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On the occurrence of herring larvae in February, 1975, in the Kattegat, Skagerrak and North Sea in conjunction with the North Sea Young Herring Survey

by

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INTRODUCTION

Ackefors (1974) presented the results from a three year study of catching late herring larvae just before metamorphosis with an Isaacs-Kidd Midwater Trawl (I.K.M.W.T.). The paper was discussed at the ICES'meeting in 1974. At the end of that meeting the following statement was made: " Interest was expressed in the results achieved in sampling late herring larvae in the Skagerrak area using I.K.M.W.T. hauls at night. It was agreed that similar studies should be made in conjunction with the North Sea Young Herring Surveys by participating countries to investigate whether in that way an earlier estimate of recruitment could be made".

It was proposed that during the North Sea Young Herring Survey in February, 1975, the participating vessels should make I.K.M.W.T. hauls at night to catch O-group herring in conjunction with the trawling for 1-group herring in the day-time. During this first joint attempt to catch O-group herring, it was decided that each country should apply its own methods of using the I.K.M.W.T. During the cruise with the Swedish research vessel ARGOS, Ackefors & Hagström (1975) made a methodological study in order to find out, if oblique or horisontal hauls at surface during night were suitable for larvae surveys with the proposed gear. A three year study in April, 1972-1974 in the Skagerrak area with only horisontal hauls at surface during night had shown that large amounts of late herring larvae could be caught with I.K.M.W.T. (Ackefors, 1974). The present paper deals with the results of horisontal as well as oblique hauls in February, 1975, in the areas Kattegat, Skagerrak and North Sea (fig. 1).

MATERIAL AND METHODS

The investigation was carried out in February 5-22, 1975, in the Kattegat, Skagerrak and North Sea (fig. 1). The area sampled in the Skagerrak comprised both shallow areas inside the 100 m depth curve and deep areas. The station net in the North Sea was mainly inside the 60 m depth curve. At certain stations the depth was not more than 20 m. In the Kattegat the depth fluctuated from 20 to 46 m. In fig. 1 only the first sample at each station is reproduced with a number.

An Isaacs-Kidd Midwater Trawl (I.K.M.W.T.) was used with an opening of 4 x 2.5 m. The trawl was 10 m long with a mesh-size of 1 cm except in the cod-end (3 m long) which had a mesh-size of 0.5 cm. An extra inner cod-end (1 m long) with a mesh-size of 0.15 cm was inserted in the cod-end. A net-sond was attached to the upper frame of the I.K.M.W.T. It was therefore possible to check each oblique tow, while the trawl was operating from surface to a depth of 3-4 m above bottom and then up to surface again. In deep areas the tows were made down to 50 m depth. At each station one oblique and one horisontal tow were made after each other. With a few exceptions this scheme was followed during the whole cruise. The duration of each tow was 20 min. All operations were performed from 1900-0500 hrs local time, i.e. from two hours after sunset until two hours before dawn. In total 65 successful tows were made, 34 oblique and 31 horisontal ones (fig. 2). The towing speed was 3.5 knots. The horisontal tows sampled the water column from surface down to 4 m depth.

The larvae were preserved in 4 % formalin. The results of all tows were raised to 30 min. tows to get comparable results with previous investigations.

RESULTS

a. Hydrographical notes

The salinity and temperature were quite different in the various parts of the sampled area. The Kattegat (Area C) was strongly influenced by the Baltic water current coming from the south. In February the salinity fluctuated from 11 to 22 ‰. Gradually the salinity increased to about 26 ‰ at 20 m level. There was a halocline between 20 and 30 m. Below the halocline the salinity was more than 30 ‰. The temperature was about 4°C at surface and increased gradually to 6-7°C at the deepest stations.

In the inner Skagerrak (Area A) the salinity fluctuated from less than 22 ‰ to 33 ‰ at surface. The isohaline for 30 ‰ was at 20 m level close to the coast. The isohaline became closer to the surface further out from the coast. At 10°32'E

it was just below the surface. At the border line between the inner Skagerrak (Area A) and the outer Skagerrak (Area B) the salinity increased from 33.5 ‰ at surface to 34.8 ‰ at 50 m level. The surface temperature increased from less than 2°C close to the coast to more than 4°C in the western part of the area B. The isotherm for 5°C was at 20-30 m level close to the coast and at 10 m level further out from the coast.

In the outer Skagerrak and in the North Sea (Area B) the salinity was more than 33 ‰ at surface and about 35 ‰ at 50 m level. The temperature was between 5 and 6°C from surface to bottom. In deep areas the temperatures were up to 7.5°C in some parts of the water column.

b. Biological observations

In February, 1975, 31 horisontal surface hauls (table 1, figs. 2-3) and 34 oblique hauls (table 1, figs. 2 and 4) from surface to bottom were carried out. The number of herring larvae was larger in area A in samples from horisontal hauls than from oblique hauls. In area B the oblique hauls contained more larvae than the horisontal hauls. Very few larvae were found in the area C. The mean number of herring larvae in the area A was 13.2 (horisontal hauls) and 3.0 (oblique hauls). The corresponding figures for area B were 4.7 and 15.7 (table 1). It is thus obvious that in one area the horisontal hauls and in another area the oblique hauls were more successful. The values were analysed with the Student's t-test. At a level of 95 % significance the populations are differently distributed in the two areas (Ackefors & Hagström, 1975). Later the figures were tested with the Mann-Whitney U test, which is a nonparametric test. The results indicate that the null hypothesis (H_0) may be rejected at both 2.5 and 5 % significance levels. Hence the population of herring larvae in the inner Skagerrak was differently distributed than the population in the outer Skagerrak and the North Sea. The herring larvae were thus closer to the surface in the inner Skagerrak than in the rest of the investigation area. In the outer Skagerrak and in the North Sea on the other hand the main concentration of larvae was somewhere in the depth range from 4 m below surface to bottom (fig. 2).

The total number of larvae from samples in the inner Skagerrak was 145 and the mean number per 30 min. haul 8.1. The corresponding figures for the outer Skagerrak including the North Sea was 367 and 10.2.

The mean length of larvae was rather similar in areas A-C, horisontal hauls 32.9-34.2 mm, oblique hauls 31.9-35.0 mm (figs. 2-3). The size range (21-42 mm) was also similar (cf. Ackefors & Hagström, 1975). The total mean length for all herring larvae was 33.7 mm and 32.7 mm for horisontal resp. oblique hauls.

The mean weight of the larvae was in the range of 0.06-0.09 g. The total mean weight was 0.08 g (table 9, figs. 2-3).

DISCUSSION

The herring larvae, 30-40 mm in length, caught in April are considered to be the result of autumn spawning herring (Jensen, 1949). The herring larvae with a mean length of 32-34 mm in February, reported about in this investigation, are also considered to be autumn spawners.

The main issue for this study was to report if this type of larva investigation is a suitable way to get an earlier estimate of recruitment to the herring stock. The results are not encouraging, because the number of herring larvae was not very large. On the other hand the present investigation covers a rather small area and is limited in time. Ackefors (1974) reported about investigations in April 1972-1974, in the inner Skagerrak with a much greater density of late herring larvae. His mean values for 30 min. hauls were 49.8, 19.2 and 361.4 herring larvae for the three reported years. In 1974 the mean number of larvae for statistical square 1539 was as large as 614.7 larvae per 30 min. haul. This might indicate that April is a more suitable time for such investigations. On the other hand the unpublished results from the investigation in April, 1975, indicates a very low density of late herring larvae (Ackefors, unpubl.). It is therefore conceivable that the 1974 year-class of autumn spawning herring in the North Sea is very weak.

The different vertical distribution of late herring larvae in the inner Skagerrak compared with the outer Skagerrak and the North Sea is conspicuous. The different hydrographical conditions in the two areas might be the reason for the different distribution. In the inner Skagerrak the salinity at surface was in the range of 22-33 ‰ while in the outer Skagerrak and the North Sea the salinity was in the range of 33-35 ‰. The temperature was 2-4°C in the inner Skagerrak and above 5°C in the outer Skagerrak and North Sea. The brackish water conditions seem thus to be the reason for the different behaviour of the herring larvae in the two areas. Johansen (1925) found the same thing in the brackish water of Kattegat in his investigations in April. Another explanation might be that the stability of the water is greater in the inner Skagerrak than in the outer Skagerrak and the North Sea where the turnover rate of water is bigger (Svansson, pers.comm.).

The mean length of larvae was in the range 32-34 mm (cf. table 1) which is about the same length that Ackefors (1974) found for a period from March 19 to April 4, 1973, in the inner Skagerrak. The mean weight was 0.06-0.08 g in February, 1975, which is slightly less than 0.10 g which Ackefors (1974) found in April, 1973. In 1972 and 1974 when the investigations took place two weeks later (in

1973. In 1972 and 1974 when the investigations took place two weeks later (in

1973. In 1972 and 1974 when the investigations took place two weeks later (in

the beginning of April) the mean length was about 40 mm and the mean weight 0.21-0.26 g. In 1975 when the investigations were carried out from the beginning to the end of April the mean length for different samples were 32-46 mm and the mean weight 0.09-0.43 g (Ackefors, unpubl.). The figures indicate a rapid growth rate of herring larvae during April.

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Table 1. Herring larvae caught with I.K.M.W.T. from February 5 to February 21, 1975, during night in horisontal hauls at surface (a) and in oblique hauls (b). Numbers per 30 min. haul. Skagerrak east of 10°E (Area A), Skagerrak west of 10°E including the North Sea (Area B) and Kattegat (Area C)(cf. fig. 1).

a. horisontal surface hauls

Area	Number hauls	Total number larvae	Mean number larvae	Range number larvae	Mean length mm	Mean weight g
Area A						
1439	3	19.5	6.5	0-18	34.3	0.07
1539	4	82.5	20.6	4.5-33	33.5	0.09
1540	2	16.5	8.3	4.5-12	37.9	0.12
Total	9	118.5	13.2	0-33	34.2	0.09
Area B						
1133	4	51.0	12.8	0-36	32.3	0.06
1134	2	4.5	2.3	0-4.5	32.0	0.07
1135	1	0	-	-	-	-
1136	2	1.5	0.8	0-1.5	22.0	0.02
1235	3	7.5	2.5	0-4.5	34.8	0.10
1236	3	18.8	6.3	0-14.3	34.8	0.06
1337	2	1.5	0.8	0-1.5	31.0	0.04
1438	1	0	-	-	-	-
Total	18	84.8	4.7	0-36	32.9	0.06
Area C						
1241	1	0	-	-	-	-
1240	1	0	-	-	-	-
1340	1	0	-	-	-	-
1341	1	0	-	-	-	-
Total	4	0	-	-	-	-
Grand total	31	203.3	6.6	0-36	33.7	0.08

Cont. table 1.

b. oblique hauls

Area	Number hauls	Total number larvae	Mean number larvae	Range number larvae	Mean length mm	Mean weight g
Area A						
1439	3	2.9	1.0	0-1.5	33.5	0.04
1539	4	7.5	1.9	0-4.5	34.3	0.09
1540	2	16.5	8.3	1.5-15	30.5	0.06
Total	9	26.9	3.0	0-15	31.9	0.07
Area B						
1133	4	55.5	13.9	10.5-21	33.1	0.09
1134	2	34.5	17.3	9-25.5	32.8	0.07
1136	1	6.0	6.0	6	28.3	0.08
1235	3	53.7	17.9	5.7-34.5	33.9	0.10
1236	4	46.9	11.7	1.5-21.4	33.0	0.09
1337	2	78.0	39.0	16.5-61.5	32.3	0.06
1438	2	7.5	3.8	1.5-6	30.4	0.05
Total	18	282.1	15.7	1.5-61.5	32.7	0.08
Area C						
1141	1	0	-	-	-	-
1240	1	0	-	-	-	-
1241	2	0	-	-	-	-
1340	1	0	-	-	-	-
1341	2	2.7	1.4	0-2.7	35.0	0.07
Total	7	2.7	0.5	0-2.7	35.0	0.07
Grand total	34	311.7	9.2	0-61.5	32.7	0.08

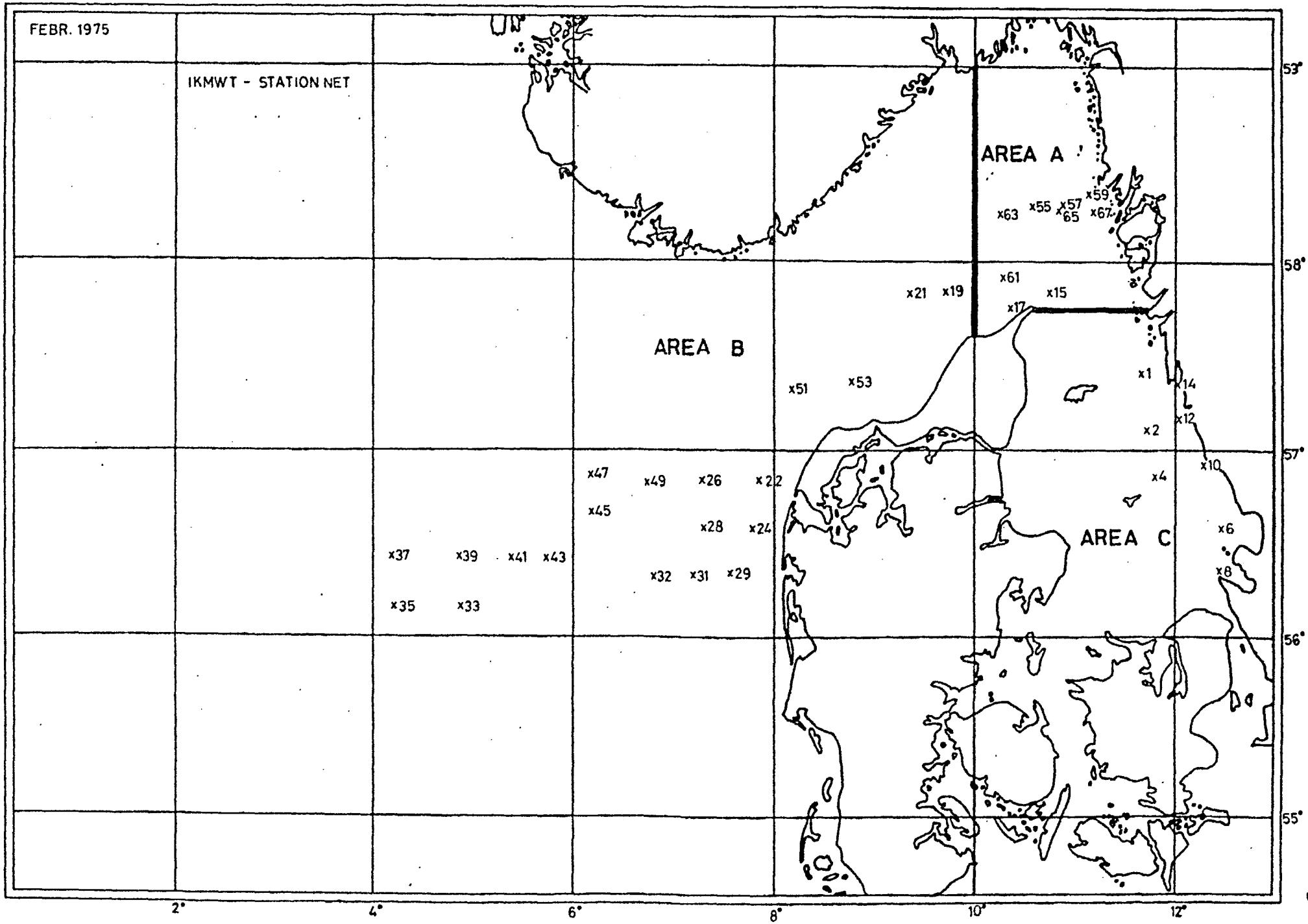
FEBR. 1975
IKMWT - STATION NET
AREA A
AREA B
AREA C
x63
x55
x57
x65
x59
x67
x61
x17
x15
x21
x19
x51
x53
x1
x14
x12
x2
x10
x4
x6
x8
x47
x49
x26
x22
x45
x28
x24
x37
x39
x41
x43
x32
x31
x29
x35
x33
53°
58°
57°
56°
55°
2°
4°
6°
8°
10°
12°

Fig. 1

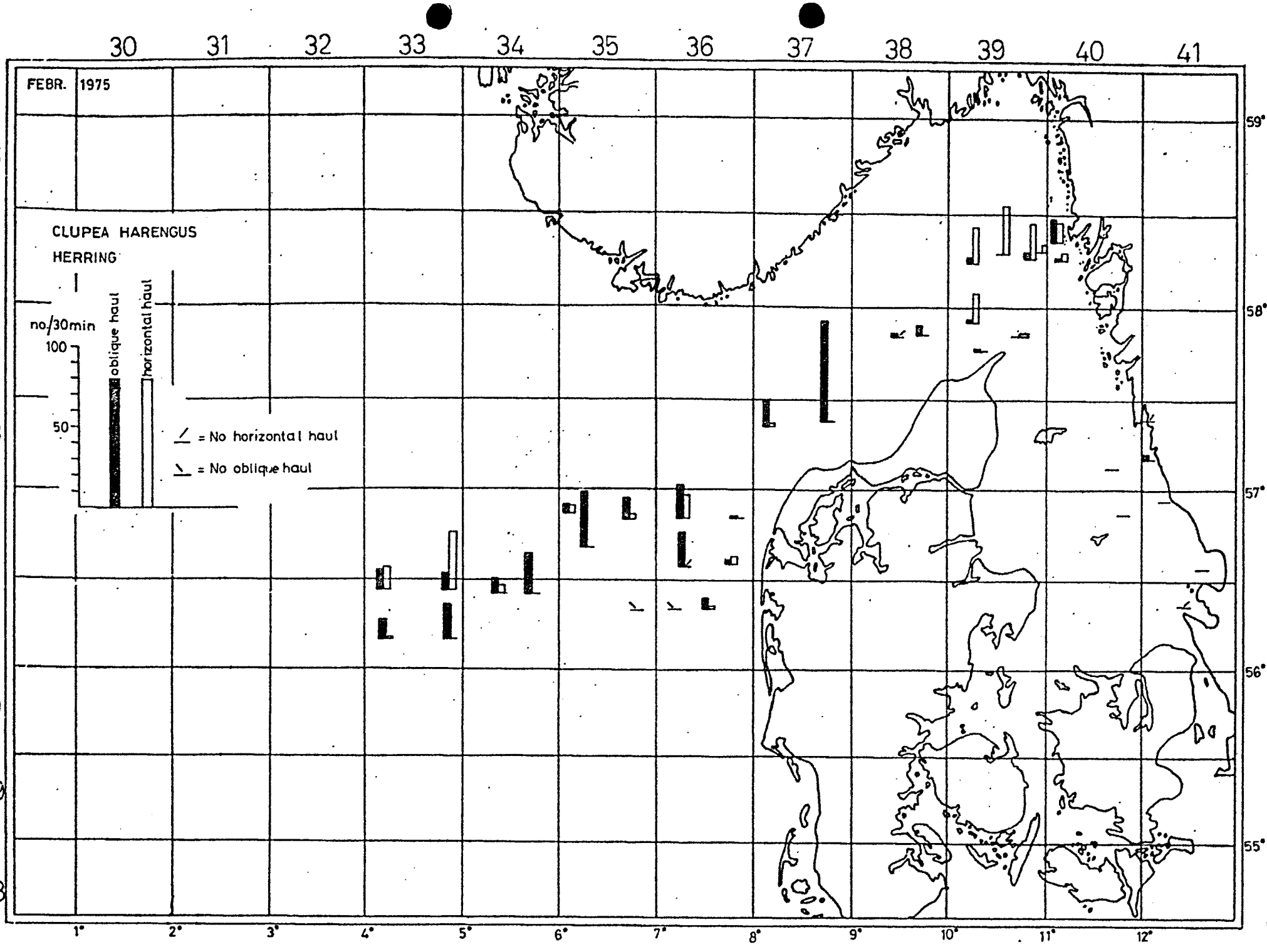
FEBR. 1975
CLUPEA HARENGUS
HERRING
no/30min
100
50
oblique haul
horizontal haul
= No horizontal haul
= No oblique haul
30
31
32
33
34
35
36
37
38
39
40
41
16
15
14
13
12
11
10
09
08
59°
58°
57°
56°
55°
1°
2°
3°
4°
5°
6°
7°
8°
9°
10°
11°
12°

Fig.2

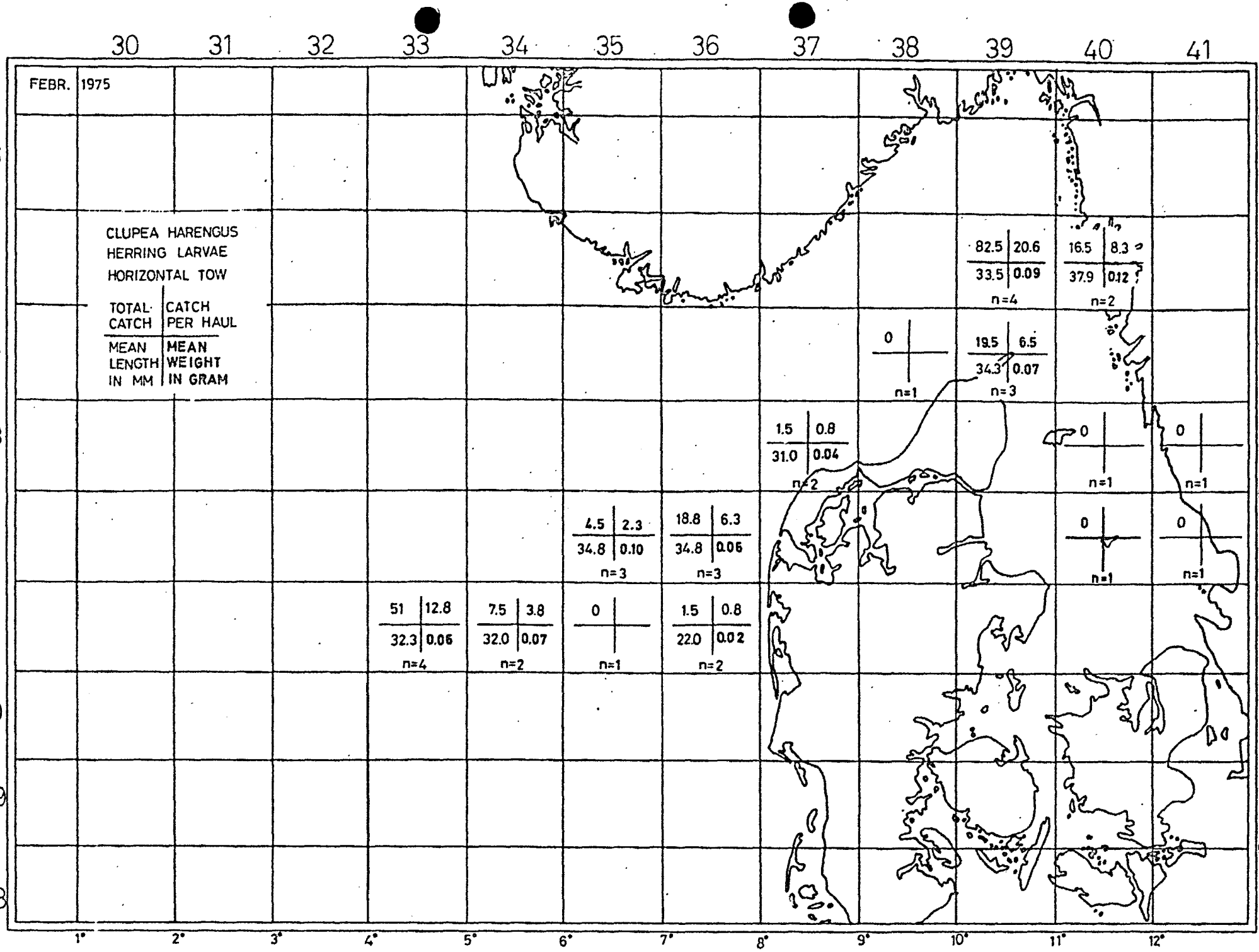
FEBR. 1975
CLUPEA HARENGUS
HERRING LARVAE
HORIZONTAL TOW
TOTAL CATCH | CATCH PER HAUL
MEAN LENGTH IN MM | MEAN WEIGHT IN GRAM
30 31 32 33 34 35 36 37 38 39 40 41
16 15 14 13 12 11 10 09 08
59° 58° 57° 56° 55°
1° 2° 3° 4° 5° 6° 7° 8° 9° 10° 11° 12°
82.5 | 20.6
33.5 | 0.09
n=4
16.5 | 8.3
37.9 | 0.12
n=2
0
n=1
19.5 | 6.5
34.3 | 0.07
n=3
1.5 | 0.8
31.0 | 0.04
n=2
0
n=1
0
n=1
4.5 | 2.3
34.8 | 0.10
n=3
18.8 | 6.3
34.8 | 0.06
n=3
0
n=1
0
n=1
51 | 12.8
32.3 | 0.06
n=4
7.5 | 3.8
32.0 | 0.07
n=2
0
n=1
1.5 | 0.8
22.0 | 0.02
n=2

Fig. 3

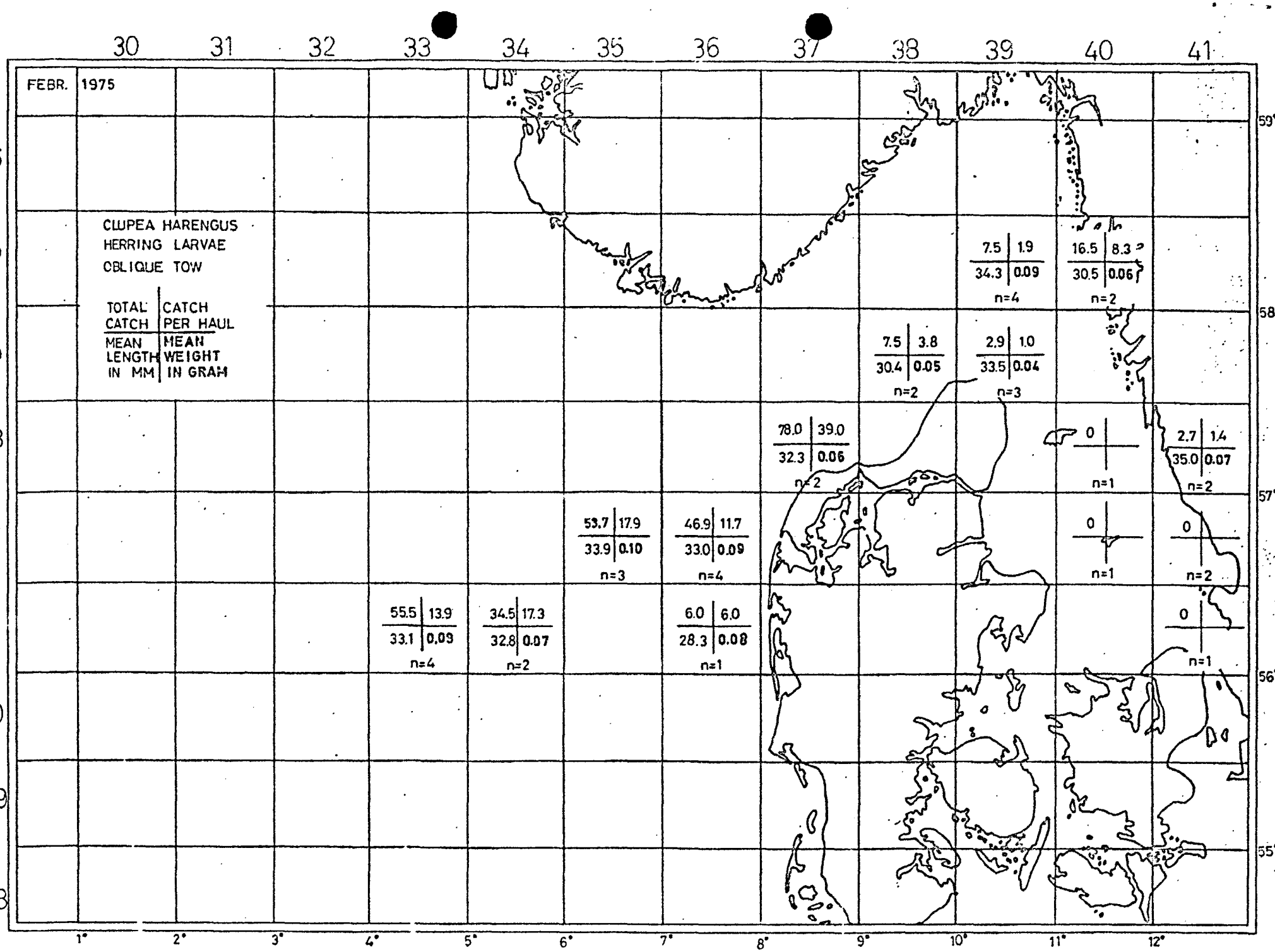
FEBR. 1975
CLUPEA HARENGUS
HERRING LARVAE
OBLIQUE TOW
TOTAL CATCH | CATCH PER HAUL
MEAN LENGTH IN MM | MEAN WEIGHT IN GRAM
30 31 32 33 34 35 36 37 38 39 40 41
16 15 14 13 12 11 10 09 08
59° 58° 57° 56° 55°
1° 2° 3° 4° 5° 6° 7° 8° 9° 10° 11° 12°
7.5 | 1.9
34.3 | 0.09
n=4
16.5 | 8.3
30.5 | 0.06
n=2
7.5 | 3.8
30.4 | 0.05
n=2
2.9 | 1.0
33.5 | 0.04
n=3
78.0 | 39.0
32.3 | 0.06
n=2
0
n=1
2.7 | 1.4
35.0 | 0.07
n=2
53.7 | 17.9
33.9 | 0.10
n=3
46.9 | 11.7
33.0 | 0.09
n=4
0
n=1
0
n=2
55.5 | 13.9
33.1 | 0.09
n=4
34.5 | 17.3
32.8 | 0.07
n=2
6.0 | 6.0
28.3 | 0.08
n=1
0
n=1

Fig. 4