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OBSERVATIONS ON HERRING LARVAE CAUGHT BY ISAACS-KIDD MIDWATER TRAWL DURING THE INTERNATIONAL YOUNG FISH SURVEYS IN THE NORTH SEA, SKAGERRAK AND KATTEGAT IN 1977 - '81

by

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Abstract

Sampling of pre-metamorphosis herring larvae by IKMT has shown great variations in abundance and geographical distribution from year to year. However, 4 out of 5 year-classes sampled by IKMT have now been assessed one year later by bottom trawl, and they all appear to be of equally poor strength. It is supposed that it is of vital importance for the larvae to reach the inshore waters of the central and southern North Sea before the spring plankton bloom. According to this hypothesis, prospects for the last year-class sampled (1980) should be better than for any of the preceeding ones.

Introduction

In recent years, sampling of pre-metamorphosis herring larvae has become a routine part of the International Young Fish Surveys (IYFS) in the North Sea, Skagerrak and Kattegat. These surveys, which are conducted each year in February, are primarily aimed at sampling juvenile herring and gadoids by means of a standard bottom trawl. In addition to the bottom trawling during daytime, most participants use an Isaacs-Kidd Midwater Trawl (IKMT) to fish for pre-metamorphosis herring larvae at night. The objective of the IKMT-sampling is to find out whether the abundance of pre-metamorphosis herring larvae (about 5 months old in February) can be used as a first estimate of the final strength of the year-class concerned. In addition, the distribution pattern of the larvae in February might provide information on drift routes; variations in drift patterns from year to year, and differences in survival rate between larvae from various spawning grounds.

Sampling by IKMT was first undertaken by Swedish workers in the, Skagerrak, and later extended to adjacent parts of the North Sea (Ackefors, 1974, 1975). Other participants in the IYFS started IKMT-sampling in 1975, but during the first 2 years of this programme, a variety of gears was used, and the results are hard to compare both between countries and between years. A standard version of the IKMT and its fishing method was proposed in 1976 (Anon 1977) and starting from 1977 all countries have gradually adopted this standard gear.

Preliminary results of the IKMT-sampling have been reported by the Herring Assessment Working Group for the Area South of 62°N (e.g. Anon 1981), and in the annual reports of the IYFS (e.g. Corten and Kuiter 1981). These results consisted mainly of numbers/haul for the various statistical rectangles. The present paper, in addition to presenting summarised abundance data, also looks into the length distribution of the larvae. This in order to see whether differences exist between areas and/or years; differences which might be related to the chances of survival for the larvae.

Material and methods

This paper only presents data for the years 1977 -'81. As mentioned in the introduction, some countries did already some IKMT-sampling in earlier years, but the sampling methods and coverage were not consistent enough to use these data for a comparison with the post-1977 period.

The table below shows which countries have participated in the IKMT-sampling since 1977.

	1977	1978	1979	1980	1981
Sweden	x	x	x	x	x
England	x	x	x	x	x
Norway	x	x	x	x	x
Netherlands	x	x	x	x	x
Scotland	x	x	x	x	x
France			x	x	

During all these cruises, the standard "Swedish" IKMT was used, except for the English cruise in 1977, on which a "Boothbay net" of 1.83 x 2.74 m mouth opening was used.

The standard IKMT is described in full detail in Anon 1976. The mouth opening of the net is 2.5 x 4.0 m, and the total length 13.3 m. Mesh size decreases from 25 mm bar in the front panel to 16 mm and 11 mm bar in the middle section, and 5 mm bar in the last section. The cod end has a lining of nylon plankton gauze with rectangular mesh openings of 1.15 mm.

The net was fished in double oblique tows from the surface to 5 metres off the bottom and back. Maximum fishing depth was 100 m in the North Sea and 50 m in the Skagerrak. Towing speed was 3 knots. According to the standard instructions, the fishing warp was paid out at a rate of 25 m per minute, and retrieved at 12½ m per minute. Hauls were made only during the hours of darkness; this in order to minimize net avoidance by the larvae.

The duration of the hauls depended on the depth of the water. Figure 1 shows the relationship between the two parameters as measured during the Dutch survey in 1981. It is seen that the relationship remains approximately linear over the whole range of water depths.

Making the tows according to this standard procedure ensures that all catches refer to the same surface area, irrespective of water depth. The exact size of this surface area is unknown, but its upper limit may be calculated as follows:

The relationship between water depth and tow duration in figure 1 can be approximated by the formula

$$y = 2.78\,x$$ in which y = bottom depth in meters, x = tow duration in minutes

Taking into account a net opening of 10 m^2 and a towing speed of 3 knots (92.6 m/min), the volume of water filtered per minute is 926 m^3.

For a given depth y', the duration of the tow is $\frac{y'}{2.78}$ minutes, and the volume filtered is

$$\frac{y'}{2.78} \cdot 926\ m^3 = y'.333\ m^3$$

The quantity of larvae taken in that haul correspond to a surface area of

$$\frac{y'.333}{y'} = 333\ m^2$$

As mentioned above, the figure of 333 m^2 is the upper limit for the standard surface area that all tows refer to. This figure is based on the assumption that all larvae present in the volume filtered, are retained in the net. In practise, there may be avoidance of larvae in front of the net, and escapement through the large meshes in the first parts of the net. The actual number of larvae caught in a standard tow will therefore refer to a surface area of less than 333 m^2, but still this (unknown) surface area will be the same for all hauls.

In this paper, all catches have therefore been expressed simply in numbers per haul, assuming that all participants have followed the standard fishing procedure, and also assuming that the relationship between bottom depth and tow duration has been the same for all vessels.

Results

Mean numbers per haul and mean lengths per statistical rectangle are shown in figures 2a - e for each survey in the period 1977 -'81.

In order to present length frequency distributions, a subdivision of the North Sea into somewhat larger areas had to be devised, as it would be unpractical to present LFD-s on a rectangle basis. The area subdivision used for this purpose is shown in figure 3, and the corresponding LFD's are given in table 1 and figure 4 for each year separately. Table 1 also gives the mean number of larvae per haul for each area.

It is seen that during the first 2 years of observations (1977 -'78), low densities of larvae were found in all parts of the North Sea. Larvae were particularly scarce in the eastern part of the North Sea, which was rather surprising as it is known that the Skagerrak and German Bight are the main nursery areas for the North Sea herring.

In 1979 high densities of larvae were found along the Scottish east coast, and to a lesser extent in the offshore waters of the northern North Sea. It was assumed that these larvae originated from spawning grounds to the west of Scotland. Larvae were still virtually absent from the coastal waters of the central and southern Nort Sea.

This picture changed drastically in 1980, when high numbers of larvae were found all over the North Sea. For the first time since the start of the programme, substantical numbers of larvae were found in the Skagerrak, central North Sea, and inshore waters along the English, Danish, German and Dutch coasts. Samples taken in the German Bight contained a much higher proportion of relatively big larvae (> 35 mm) than samples taken in other areas.

In 1981 this trend continued, and the distribution of the larvae shifted even further to the south and east. Very high densities were found in the Skagerrak and along the Danish, German and Dutch coasts. In addition, the larvae found in these waters were bigger than they had been on any previous occasion; both along the Danish and German coast the mean length of the larvae was well over 35 mm.

Relationship between abundance of pre-metamorphosis larvae and subsequent year-class strength

Of the 5 year-classes sampled by IKMT during their pre-metamorphosis stage, 4 have been assessed one year later by bottom trawl. The abundance estimates found at this age ($1\frac{1}{2}$ year) are shown below:

year-class	abundance as $1\frac{1}{2}$ year-olds in No/hour for standard area
1976	575
1977	139
1978	535
1979	551

For background information, it should be mentioned that the average abundance index for year-classes of normal strength in the North Sea (such as 1968 -'73) is about 1500 herring per hour.

The year-classes listed above have therefore all been relatively weak, and of approximately equal strength. Year-class 1977, which in the above table is lower than the other ones, has probably been underestimated during the trawl survey, and should be more in line with the others (Anon 1981).

So all we can conclude for the moment is that the large increase in larval abundance in 1980 has not resulted in a year-class of appreciably greater strength than the preceeding 3 ones. This observation might cast some doubt on the usefulness of the IKMT-programme. If large variations in larval abundance are not reflected in the size of the corresponding year-classes, recruitement strength might be determined after the time of the IKMT-sampling, and the sampling of pre-metamorphosis herring larvae may be of little use in predicting year-class strength. However, it could very well be that the abundance of herring larvae, required for a really strong year-class, is still much higher than the level reached in 1980. This question can only be answered after such a strong year-class (as confirmed by bottom trawling at age $1\frac{1}{2}$) has passed through the IKMT-stage.

Apart from the abundance of larvae in absolute terms, the geographical distribution might also be of importance. It is known that herring need coastal waters to pass through metamorphosis and to grow up during their first summer. The main nursery areas for North Sea herring are the coastal waters of the German Bight, the Skagerrak, and the inshore waters along the English east coast. Probably the larvae have to reach these waters within a given period of time, or else they will starve in the open sea or get eaten by predators. In the years 1977-'79, very few larvae were found in the coastal waters of the central and southern North Sea, and there could be very little hope, therefore, for a succesful recruitement of the corresponding year-classes.

In 1980 the picture was considerably more favourable, but a comparison with 1981 shows that the larvae were still distributed relatively offshore and were of a relatively small size. It could be assumed that, although the larvae had travelled a long way in the right direction, they still didnot make it in time to catch up with the spring plankton bloom in the inshore waters. Another possibility of course is that the numbers of larvae were decimeted in the early spring by some unusually abundant predator.

The picture for 1981 (year-class 1980 which had not yet been sampled at age $1\frac{1}{2}$) is still more favourable than in the preceeding year. The larvae had penetrated even further into the Skagerrak and the inshore waters of the German Bight and their length, especially in the coastal zone is relatively very great. If the IKMT-results are in any way related to subsequent recruitment, year-class 1980 should become stronger than any of the other year-classes sampled so far.

Acknowledgements

This paper is based on the results of a joint international survey and the present authors have contributed only a small proportion of all the basic data. Credit for this work (if any) should therefore equally go to all participants in the IYFS that have contributed to the IKMT-programme.

References

Ackefors, H. 1974 — On the occurrence of herring larvae in March - April, 1972 -'74, in the Skagerrak. ICES C.M. 1974/H : 34.

Ackefors, H. 1975 — On the occurrence of herring larvae in February 1975 in the Kattegat, Skagerrak, and North Sea in conjunction with the North Sea Young Fish Survey. ICES C.M. 1975/H : 31

Anon. 1977 — Report of the Working Group on North Sea Herring Larval Surveys. ICES Coop. Res. Rep. 68.

Anon. 1981 — Report of the Herring Assessment Working Group for the area south of 62°N. ICES C.M. 1981/H :8

Corten, A. and C.J. Kuiter, 1981. — Report on the ICES Young Fish Survey in the North Sea, Skagerrak and Kattegat in 1981 : Herring data. ICES C.M. 1981/H :17

Table 1.
Length distribution herring larvae by sub-area.

AREA	YEAR	Number of hauls	Mean number of larvae per haul	Length distribution in mean numbers per haul x 10																										
				⩽20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	>45
Scottish East Coast	1979	13	76.23	3	3	3	12	15	25	43	52	56	50	63	63	72	66	68	69	41	34	19	5	1	2					
	1980	32	33.38	2	4	7	10	18	29	35	40	36	28	34	22	21	19	10	10	6	2	2	1							
	1981	20	20.60	2	2	1	4	7	8	13	22	24	23	25	20	22	13	9	5	2	1	2	1	2	1	1	1			
English East Coast	1978	12	5.83				1	1	3	3	9	6	7	3		7		10	8	1										
	1979	15	2.00						1	1	2	3	3	3	2	1	1	1	1	1	1	1								
	1980	12	25.50	3	2	5	6	17	14	25	25	27	19	19	17	24	17	12	7	2	5	3	3	3	1			1		
	1981	22	14.01	2	1	11	6	7	25	12	19	20	4	10	6	9	1	2	5	1	1									
Dutch Coast	1977	11	1.18								2	2	1	2	4	1	1													
	1978	19	2.05					1	1	1			1	1	2	3	4	1	2	2	2	2				1				
	1979	9	0.33																1		1	1								
	1980	12	12.75			1		1	7	2	11	11	11	18	11	13	8	6	10	6	3	2	3	5	1		1			
	1981	15	53.42			1	3	1	3	5	6	14	19	39	28	57	55	59	57	54	47	38	15	13	11	5	3	2	1	
German Coast	1977	11	0.45									1		1		1					1						1			
	1978	16	0.81											1		1		1		2	3			1	1					
	1980	10	13.10					2			1	2	7	3	4	6	4	6	5	10	6	13	14	11	10	7	6	10	4	
	1981	12	39.06			1		1	3		3	6	4	12	22	31	31	28	41	40	43	28	22	17	13	18	12	8	3	6
Danish Coast	1978	21	0.29											1					1				1							
	1979	9	0.44							2														1						1
	1980	15	25.07				1	1	3	6	7	11	15	26	31	33	16	17	10	9	9	9	8	9	7	7	9	3	1	
	1981	17	38.60					1	2	2	4	4	7	8	14	22	22	30	38	39	35	40	23	25	21	21	12	8	4	2
Skagerrak	1977	42	0.24													1							1							
	1978	51	0.84			2				1					1	2	1	1	1		1			1						
	1980	42	17.64			1	2	7	10	13	14	18	24	18	14	13	7	8	7	5	5	2	2	3	1	1	1	1	1	
	1981	55	39.25		1	2	3	4	7	10	19	28	27	49	42	36	28	22	26	13	18	14	10	13	4	6	5	3	1	4
Central North Sea	1977	57	1.14	1				1						4	2	2		1					1							
	1978	75	2.99	1		1		1	1	2	1	3	2	4	3	3	3	2	2	1										1
	1979	74	0.64								1					1		1	1		1		1							
	1980	84	42.25	6	5	13	13	29	39	44	47	48	39	37	27	25	17	12	8	7	4	1	1	1						
	1981	102	25.46	1	1	3	3	4	11	11	14	14	11	17	14	28	25	19	23	14	14	10	7	5	2	2	2	1	1	
Northern North Sea	1977	27	3.74								1	3	3	3	5	6	3	7	3	2	1									
	1978	68	4.07	1		1	2	2	6	5	5	6	4	3	3	2	1	1												
	1979	74	11.97		1	2	3	2	5	9	13	15	14	11	13	12	10	5	5	1	1									
	1980	111	20.87	3	5	6	8	13	24	26	24	29	24	19	13	8	4	2	2	1										
	1981	43	4.75	3	1	2	4	4	7	5	4	6	4	3	2	2	1	1												

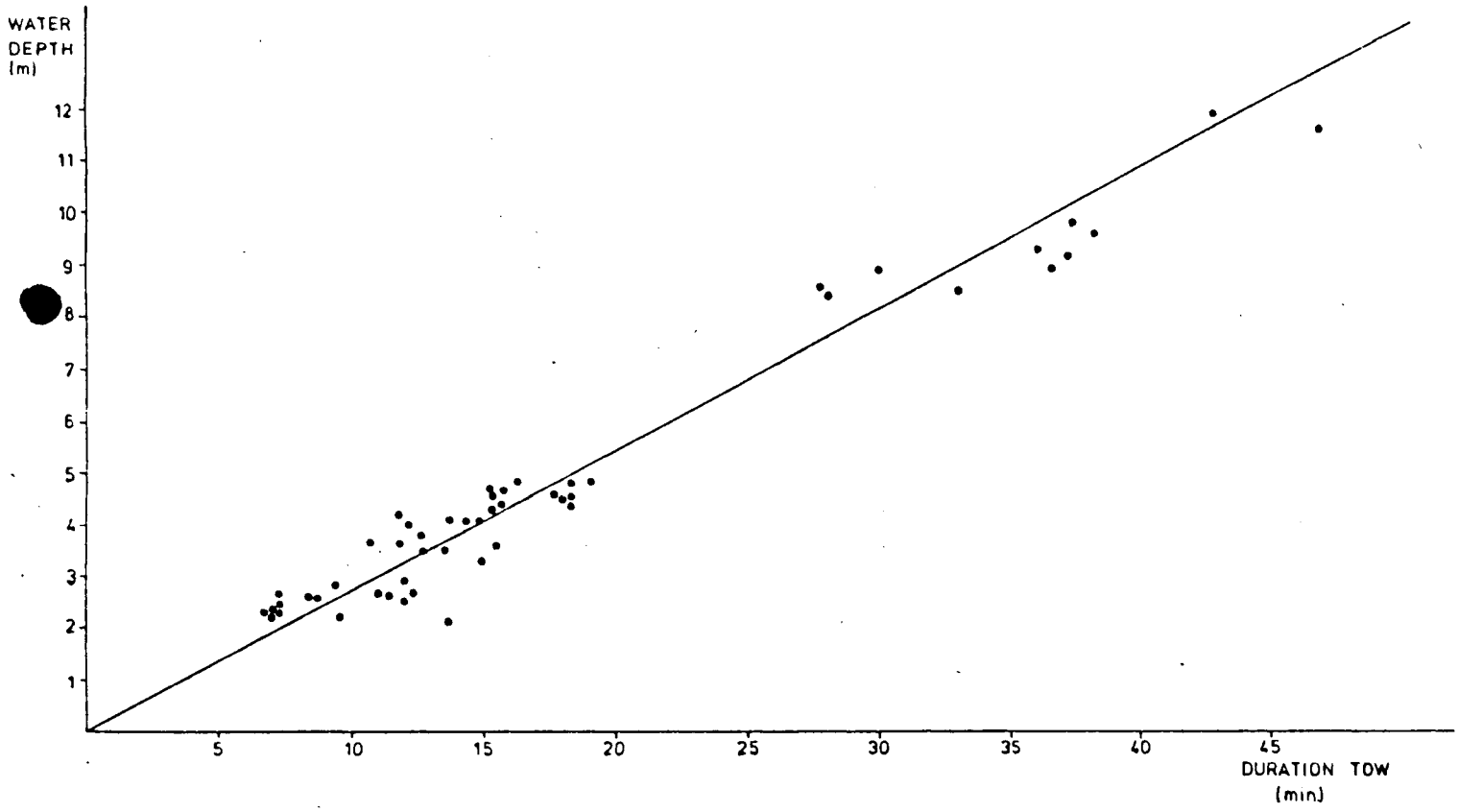

Figure 1.

Relationship between water depth and tow duration, as measured during the Dutch survey in 1981. Regression line drawn by eye.

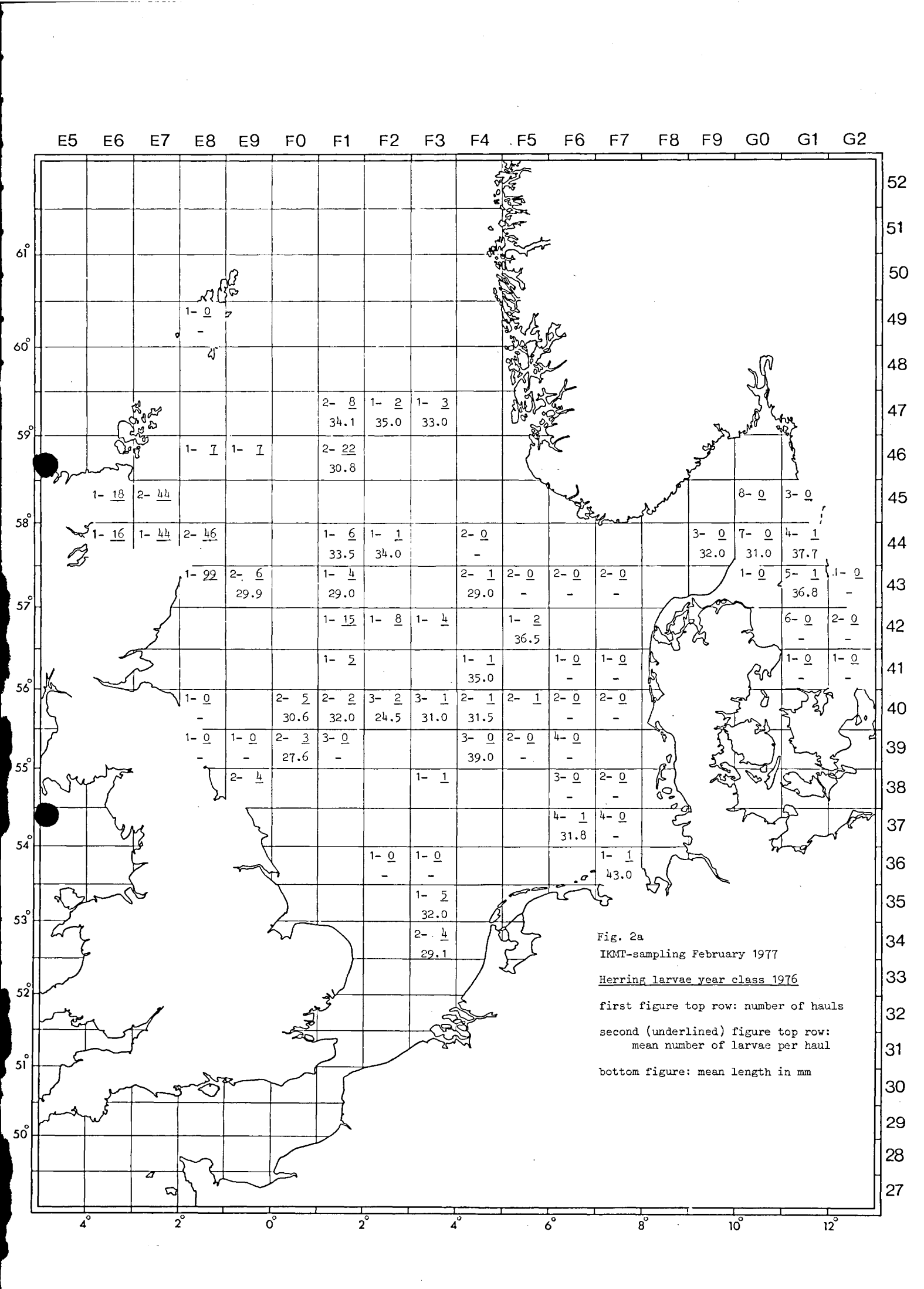

Fig. 2a

IKMT-sampling February 1977

Herring larvae year class 1976

first figure top row: number of hauls

second (underlined) figure top row: mean number of larvae per haul

bottom figure: mean length in mm

Fig. 2b

IKMT-sampling February 1978

Herring larvae year class 1977

first figure top row: number of hauls

second (underlined) figure top row: mean number of larvae per haul

bottom figure: mean length in mm

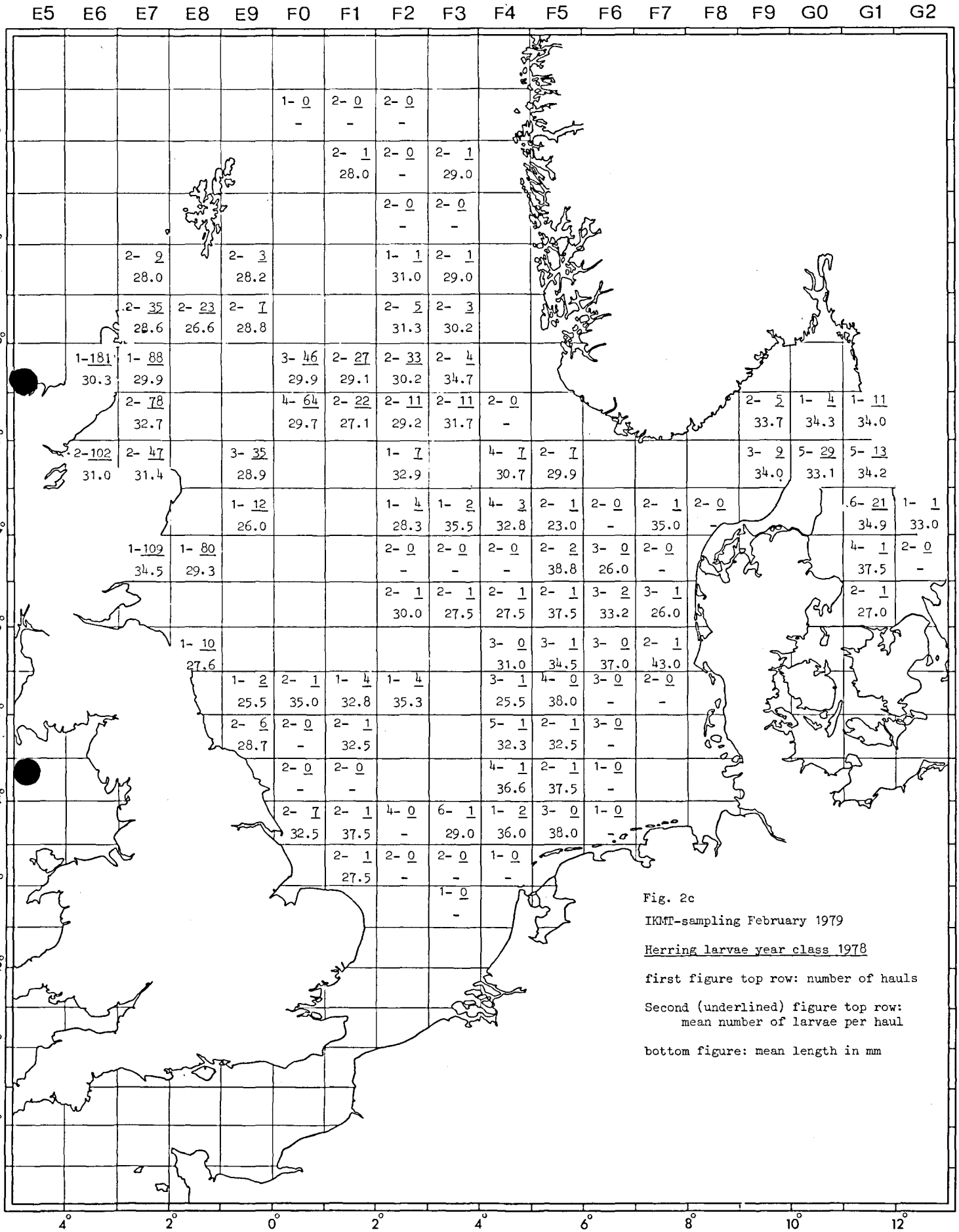

Fig. 2c

IKMT-sampling February 1979

Herring larvae year class 1978

first figure top row: number of hauls

Second (underlined) figure top row: mean number of larvae per haul

bottom figure: mean length in mm

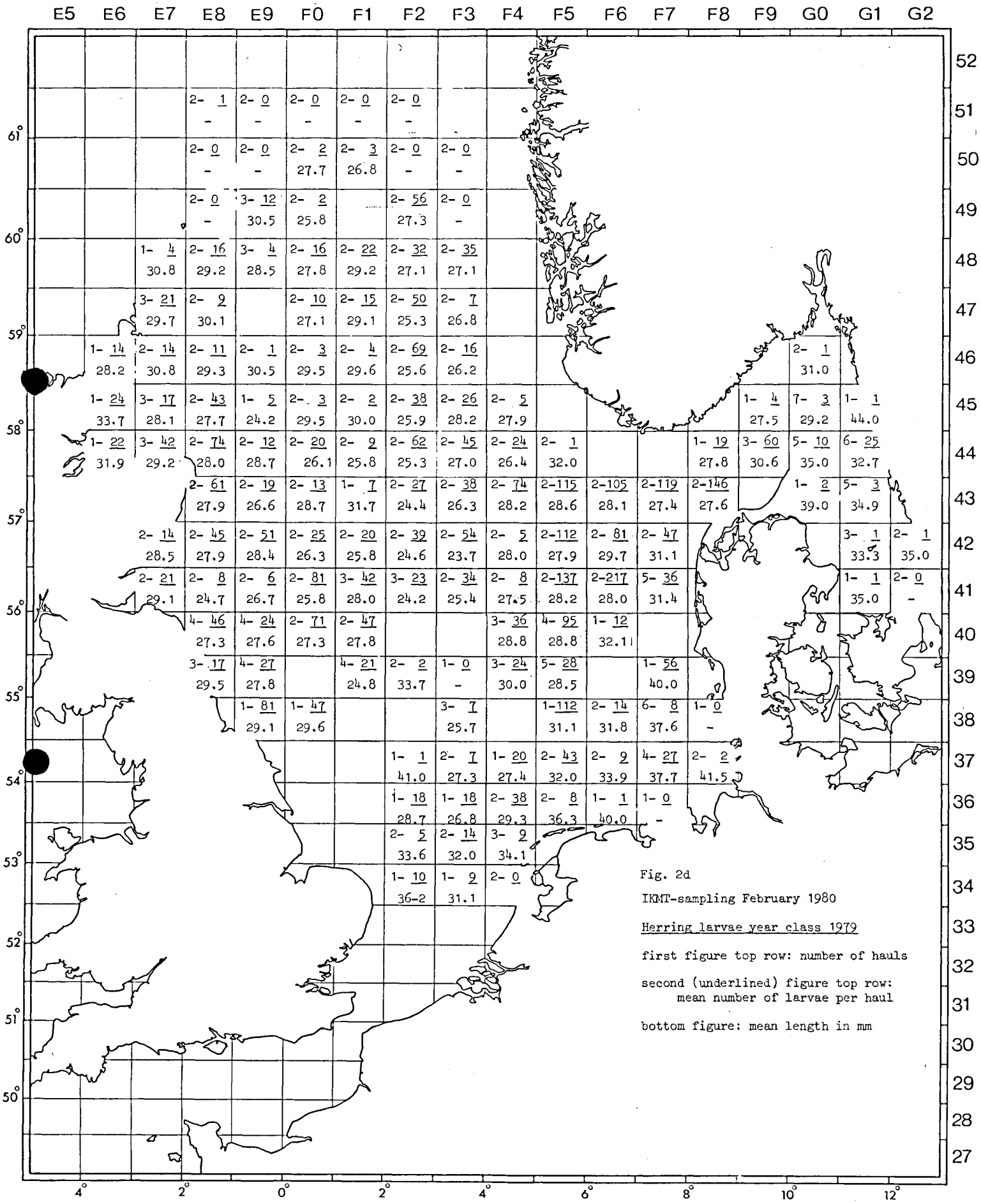

Fig. 2d

IKMT-sampling February 1980

Herring larvae year class 1979

first figure top row: number of hauls

second (underlined) figure top row: mean number of larvae per haul

bottom figure: mean length in mm

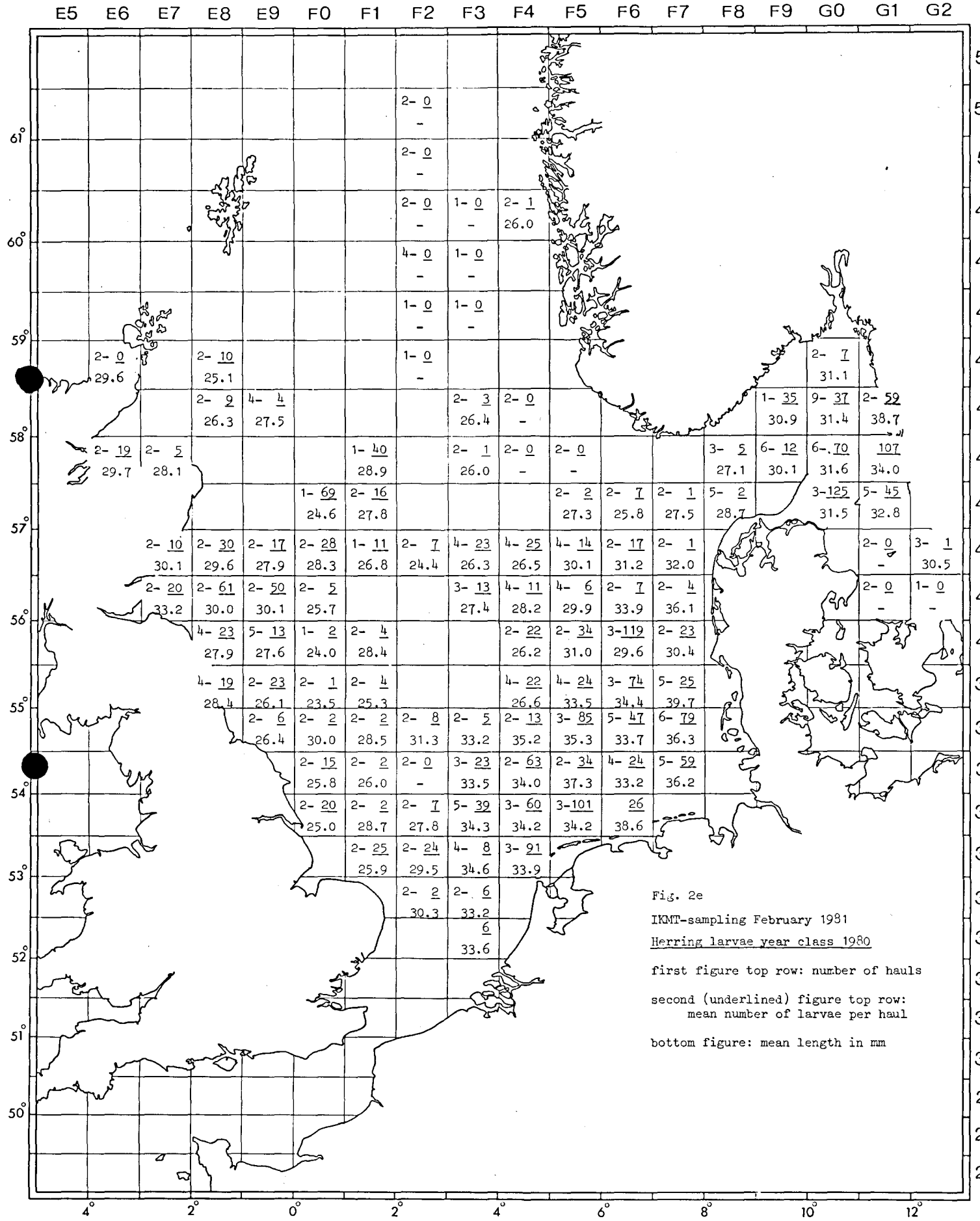

Fig. 2e

IKMT-sampling February 1981

Herring larvae year class 1980

first figure top row: number of hauls

second (underlined) figure top row: mean number of larvae per haul

bottom figure: mean length in mm

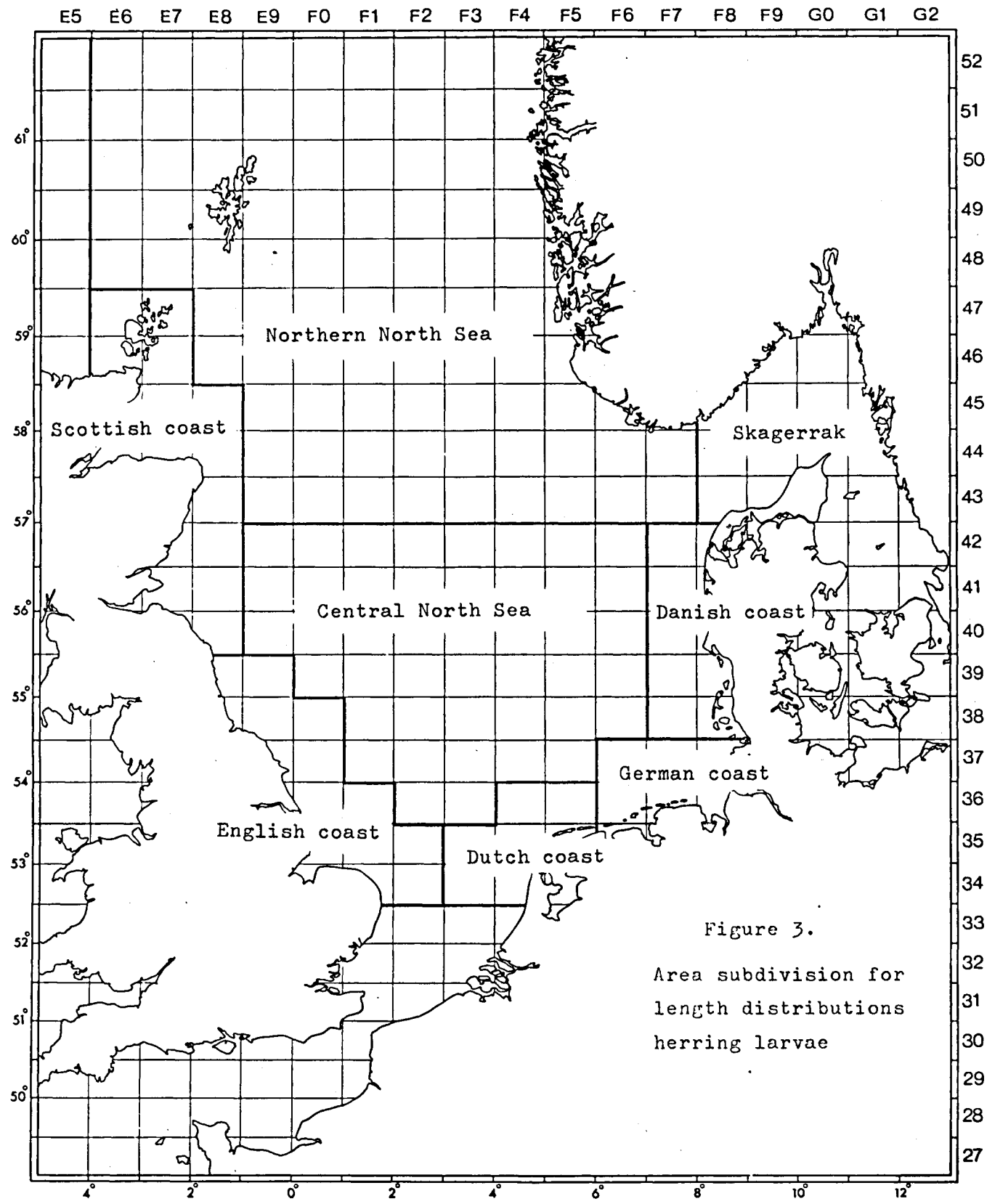

Figure 3.

Area subdivision for length distributions herring larvae

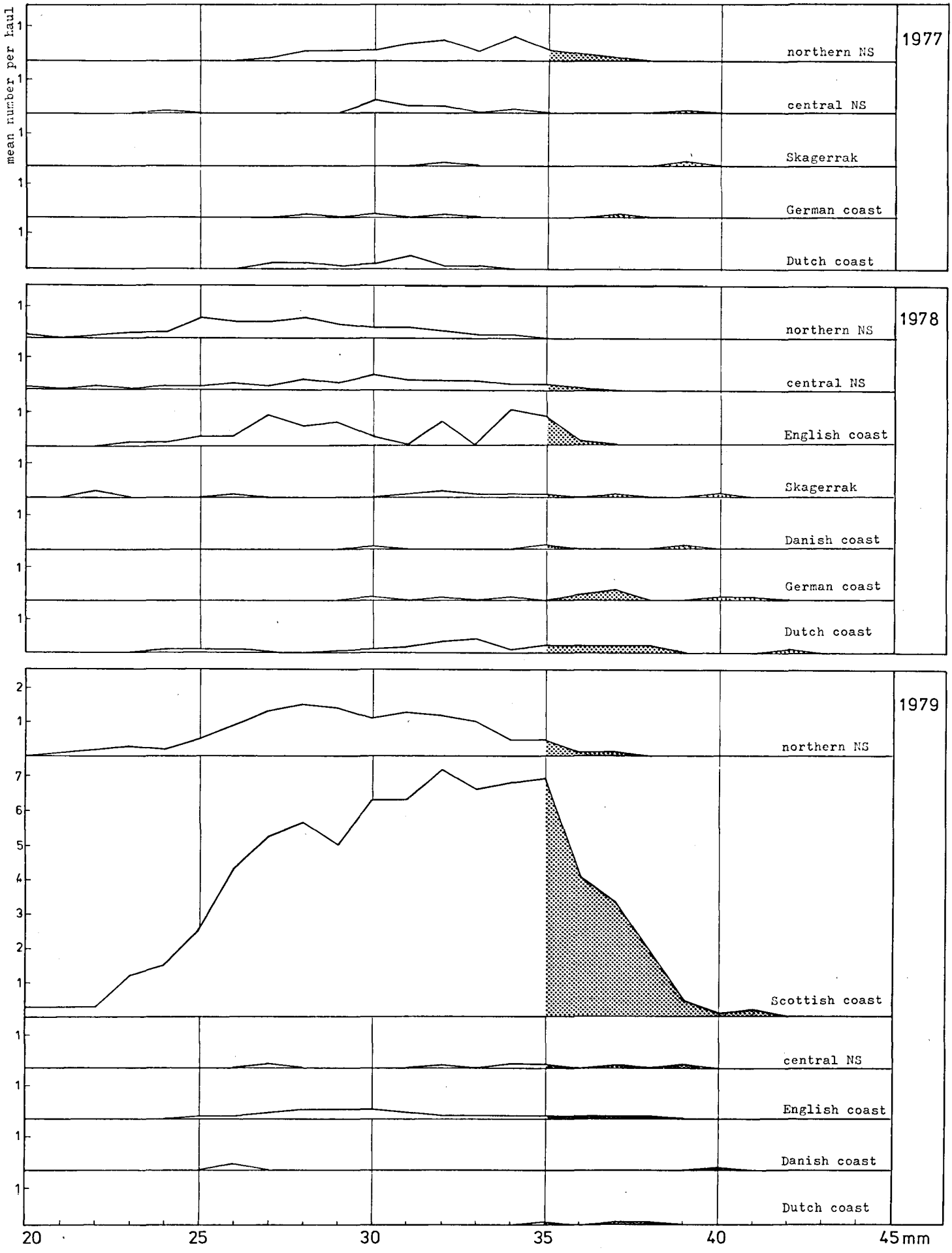

Figure 4a.

Length distributions herring larvae in 1977 - 79.

Larvae > 35mm are shaded to illustrate proportion of big larvae.

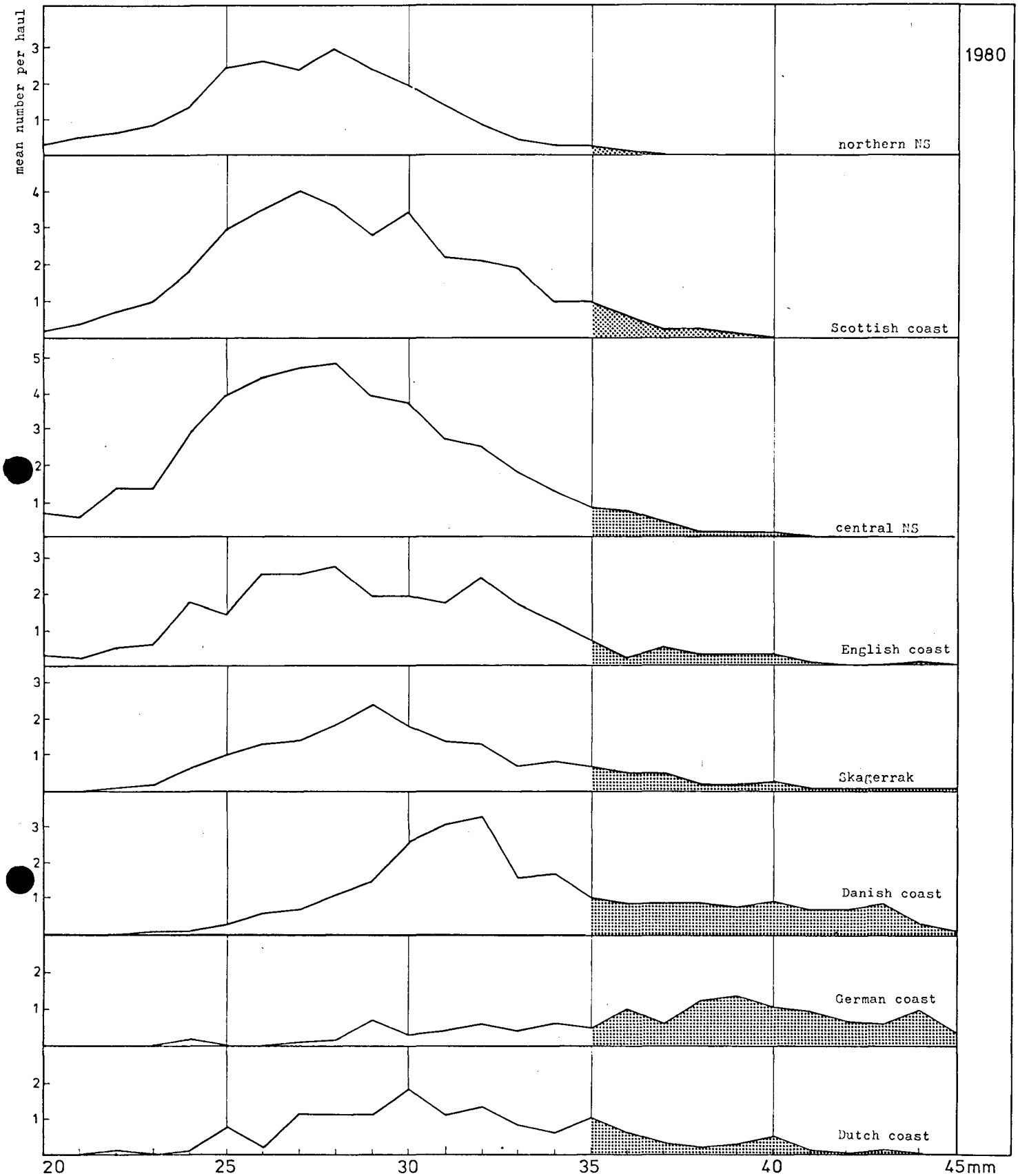

Figure 4b.

Length distributions herring larvae in 1980

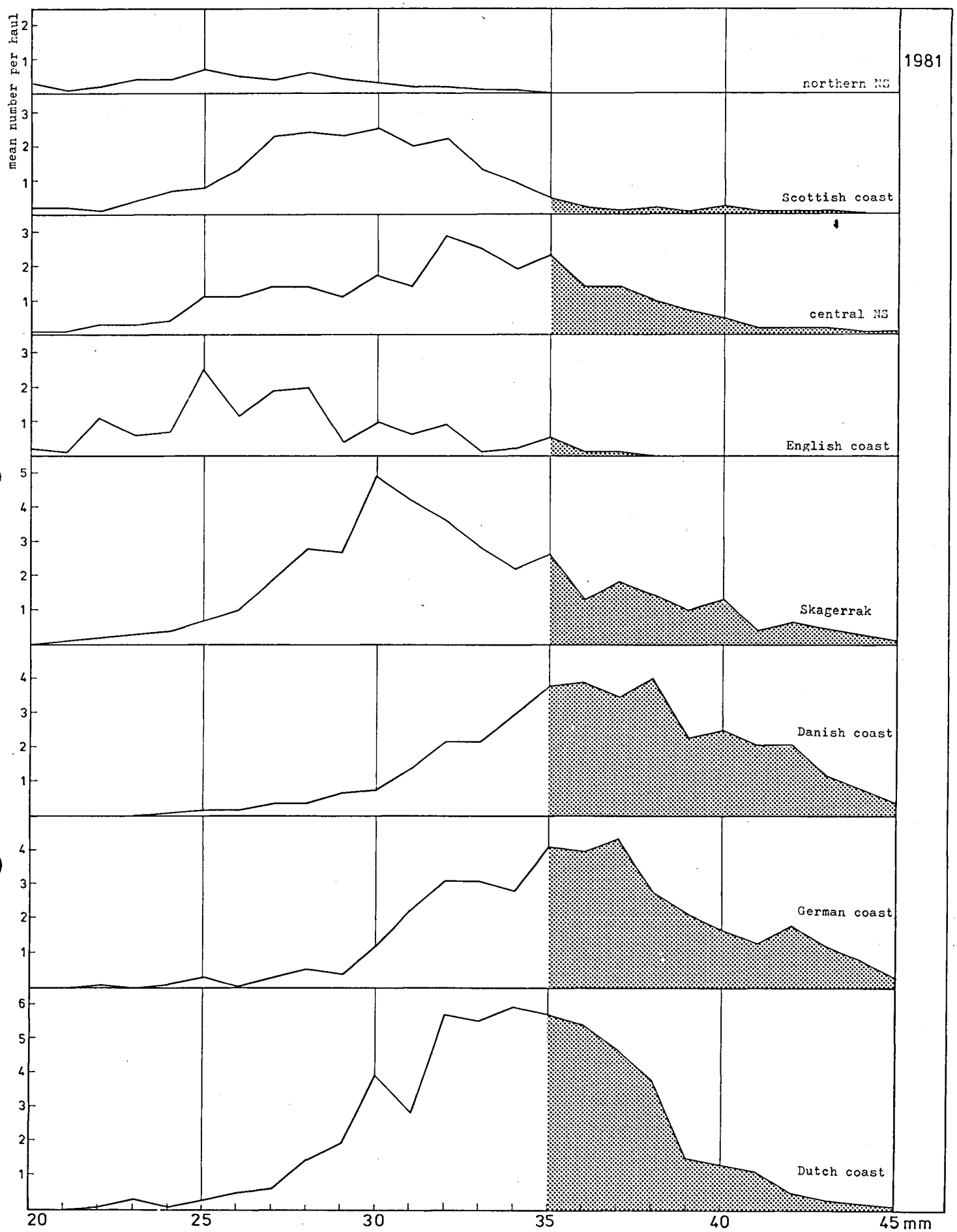

Figure 4c.
Length distributions herring larvae in 1981