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International Council for the Exploration of the Sea

CM 1975/H:13
Pelagic Fish (N) Committee

THE DISTRIBUTION OF EGGS AND LARVAE OF SOME PELAGIC FISH SPECIES IN THE CENTRAL AND SOUTHERN NORTH SEA DURING JUNE 1972

by

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ABSTRACT

A survey was undertaken in June 1972 to investigate the distribution and abundance of pelagic fish eggs and larvae in the central and southern North Sea. The results are presented as a series of charts contoured at different levels of density for sprat, mackerel, horse mackerel and pilchard. The total numbers of eggs and larvae are determined for each species within sub-areas and overall. Assessments of spawning stock size are made for sprat, mackerel and horse mackerel.

INTRODUCTION

This survey was undertaken by the research vessel CLIONE between 4-16 June and 19-27 June 1972. It was designed to investigate the distribution and abundance of eggs and larvae of pelagic fish species (principally sprat and mackerel) over the central and southern region of the North Sea, corresponding with ICES sub-areas IVb and IVc, and covered an area between the limits 52° and 57°N. It was also combined with a survey to determine the distribution and abundance of 0-group gadoids using a Boothbay sampling net. The basic station grid was constructed around a framework of 30' latitude x 30' longitude, which resulted in stations spaced about 17 nautical miles apart on the east-west legs, with a north-south separation between these legs of 30 nautical miles. However, in some areas sampling frequency was increased by the interpolation of additional stations, particularly off the northeast coast of England and the Wash.

A total of 193 plankton stations were worked using a fibreglass bodied high speed townet, 50.8 cm in diameter, which was fitted with a nosecone possessing an intake aperture 20.3 cm in diameter. Internal and external flowmeters were attached and the filtration net was of nylon gauging 23.62 meshes to the centimetre.

Double oblique tows from the surface to within about 6 m of the bottom were made at each station with the vessel's speed maintained at 5 knots. Fish eggs and larvae were picked out from the samples, identified, and the numbers raised to the equivalent beneath 1 m^2 of sea surface using the ancillary data for each tow. The densities were then plotted on charts and contoured by logarithmic intervals. Appropriate keys to identify the density contour levels are shown in each chart.

In order to better compare the relative distributions of egg and larval abundance over the survey region it was divided into smaller sub-areas, as shown and named in Figure 1. Within each of these the total numbers of eggs and larvae for each species was estimated by planimetering the areas within each density range and raising by average density to give total numbers. The results are summarized in Table 1. Using the fecundity data available, very approximate estimates of spawning stock sizes were then determined for sprat, mackerel and horse mackerel.

RESULTS

Sprat (*Sprattus sprattus*)

The eggs (Figure 2a) were distributed over a wide area of the central North Sea with several more localised higher density patches in evidence. Some of these are in the general proximity of winter fishing localities, although the latter are extremely localised compared with the spawning fish distributions. Spawning was at a generally lower density in the Southern Bight and confined mainly to the western half. A partial northern boundary was evident to the north and northeast of the Dogger Bank region, but with the contours remaining open to the east and west.

Table 1 shows that the maximum egg populations were within the northeast coast of England (36%) and Scottish east coast (24%) sectors. The larval distributions are given on the basis of size groupings, and the smallest, 3-5 mm in length (Figure 2b) showed a similar distribution to that of the eggs. At the environmental temperatures prevailing (11-13°C) the eggs should have hatched in about 3-4 days and this distribution of smallest larvae does relate to the spawning patches shown in Figure 2a.

Maximum numbers (48%) were within the Dogger sector, followed by the German Bight (20%) and eastern half of the Southern Bight (17%) (Table 1). The larger size groups (Figures 2c and d) tended to be mainly distributed within a band extending between the Southern and German Bights, within the southeastern half of the survey area, and showed reduced densitites towards the English coast. In the 5-9 mm and 10-14 mm size groups the eastern half of the southern North Sea and German Bight sectors accounted for about 68% of the total numbers (Table 1). Distribution charts for the larger larvae are not given, but in the 15-19 mm size group the southern North Sea and German Bight sectors accounted for about 88% of the total (Table 1). The distribution of larger larvae was generally in marked contrast to that of the smaller ones, with a shift in the centre of abundance towards the Southern Bight-German Bight axis. Larvae in the size range 20-24 mm were only caught in relatively small numbers at a few stations, and 75% of the total were within the western half of the southern North Sea (Table 1). The distribution of the sprat by-catch taken during the ICES Young Herring Surveys in the month of February 1972 (originally analysed in Johnson, 1974) is shown in Figure 3. This distribution is incomplete because at the time of the survey a large proportion of the total population was still confined to very localized overwintering areas inshore and these regions were not adequately covered by the sampling positions on the survey. The contoured densities are expressed as numbers per hour fishing with the bottom herring trawl. There are a number of similar features between this distribution and that of the eggs (Figure 2a), particularly in relation to the northern boundaries and the generally lower densities over the shallower parts of the Dogger region. However, the fact that the two distributions do not match in precise detail is hardly unexpected in view of the 4 month interval between the surveys.

The general pattern of distribution shown by the smaller larvae (< 10 mm) in June 1972 (Figures 2b and c) is very similar to that shown as typical for June by Bainbridge *et al* (1974). This was determined from material collected by the Continuous Plankton Recorder (CPR) over the period 1948-1967. Although this was only identified as 'clupeids' it was assumed to have been predominantly sprat.

In February 1973 a very extensive and dense concentration of the 1972 yearclass was located as 0-group fish by research vessel in the coastal waters near Flamborough Head (Johnson and Hulme, 1974). It is of interest to note that this concentration area would not have been predictable from the larval distributions recorded in June 1972 when larvae were noticeably absent from the immediate coastal waters of this region. The nearest high density patches were then centred about 30-40 nautical miles northeast of Flamborough Head and the inshore concentration of 0-group fish must have built up later in the season.

Mackerel (*Scomber scombrus*)

The eggs (Figure 4a) were mainly found within a broad band extending across the North Sea from the Fisher Bank and German Bight areas towards the northeast coast of England.

The ICES Report of the Mackerel Working Group for 1974 reproduces an egg distribution chart (Figure 4b) covering the northern North Sea (ICES region IVa) relating to a survey undertaken between 22 June-6 July 1972 by Iversen (1973). The area covered just overlapped with the northern limit of the CLIONE survey, although there was a time interval of 2-3 weeks between them. It is evident that egg densities were generally much higher on the later survey.

The larvae (Figure 4c) were mainly confined to the east of the Dogger Bank and within the German Bight, these sectors accounting for 84% of the total number (Table 1).

The average pattern of mackerel larval distribution for June as shown by Bainbridge *et al* (1974), also determined from CPR samples over the period 1948-1967, showed that the larvae tend to be relatively more abundant over the western half of the central North Sea in this month, whereas the results of the June 1972 survey showed them to be relatively more abundant over the eastern half. The CPR results also suggested that peak larval production was attained during July.

Horse Mackerel (*Trachurus trachurus*)

The distribution of eggs (Figure 5a) showed spawning to be mainly confined to the southeast of a line between the Wash and Jutland coast of Denmark, with moderate densities throughout most of the German Bight and higher density patches to the south of the Dogger. However, the main spawning appeared to be within the Southern Bight and towards the eastern side, but the southern limits of spawning were not covered. These are shown in the surveys analysed by Macer (1974) and Wallace and Pleasants (1972). The eastern half of the southern North Sea accounted for 49% of the total eggs, whilst the Dogger and German Bight sectors accounted for a further 28% (Table 1).

The larval distributions (Figure 5b) were much more restricted and were mainly within the Southern Bight and southeastern corner of the German Bight, with 97% of the total number within these two sectors (Table 1).

Pilchard (*Sardina pilchardus*)

The eggs (Figure 6) were restricted to the eastern half of the Southern Bight where they extended in a rather narrow band along the Netherlands coast from Texel to the Schelde estuary. The larvae (not shown) were mainly confined to a small patch just off the Schelde, although, as with horse mackerel, the southern limits of spawning were not covered.

Previous surveys (Wallace and Pleasants, 1972) have shown the northern limits of pilchard spawning to be within the Southern Bight and the results of the June 1972 survey are in accord with this, although Aurich (1953) noted the occurrence of pilchard eggs within the German Bight over the period 1949-52.

ESTIMATION OF SPAWNING STOCK SIZES

There are obvious difficulties in attempting to estimate the size of a spawning population from the results of a single survey since it is not possible to employ the usual method of constructing a total egg production curve and relating this to the total number of spawners through the average fecundity. However, in the case of serial spawning fish such as sprat, mackerel and horse mackerel, where eggs are spawned in discrete batches and with ripening periods between successive batches, it should be possible to assess the spawning stock size necessary to account for the total number of eggs recorded on a single survey. Such an estimate is likely to be a minimal one since, even if the survey is undertaken at a time of peak spawning activity, it seems unlikely that all the potential spawners will be active simultaneously particularly in the case of a species which has a very extended season (such as sprat). The method used in this assessment required information on egg batch size, the relation of this to length or weight of fish, the average size of fish in the spawning population, sex ratio, egg development time and egg mortality rate. It was found that the background data available were rather limited, and in cases where they were entirely lacking reasonable assumptions had to be made. Nevertheless, the results of these assessments and the parameters used in arriving at them are summarised in Table 2, which also includes an estimate of spawning stock for the Norwegian mackerel egg survey in the northern North Sea. The sources for the various data used are summarised by species and type of information below. The sex ratio was assumed to be 1:1 for all species.

SPRAT

Egg batch/size/fecundity/length or weight (Heidrich, 1925: Petrova 1960; de Silva 1973). Egg development time (Cunningham, 1896).

Mortality rate in the egg stage (Grauman and Polivaiko, 1975). Average size of fish in the spawning population (ICES Young Herring Survey, February 1972 and length distribution in the German Industrial Fishery in 1972, Tiews, 1974).

MACKEREL

Egg batch size/fecundity/length (Bigelow and Welsh, 1925; Sette 1943; and Macer, unpublished data). Development time and mortality rate in the egg stage (Sette, 1943). Average size of fish in the spawning population (ICES data sheets of mackerel length distributions taken by Dutch trawl in the central and northern North Sea in the second quarter of 1972 - the estimate excluded all fish below 30 cm in length).

HORSE MACKEREL

Egg batch size/fecundity/length (Macer, 1974 and unpublished data). Egg development times and average size of fish in the population were those used by Macer in his 1974 assessments. The mortality rate in the egg stage was not known and assumed to be the same as mackerel.

CONCLUSIONS

The results of the June 1972 survey showed that at that time sprat and mackerel provided the largest population of eggs in the central North Sea. The sprat were probably near their peak spawning activity, whereas the mackerel (as shown by the results of the Norwegian survey undertaken 2-3 weeks later further north) had probably not yet attained their peak level. Horse mackerel spawning was mainly confined to the southeastern part of the North Sea and showed its highest abundance in the Southern Bight. However, the southern limits of its spawning were not covered. This also applied to the pilchard, whose eggs were found only towards the southern limits of the survey area.

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TABLE 1 An analysis by sectors of the total numbers of eggs and larvae recorded for each pelagic species during the June 1972 survey

SECTOR	SECTOR AREA ($m^2 \times 10^{-9}$)	SPRAT (No $\times 10^{-9}$)					
		EGGS	LARVAE (mm length groups)				
		($\times 10^{-9}$)	3-5	5-9	10-14	15-19	20-24
E coast Scotland	33.18 (12.5)	6,568 (24.4)	182 (1.7)	65 (0.4)	49 (0.9)	5 (0.7)	0
NE coast England	33.93 (12.8)	9,671 (36.0)	856 (8.1)	550 (3.3)	232 (4.3)	15 (2.0)	0
Wash	12.97 (4.9)	342 (1.3)	49 (0.5)	47 (0.3)	3 (0.1)	1 (0.1)	0
S North Sea (West)	16.67 (6.3)	1,390 (5.2)	412 (3.9)	1,006 (6.0)	788 (14.6)	180 (23.9)	33 (75.0)
S North Sea (East)	21.83 (8.2)	1,589 (5.9)	1,814 (17.2)	4,610 (27.3)	2,024 (37.6)	304 (40.4)	4 (9.1)
Dogger	42.08 (15.8)	2,898 (10.8)	5,031 (47.8)	3,284 (19.5)	416 (7.7)	66 (8.8)	4 (9.1)
German Bight	34.64 (13.0)	3,675 (13.7)	2,101 (19.9)	6,771 (40.2)	1,631 (30.3)	176 (23.4)	1 (2.3)
Gut-Fisher Bank	40.56 (15.3)	552 (2.1)	37 (0.4)	2 (Ø)	9 (0.2)	0	1 (2.3)
Jutland	29.98 (11.3)	178 (0.7)	51 (0.5)	526 (3.1)	228 (4.2)	6 (0.8)	1 (2.3)
Grand totals	265.84	26,863	10,533	16,861	5,380	753	44

(n) = % distribution between sectors

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TABLE 1 (continued)

SECTOR	SECTOR AREA ($m^2 \times 10^{-9}$)	MACKEREL		HORSE MACKEREL		PILCHARD	
		EGGS	LARVAE	EGGS	LARVAE	EGGS	LARVAE
		($\times 10^{-9}$)		($\times 10^{-9}$)		($\times 10^{-9}$)	
E coast Scotland	33.18 (12.5)	406 (1.8)	0	0	0	0	0
NE coast England	33.93 (12.8)	4,268 (18.8)	80 (3.2)	3 (Ø)	0	0	0
Wash	12.97 (4.9)	44 (1.2)	2 (0.1)	20 (0.2)	0	0	0
S North Sea (West)	16.67 (6.3)	671 (3.0)	10 (0.4)	2,288 (21.7)	287 (18.7)	0	38 (23.6)
S North Sea (East)	21.83 (8.2)	805 (3.5)	129 (5.2)	5,190 (49.1)	898 (58.4)	484 (100.0)	123 (76.4)
Dogger	42.08 (15.8)	8,306 (36.6)	1,107 (44.5)	1,106 (10.5)	45 (2.9)	0	0
German Bight	34.64 (13.0)	4,264 (18.8)	1,001 (40.2)	1,836 (17.4)	308 (20.0)	0	0
Gut-Fisher Bank	40.56 (15.3)	1,132 (5.0)	14 (0.6)	0	0	0	0
Jutland	29.98 (11.3)	2,790 (12.3)	144 (5.8)	117 (1.1)	0	0	0
Grand totals	265.84	22,686	2,487	10,560	1,538	484	161

(n) = % distribution between sectors

TABLE 2 Estimates of parameters used to calculate the total weights of the spawning populations of sprat, mackerel and horse mackerel in the North Sea during June 1972

Species	Total number of eggs	Mean length of ♀	Mean batch size	Total number of ♀ spawners	Total number of ♂ + ♀ spawners	Mean weight of spawning fish	Total weight of spawning population	Raising factor to allow for mortality in the egg stage	Corrected total weight of spawning population
	($\times 10^{-9}$)	(cm)		($\times 10^{-6}$)	($\times 10^{-6}$)	(gms)	(tonnes)		(tonnes)
SPRAT (*Sprattus sprattus*)	26,863	12.4	2,500	10,745	21,490	15	322,356	x 1.6	515,770
MACKEREL (*Scomber scombrus*)									
i. S of 57°N	22,696	34.6	31,670	716	1,433	384	550,137	x 1.2	660,164
ii.* N of 57°N	18,052	34.6	31,670	570	1,140	384	437,764	x 1.2	525,317
HORSE MACKEREL (*Trachurus trachurus*)	10,560	29.5	48,370	218	436	231	100,850	x 1.2	121,020

*Determined from Iversen's (1973) egg distribution chart

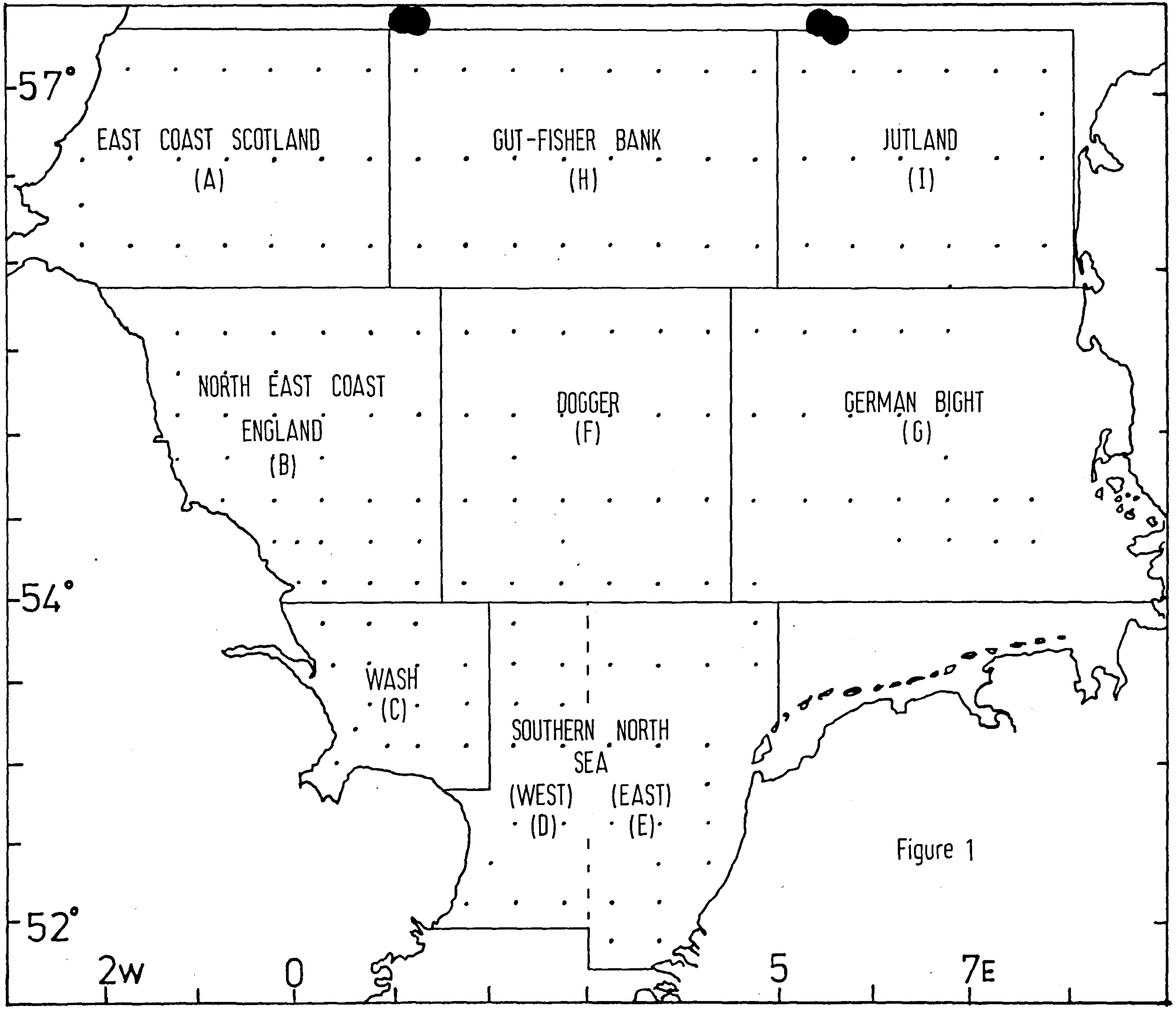
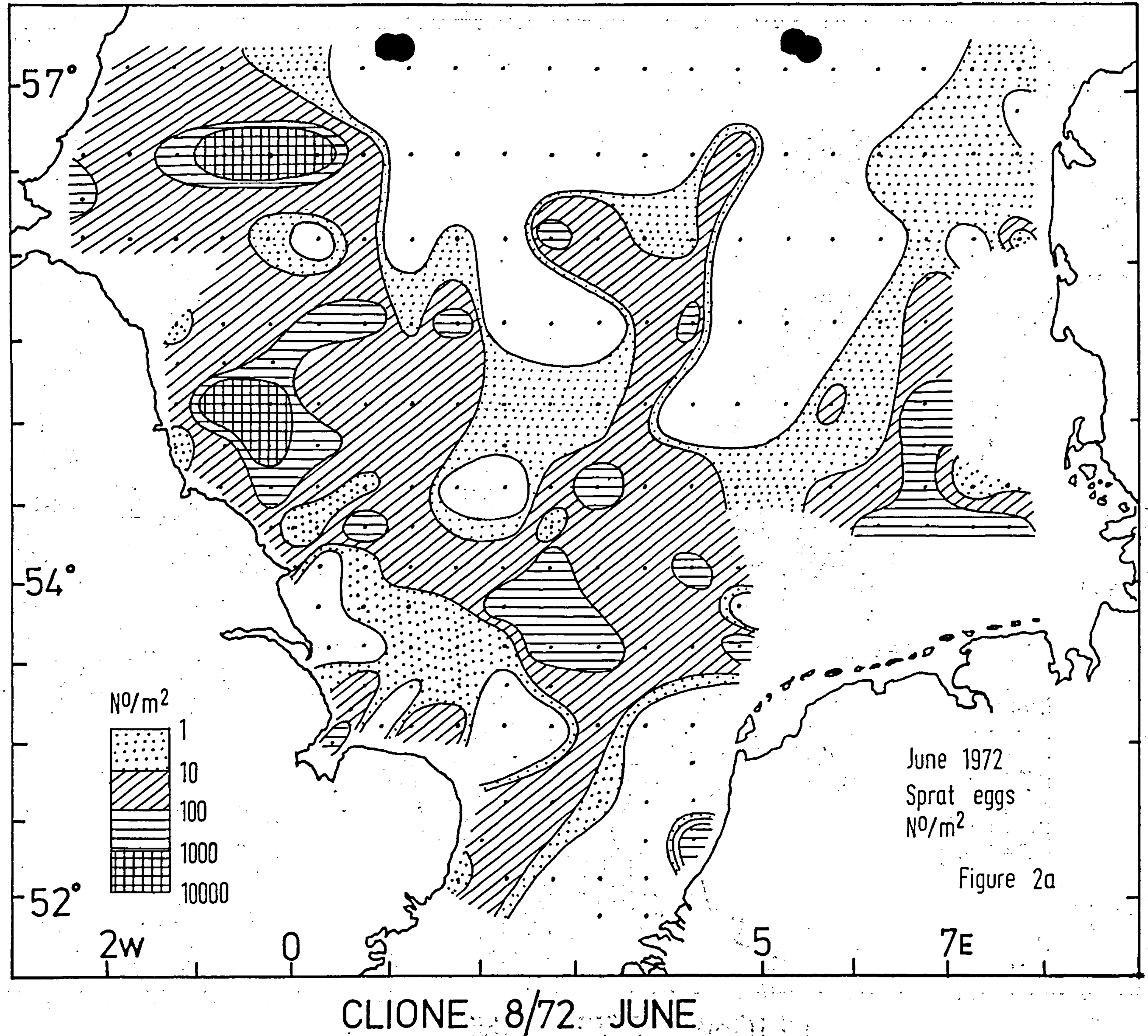
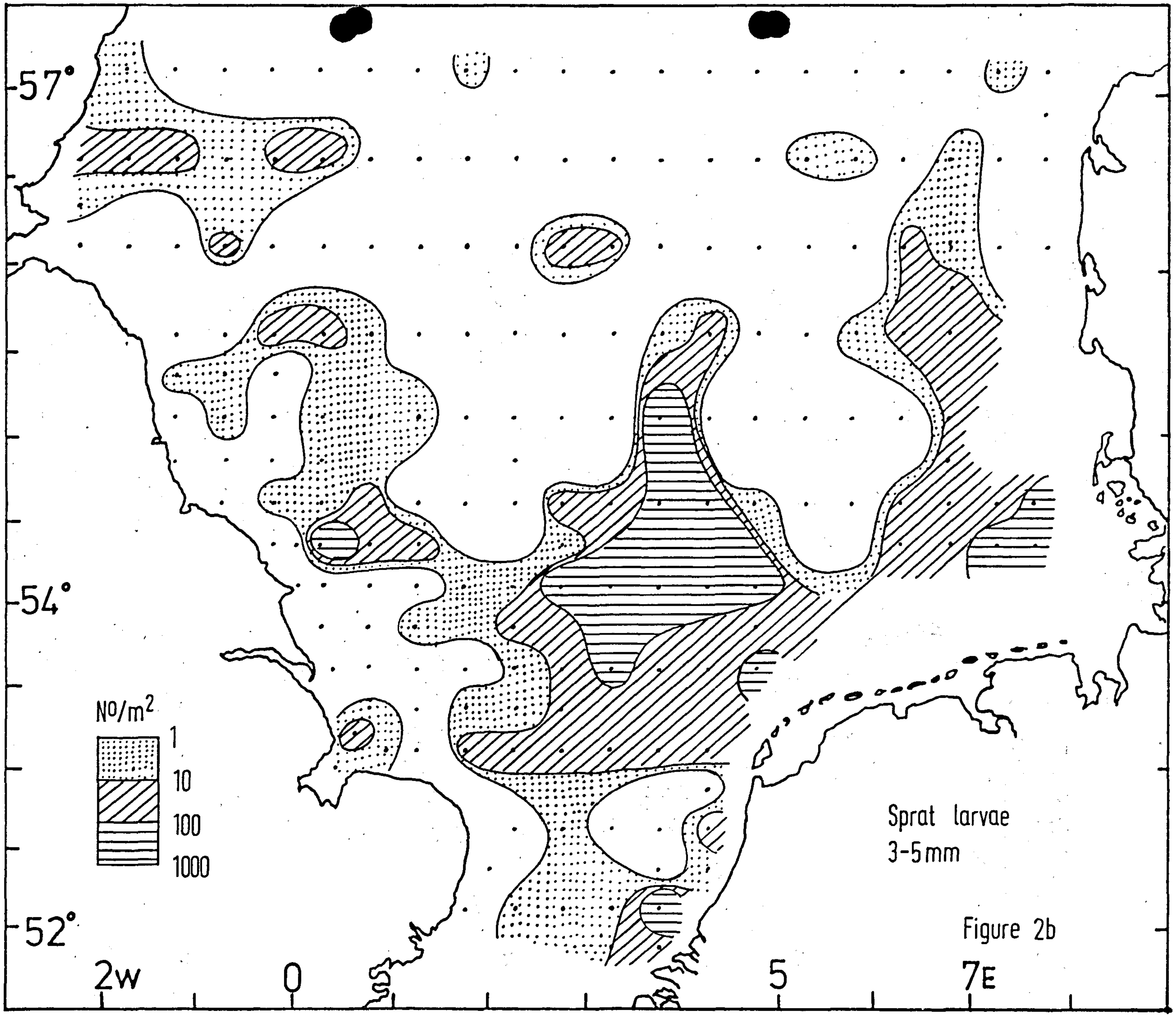


Figure 1

CLIONE 8/72 JUNE


57°
54°
52°
2W
0
5
7E
N0/m2
1
10
100
1000
10000
June 1972
Sprat eggs
N0/m2
Figure 2a
CLIONE 8/72 JUNE



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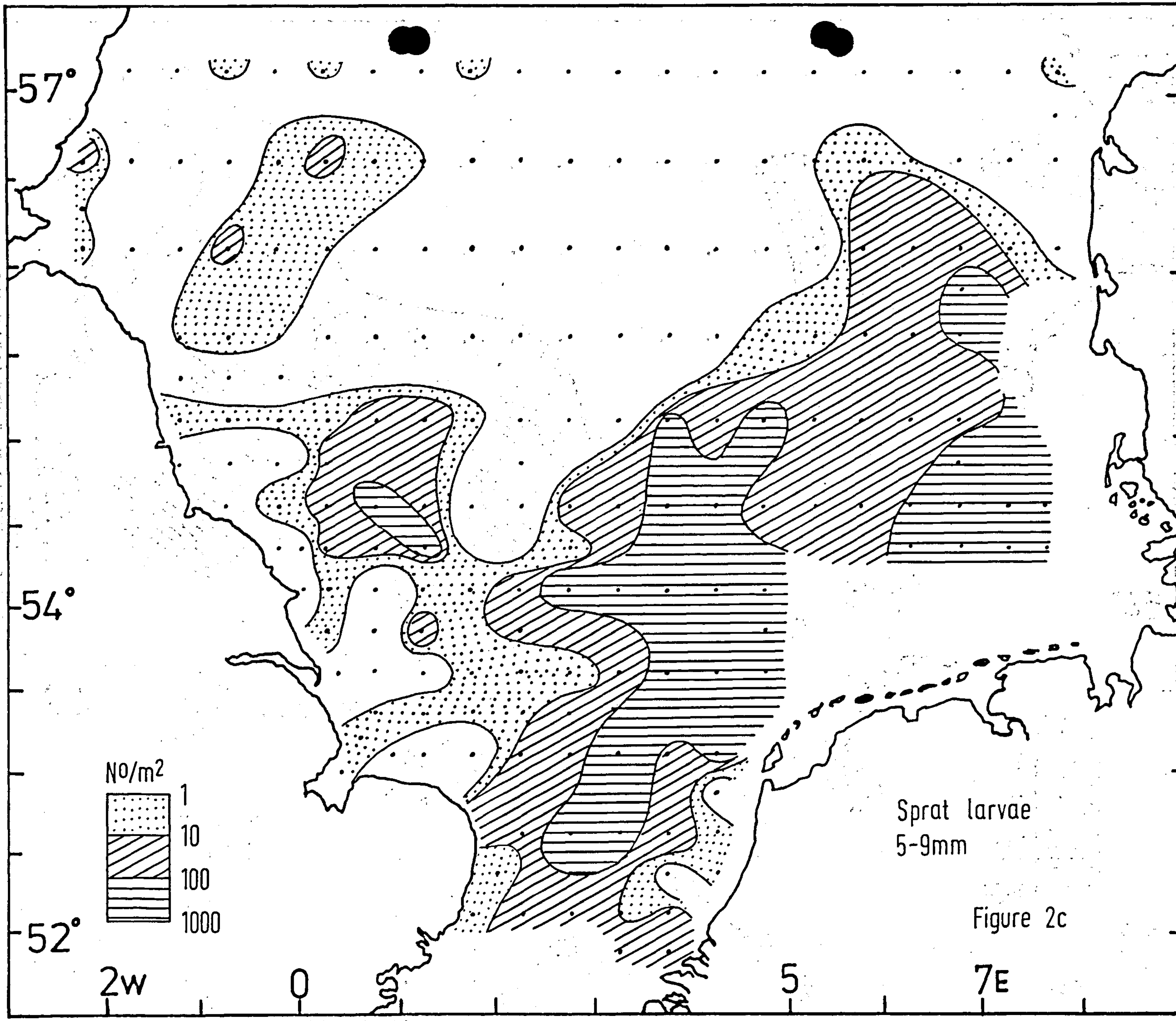

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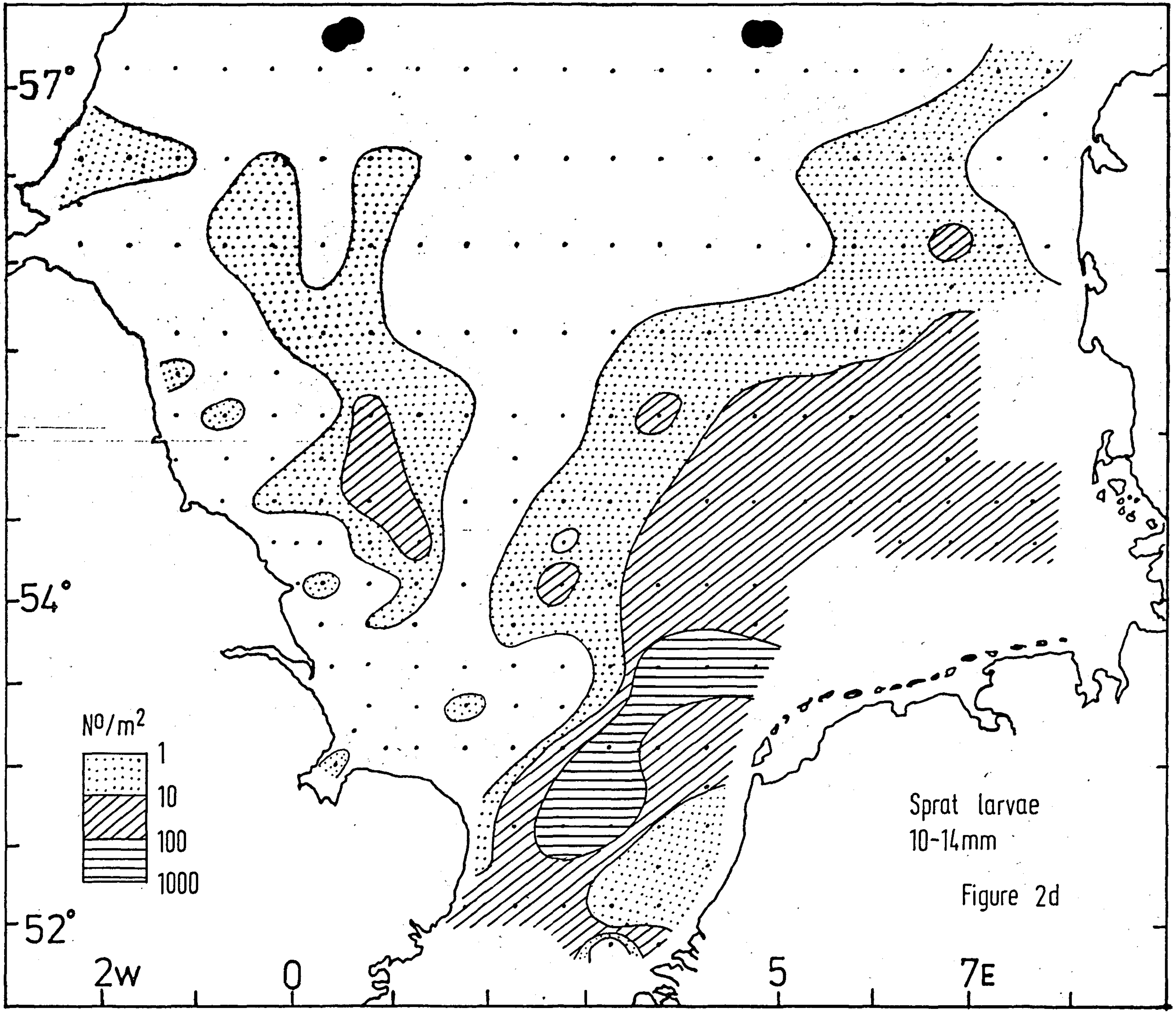

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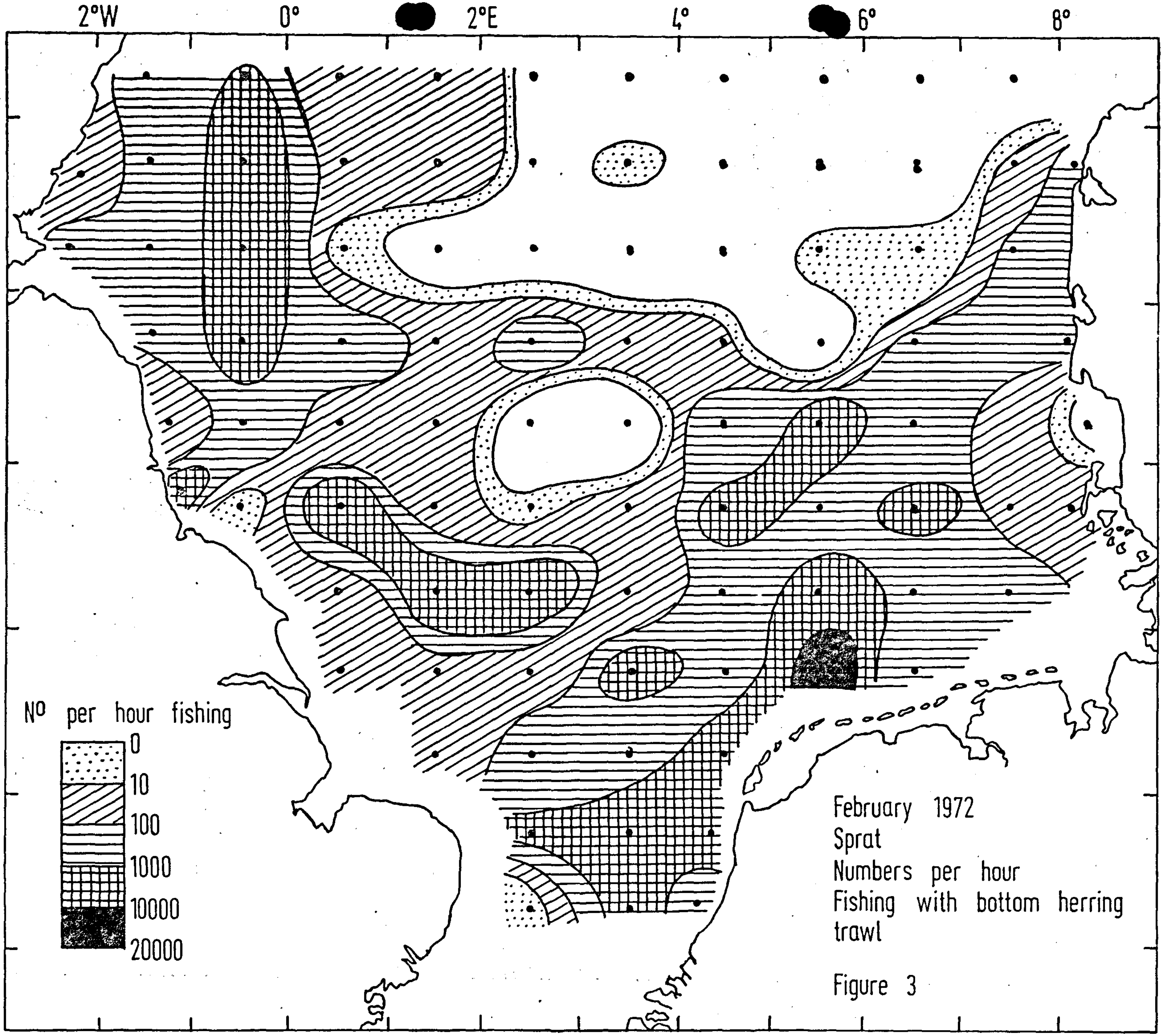
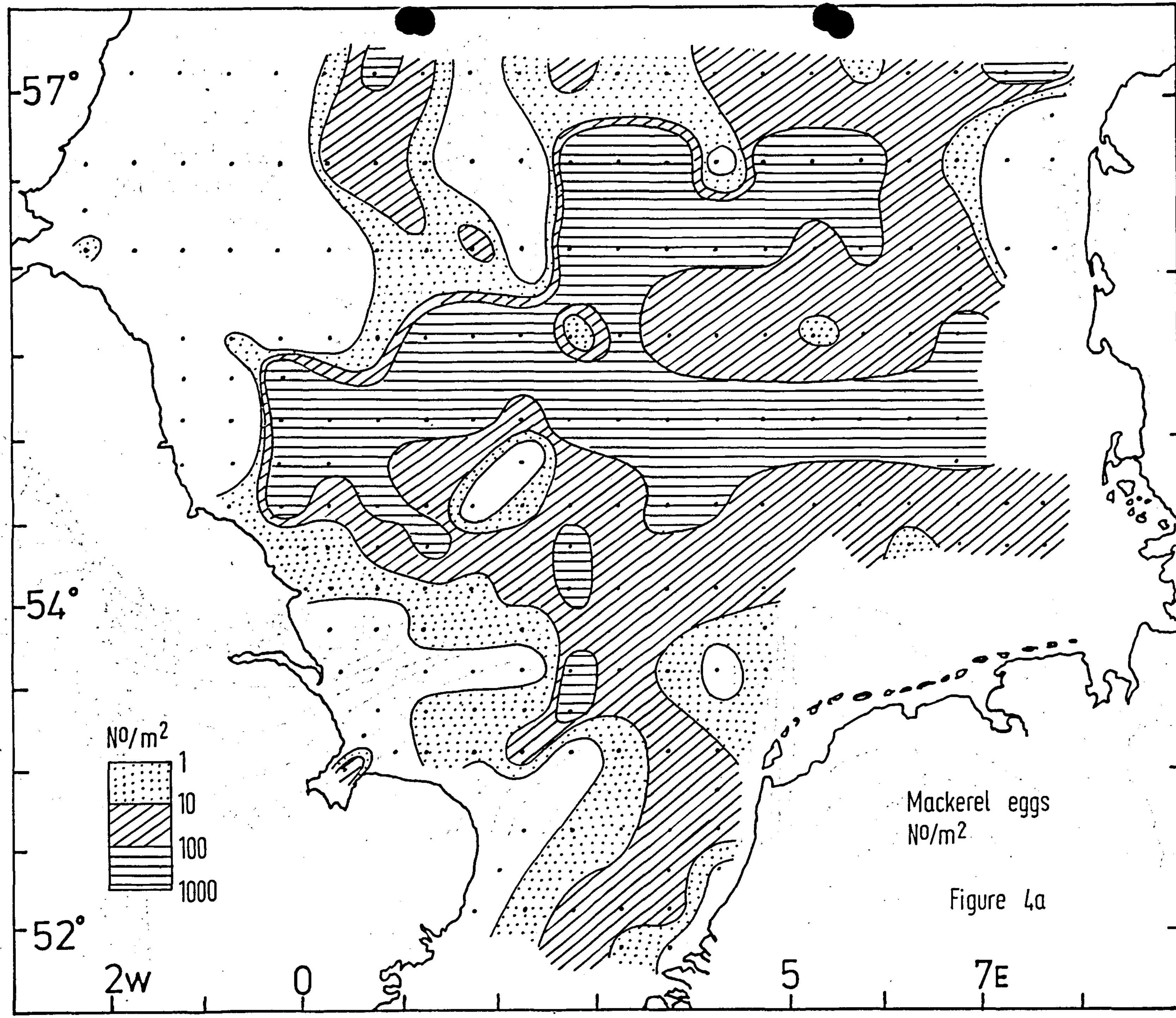


February 1972
Sprat
Numbers per hour
Fishing with bottom herring trawl

Figure 3



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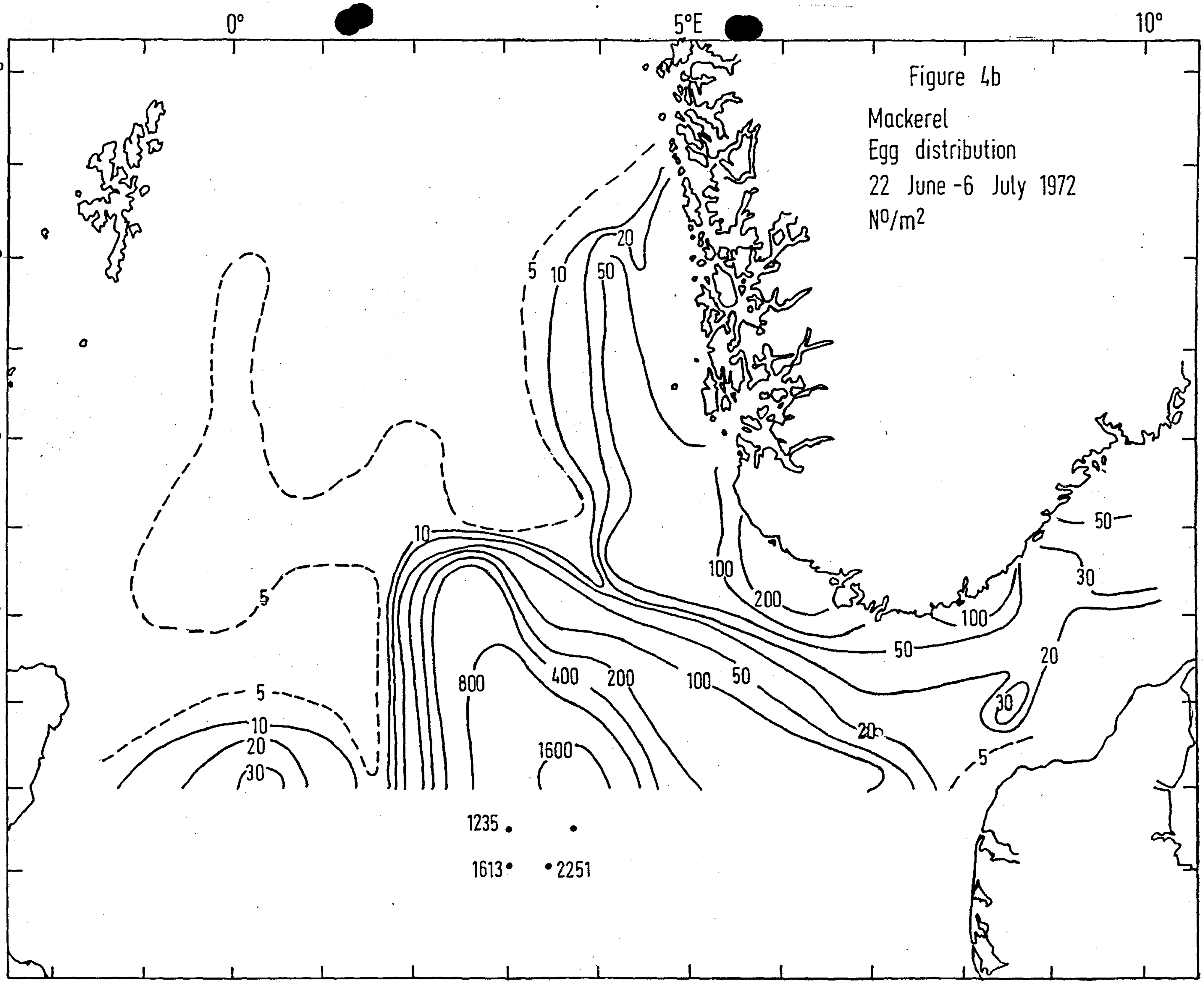
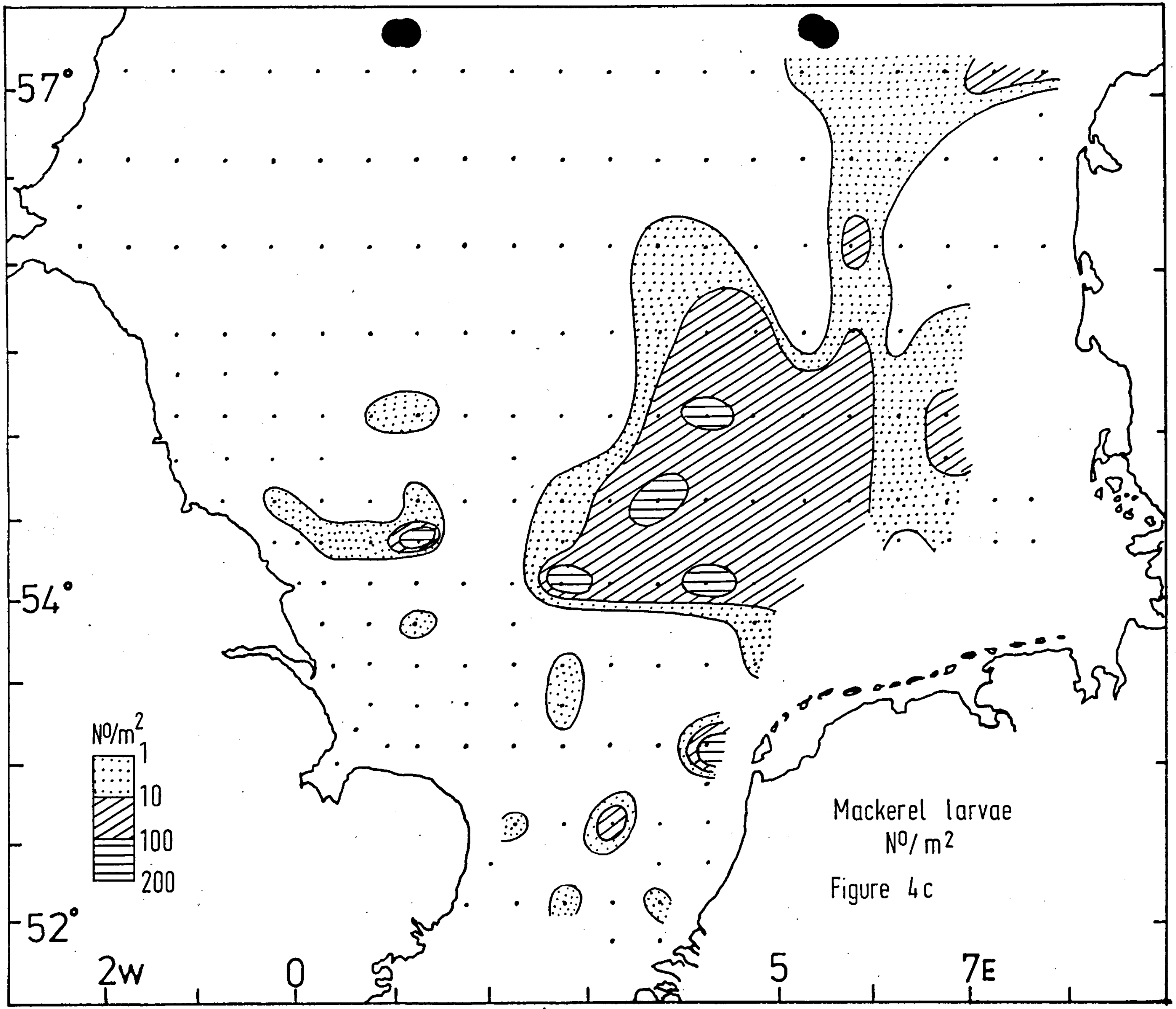

0°
5°E
10°
61°
60°
59°
58°
57°
Figure 4b
Mackerel
Egg distribution
22 June -6 July 1972
N0/m2
5
10
20
50
100
200
400
800
1600
30
1235
1613
2251



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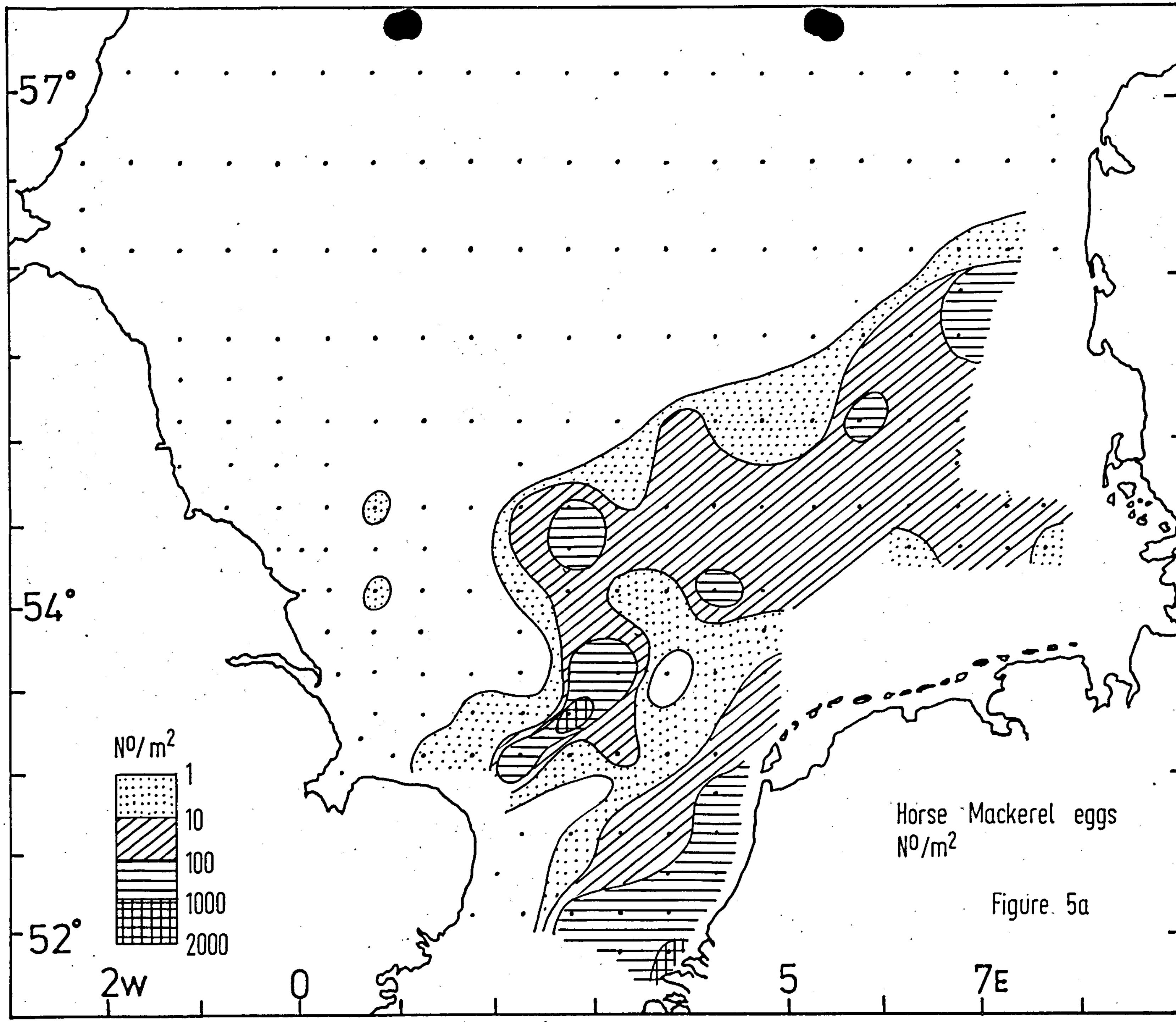

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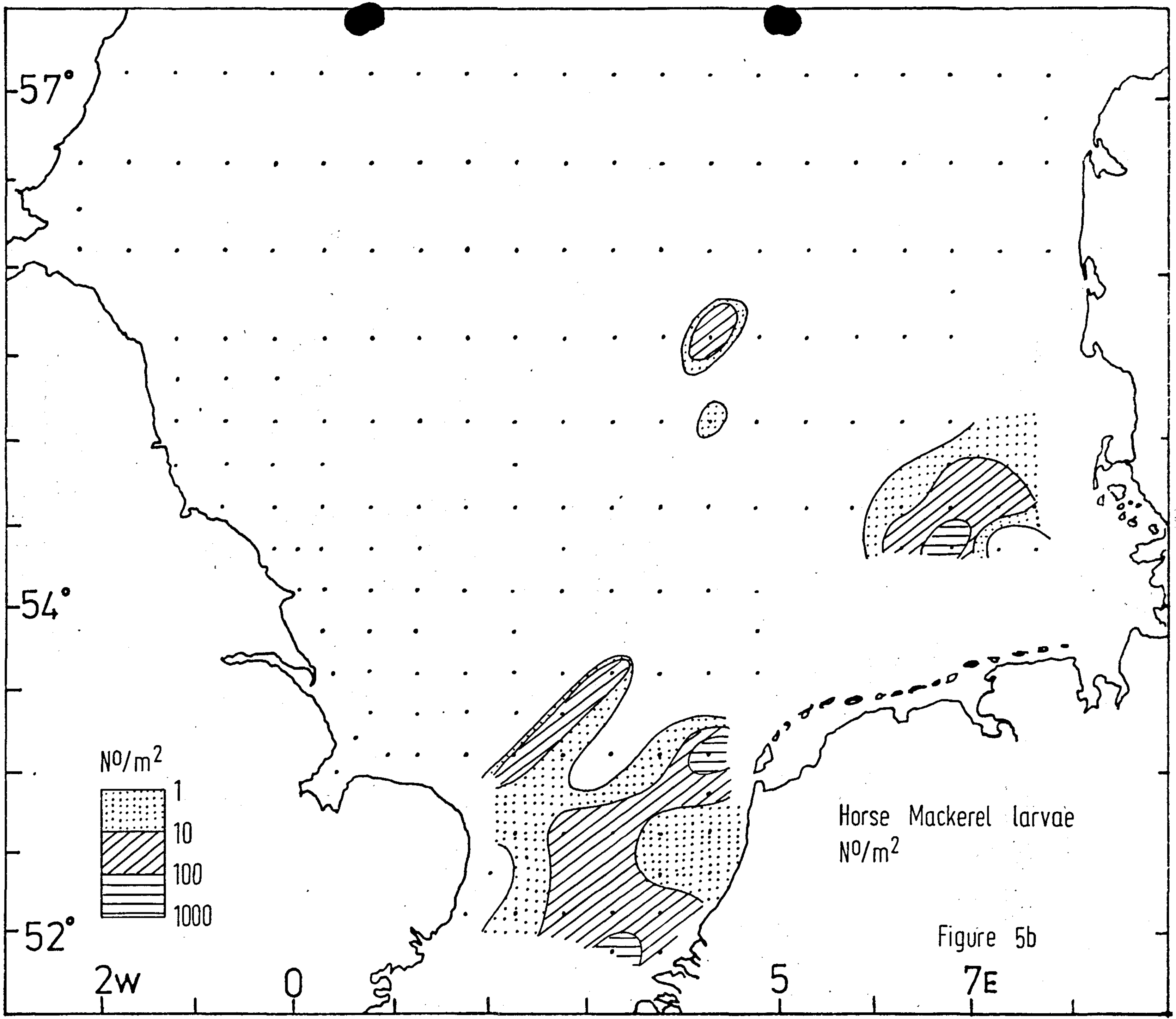

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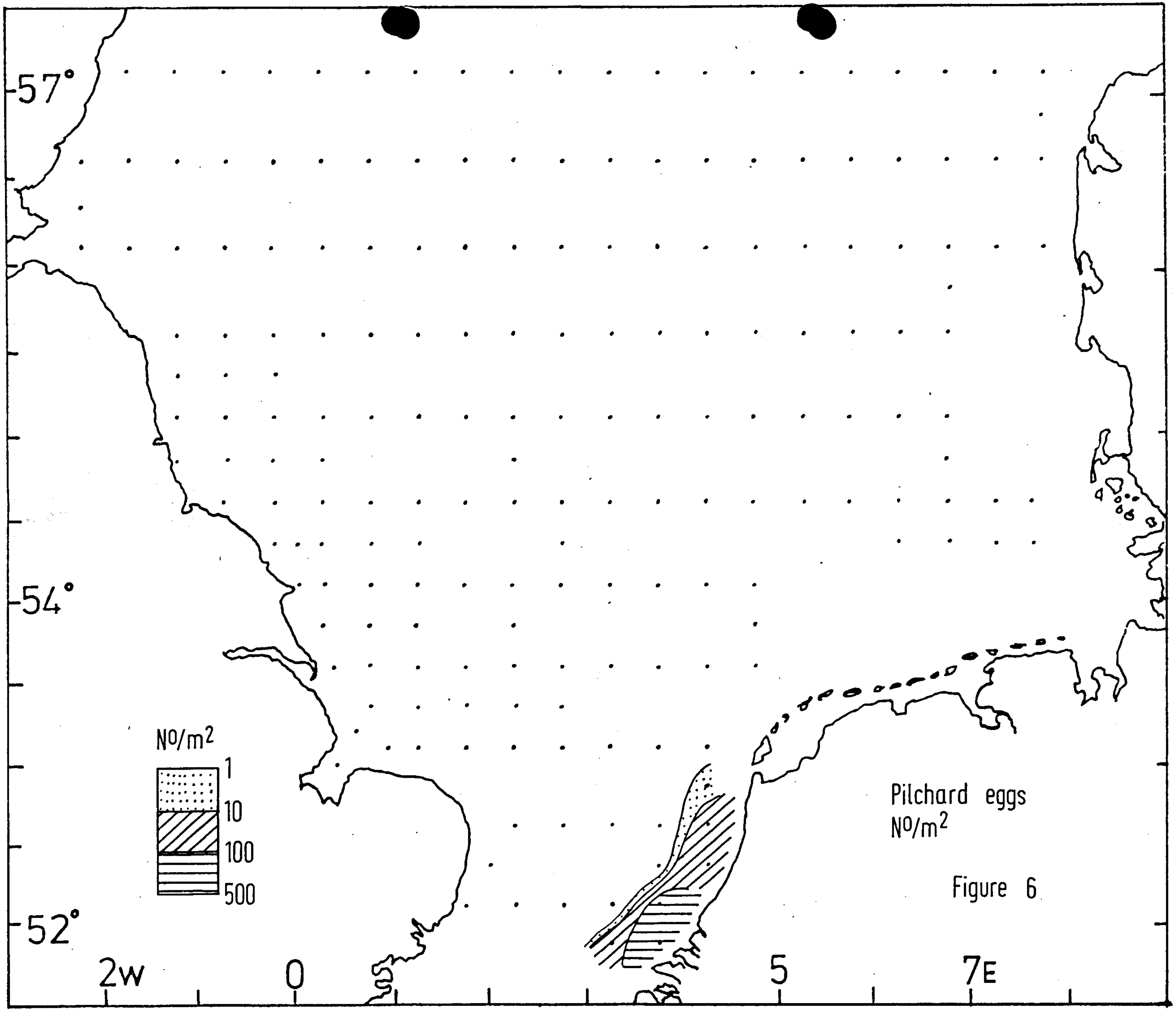

Figure 6

CLIONE 8/72 JUNE