INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

C.M. 1982/G : 33
Demersal Fish Committee
Ref.: Pelagic Fish Committee

REPORT OF THE MEETING OF THE COORDINATORS OF THE NORTH SEA STOMACH SAMPLING PROJECT 1981.

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IJmuiden, 12 - 16 July 1982

1. Terms of reference

During the 69th Statutory Meeting in Woodshole, ICES adopted the following resolution (C. Res. 1981/2 : 21):

(i) member countries should collect stomach content data on saithe and mackerel in 1982 as a continuation of the programme agreed for 1981.

(ii) Coordinators for all species considered in the stomach sampling scheme should meet in IJmuiden for 5 days to prepare an interim report on the results of the sampling scheme for the 1982 Statutory Meeting.

2. Participation

The meeting was held in IJmuiden from 12 - 16 July 1982. It was attended by:

N. Daan (Chairman)	Netherlands
H. Gislason	Denmark
J.R.G. Hislop	UK (Scotland)
J.G. Pope	UK (England)
T. Westgård	Norway

Mrs. J. Beaudouin, the coordinator for haddock, was not able to attend the meeting. However, during the meeting a letter was received from Mr. B. Letaconnoux explaining the situation in respect of the stage of analysis for this species as well as providing a description of preliminary results. This letter was appreciated by the members of the Group.

3. Introduction

A good deal of progress has been made in the analysis of the stomachs collected in 1981 and the computer processing of the data. However, since the sampling intensity for the different species has been rather variable and also because the amount of work involved in the primary analysis of the stomach contents varies with the specific feeding habits of each species, the progress that has been made varies considerably with the species. It was appreciated that in particular the large

quantities of fragmented pieces of hardly recognizable benthic animals in haddock has held back the analysis of these samples. A fuller account of the situation is given in section 4 and in the sections presenting the results for individual species.

It should in general be made clear that at this stage only very preliminary results can be presented. Firstly, in the process of exchanging samples between countries jars have been misplaced in the batches prepared for mailing and as a consequence samples are still turning up at odd places. In fact, it has as yet not been possible to trace the present location of the sets of samples taken by the G.A. Reay during the 4th quarter of 1981. Secondly, up to this stage the emphasis has been placed on the primary analysis and the primary processing by computer. In the latter process an important feature should be to check against input errors. During the meeting it became evident that there are still input errors present in the files and that the checking routines in the software have to be extended. Lastly the analysis programs available so far do not allow for a completely homogeneous analysis for all species and more effort is required in the near future to adapt the programs in this respect.

4. General information on sampling intensity

The numbers of samples and the total numbers of stomachs collected in 1981 are presented by species, quarter and country in table IV-1. Only in those cases where the samples have been analysed are the number of samples and the corresponding number of stomachs accurately known. In other instances the figures are approximate and have been placed in brackets.

Taking into account that the haddock figures for the last two quarters are largely underestimates, it is concluded that the target of 1500 stomachs per quarter has been exceded for cod, haddock and whiting in all instances. For mackerel and saithe the numbers sampled have remained well below the target in all quarters.
The number of stomaches sampled by size group, species and quarter are given in table IV-2. Sampling has been unsatisfactory for cod over 100 cm and whiting over 50 cm. Apart from the fact that the numbers of stomachs are generally low for saithe and mackerel, there is an almost complete lack of information for saithe below 40 cm and mackerel below 25 cm. All of these sampling deficiences result from the difficulty of catching sufficient numbers of these species and sizes in general purpose trawl surveys and there is therefore a need for programmes dedicated to this fish.

TABLE IV-1 - Number of samples (n) and number of stomachs (N) by species, country and quarter.

Figures in brackets represent preliminary estimates.

Quarter	Country	Cod n/N	Haddock n/N	Whiting n/N	Saithe n/N	Mackerel n/N
1	Eng	195/ 861	(84/ 250)	252/ 2066	19/ 187	3/ 19
	Ger	108/ 431	(? /1398)	99/ 688	16/ 51	
	Net	288/ 1861	(212/1378)	336/ 2234	10/ 20	6/ 6
	Nor	124/ 532	(188/1228)	155/ 967	15/ 76	3/ 3
	Sco	74/ 483	(96/ 608)	115/ 2108	2/ 2	---
	USS	38/ 192	---	---	---	---
	Total	827/ 4360	(580/4862)	960/ 8063	62/ 336	12/ 28
2	Den	---	(12/ 69)	---	17/ 141	---
	Eng	112/ 431	(? / ?)	40/ 268	5/ 5	10/ 53
	Net	253/ 1650	(76/ 388)	221/ 1649	2/ 7	35/ 208
	Sco	84/ 355	(192/1540)	153/ 2401	7/ 17	
	Nor	---	---	---	---	42/ 310
	Total	449/ 2436	(280/1997)	414/ 4318	31/ 170	87/ 576
3	Eng	73/ 536	(? / ?)	21/ 159	22/ 86	11/ 70
	Ger	10/ 91	(? / ?)	(6/ 49)		
	Net	176/ 1167	(55/ 338)	165/ 1243		69/ 434
	Nor	16/ 77	(? / 364)	29/ 170	14/ 117	73/ 543
	Sco	97/ 499	(312/ ?)	(134/ 556)	1/ 1	
	Total	368/ 2370	(367/ 702)	(355/ 2177)	37/ 204	153/1047
4	Bel	4/ 101	---	(9/ 92)		
	Den	125/ 539	(51/ ?)	(44/ 862)	3/ 201	12/ 115
	Eng	(? / ?)	(? / ?)	(? / ?)	(? / ?)	(17/ ?)
	Ger	41/ 435	(? / ?)	(37/± 300)		
	Net	128/ 707	(43/ 234)	(161/ 1231)		22/ 95
	Nor	27/ 53	(85/ 623)	(26/ 124)	20/ 205	14/ 94
	Sco	36/ 178	(234/)	(131/ 478)	1/ 1	
	Total	(373/ 2227)	(413/ 857)	(408/ 3087)	(24/ 407)	(48/ 304)
TOTAL YEAR		(2017/11393)	(1640/8418)	(2137/17645)	(154/1117)	(300/1955)

TABLE IV-2 - Number of stomachs sampled by size group, species and quarter.

Quarter	Species	Size group									
		7-10	10-15	15-20	20-25	25-30	30-40	40-50	50-70	70-100	100-150
1	Cod	1	113	253	532	610	854	460	557	683	117
	Haddock	not available									
	Whiting ☆	-	1526	1727	1683	1651	1290	180	4	-	-
	Saithe	-	-	-	-	-	-	3	109	208	16
	Mackerel	-	-	3	13	10	-	-	-	-	-
2	Cod	-	37	180	330	370	538	391	392	180	19
	Haddock	not available									
	Whiting ☆	-	428	765	941	1196	931	57	-	-	-
	Saithe	-	-	-	-	-	14	6	42	105	3
	Mackerel	-	-	3	23	49	252	217	-	-	-
3	Cod	90	355	232	87	186	372	347	367	260	49
	Haddock	not available									
	Whiting ☆	-	180	203	376	420	363	28	2	-	-
	Saithe	-	-	-	-	-	39	48	60	53	4
	Mackerel	-	-	-	33	275	550	209	-	-	-
4	Cod	1	177	199	198	223	384	334	358	300	53
	Haddock	not available									
	Whiting ☆	not available									
	Saithe	-	-	-	-	-	-	46	82	78	166
	Mackerel	-	-	-	-	33	213	58	-	-	-

☆ In the case of whiting the values represent the numbers of stomachs examined to date.

5.1. Cod

The stomach samples of cod (table IV-1 and fig. 5.1.1.) have all been analysed and stored on computer files. However, output is only available for the first two quarters of 1981, because, in the process of weighting samples taken in individual squares according to the abundance of the different size classes in those squares, output is required from another program dealing with survey data and the analysis of the survey data from the 3rd and 4th quarter has not yet been completed.

Tables V-1 and V-2 present summaries of the information for the 1st (Q1) and 2nd quarter (Q2) respectively. Although these data cannot be readily compared with similar information for 1980 (DAAN, 1981) because the earlier set applied only to cod feeding in Roundfish Area 6 averaged over the year whereas these tables refer to the total North Sea, they both indicate similar trends in "preferred" size classes of prey and in the amount of fish prey with size of cod.
The percentage consisting of commercial fish species amounted to over 50% in large cod in Q1, but this component was considerably reduced in Q2 (fig. 5.1.2.).

TABLE V-1
STOMACH CONTENT DATA FOR COD BY SIZE CLASS - 1st QUARTER 1981

Size class	7-10	10-15	15-20	20-25	25-30	30-40	40-50	50-70	70-100	>=100
n Squares sampled		26	48	69	76	96	69	90	93	40
N Stomachs		113	253	532	610	854	460	557	682	117
% Empty		10,0	10,7	11,9	13,7	11,2	12,3	19,5	14,5	22,5
Mean N/hour		4,5	12,7	20,1	16,1	14,6	10,8	5,9	5,6	1,8
Mean Length		13,3	18,3	22,6	27,3	34,2	44,3	59,2	82,8	107,7
Mean W Stomach Contents		0,60	0,92	1,51	1,89	5,45	16,84	33,58	66,47	138,16
Mean N of Prey Organisms		2,83	2,18	2,56	4,31	5,11	4,82	5,04	4,88	5,95
Average W per Prey Item		0,21	0,42	0,59	0,44	1,07	3,49	6,66	13,61	23,22
Food Composition in Weight % by Major Taxa:										
PHAEOPHYTA								0,01	0,00	
CNIDARIA		1,02		0,07	0,05	0,28	0,09	0,08	0,07	
RHYNCHOCOELA					0,01					
ANNELLIDA		13,27	8,09	5,05	9,18	12,30	7,85	4,78	2,66	0,84
GASTROPODA		6,15	7,75	2,60	2,40	3,66	0,51	0,37	0,25	0,32
BIVALVIA		7,16	4,59	20,08	7,35	8,71	2,13	0,34	0,23	0,15
SCAPHOPODA						0,00		0,00		
CEPHALOPODA				0,88	5,84	3,03	0,33	0,67	0,42	0,29
PYCNOGONIDA				0,32	0,58					
CRUSTACEA		32,57	55,02	36,09	37,78	31,71	49,77	13,44	9,54	7,39
SIPUNCULA				0,04					0,00	
ECHIURA					0,50	0,42	0,75	0,56	0,01	
PRIAPULIDA				0,02		0,12	0,04			
ECHINODERMATA			0,02	0,09	0,30	0,24	1,06	1,23	0,05	0,08
CHAETOGNATHA					0,16	0,08				
UROCHORDATA						0,08			0,00	
CEPHALOCHORDATA				0,00		0,03	0,06	0,00		
AGNATHA					0,04					
GNATHOSTOMATA		39,83	24,54	34,76	35,82	39,32	37,41	78,51	82,63	90,92
Weight % Commercial species:										
COD						0,49	0,35	2,60	5,19	13,49
HADDOCK				0,27	2,58	2,22	1,45	7,80	21,19	1,76
WHITING		1,49		0,00	0,05	8,15	3,70	16,39	28,03	28,46
NORWAY POUT				3,05	6,09	3,24	1,01	6,83	6,31	1,81
HERRING					0,61	0,05	3,01	4,58	2,87	3,21
SPRAT		9,20	8,09	22,83	3,56	13,80	1,53	1,38	3,13	1,33
SANDEEL		0,83	0,29	1,50	0,40	3,22	9,83	26,80	0,43	0,03
PLAICE								0,14	0,71	4,15
SOLE						0,10	0,07	0,00	0,81	
LEMON SOLE									0,46	8,15
DAB				0,19	0,03	0,55	6,56	6,12	7,39	15,04
NORWAY LOBSTER				0,25	0,29	0,08	0,41	1,73	4,14	1,94
BROWN SHRIMP		25,33	46,48	22,54	3,81	1,64	1,01	0,41	0,24	0,01
PANDALUS		1,21	0,08	0,26	3,11	1,84	0,13	0,97	0,07	0,00
Size Class Distribution Prey in Number %:										
Eggs				0,56	0,53			6,95	6,87	
<=7 mm		18,37	6,99	5,81	4,86	1,91	0,25	0,30		
7-10 mm		0,91	2,87	6,50	7,13	4,93	1,24	0,39	0,27	
10-15 mm		44,08	25,40	13,20	32,87	25,33	4,81	7,78	0,32	0,06
15-20 mm		0,31	1,94	3,53	6,89	6,81	4,09	2,34	0,96	0,11
20-25 mm		0,45	3,17	6,36	13,72	3,73	3,93	5,56	3,03	3,26
25-30 mm		0,61	1,58	3,20	4,01	8,08	10,79	4,00	5,63	3,60
30-40 mm		9,45	15,82	6,18	5,86	10,18	26,76	6,91	8,86	7,24
40-50 mm		5,65	16,55	12,18	2,98	5,48	7,70	5,71	4,55	2,51
50-70 mm		4,80	8,25	11,13	5,54	3,83	8,71	6,32	7,00	5,67
7-10 cm		0,94	1,52	3,89	1,71	4,38	6,40	8,01	12,97	10,28
10-15 cm				0,49	1,04	3,09	7,66	16,01	16,51	15,75
15-20 cm					0,28	0,09	1,40	9,37	10,05	19,05
20-25 cm						0,02	0,44	7,85	6,17	12,33
25-30 cm							0,05	0,42	2,38	4,02
30-40 cm								0,23	0,35	2,39
Not known		14,41	15,92	27,16	12,57	22,15	15,77	11,85	10,53	13,74

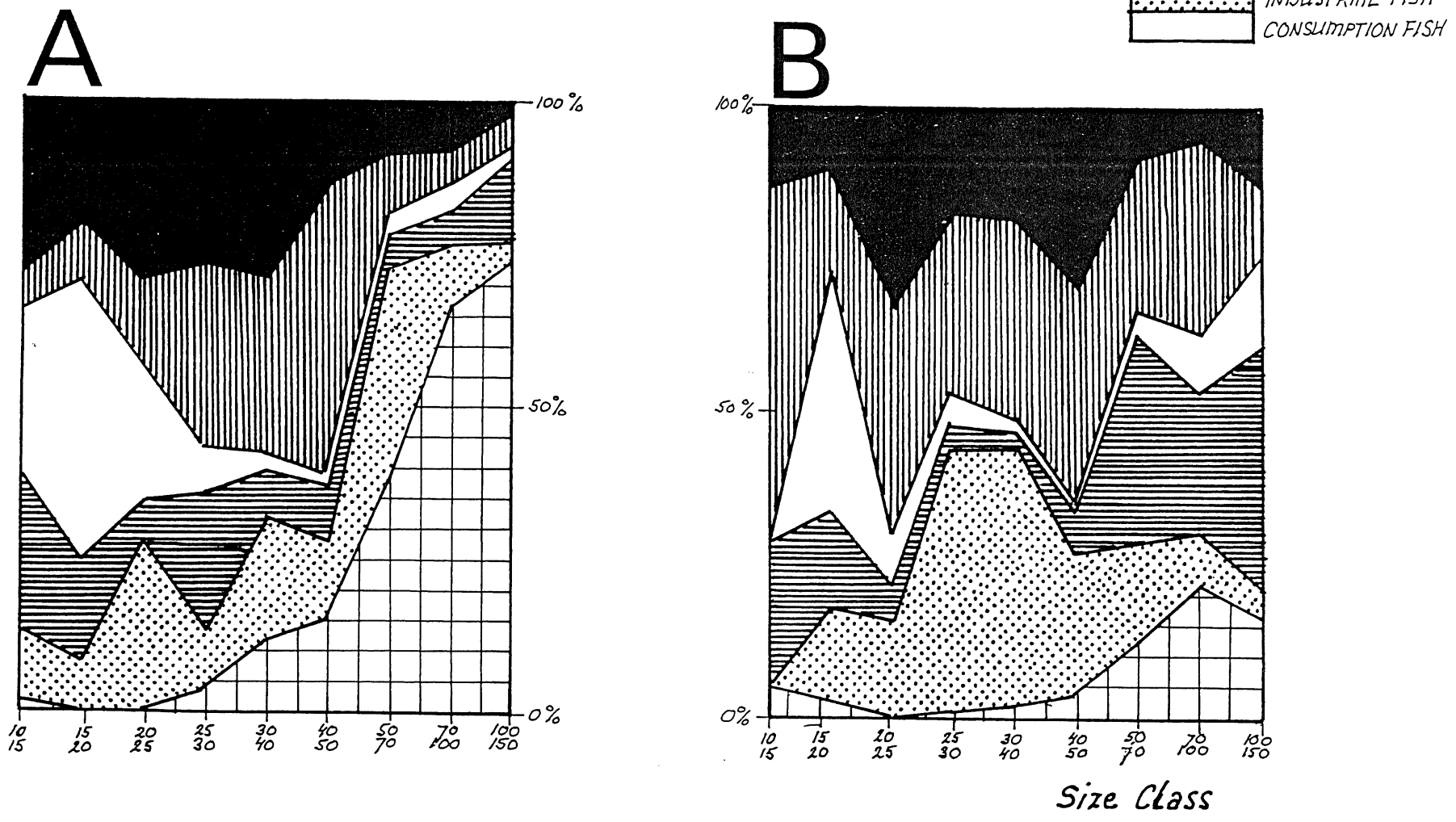
TABLE V-2
STOMACH CONTENT DATA FOR COD BY SIZE CLASS - 2nd QUARTER 1981

Size class	7-10	10-15	15-20	20-25	25-30	30-40	40-50	50-70	70-100	>=100
n Squares sampled		7	26	44	50	74	58	65	44	13
N Stomachs		37	180	330	370	538	391	392	180	19
% Empty		35,8	18,3	19,7	12,7	11,1	10,4	9,0	1,8	0,0
Mean N/hour		1,3	14,1	46,4	51,3	25,4	19,5	8,6	3,9	1,3
Mean Length		13,5	18,7	22,9	27,4	34,5	44,2	57,8	81,2	105,5
Mean W Stomach Contents		,26	,78	1,19	2,69	7,96	14,99	34,70	112,53	158,18
Mean N of Prey Organisms		2,02	3,06	2,85	6,65	12,70	7,82	11,05	137,95	11,85
Average W per Prey Item		,13	,25	,42	,41	,63	1,92	3,14	0,82	13,35
Food Composition in Weight % by Major Taxa:										
CNIDARIA						0,13	0,09	0,04	0,13	
ANNELLIDA		9,67	4,10	22,66	10,60	4,27	8,44	3,39	4,20	12,45
GASTROPODA			2,31	2,25	1,52	2,84	3,75	0,03	0,06	
BIVALVIA			3,62	7,29	1,47	0,93	0,22	0,17		
SCAPHOPODA								0,00		
CEPHALOPODA				0,02	0,10	0,11	0,02	0,02	0,13	0,13
CRUSTACEA		58,72	55,88	45,43	35,30	34,39	36,31	29,48	41,13	26,12
SIPUNCULA					0,01					
ECHIURA		3,19	0,02	0,06	0,04	0,00				
PRIAPULIDA					0,05	0,01	0,04	0,02		
ECHINODERMATA				0,29	3,04	9,99	16,81	4,12	0,01	
CHAETOGNATHA			0,22							
UROCHORDATA				0,15		0,09				
CEPHALOCHORDATA			0,01				0,00			
GNATHOSTOMATA		28,43	33,84	21,85	47,88	47,24	34,32	62,75	54,33	61,31
Weight % Commercial species:										
COD			1,27	0,20	0,20	0,63	0,34	4,22	6,75	
HADDOCK					0,33	1,29	0,72	3,30	2,65	0,26
WHITING						0,12	1,08	3,62	8,30	11,73
SAITHE							0,21			
NORWAY POUT				0,27		0,88	0,44	2,87	2,82	0,35
HERRING		4,70	1,69	0,06	0,15	0,26	1,25	1,64	4,08	2,83
SPRAT			0,01	1,34	0,35	6,02	3,23	2,64	0,93	3,39
SANDEEL			15,29	13,90	43,05	34,92	19,39	10,94	5,82	1,42
PLAICE				0,01			0,00	0,16		2,50
SOLE						0,00	0,10	0,07		
DAB			0,56	0,56	0,27	0,47	1,25	21,75	12,14	13,20
NORWAY LOBSTER						0,08	0,21	3,48	8,32	14,79
BROWN SHRIMP			38,58	8,44	4,98	0,67	0,59	0,00		0,02
PANDALUS			0,30		0,34	0,88	0,34	0,29	0,01	0,19
Size Class Distribution Prey in Number %:										
Eggs				3,98	0,05	30,67	2,36			
<=7 mm		18,32	13,66	1,91	1,54	3,26	0,54	0,74		
7-10 mm		4,27	0,76	3,34	2,51	0,63	2,16	0,03		
10-15 mm		26,11	12,29	37,66	14,26	4,19	3,38	0,82	0,03	
15-20 mm		0,92	7,96	2,85	3,30	2,55	16,84	4,78	0,03	
20-25 mm			7,46	4,20	2,73	6,21	11,05	10,79	6,32	0,32
25-30 mm		4,27	11,01	4,72	32,77	22,61	21,47	45,24	86,68	2,92
30-40 mm		6,56	6,01	4,96	1,76	2,99	3,01	5,40	0,93	13,31
40-50 mm		9,01	13,24	3,11	10,90	1,46	4,40	1,28	0,07	1,46
50-70 mm		2,60	11,27	8,85	14,46	13,54	18,12	8,13	2,34	5,03
7-10 cm				0,71	2,65	6,70	6,31	4,54	1,67	15,62
10-15 cm				1,13	1,42	1,78	2,89	6,36	0,94	16,59
15-20 cm					0,04	0,20	2,22	5,89	0,49	32,98
20-25 cm						0,00	0,10	1,08	0,31	5,52
25-30 cm					0,00	0,01			0,07	0,97
30-40 cm										1,46
40-50 cm									0,01	0,49
Not known		27,94	16,33	22,58	11,61	3,22	5,16	4,92	0,13	2,84

Fig. 5.1.2.

Cod: Percentage weight of various prey groups by predator size class

A - 1st Quarter
B - 2nd Quarter



5.2. Haddock

An estimate of the numbers of samples of stomachs collected during each quarter of 1981 is given in table IV.1. The French workers have experienced some difficulties in the analysis and processing of the large amount of material sent to Nantes and the current situation is that approximately 2000 stomachs collected during the first quarter have been analysed and the data from 1200 of these have been filed in the computer. In addition, a further 400 stomachs collected during the second quarter have been analysed, but the data have not yet been computerized.

The preliminary impression from the material that has been analysed to date is that the food of haddock consists mainly of polychaetes, echinoderms and crustaceans and rather small numbers of fish (mainly sandeels, Norway pout, sprats and Maurolicus).

5.3. Whiting

The numbers of whiting stomachs collected by each country in each quarter of 1981 are given in table IV.1. The total number of stomachs collected was approximately 17650 and of these nearly 14000 (representing all the material collected during Q1 and Q2, and most of the material collected during Q3) have been processed and the data filed in the Aberdeen computer. The geographical distributions of the samples that have so far been analysed are shown in fig. 5.3.1., for Q1 and Q3 respectively, and the numbers of stomachs of each size group that have been analysed in each quarter are given in table IV.2. Unfortunately, as difficulties have been experienced in developing programs for the retrieval and tabulation of the data, no outputs were available for consideration by the Working Group. It is hoped that the remaining stomachs will be analysed and the output programs perfected, before the end of 1982.

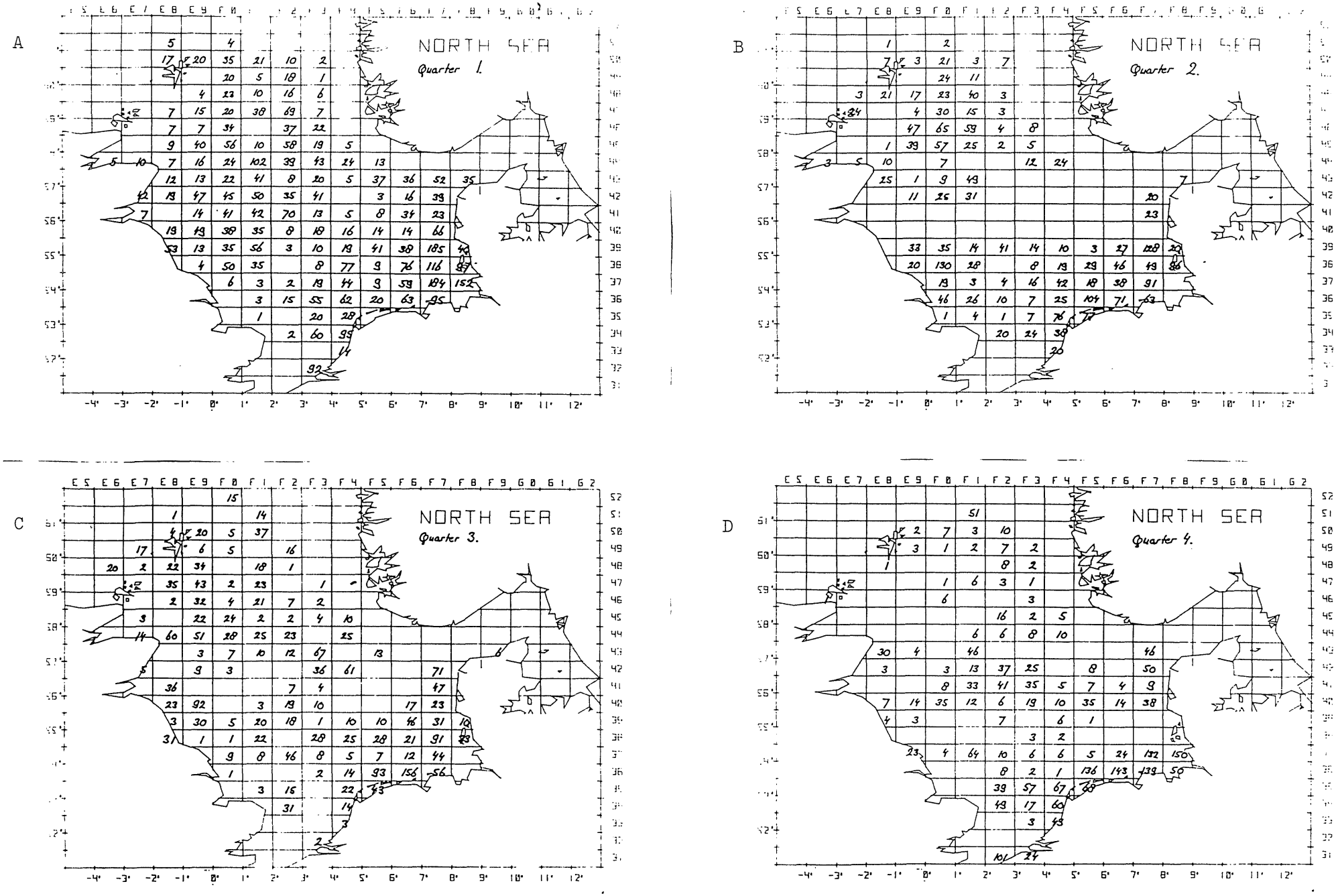
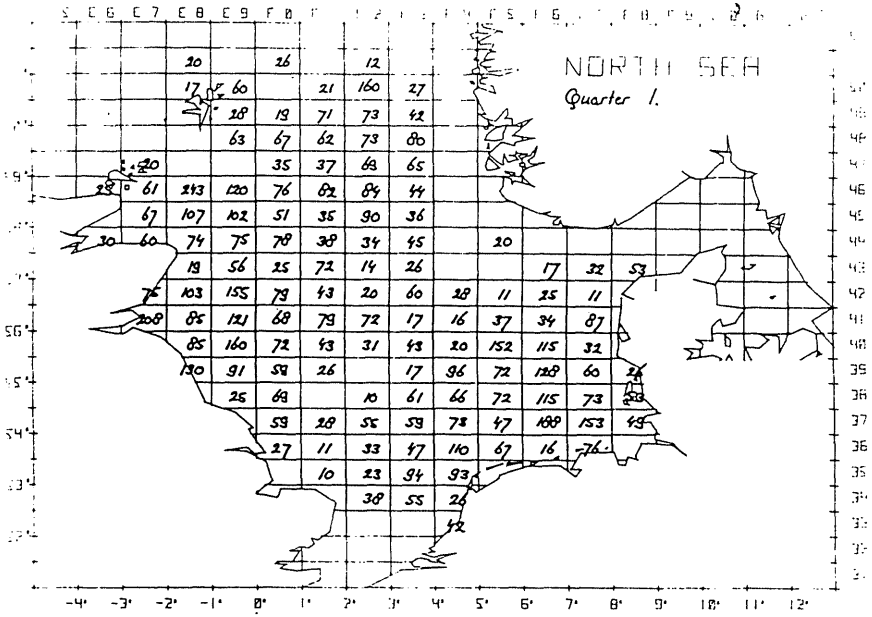


Fig. 5.1.1
Number of COD stomachs sampled by statistical rectangle and quarter.

A



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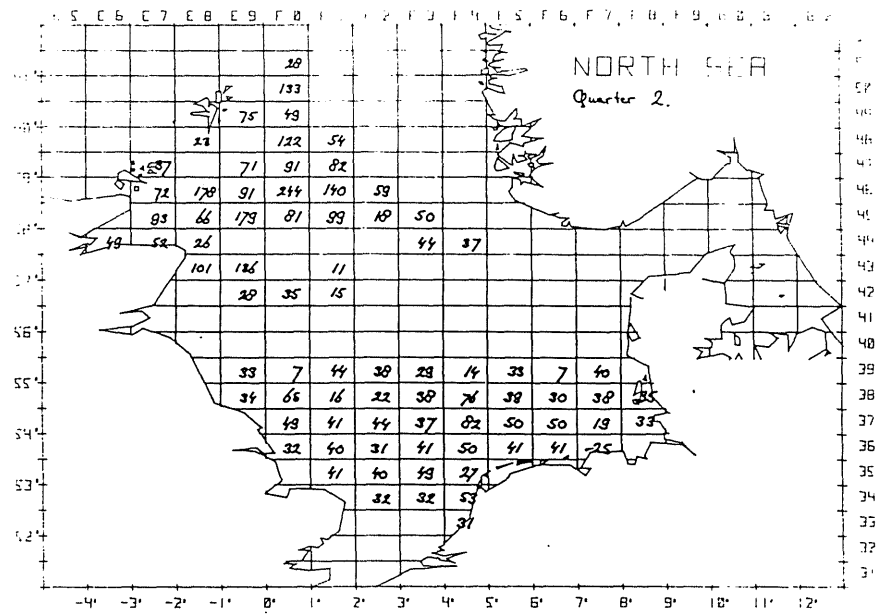

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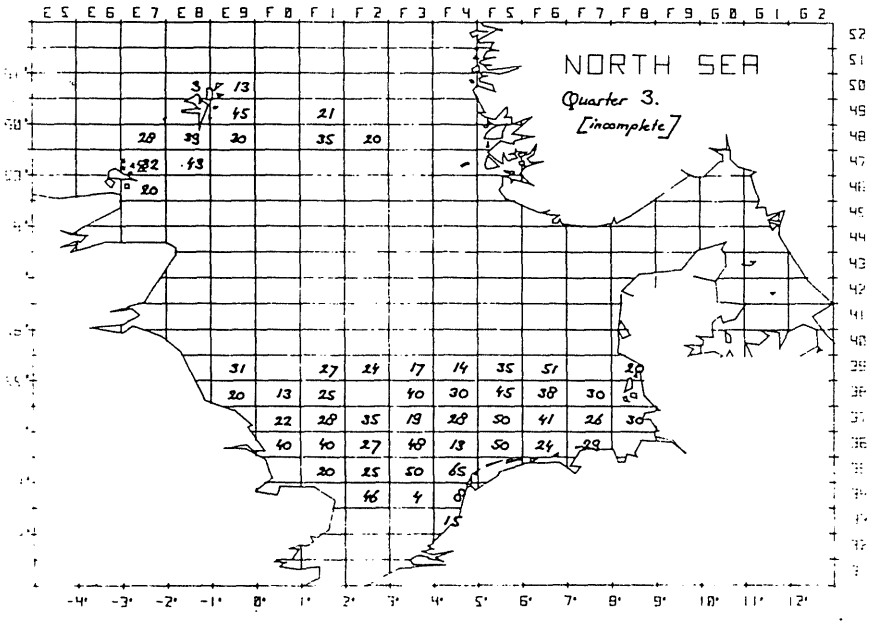


D

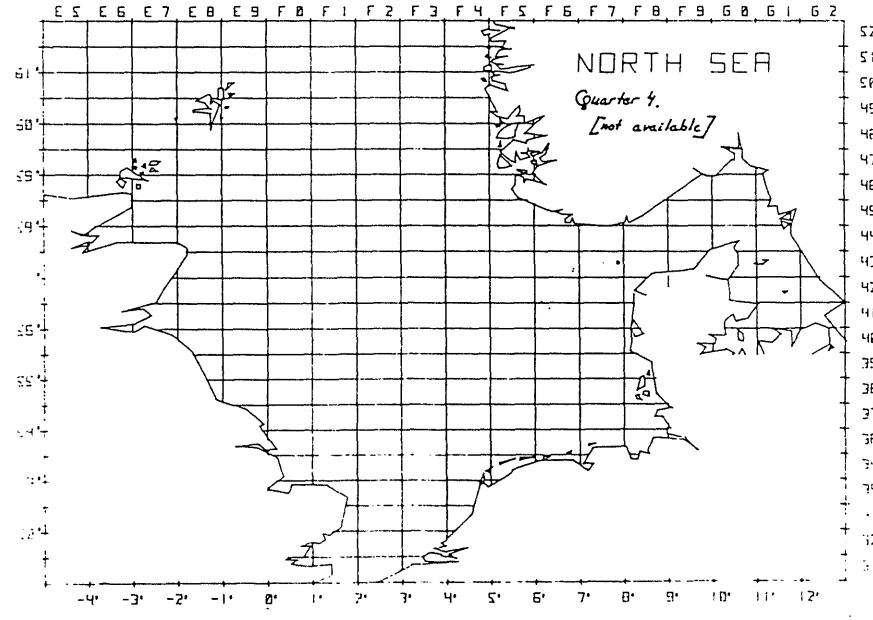


Fig. 5.3.1.
Number of WHITING stomachs sampled by statistical rectangle and quarter.

5.4. Saithe

The available samples of saithe stomachs from all quarters in 1981 have been analysed and processed as well as additional samples taken in Q1 and Q3 1980 and Q1 1982.
However, according to cruise reports further samples from 1981 and 1982 can be expected and the results presented in this section should therefore be regarded as preliminary.

In general the intensity of sampling has been low and especially so from the length groups below 50 cm (table IV-2). Figure 5.4.1. shows the spatial distribution of the stomachs examined in 1981. Most of the samples come from the northern part of the North Sea, which represents the major distribution area of saithe.

In view of the low sampling intensity and because the gears actually used do not seem very appropriate for catching saithe it was decided not to weight the stomach samples by the number caught per hour but to regard them as random samples from the whole population. In some cases larger samples than the agreed 25 stomachs per sizegroup and haul have been collected. When calculating the average stomach content these samples were weighted as if only 25 stomachs had been sampled.

Tables V-4.1a to d show the preliminary results for 1981. The average weight of one prey item was calculated by excluding the weight of food remains which could not be counted and by dividing the remainder by the average number of prey items found. As could be expected both the average weight of the stomach contents and the average weight of one prey item in general increases with the size of the predator. Due to the low number of samples it seems difficult to draw any firm conclusions from the tables with respect to seasonal differences in the food composition and in the weight of the stomach contents. It thus appears reasonable to calculate the average yearly food composition as a straightforward average of the four quarters.
However, in addition to the samples from 1981, 31 samples from Q1 and Q3 1980 and 10 samples from the Q1 1982 were available. Before the average annual foodcomposition was calculated these samples were added to the respective quarter. Table V-4.2. and fig. 5.4.2. present the average yearly stomach contents.

Apparently saithe between 25 and 40 cm of length mainly feed on sandeel, those between 40 and 70 cm on euphausids and those above 70 cm on Norway pout and Maurolicus. However, particularly in the case of saithe below 40 cm, which have been mainly caught in coastal waters, it must be remembered that the estimates are based on very few samples.

TABLE V-4.1a - SAITHE: Results from stomach ana[illegible]s, 1st quarter 1981.

Length group (cm)	40-50	50-70	70-100	> 100
Nr. of squares sampled	3	15	22	10
Total number of stomachs	3	109	208	16
Percentage empty	33.3	22.0	15.9	25.0
Average weight of stomach contents	13.2	23.5	54.5	120.7
Average number of prey items	14.7	49.9	40.5	16.2
Average weight per prey item	.86	.43	1.30	7.45
Food composition in weight % :				
Norway pout		47.1	75.8	93.1
Cod				
Haddock		10.4	4.2	2.5
Whiting			1.1	
Gadiculus thori				
Micromesistius poutassou				
Unidentified gadoids			.1	.8
Argentina sphyraena		5.8	1.1	
Maurolicus muelleri		2.3	2.4	1.5
Sandeel				.3
Herring	90.9		2.6	
Sprat			.3	
Hippoglossoides platess.		.4	.4	.4
Other pleuronectoids				
Unidentified pleuronectoids				
Unidentified fish	4.3	3.6	2.6	1.2
Fish total	95.2	69.6	90.6	99.8
Euphausiacea	4.8	29.5	9.3	.1
Cephalopoda		.8	.2	.1
Other invertebrates				

TABLE V-4.1 - SAITHE: Results from stomach analysis, 2nd quarter 1981.

Length group (cm)	30-40	40-50	50-70	70-100	> 100
Number of squares sampled	5	5	3	5	3
Total number of stomachs	14	6	42	105	3
Percentage empty	14.3	16.7	.0	5.5	.0
Average weight of stomach comtemts	6.7	19.5	37.1	49.2	89.5
Average number of prey items	10.8	83.8	76.1	51.0	54.5
Average weight per prey otem	.59	.21	.41	.93	1.52
Food composition in weight % :					
Norway pout			4.5	31.5	1.4
Cod	1.6		.4	.5	
Haddock			4.5	3.1	1.5
Whiting					
Gadiculus thori			1.7	7.5	
Micromesistius poutassou				1.5	
Unidentified gadoids	2.2		1.8	5.9	
Argentina sphyraena			.5	.1	
Maurolicus muelleri		13.4	37.9	38.6	94.2
Sandeel	75.5			.6	.5
Herring	1.3				
Sprat					
Hippoglossoides platess.					
Other pleuronectoids					
Unidentified pleuronectoids					
Unidentified fish	3.8		3.2	3.2	
Fish total	84.4	13.4	55.1	92.4	97.1
Euphausiacea	15.6	86.6	44.9	7.1	2.9
Cephalopoda					
Other invertebrates			.1	.3	

TABLE V-4.1c - SAITHE: Results from stomach analysis, 3rd quarter 1981.

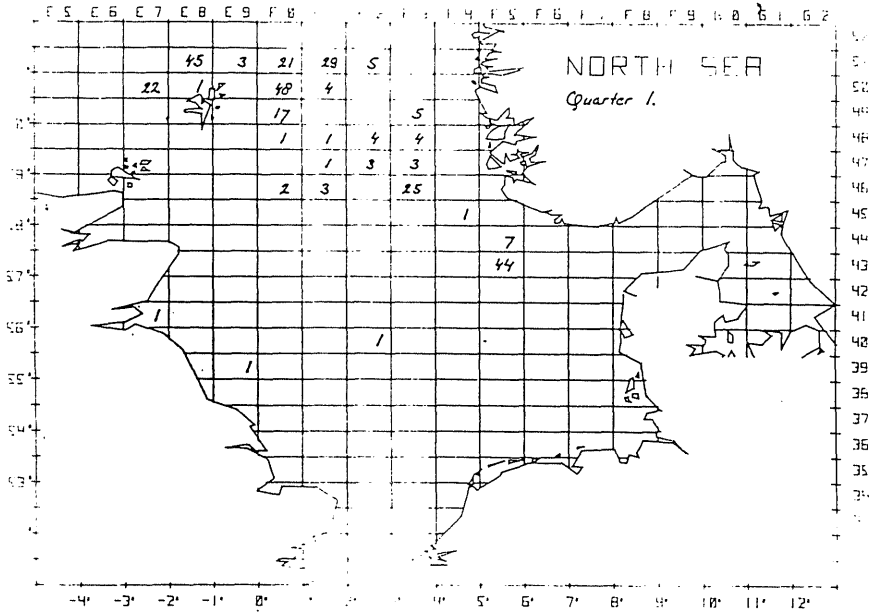
Length group (cm)	30-40	40-50	50-70	70-100	> 100
Number of squares sampled	9	8	10	6	2
Total number of stomachs	39	48	60	53	4
Percentage empty	19.1	8.3	28.3	18.9	.0
Average weight of stomach contents	4.1	6.1	9.2	27.3	44.3
Average number of prey items	69.3	49.9	20.8	124.2	1.0
Average weight per prey item	.05	.10	.33	.18	44.3
Food composition in weight % :					
Norway pout	.7		3.8	5.0	
Cod					
Haddock	32.9	8.6	4.6	5.7	
Whiting			2.5		
Gadiculus thori				1.3	
Micromesistius poutassou					
Unidentified gadoids	27.1	11.2	2.1	6.2	90.9
Argentina sphyraena					
Maurolicus muelleri		1.2	30.9	12.6	
Sandeel	22.6	.3	2.1		
Herring					
Sprat					
Hippoglossoides platess.					
Other pleuronectoids					
Unidentified pleuronectoids					
Unidentified fish		1.9	1.7	1.2	9.1
Fish total	83.3	23.2	47.7	32.0	100.0
Euphausiacea	12.5	72.0	52.3	68.1	
Cephalopoda	4.2				
Other invertebrates		4.8			

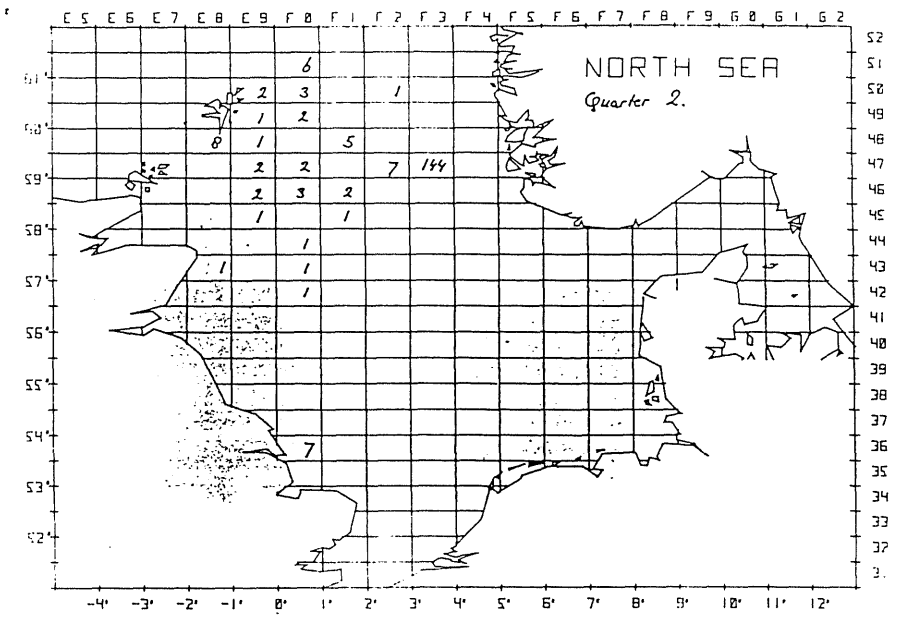
TABLE V.4.1.d - SAITHE: Results from stomach analysis 4th quarter 1981.

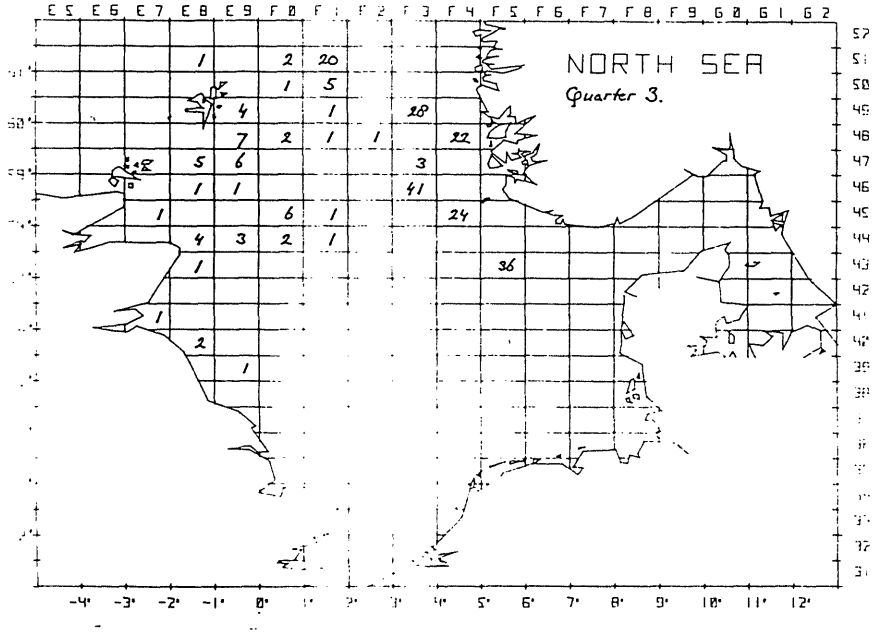
Length group (cm)	40-50	50-70	70-100	> 100
Nr. of squares sampled	2	9	8	2
Total nr. of stomachs	46	82	78	166
Percentage empty	.0	13.4	27.9	24.4
Av. weight of stom. cont.	9.8	11.1	13.6	26.5
Av. nr. or preyitems	40.2	41.3	8.9	3.6
Av. weight per preyitem	.14	.20	1.21	6.27
Food composition in weight %:				
Norway pout	6.3	13.3	8.5	.1
Cod				
Haddock	3.0		4.8	10.9
Whiting				2.0
Gadiculus thori			9.9	1.2
Micromesistius poutassou				
Unidentiefied gadoids			5.8	13.0
Argentina sphyraena				
Maurolicus muelleri	2.0	1.6	4.0	
Sandeel			11.4	16.0
Herring				
Sprat				
Hippoglossoides platess.				2.4
Other pleuronectoids			4.9	6.4
Unidentiefied pleuronectoids			5.0	17.5
Unidentiefied fish	12.3	1.9	15.6	25.3
Fish total	23.6	16.8	69.9	94.8
Euphausiacea	76.5	83.1	18.7	
Cephalopoda			11.2	.3
Other invertebrates		.1	.1	4.9

TABLE V.4.2. - SAITHE: Average annual stomach content.
Samples from 1980, 81 and 82.
(Preliminary results)

Length group (cm)	25-30	30-40	40-50	50-70	70-100	> 100
Total no. of stomachs	3	78	138	350	507	203
Av. weight of stom. cont.	5.3	4.9	12.0	20.4	43.5	73.2
Av. weight of one preyitem	.43	.51	.45	.37	.92	4.23
Food composition weight %						
Commercial species						
Cod		.9		.1	.1	
Haddock		17.4	5.6	4.8	4.7	6.0
Whiting				.6	.2	3.0
Herring		0.4	10.4		.7	6.3
Sprat					.1	
Sandeel	85.1	60.6	.1	.8	3.4	4.8
Norway pout		.4	10.0	19.9	37.0	37.1
Blue Whiting				.1	.4	
Total	85.1	79.7	26.1	26.3	46.6	57.2
Gadiculus thori			.1	.5	5.7	1.3
Argentina sphyraena				1.3	1.0	
Maurolicus muelleri			4.7	19.2	14.7	27.8
Hippoglossoides platess				.1	.2	2.3
Other pleuronectoids					2.7	5.5
Fish total	85.1	79.7	30.9	47.4	70.9	94.1
Euphausiacea		8.7	68.1	52.5	26.3	4.9
Cephalopoda	14.9	11.5	1.1	.3	2.9	.1
Other invertebrates				.1	.1	1.2







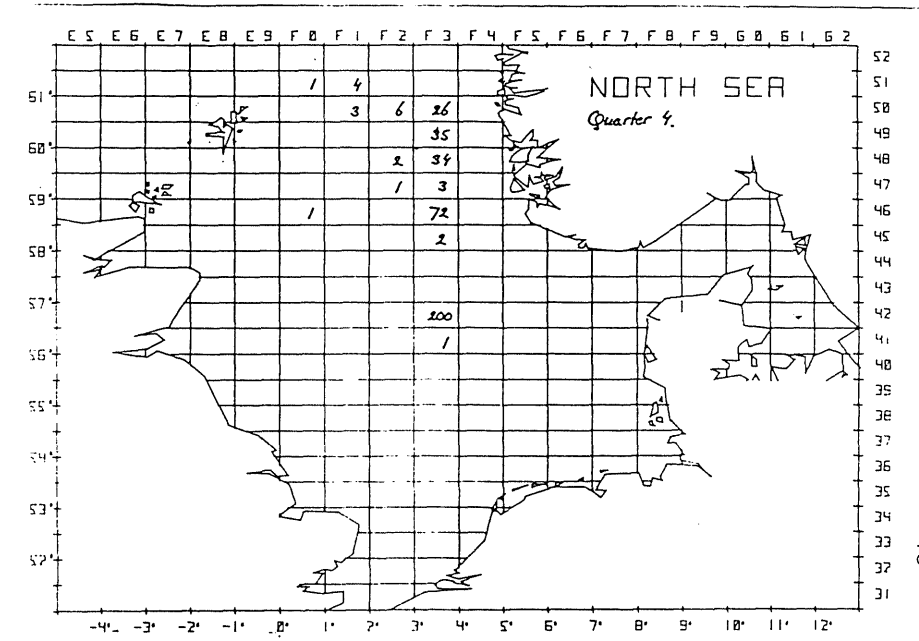
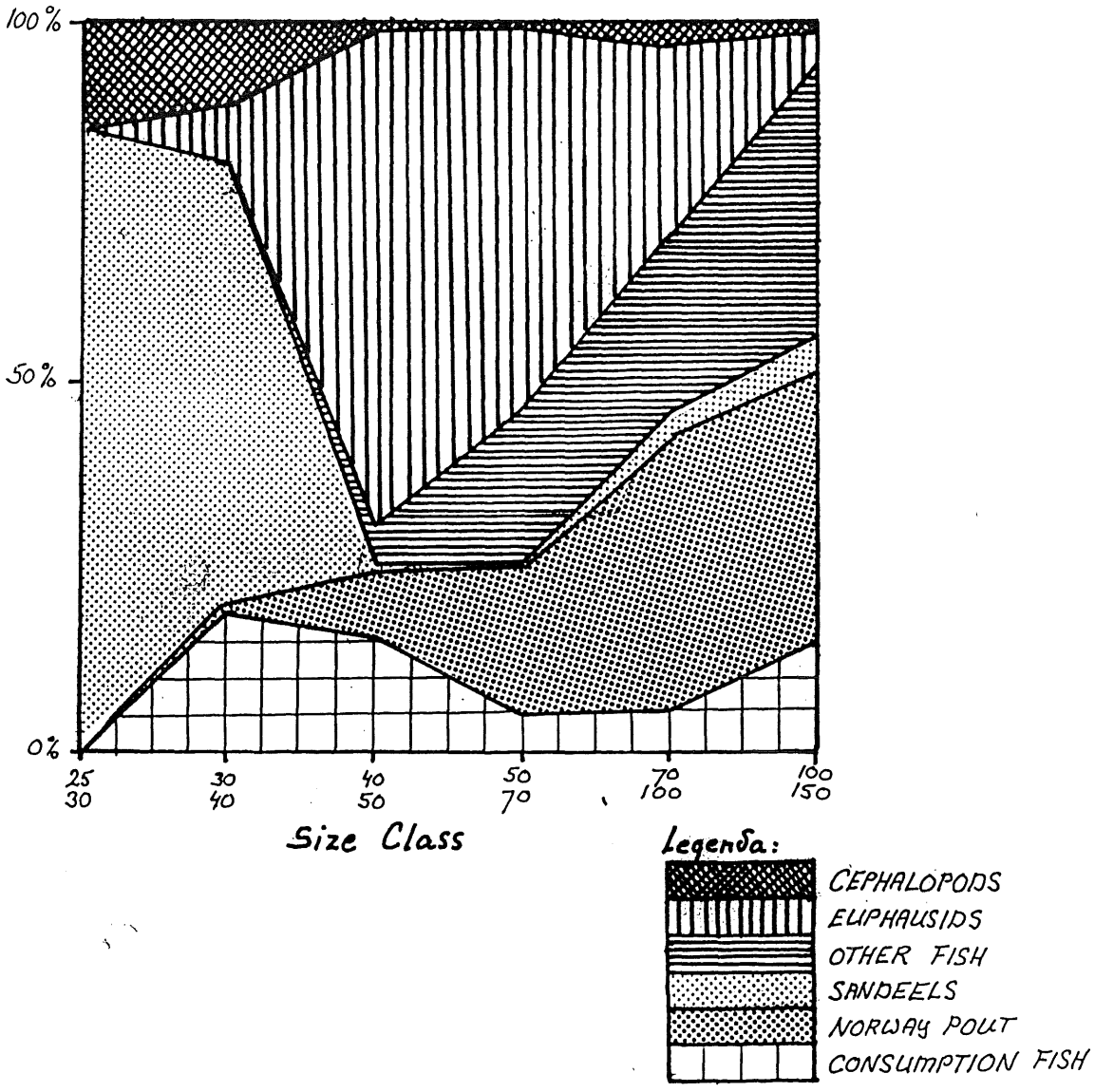


Fig. 5.4.1.
Number of SAITHE stomachs sampled by statistical rectangle and quarter.

Fig. 5.4.2.

SAITHE: Percentage weight of various prey groups by predator size class. (Samples from all quarters in 1980, 1981 and 1982 combined).



5.5. Mackerel

The extent of sampling of mackerel stomachs during 1981 is shown in figure 5.5.1. It is seen that in Q1 there has been a poor coverage with samples mainly from the central North Sea. In Q2 and Q3 there are samples from each main area defined in figure 5.5.2. In Q4 samples are missing completely from the northwestern North Sea and sampling was very sparse in the northeastern North Sea. A total of about 300 samples representing 1721 stomachs was collected from the North Sea. In addition to this, 273 stomachs were sampled to the north of 61°30'N. The results for these latter samples have not been included in the present analysis.
In table V-5.1 the weight percentage distribution of the prey species in the mackerel stomach contents is shown down to the lowest recognizable taxonomic level for all samples taken in 1981.
Calanus made up about 20%, euphausids 28% and 35% was recognized as fish. The smallest fish prey item was in the size class 0.2 - 0.24 cm, the two biggest were herring and sandeel in the 15 - 19 cm size class.

It may be difficult to map the possible effect of prey size on the choice of diet for mackerel with any degree of precision on the basis of the present material. The relatively few samples are spread out over an huge area, time period and different size classes of mackerel. In table IV-2 the distribution of sampled individuals of mackerel in different size classes and quarters of the year is shown for the total material.

However, if the size classes are grouped in larger units some comparison can be made between small (15 - 34 cm) and large (35 - 49 cm) mackerel in the southern part of the North Sea, which both were fairly well represented in the samples from Q2, Q3 and Q4. The results are presented in table V-5.2a and b and fig. 6.4.

Both size groups feed heavily on fish in this area, 67.4% of the weight of the stomach contents representing fish remains for the large and 51.5% for the small mackerel. There is a tendency for the larger fish to eat larger prey fish. The 10 - 14 and 15 - 19 cm size classes of herring and the 15 - 19 cm size class of sandeel constitute 14.3% of the weight of the stomach contents of the large mackerel and these size groups are not represented in the small mackerel.

The geographical differences in the food habits of mackerel are rather pronounced in the material gathered during the present investigations. While in the southern North Sea about 60 - 70% of the stomach contents were represented by fish, only 5 - 25% were fish in the northeastern North Sea in Q2 and Q3 (see table V-5.3 and V-5.4). In the central North Sea about 17% of the stomach contents were fish (see table V-5.5) while fish contributed as much as 88.7% of the stomach content in the northwestern North Sea (table V-5.6). Looking at these results one must bear in mind that different gears (trawl, gill net and hook-and-line) have been used for collecting samples, which may affect to some extent the amount of food in the stomachs as well as the food composition. In general the results presented here seem to be in fairly good agreement with those of WALSH and RANKINE (1979), who also found that fish constituted an appreciable part of the mackerel diet.

To move nearer towards the computation of the consumption of commercial fish species such as sprat, herring, sandeel and Norway pout by the North Sea mackerel stock, at least three requirements have to be met:
- The relative abundance of the different age classes of the North Sea mackerel stock in different areas at different times of the year has to be estimated. The migration pattern qualitively described in the 1981 report of the Mackerel Working Group (ANON., 1981) has in some

way to be quantified.
- Estimates of the consumption rate either from digestion rates or from metabolic requirements have to be made for mackerel of different sizes.
- More samples of mackerel stomachs must be collected in the future to fill in the blank parts of the picture.

Table V-5.1 - Species composition of prey of mackerel in the North Sea in 1981.

Species: 8850030302 Scomber Scombrus

Timeperiod: 1/01 - 31/12 for the years: 81 - 81

Sizegroups (cm): 15.0 - 49.0

Vertices of sampled area:

61.30N	3.00W
52.00N	3.00W
52.00N	10.00W
61.30N	10.00W

Number of stations sampled in given area and time period: 134
Total number of stomachs : 1721
Total number of stomachs empty : 120
Total number of stomachs regurgitated : 5
Percentage of stomachs empty : 7.0

Taxon	Size group	Weight grams per pred.	Weight %	Number per pred.	Number %
Phaeophycea		0.00	0.0	0.01	0.0
Phaeophyceae Fucales		0.00	0.0	0.00	0.0
Fucaceae		0.00	0.0	0.00	0.0
Rhodophyceae		0.00	0.0	0.00	0.0
Anthophyta I		0.00	0.0	0.00	0.0
Hydrozoa		0.00	0.0	-0.01	0.0
Physophora hydrostatica		0.00	0.0	0.02	0.0
Polychaeta		0.00	0.0	0.00	0.0
Aphrodite aculeata		0.00	0.0	0.00	0.0
Nereis pelagica		0.00	0.1	0.00	0.0
Gastropoda		0.00	0.0	8.72	0.6
Clione limacina		0.01	0.2	2.13	0.1
Bivalvia		0.00	0.0	0.00	0.0
Cardiidae		0.00	0.0	0.00	0.0
Alloteuthis subulata		0.02	0.6	0.03	0.0
Crustacea		0.00	0.0	-0.01	0.0
Cladocera		0.00	0.0	0.00	0.0
Copepoda		0.03	0.7	97.84	6.7
Copepoda Calanoida		0.04	0.9	73.73	5.0
Calanus Finmarchicus		0.83	20.1	836.38	57.1
Temoridae		0.00	0.1	13.74	0.9
Copepoda Cyclopoida		0.00	0.0	0.01	0.0
Mysida		0.00	0.0	0.00	0.0
Mysidae		0.00	0.0	1.87	0.1
Amphipoda		0.00	0.1	1.19	0.1
Hyperiidae		0.00	0.1	0.63	0.0
Parathemisto		0.00	0.0	0.01	0.0
Euphausiidae		0.06	1.4	1.50	0.1
Meganyctiphanes norvegica		1.09	26.5	13.53	0.9
Thysanoessa		0.00	0.0	0.03	0.0
Thysanoessa inermis		0.06	1.4	2.47	0.2
Thysanoessa raschii		0.00	0.0	0.00	0.0
Caridea		0.00	0.0	0.01	0.0
Crangonidae		0.00	0.1	0.04	0.0
Brachyura		0.09	2.2	46.58	3.2
Portunidae		0.05	1.2	0.07	0.0
Diptera		0.00	0.0	0.00	0.0
Gymnolaemata Cheilostomata		0.00	0.0	0.00	0.0
Ophiuroidea		0.00	0.0	0.00	0.0
Echinozoa		0.00	0.0	0.00	0.0
Urochordata		0.00	0.0	0.00	0.0
Salpidae		0.00	0.1	0.05	0.0
Oikopleuridae		0.18	4.4	362.19	24.7
Teleostei		0.53	12.8	0.56	0.0
Clupea harengus		0.14	3.4	0.02	0.0
Clupea sprattus		0.07	1.6	0.02	0.0
Maurolicus muelleri		0.01	0.3	0.01	0.0
Gadidae		0.00	0.1	0.02	0.0
Trisopterus esmarkii		0.15	3.7	0.10	0.0
Syngnathum rostellatus		0.01	0.2	0.15	0.0
Trachurus trachurus		0.04	0.9	0.02	0.0
Ammodytidae		0.33	8.0	0.43	0.0
Hyperoplus lanceolatus		0.15	3.5	0.02	0.0
Callionymus lyra		0.00	0.1	0.01	0.0
Pleuronectiformes		0.00	0.0	0.00	0.0
Limanda limanda		0.00	0.1	0.00	0.0
Aves		0.00	0.0	0.00	0.0
9999999999		0.20	4.9	-0.01	0.0

Note: When a variable is negative it is not possible to compute.

TABLE V-5-2- Composition of the diet of mackerel in the southern North Sea.
A. 15 - 34 cm.

Timeperiod: 1/1 - 31/12 for the year: 1981.

Vertices of sampled area: 54.30 N 1.00 W
52.00 N 1.00 W
52.00 N 9.00 E
54.30 N 9.00 E

Number of stations sampled : 50
Total number of stomachs :230
Total number of stomachs empty : 16
Total number of stomachs regurgitated : 1
Percentage of stomachs empty :7.0

Taxon	Size group	weight grams per pred.	weight %	number per pred.	number %
Phaeopycea	unknown	0.00	0.1	0.02	0.0
Alloteuthis subulata	3.-3.9 cm	0.00	0.1	0.00	0.0
Copepoda	.1-.14 cm	0.00	0.2	17.39	1.7
Copepoda Calanoida	.1-.14 cm	0.00	0.2	14.61	1.4
	.2-.24 cm	0.05	2.4	93.20	9.0
	.3-.39 cm	0.00	0.1	2.91	0.3
Calanus finmarchicus	.3-.39 cm	0.01	0.7	14.44	1.4
Temoridae	.1-.14 cm	0.00	0.2	17.91	1.7
Mysidae	.4-.49 cm	0.01	0.7	13.31	1.3
Amphipoda	.3-.39 cm	0.00	0.1	0.73	0.1
Brachyura	.3-.39 cm	0.14	7.4	72.48	7.0
Portunidae	1.5-1.9 cm	0.00	0.1	0.00	0.0
Ophiuridae	unknown	0.00	0.2	0.00	0.0
Qikopleuridae	.1-.14 cm	0.39	20.1	788.01	76.0
Teleostei	4.-4.9 cm	0.01	0.3	0.01	0.0
	5.-6.9 cm	0.02	0.8	0.01	0.0
	7.-9.9 cm	0.01	0.7	0.00	0.0
	unknown	0.75	38.2	0.25	0.0
Clupea harengus	7.-9.9 cm	0.07	3.5	0.01	0.0
Synnathum rostellatus	4.-4.9 cm	0.06	2.9	1.15	0.1
Trachurus trachurus	3.-3.9 cm	0.02	0.8	0.03	0.0
Ammodytidae	5.-6.9 cm	0.01	0.3	0.00	0.0
	unknown	0.04	1.9	0.06	0.0
Hyperoplus lanceolatus	10.-14. cm	0.04	2.1	0.00	0.0
9999999999	unknown	0.30	15.1	0.04	0.0

B. 35-49 cm

Timeperiod: 1/1 - 31/12 for the year: 1981.

Vertices of sampled area: 54.30 N 1.00 W
52.00 N 1.00 W
52.00 N 9.00 E
54.30 N 9.00 E

Number of stations sampled : 50
Total number of stomachs : 85
Total number of stomachs empty : 6
Total number of stomachs regurgitated : 0
Percentage of stomachs empty :7.1

Taxon	Size group	weight grams per pred.	weight %	number per pred.	number %
Phaeophycea	unknown	0.02	0.4	0.04	0.0
Anthophyta I	2.5-2.9 cm	0.02	0.3	0.01	0.0
Alloteuthis subulata	3.-3.9 cm	0.10	1.8	0.19	0.0
Copepoda	.1-.14 cm	0.04	0.6	141.55	35.0
Copepoda Calanoida	.2-.24 cm	0.08	1.4	156.76	38.7
Crangonidae	2.5-2.9 cm	0.01	0.1	0.05	0.0
	4. -4.9 cm	0.01	0.2	0.02	0.0
	5. -6.9 cm	0.01	0.2	0.01	0.0
Brachyura	.3-.39 cm	0.00	0.1	2.31	0.6
Portunidae	.5-.69 cm	0.00	0.1	0.06	0.0
	.7-.99 cm	0.02	0.4	0.18	0.0
	1. -1.4 cm	0.04	0.7	0.13	0.0
	1.5-1.9 cm	0.04	0.8	0.07	0.0
	2. -2.4 cm	0.09	1.5	0.08	0.0
	2.5-2.9 cm	0.35	6.2	0.18	0.0
	3. -3.9 cm	0.23	4.0	0.09	0.0
	unknown	0.03	0.5	0.06	0.0
Urochordata	3. -3.9 cm	0.00	0.1	0.01	0.0
Oikopleuridae	.1-.14 cm	0.05	0.9	101.88	25.2
Teleostei	7. -9.9 cm	0.08	1.4	0.04	0.0
	unknown	0.12	2.2	0.14	0.0
Clupea harengus	7. -9.9 cm	0.38	6.7	0.07	0.0
	10. -14. cm	0.24	4.1	0.04	0.0
	15. -19. cm	0.21	3.6	0.01	0.0
Clupea sprattus	7. -9.9 cm	0.34	6.0	0.05	0.0
Trachurus trachurus	5. -6.9 cm	0.13	2.2	0.05	0.0
	7. -9.9 cm	0.16	2.8	0.04	0.0
Ammodytidae	3. -3.9 cm	0.03	0.5	0.08	0.0
	4. -4.9 cm	0.04	0.6	0.06	0.0
	5. -6.9 cm	0.10	1.8	0.06	0.0
	7. -9.9 cm	0.26	4.6	0.07	0.0
	unknown	0.18	3.1	0.04	0.0
Hyperoplus lanceolatus	10. -14. cm	1.17	20.4	0.20	0.0
	15. -19. cm	0.38	6.6	0.02	0.0
Callionymus lyra	3. -3.9 cm	0.00	0.1	0.01	0.0
	4. -4.9 cm	0.01	0.2	0.01	0.0
	5. -6.9 cm	0.03	0.5	0.02	0.0
9999999999	unknown	0.70	12.3	-0.11	0.0

Note: When a variable is negative it is impossible to compute.

TABLE V-5-3- The diet of mackerel in the northeastern North Sea in the 2nd quarter of 1981.
Size group 15 - 49 cm.

Timeperiod: 1/4 - 31/6 for the year: 1981.

Vertices of sampled area: 61.30 N 2.00 E
57.30 N 2.00 E
57.30 N 10.00 E
61.30 N 10.00 E

Number of stations sampled : 14
Total number of stomachs :231
Total number of stomachs empty : 14
Total number of stomachs regurgitated : 0
Percentage of stomachs empty :6.1

Taxon	Size group	weight grams per pred.	weight %	number per pred.	number %
Calanus finmarchicus		2.64	41.12	643.29	98.6
Euphausiidae		0.15	2.3	0.79	0.0
Meganyctiphanes norvegica		3.23	50.2	32.77	1.2
Thysanoessa inermis		0.11	1.7	2.27	0.1
Teleostei		0.26	4.0	0.35	0.0
Maurolicus muelleri		0.02	0.4	0.02	0.0
Gadidae		0.02	0.3	0.14	0.0

TABLE V-5-4- The diet of mackerel in the northeastern North Sea in the 3rd quarter of 1981. Size group 15 - 49 cm.

Timeperiod: 1/7 - 31/9 for the year: 1981.

Vertices of sampled area: 61.30 N 2.00 E
57.30 N 2.00 E
57.30 N 10.00 E
61.30 N 10.00 E

Number of stations sampled : 9
Total number of stomachs :133
Total number of stomachs empty : 12
Total number of stomachs regurgitated : 0
Percentage of stomachs empty :9.0

Taxon	Size group	weight grams per pred.	weight %	number per pred.	number %
Copepoda		0.03	1.2	126.32	5.3
Copepoda Calanoida		0.02	0.7	37.59	1.6
Calanus finmarchicus		1.11	40.61	113.38	46.9
Euphausiidae		0.15	5.4	3.01	0.1
Meganyctiphanes norvegica		0.11	4.0	0.66	0.0
Thysanoessa inermis		0.11	3.9	1.76	0.1
Oikopleuridae		0.55	20.0	1089.92	45.9
Teleostei		0.03	1.1	0.08	0.0
Clupea sprattus		0.57	20.9	0.19	0.0
Trisopterus esmarkii		0.04	1.3	0.02	0.0
9999999999		0.02	0.8	-0.07	0.0

TABLE V-5-5- The diet of mackerel in the central North in 1981.
Size group 15 - 49 cm.

Timeperiod: 1/1 - 31/12 for the year: 1981.

Vertices of sampled area: 57.30 N 1.00 W
54.30 N 1.00 W
54.30 N 9.00 E
57.30 N 9.00 E

Number of stations sampled : 44
Total number of stomachs :571
Total number of stomachs empty : 44
Total number of stomachs regurgitated : 3
Percentage of stomachs empty :7.7

Taxon	Size group	weight grams per pred.	weight %	number per pred.	number %
Gastropoda		0.01	0.1	26.29	1.4
Clione limacina		0.03	0.6	6.42	0.3
Alloteuthis subulata		0.04	0.9	0.04	0.0
Copepoda		0.05	1.0	179.04	9.7
Copepoda Calanoida		0.03	0.6	62.14	3.3
Calanus finmarchicus		1.13	25.6	1126.81	60.7
Hyperiidae		0.01	0.2	1.84	0.1
Parathemisto		0.00	0.0	0.02	0.0
Euphausiidae		0.07	1.7	2.47	0.1
Meganyctiphanes norvegica		1.94	44.2	27.09	1.5
Crangonidae		0.00	0.1	0.01	0.0
Brachyura		0.02	0.4	14.63	0.8
Portunidae		0.00	0.1	0.01	0.0
Oikopleuridae		0.20	4.6	405.57	21.9
Teleostei		0.24	5.5	0.41	0.0
Clupea harengus		0.13	2.9	0.02	0.0
Trachurus trachurus		0.00	0.1	0.00	0.0
Ammodytidae		0.37	8.5	0.57	0.0
Limanda limanda		0.00	0.1	0.00	0.0
9999999999		0.12	2.7	-0.02	0.0

Note: when a variable is negative it is not possible to compute.

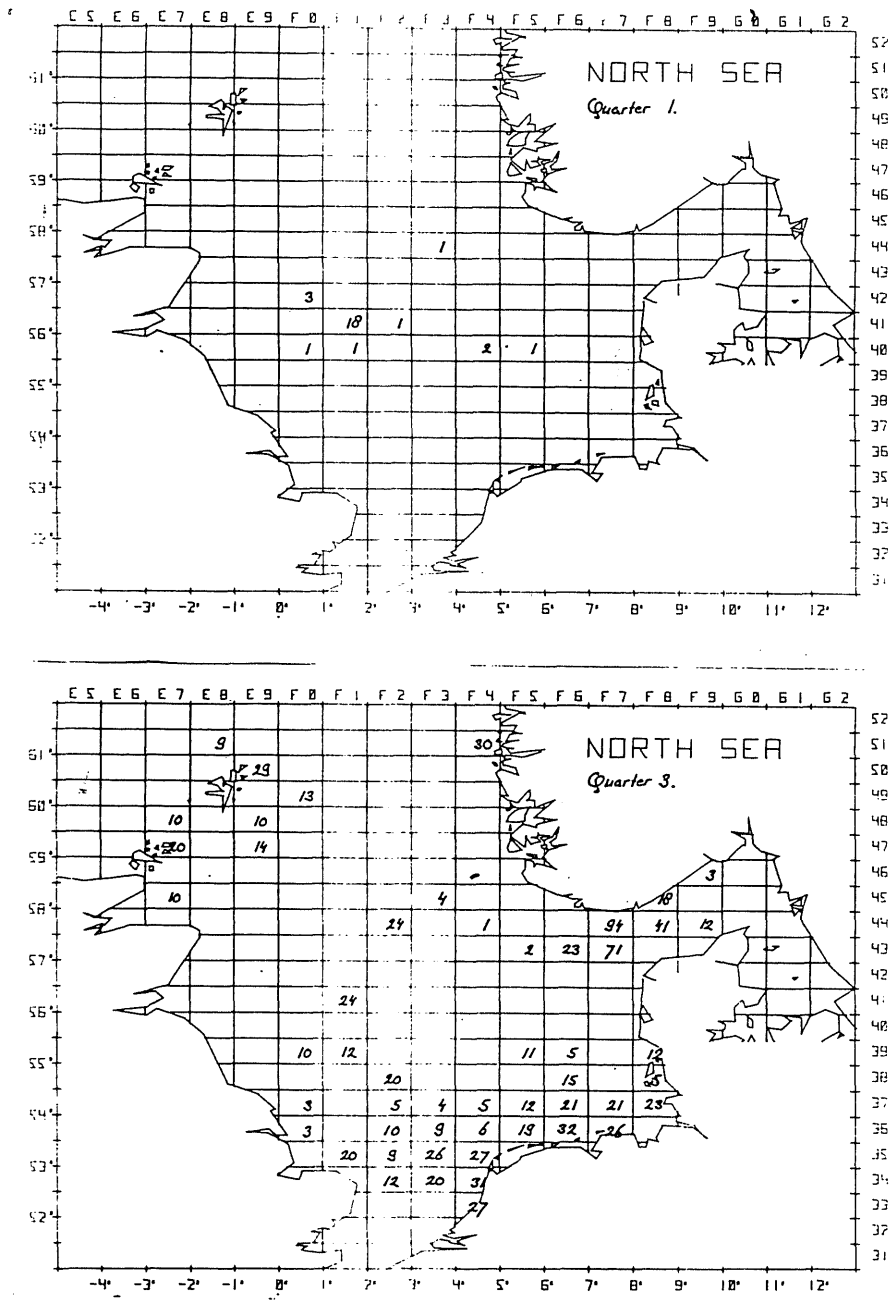
TABLE V-5-6- The diet of mackerel in the nortwestern North Sea during the 2nd and 3rd quarter of 1981.
Size group 15 - 49 cm.

Timeperiod: 1/4 - 31/9 for the year: 1981.

Vertices of sampled area: 61.30 N 3.00 W
57.30 N 3.00 W
57.30 N 1.00 E
61.30 N 1.00 E

Number of stations sampled : 13
Total number of stomachs :154
Total number of stomachs empty : 2
Total number of stomachs regurgitated : 1
Percentage of stomachs empty :1.3

Taxon	Size group	weight grams per pred.	weight %	number per pred.	number %
Copepoda	.1-.14 cm	0.03	0.5	128.62	49.1
	.2-.24 cm	0.02	0.4	44.16	16.9
	.3-.39 cm	0.04	0.7	43.51	16.6
Calanus finmarchicus	.3-.39 cm	0.01	0.2	10.98	4.2
Euphausiidae	.7-.99 cm	0.02	0.3	2.18	0.8
	unknown	0.02	0.4	1.34	0.5
Meganyctiphanes norvegica	1.-1.4 cm	0.02	0.4	0.66	0.3
	2.-2.4 cm	0.01	0.1	0.12	0.0
	3.-3.9 cm	0.02	0.4	0.10	0.0
Thysanoessa	1.5-1.9 cm	0.01	0.1	0.13	0.0
	2.-2.4 cm	0.01	0.1	0.13	0.0
Thysanoessa inermis	1.-1.4 cm	0.41	6.8	22.73	8.7
Salpidae	1.5-1.9 cm	0.02	0.3	0.42	0.2
	unknown	0.01	0.2	0.11	0.0
Teleostei	unknown	2.01	33.4	2.88	1.1
Maurolicus muelleri	5.-6.9 cm	0.09	1.5	0.05	0.0
Trisopterus esmarkii	4.-4.9 cm	0.06	1.1	0.10	0.0
	5.-6.9 cm	1.41	23.5	0.89	0.3
	7.-9.9 cm	0.14	2.3	0.05	0.0
	unknown	0.03	0.4	0.02	0.0
Ammodytidae	3.-3.9 cm	0.04	0.7	0.24	0.1
	4.-4.9 cm	0.20	3.4	0.43	0.2
	5.-6.9 cm	0.82	13.7	1.13	0.4
	7.-9.9 cm	0.33	5.5	0.25	0.1
	unknown	0.19	3.2	0.31	0.1
9999999999	unknown	0.01	0.1	-0.06	0.0



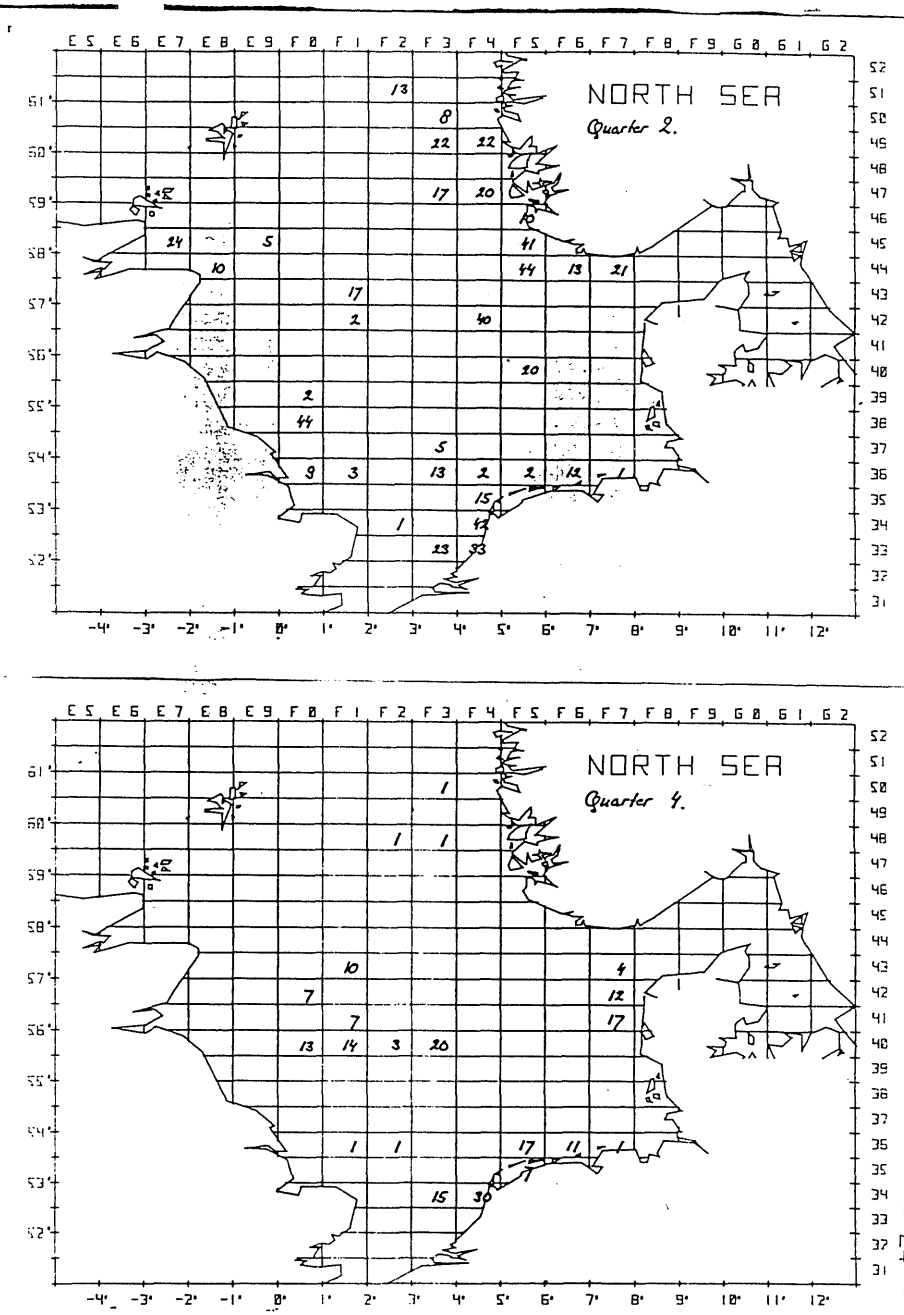
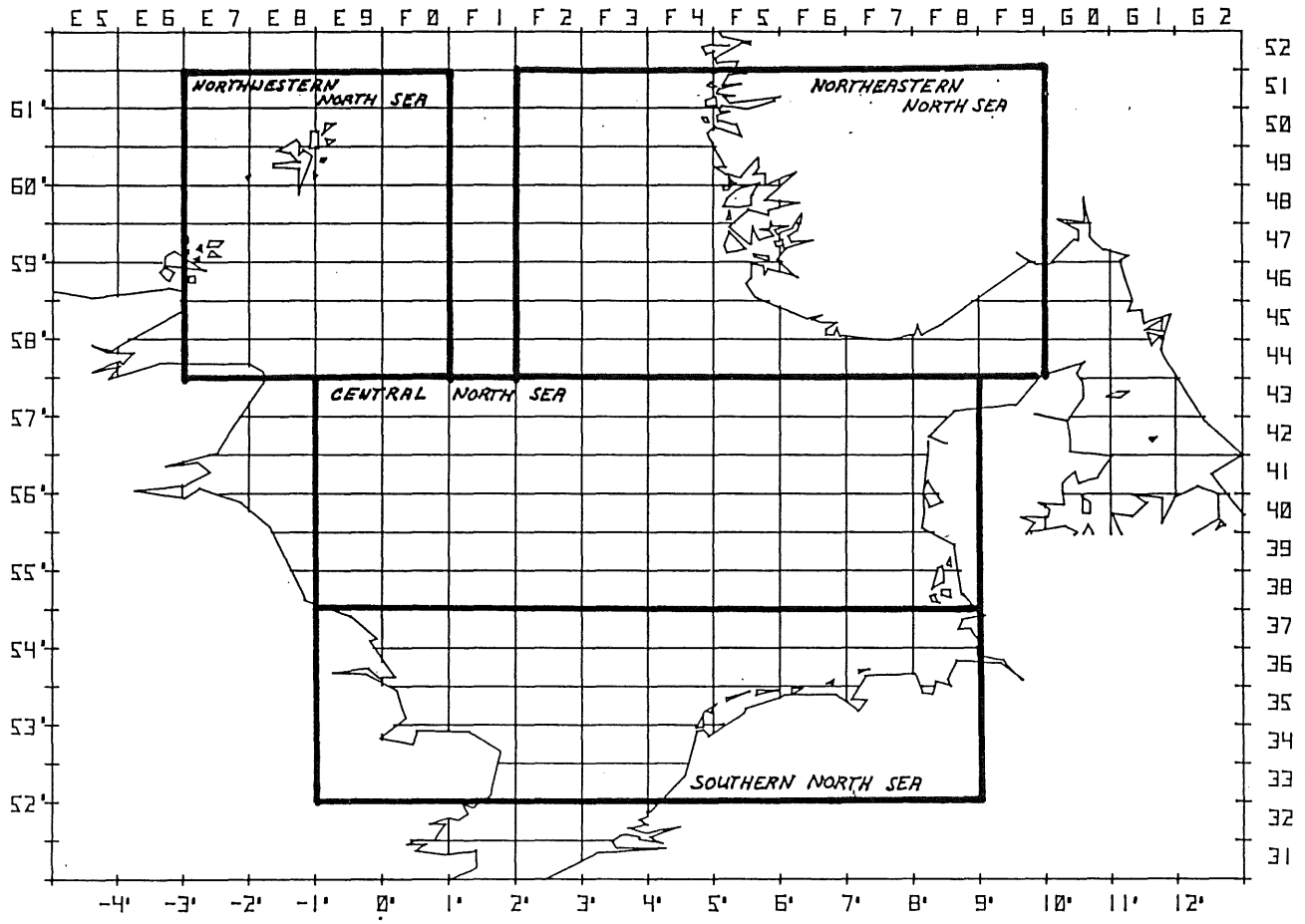


Fig. 5.5.1

Number of MACKEREL stomachs samples by statistical rectangle and quarter.

Fig. 5.5.2.

Definition of the areas used to separate the samples of mackerel stomachs.



6. Preliminary comparisons

The size distribution (by weight) of the prey fish eaten by each size of predator has been estimated for cod from Q1 and Q2 1981 (fig. 6.1. and 6.2.), for saithe for all data combined from 1980 - 1982 (fig. 6.3.) and for mackerel for all 1981 results from an area of the North Sea south of 54°30'N (fig. 6.4.). For mackerel only two size classes have been considered and the size distribution of other prey than fish has been included in the figure. Figure 6.5 plots the average length of fish prey for each size group of the three predators.

These preliminary results show that for cod in Q1 1981 average fish prey size increased steadily from 57 mm for the 10 - 15 cm size class to 241 mm for the 100 - 150 cm size class.
Similarly for cod in Q2 the average fish prey size increased steadily from 43 mm for the 10 - 15 cm size class to 244 mm for the 100 - 150 cm size class.
For small saithe the average fish prey size was similar to that of the cod of the same 25 - 30 cm size class at 74 mm but the large saithe of the 100 - 150 cm eat considerably smaller fish prey than did the equivalent sized cod. The average length of fish prey for the 100 - 150 cm saithe was 165 mm. This apparently nonisometric change in fish prey length with saithe predator size group is probably due to the preponderance of sandeel in the diet of the small saithe. Since the weight length relationship of sandeel runs at a considerably lower level than of other fish, this suggests that saithe are eating fish of a lesser weight than cod throughout their size rang.
The average fish prey length of mackerel was similar to that of cod, being 72 mm for the 15 - 34 cm length group and 114 mm for the 35 - 49 cm length group.

Fig. 6 - Size distribution of prey in weight % for different predator size classes (Black columns: fish prey only; open columns: other prey; 9999: prey size not known).

Fig. 6.1 - COD: 1st quarter 1981

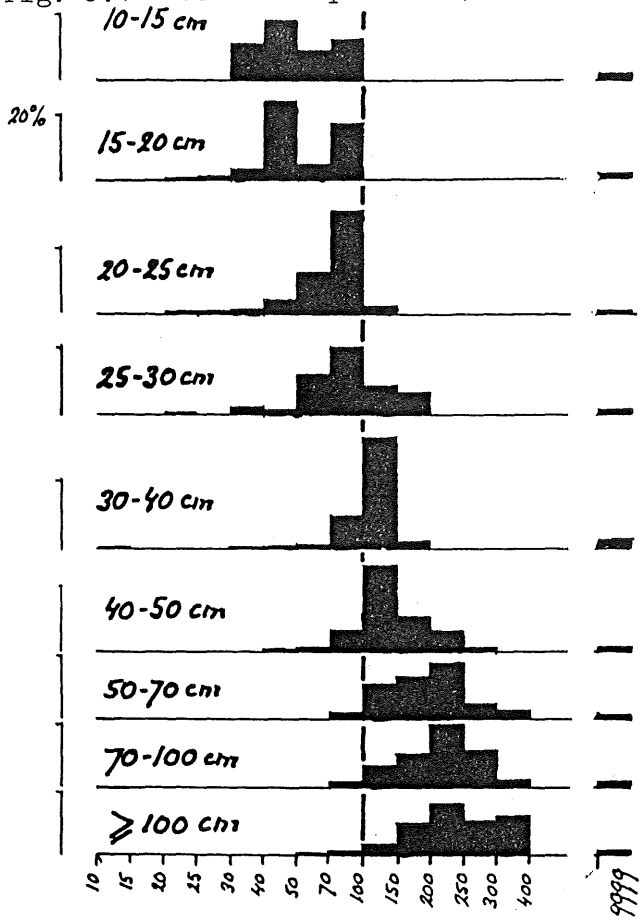


Fig. 6.2 - COD: 2nd quarter 1981

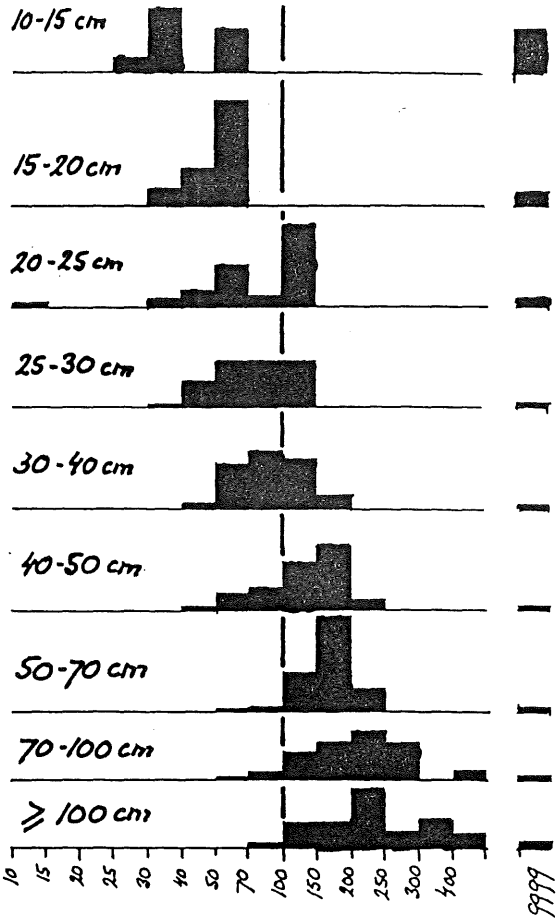


Fig. 6.3 - SAITHE: all quarters combined

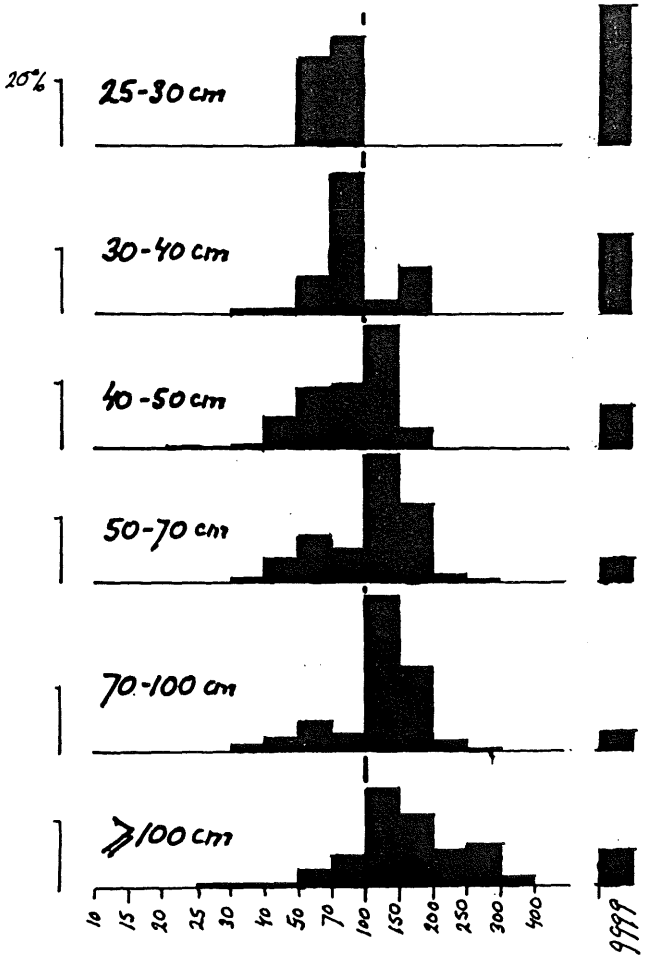


Fig. 6.4 - MACKEREL: 2nd, 3rd and 4th quarter 1981 combined

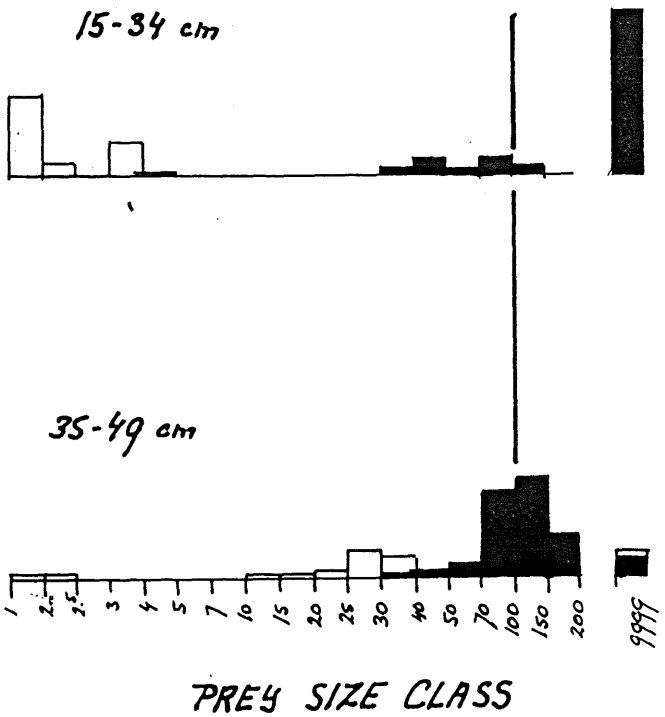


Fig. 6.5 - Average length of fish prey in relation to predator size group midpoints.

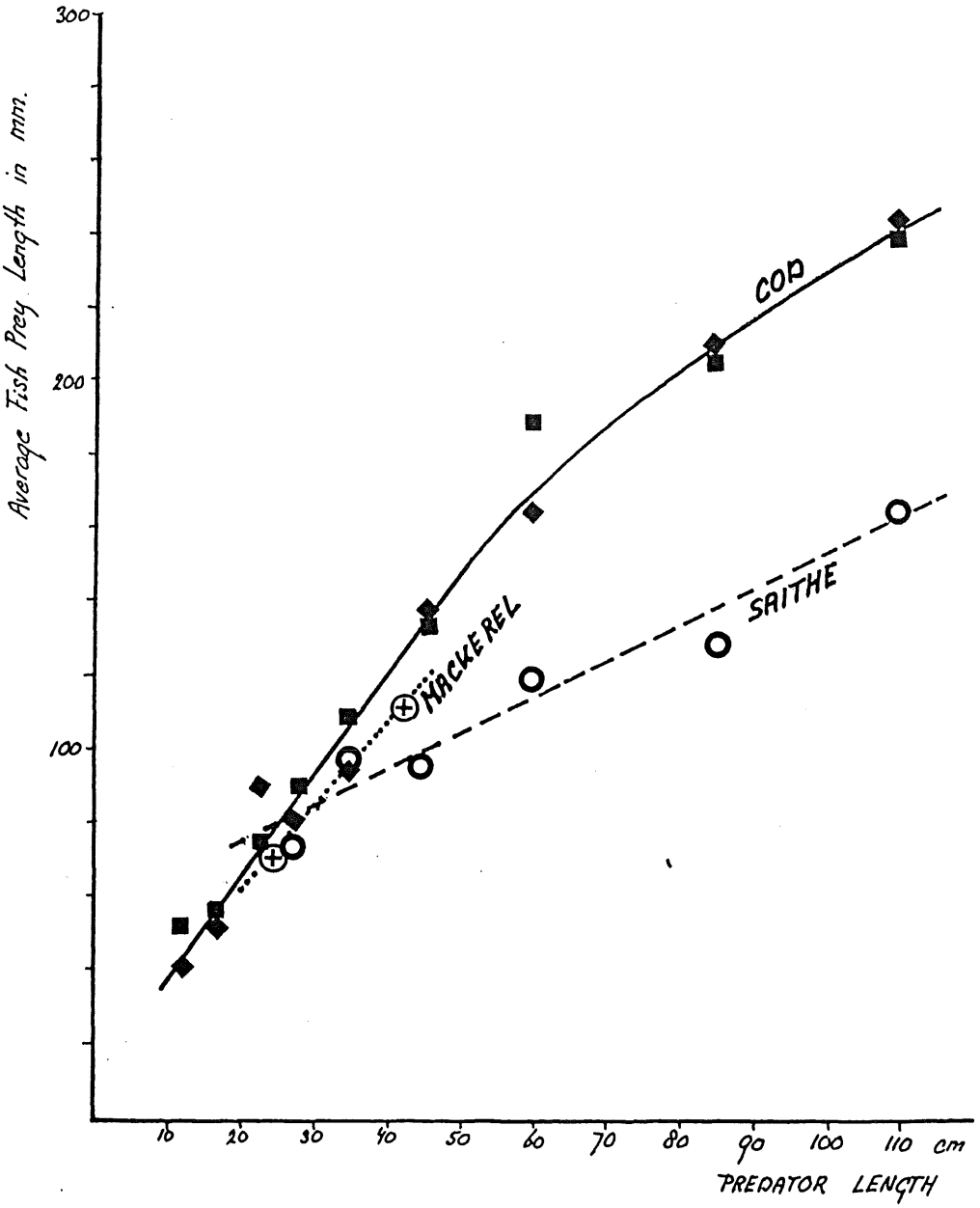
■ - Cod Q1

◆ - Cod Q2

O - Saithe, all data 1980 - 1982

⊕ - Mackerel, all data 1981 south of 54°30'N

Lines have been drawn by eye.



7. Sundry related topics

7.1. Food preference analysis

At the institute in IJmuiden a start has been made in the application of the method of interpretation of stomach contents data in relation to prey abundance developed by ANDERSEN (1981), which has been earlier applied to real data from Kiel bay by ARNTZ & URSIN (1981 a, b), to the North Sea cod data, but no results were as yet available to the group.

7.2. Digestion experiments

The importance of digestion experiments in relation to stomach content studies has been well recognized by the ICES ad hoc Working Groups on Multispecies Assessment in the North Sea and in the Baltic (ANON., 1980; ANON., 1980a). Now that the results of the stomach sampling project become available, the immediate problem of estimating food consumption places a high priority on such experiments.

Dr. H. Heessen has recently been carrying out digestion experiments on cod at the IJmuiden laboratory and some preliminary results are incorporated in this report. Figure 7.2.1 presents graphs indicating the % recovered food in the stomachs after different time lapses for cod of three different size classes, fed on brown shrimp of two different size classes and on one size class of herring. All experiments refer to an ambient temperature of 11°C. In figure 7.2.2 all available data points for the different size classes of cod are shown for the two prey species separately.

Although the information is still rather limited, several features become apparent from these data. The linear approximation of stomach evacuation seems to be as good as anything else as a description of the remaining weight at time expressed as the percentage of the food ingested. Secondly, the main difference between digestion of brown shrimp and herring appears to be that digestion of the former is rather more variable than that of herring. The average digestion rate appears to be approximately the same (60 hours). Thirdly, the high percentage of food recovered after up to 18 hours after feeding is in contrast with many digestion experiments in which pellets or chopped pieces of meat have been used. This indicates that at the beginning the loss of weight is retarded because it needs time for the gastric enzymes to penetrate through the skin of the prey. In fact this feature suggests that the often advocated exponential model for digestion has some serious drawbacks. Also, the earlier experiments with fragmented prey or pellets appear not to be directly applicable to natural situations. Lastly, the level of variation in the results for individual size groups of predator and size groups of prey indicate that probably rather large numbers of experimental animals have to be sacrified in order to establish differential digestion rates between size groups of predator and prey.

In Aberdeen it was planned to carry out similar experiments on whiting. Although it proved difficult to obtain live whiting in 1981 and only seven observations were made on the rate at which sandeels are digested, a large number of live whiting was established in July 1982 and it is intended to undertake further experimental work in September.

Experimental work on mackerel and saithe to be carried out in seine nets in Norwegian fjords is still under consideration.

The general design of this kind of experimental work was discussed. One difficulty is the vast number of possible combinations of predator size class, prey size class and prey type from which in practive only a few can be selected. In order to make efficient use of the limited

effort available it might seem appropriate to follow a Latin square matrix design, in which a restricted number of possible combinations are chosen. Another possibility would be to calibrate digestion rates for extremes in the range of predator and prey size for specific organisms and interpolate from these over the total range. However useful such approaches would be from a theoretical point of view, in practice problems arise in respect of the availability of the required combinations, because the experiments are heavily dependent on obtaining experimental fish, that are prepared to take the food that the experimental design would require. One, therefore, is inclined to use the rather haphazardly collected specimens at hand, but it was concluded that the experiments carried out by the different laboratories should be organized in such a way that they would yield complementary results and that they should cover as wide ranges of size classes and prey types as possible rather than being concentrated on the most convenient size classes of predator and prey items.

Fig. 7.2.1 - Percentage recovered food against time lapse after feeding for different size classes of cod and for different prey:
A - Cod fed on brown shrimp of 40 - 49 mm.
B - Cod fed on brown shrimp of 60 - 69 mm.
C - Cod fed on herring of 15 - 20 mm
Courtesy of Dr. H. Heessen, IJmuiden

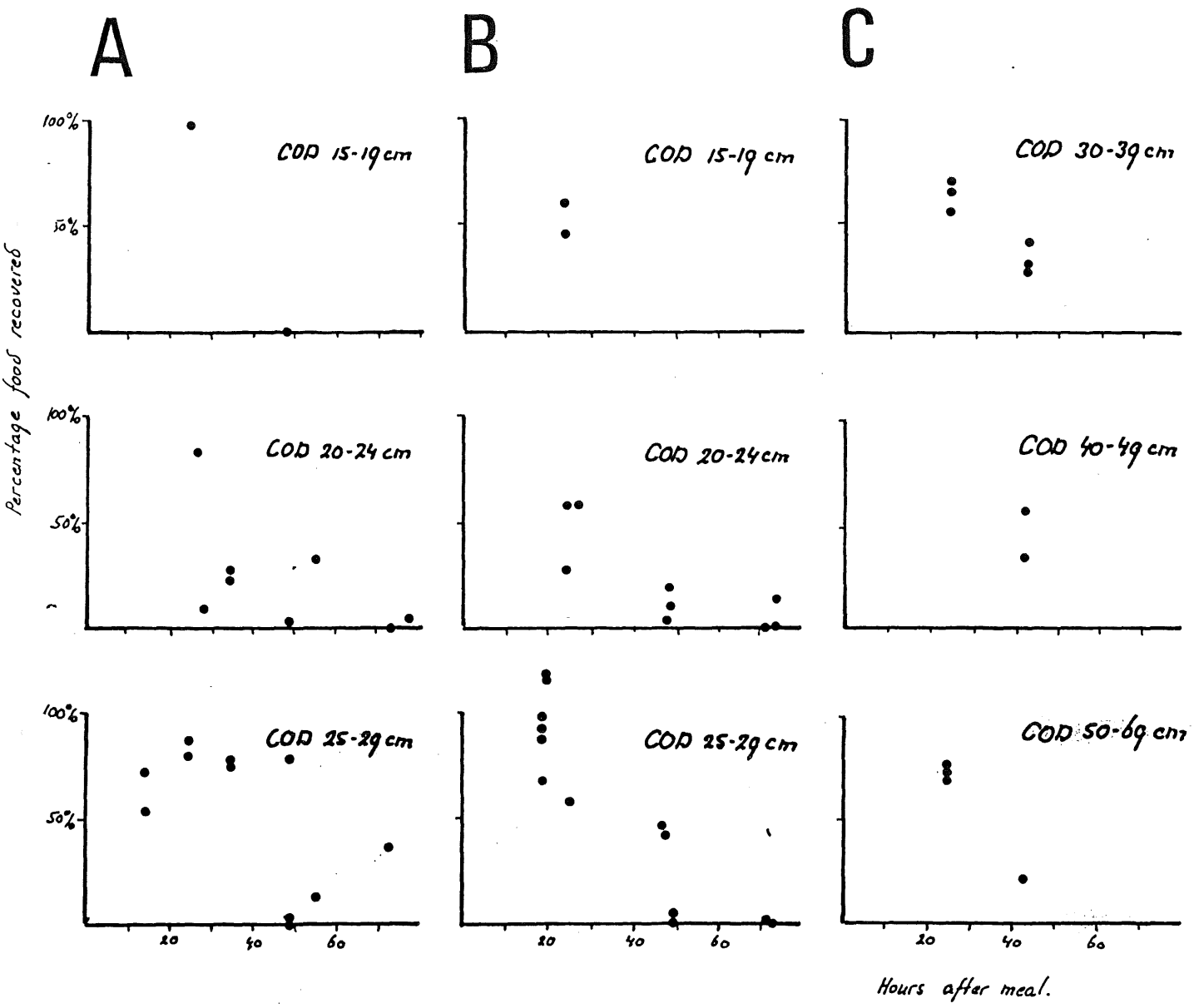
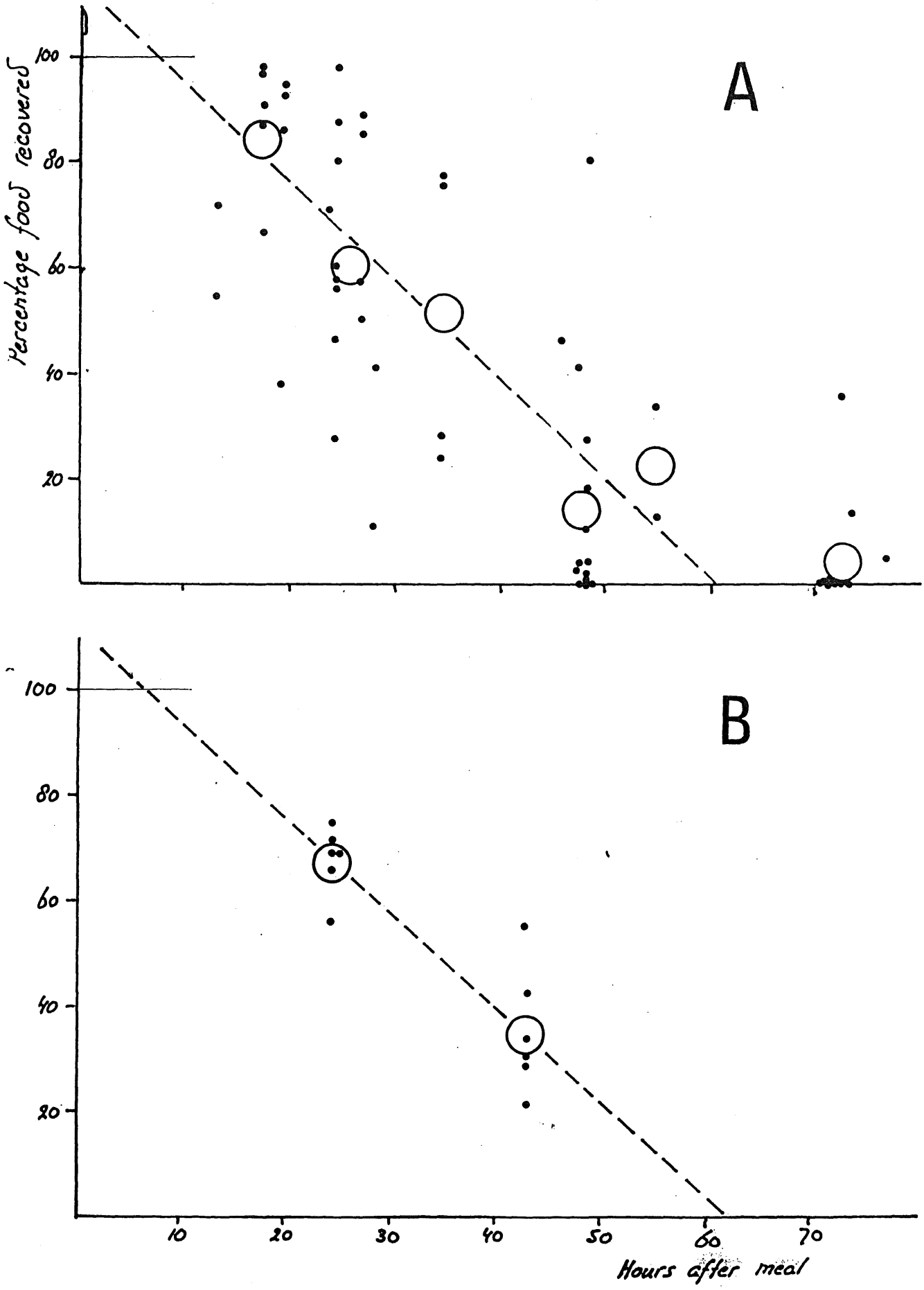


Fig. 7.2.2 - Percentage recovered food against time lapse after feeding for two prey types: A - brown shrimp
B - herring
(experiments with different predator and prey size classes combined)
Lines are drawn by eye through means for grouped data.
Courtesy of Dr. H. Heessen, IJmuiden.



8. Problems associated with the 1981 stomach sampling project

8.1. The analysis of the haddock stomach contents

Because haddock are essentially browsing feeders, their stomachs typically contain large numbers of small food items, covering a wide range of taxa, and the food items are often macerated. This creates considerable problems when a large amount of material has to be analysed according to the instructions set out in the Manual for the Stomach Sampling Project. The Group discussed ways in which the analysis might be facilitated, bearing in mind the main aims of the project and the need to have results within a reasonable period of time. It was decided that only fish prey, and any crustacean of commercial importance (Crangon, Pandalus, Nephrops) should be treated according to the detailed analysis set out in the Manual. All other invertebrates should be treated cursorily and should be weighed and counted after classification according to major taxa such as echinoderms, crustaceans etc. The possibility of a more detailed analysis of the non-fish prey at a later stage could be left open by keeping the samples. In addition, some laboratories offered to take over part of the analysis of the samples along the lines proposed above, if this would help the coordinator for haddock.
However, the Group decided that the final decision on which course to follow should be taken after consultation with Mrs. Beaudouin.

8.2. Further sampling

The Group noted that the request for additional sampling of saithe and mackerel in 1982, set out in part 1 of the Council Resolution 1981/2.21, had so far met with very limited success. This is partly caused by the fact that there are less research vessel surveys being carried out, but also it appears that some countries still carrying out surveys have overlooked this recommendation. It was concluded that an urgent request for intensive sampling of saithe and mackerel should be repeated for 1983.

In addition, this request should also apply to large cod (over 70 cm) and to large whiting (over 50 cm), whenever these appear in research vessel catches.

Sampling for cod has been continued in 1982 in Roundfish Area 6 (southeastern North Sea) in order to develop a data set, which allows investigations of annual changes in food composition from a restricted area.

8.3. Further analysis

The possibilities of an integrated analysis of the available data for all species has been discussed at length. The general view, however, was that as a first step the coordinators should have a go at a detailed analysis individually and present the results at the Statutory Meeting in 1983 or possibly at the Workshop "Benthic orhanisms as food of demersal fish on the shelves of the North Atlantic", advocated by the North Sea Benthos Working Group (ANON., 1982 b). This individual approach seems to be appropriate because the different species present specific problems, which will require slight modifications in the ways the ultimate food consumption by the average population by age or size group should be calculated. Still, some guidelines for the tabulated data were set out in order to ensure that the results presented in these reports will be comparable:

- Detailed stomach contents composition should be given for the total North Sea, by quarter and predator age group. For fish prey, sizes or, whenever possible, ages should be indicated but for other prey data on size need not be included.
  It is recommended that the Roundfish Area ALK's are used to work up the data.
- Prey size preference data should be given for the total North Sea, by quarter and predator size group. Prey should be grouped in major taxonomic units (Pisces, Crustacea, etc.).
- General comparative data should be presented on factors which may affect estimates of annual food consumption by quarter, predator size group and Roundfish Area (e.g. average stomach content weight, average prey size weight etc.).
- Preliminary estimates of the annual food consumption should be given for the total North Sea, by predator age group, with particular reference to consumption of various ages of exploited fish species.

As a follow up of these individual species analyses, the Group should meet in early 1984 in order to carry out an integrated analysis. This meeting should be held in a place, where a complete stomach content data bank has been set up (cf section 8.4) and where appropriate analysis software is available.

The results of this meeting could then form the basis for a trial multispecies assessment for the North Sea and it was suggested that ICES might consider setting up a Multispecies Assessment Working Group to meet in 1984, after the meeting of the coordinators and after the period in which the traditional assessment working groups meet.

8.4. Exchange of data

The Group decided that all the basic information should be made available on magnetic tape to all contributing institutes. To this end a record format for the exchange tape should be agreed upon as soon as possible. It was noted that to this end the ICES Systems Analyst should be consulted as well as representatives from computer sections in the different laboratories. In order to facilitate the discussion a proposal has been prepared (table VIII-1), which follows in general the views expressed by the Study Group on Exchange of IYFS data (ANON., 1982c). Tape specifications have already been specified in that report.

In order that the data can be exchanged in the course of 1983 an ultimate decision on the format should be taken before the end of 1982 and timely comments are welcomed.

TABLE VIII-1 - Specification of record type stomach content data.

Position	Name	Type (1)	m/o (2)	Range	Comments
1- 2	Record type	2 A	m		fixed value HH.
3	Quarter	1 N	m	1 to 4	
4- 6	Country	3 A	m		ICES alpha code (see App. I of ANON., 1982 c, default XXX).
7- 9	Ship	3 A	m	not yet defined	See ANON., 1982 c, default XXX.
10-12	Gear	3 A	m	not yet defined	See ANON., 1982 c, default XXX.
13-14	Year	2 N	m	65 to 99	
15-16	Month	2 N	m	1 to 12	
17-18	Day	2 N	o	1 to 28/29/30/31	Not known 99.
19-22	Time hauled	4 N	m	0 to 2400, 9999	In GMT, not known 9999.
23-25	Fishing depth	3 N	o	0 to 999	In metre, 0 decimal.
26-29	Square	4 AN	m		ICES Statistical rectangle.
30-39	Predator code	10 N	m		NODC 10 digit code.
40-44	Predator size code	5 N	m	-1 to 99999	See appendix I.
45-51	Number per hour fishing	7 N	o		
52-54	Number with food	3 N	m		
55-57	Number regurgitated	3 N	m		
58-60	Number empty	3 N	m		
61-70	Prey species code	10 N	m		NODC 10 digit code.
71-77	Prey size code	5 N	m	-1 to 99999	See appendix I
78-85	Prey weight	8 N	m		In mg.
86-91	Number of prey	6 N	o		No information: space filled
92-100	Padding field	9 N			Space filled

(1) All numeric fields (N) right justified, zero filled.
all alpha (A) and mixed alpha/numeric fields (AN) left justified, space filled.

(2) m : mandatory ; o : optional.

9. Future programmes of stomach sampling

The rationale of the 1981 Year Of The Gut was to provide a nonsubjective basis for estimating the matrix of vulnerability to predation by each predator species size class, for each prey species size class. This matrix is essential to the practical use of multispecies virtual population analysis and analogous multispecies size/age structured models of predation.
The matrix may be considered (URSIN, 1982) to be the product of size preference effects, species suitability effects (behaviour etc.) and effects resulting from geographical overlap of predator and prey. Current models imagine these effects to remain the same from year to year so that the diet composition of each predator size group is only a factor of relative abundance of prey of each species and size. This may not be the case. For example, threshold effects such as prey/predator switches might alter the first two factors while geographical distributions may change with time. There will thus be a need to investigate the hypothesis of a stationary preference matrix. This might be investigated in part by examination of the detailed components but the most definitive test will be provided by a second, and possibly subsequent, exercize similar to that of 1981 aimed to provide annual consumption results. Provided that these results are of suitable precision they will enable any important shifts in preference to be detected. Clearly, the development of precision estimates for the consumption figures, the investigation of the likely scale of a significant shift in preference and the determination of appropriate precision levels to detect such shifts will be important tasks which will need to be carried out before a second exercize can be planned.
Specific questions related to the preference model might be better addressed by intensifying sampling in particular areas and/or seasons, possibly in connection with such a main programme. In this respect a combination of intense stomach content studies and studies of prey biomass distributions in the environment can be expected to elucidate the factors underlying apparent preference changes.

Since it is foreseen that in 1984 the analysis of the 1981 project will be advanced to the stage that actual trials of North Sea multispecies assessments can be made, the planning of a follow up of the Stomach Sampling Project in 1985 should be considered. Essentially the same amount of research vessel effort would be required as in 1981 to collect the samples because both the geographical and the time scale of the sampling would be bound to be the same. However, the intensity of sampling (numbers of stomachs to be collected per size class; the significance of sampling the smaller size classes of the different predators) should be critically reviewed as well as the amount of detail to be collected in the stomach contents analysis. This may well result in a reduced laboratory work load.

10. Recommendations

1. Sampling of all size classes of saithe and mackerel and of large cod (over 100 cm) and large whiting (over 50 cm) should be continued in 1983, whenever catches of these species size groups are made by research vessels.
   In addition sampling programmes on board commercial vessels should be initiated.
2. The Mackerel Working Group should look into the problems of biomass distributions of the North Sea mackerel stock in different quarters in order to give guidelines how to estimate the average consumption by the total stock based on weighting factors for the stomach samples

taken in different areas.

3. Species coordinators should present individual reports on analysis of stomach content data in 1983 in order to prepare a basis for an integrated analysis in 1984.

4. The precision of prey consumption estimates should be estimated and the sensitivity of the vulnerability factors to these effects should be investigated.

5. The species coordinators should meet again in early 1984 in order to carry out an integrated analysis of the complete data set in order to set the stage for a Multispecies Assessment Working Group later in that year.

11. References

Andersen, K.P., 1981 - An Interpretation of the Stomach Contents of Fish in Relation to Prey Abundance. ICES C.M. 1981/L: 43.

Anon., 1980 - Report of the Ad Hoc Working Group on Multispecies Assessment Model Testing. ICES C.M. 1980/G: 2.

Anon., 1981 - Report of the Mackerel Working Group. ICES C.M. 1981/H: 7.

Anon., 1982a - Report of the Ad Hoc Working Group on Multispecies Assessments in the Baltic. ICES C.M. 1982/Assess.: 15.

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APPENDIX I - List of size class codes to be used on the exchange tape for stomach content data.
Note that in respect of the standard notation the codes have to be multiplied by 10.
Code -1 has been added to take account of Nauplii.

-1 = Nauplii
0 = Egg.

1	= 0.01	- 0.019	cm,
2	= 0.02	- 0.029	cm,
3	= 0.03	- 0.039	cm,
4	= 0.04	- 0.049	cm,
5	= 0.05	- 0.059	cm,
6	= 0.06	- 0.069	cm,
7	= 0.07	- 0.079	cm,
8	= 0.08	- 0.089	cm,
9	= 0.09	- 0.099	cm,
10	= 0.1	- 0.14	cm
15	= 0.15	- 0.19	cm,
20	= 0.2	- 0.24	cm,
25	= 0.25	- 0.29	cm,
30	= 0.3	- 0.39	cm,
40	= 0.4	- 0.49	cm,
50	= 0.5	- 0.69	cm,
70	= 0.7	- 0.9	cm,
100	= 1.0	- 1.4	cm,
150	= 1.5	- 1.9	cm,
200	= 2.0	- 2.4	cm,
250	= 2.5	- 2.9	cm,
300	= 3.0	- 3.9	cm,
400	= 4	- 4.9	cm,
500	= 5	- 6.9	cm,
700	= 7	- 9.9	cm,
1000	= 10	- 14	cm,
1500	= 15	- 19	cm,
2000	= 20	- 24	cm,
2500	= 25	- 29	cm,
3000	= 30	- 39	cm
3100	= 30	- 34	cm,
3500	= 35	- 39	cm,
4000	= 40	- 49	cm,
4100	= 40	- 44	cm,
4500	= 45	- 49	cm,
5000	= 50	- 69	cm,
7000	= 70	- 99	cm,
10000	= 100	-149	cm,
99999	= unknown or not recorded.		