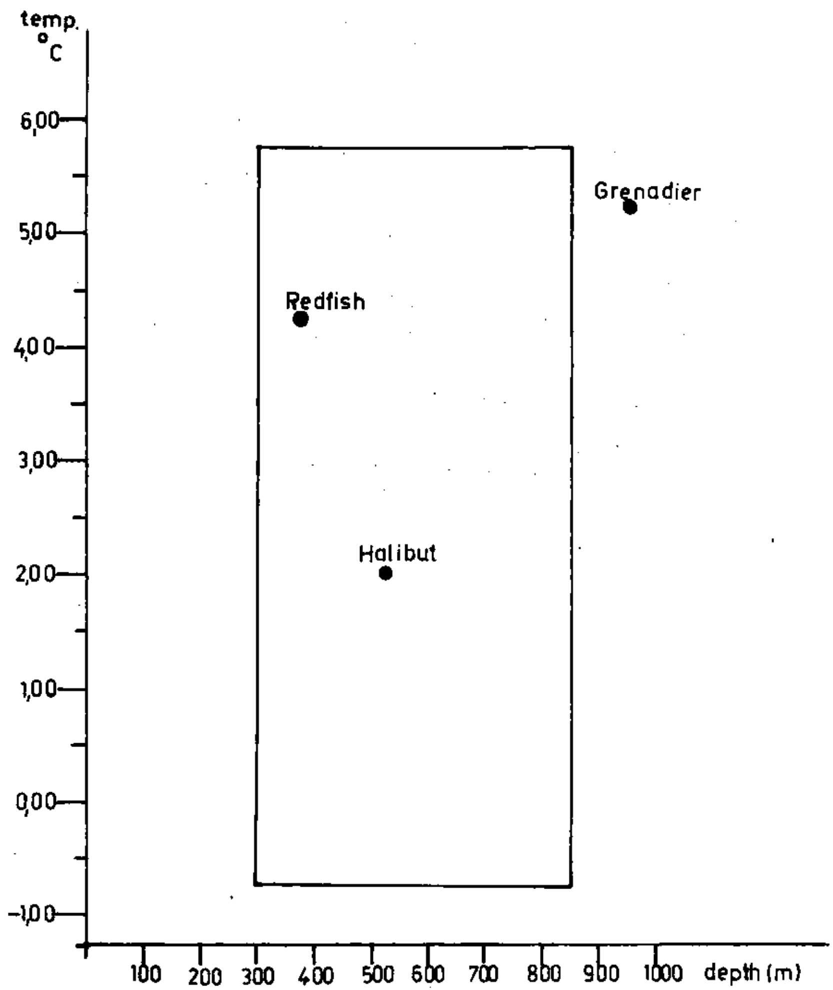

Fig. 16 Ecological positions of the main species (estimated maxima of distributions by temperature and depth) and range covered by this survey

APPENDICES

Appendix 1. Non fishable stations

ICNAF Area	Stratum/ Station	Position Lat N	Long W	reason
3 K	28/1	49°37'	52°26'	jammed net depth not in
	28/3	49 19	52 54	range sought
	31/1	51 42	52 27	rough bottom
	33/5	51 18	51 45	steep slop
	33/6	51 27	51 53	depth not in range sought
	47/1	51 53	50 32	rough bottom
2J	211/1	53 00	53 12	depth not in range sought
	231/1	52 35	51 25	rough bottom
	231/2	52 00	51 12	"
	230/1	52 40	51 29	"
	230/2	53 01	51 55	"
	236/1	53 50	52 26	"
	203/2	54 23	56 01	"
	204/2	54 27	56 15	"
2 H	H 33/6	55 23	58 25	rought bottom
	H 35/1	55 53	57 20	rough bottom, steep slope
	H 35/2	55 33	56 45	"
2 G	G 8/3	60 23	61 00	dpth not in range sought
	G 21/1	58 17	60 05	"
	G 22/1	58 17	60 00	"
	G 22/2	57 53	59 50	"
	G 14/1	59 27	60 15	rough bottom
0	0 21/3	61 10	62 05	"
	0 21/1	61 34	62 15	"

Appendix 2 Catch and environmental data

Area Station	Lokal time [illegible]	depth (m)	temp. (°C)	S. ment. (kg)	R. hipp. (kg)	M. rup. (kg)	time group [illegible]
3K							
159	22.3	329	3.97	408	10	0	0
160	2.3	323	4.04	41	23	0	0
161	4.9	337	3.01	49	5	0	2
162	7.6	332	3.46	975	6	0	5
163	12.4	528	3.98	1205	13	0	7
164	16.8	446	5.60	337	2	0	5
165	19.7	470	4.00	357	3	0	2
166	1.6	770	3.82	470	51	334	0
167	5.2	583	3.89	277	21	27	3
168	9.9	342	3.40	408	2	0	7
169	14.6	328	3.63	156	0	0	7
170	19.8	337	3.60	132	7	0	2
171	23.8	309	3.20	34	8	0	0
172	3.3	308	3.29	47	+	0	1
173	7.2	348	[illegible]	82	1	0	8
174	[illegible]	[illegible]	3.87	357	3	0	7
175	[illegible]	[illegible]	4.01	116	7	0	6
176	[illegible]	641	4.07	107	2	+	2

App. 2 (continued)

Area Station	Lokal time (=GMT-4h)	depth (m)	temp. (°C)	S. ment. (kg)	S. hipp. (kg)	M. rup. (kg)	time group $4 - \frac{\cos(t \cdot 15)}{0,25}$
3K 177	22.2	785	3.75	0	27	1	0
178	4.0	419	4.29	528	7	0	2
179	7.8	582	—	995	37	0	5
180	13.8	791	—	0	18	1	7
181	8.5	319	3.59	9	6	0	6
182	13.6	331	3.09	57	3	0	7
183	18.1	428	3.09	16	70	0	3
184	3.0	390	2.71	70	30	0	1
185	6.6	325	2.60	250	29	0	4
186	10.3	453	3.13	1	42	0	7
187	16.6	435	3.05	10	54	0	5
188	20.1	327	—	51	35	0	1
189	6.8	365	3.02	23	26	0	4
190	10.8	476	2.91	3	77	0	7
191	14.8	338	2.33	220	8	0	6
192	19.1	358	2.72	99	25	0	2
193	23.3	465	2.82	2	405	0	0
194	6.7	375	1.16	2	88	0	4
195	15.8	318	2.18	44	26	0	6
2J							
50	19.0	332	3.26	139	145	0	2
51	22.6	418	2.64	28	90	0	0
52	3.7	480	3.53	12	327	0	1
53	9.5	365	1.36	104	174	0	7
54	11.7	381	1.42	171	150	0	7
55	16.7	509	3.27	34	130	0	5
56	20.3	573	3.29	6	97	0	1
57	0.5	578	3.41	3	60	0	0
58	10.5	330	4.17	1 207	12	0	7
59	14.1	318	4.00	1 372	6	0	7
60	4.9	368	3.72	643	15	0	2
61	9.0	436	3.62	56	18	0	6
62	13.4	489	3.46	43	140	0	7
63	17.2	533	3.29	9	135	0	4
64	20.3	501	3.39	10	68	0	1
65	0.9	449	3.30	163	56	0	0
66	4.8	311	3.07	470	122	0	2
68	14.6	667	4.01	185	127	91	7
69	17.5	478	4.22	384	124	0	4
70	20.9	341	3.63	564	132	0	1
71	0.3	495	4.18	708	90	1	0
72	4.0	624	4.10	373	25	16	2
73	9.8	557	4.02	210	42	244	7
74	13.3	441	4.18	3 425	88	7	7
75	15.8	375	4.08	4 500	450	0	6
76	20.3	364	3.90	378	352	0	1
77	0.5	480	4.21	456	90	0	0
79	7.8	630	4.21	1 478	175	92	5
80	11.6	830	4.00	2	24	396	7
85	5.0	487	1.68	3	241	0	2
86	9.4	321	0.31	10	34	0	7
84	21.3	321	0.37	0	375	0	0
2H							
147	15.5	375	3.95	657	168	0	6
148	18.3	443	4.01	100	192	332	3
149	22.3	357	3.47	83	163	0	0

App. 2 (continued)

Area Station	Lokal time (= GMT - 4h)	depth (m)	temp. (°C)	S. ment. (kg)	R. hipp. (kg)	M. rup. (kg)	time group $4 - \frac{\cos(t \cdot 15)}{0.25}$
2H 150	1.8	573	4.15	39	108	33	0
151	6.8	322	3.41	42	35	0	4
152	9.1	382	3.96	78	29	0	6
153	13.2	546	3.52	3	96	0	7
154	16.8	611	3.53	0	88	0	5
155	19.8	636	3.45	+	206	0	2
156	5.2	413	—	11	124	0	3
157	8.8	351	3.51	44	70	0	6
158	14.2	323	2.31	57	517	0	7
2G							
124	21.1	385	3.93	56	100	0	1
125	23.8	404	3.99	68	79	0	0
126	4.2	773	3.60	2	79	35	2
127	8.2	576	3.51	2	4	0	6
134	5.5	434	0.86	0	185	0	3
136	16.3	450	—	3	168	0	5
137	19.3	501	4.18	7	281	0	2
138	23.7	533	3.69	4	78	0	0
139	4.6	410	1.89	4	446	0	2
140	9.4	585	4.28	10	843	0	7
141	12.6	463	4.14	15	566	0	7
142	16.6	407	3.60	0	21	0	5
143	10.7	465	3.77	727	711	36	7
144	16.7	321	3.61	49	1010	0	5
145	20.6	545	3.82	53	274	478	1
146	7.3	304	3.80	370	101	0	5
O							
87	9.5	369	1.64	2	36	0	7
88	13.2	314	1.02	0	12	0	7
89	22.4	455	1.05	+	8	0	0
90	3.1	549	1.14	0	13	0	1
91	7.4	600	1.17	+	16	0	5
92	12.5	348	0.11	+	15	0	7
93	15.8	342	0.10	+	40	0	6
94	19.9	324	0.59	0	11	0	2
95	0.8	431	0.31	+	25	0	0
96	6.1	360	0.03	+	9	0	4
97	10.6	369	0.59	2	23	0	7
98	15.5	469	1.34	29	264	0	6
99	19.0	463	1.48	38	297	0	2
100	23.4	377	0.92	17	32	0	0
101	5.6	606	2.09	26	188	9	3
102	12.4	843	3.56	0	16	84	7
110	11.5	316	0.61	21	19	0	7
111	15.1	369	1.03	20	43	0	6
112	21.0	794	2.36	+	18	7	1
113	3.8	808	2.57	0	48	78	1
114	8.6	471	2.49	122	108	0	6
115	13.0	827	2.80	3	92	23	7
116	16.6	537	2.99	280	114	0	5
117	20.2	569	4.10	240	107	0	1
118	0.7	563	4.17	40	20	0	0
129	21.9	410	2.04	32	150	0	0
131	9.1	374	1.70	4	87	0	6
132	20.5	584	0.13	1	110	0	1