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On the occurrence of herring larvae in March-April, 1972-1974, in the Skagerrak

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INTRODUCTION

In order to catch small eels migrating from the Skagerrak into the Swedish westcoast a lot of hauls were taken with an Isaacs-Kidd Midwater Trawl (IKMWT) from the end of March to the middle of April in 1972 (Lindquist, 1972). Many other species were also caught especially different kinds of larvae and adult sprats. Among the larvae there were many herring larvae. Hauls were made in the beginning of the cruise both at night (2130 - 0030 hrs local time) and in the daytime (0830 - 1130 hrs). As the small eels only were caught at night and at surface, the main part of the hauls were carried out as nighthauls at surface. Comparisons with hauls taken at night and in the daytime at various depths showed that the maximum number of herring larvae also were caught at night at surface. The herring larvae were in the size range of means at various stations from 36.2 mm $\pm$ 0.65 mm ($\bar{m} \pm 2$ s) to 44.0 mm $\pm$ 0.54 mm. This size of herring larvae is normally impossible to get with common plankton nets or gears like Gulf III. As the mean number of larvae at the different stations were as high as 49.8 larvae, it was obvious that this method was very good

for collecting big herring larvae just before metamorphosis. Hence, it was decided to continue with similar investigations the following years. As we now have three years' experience, it is time to report about our results.

I want to thank the director, dr A. Lindquist, who has organized the cruises 1972-1974, for the material, which he has placed at my disposal.

MATERIAL AND METHODS

During March-April 1972-1974, the investigations were carried out in the Skagerrak and the northern Kattegat mainly north of 57°30'N and east of 10°00'E as well as in some areas in the fiords of the Swedish west-coast. An Isaacs-Kidd Midwater Trawl was used with an opening of 4 x 2.5 m (cf. Lindquist, 1972). 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. Preliminary investigations showed that very few fish-larvae were caught in the trawl. A 1 m long cone of nylon net (mesh-size 0.15 cm) was therefore inserted in the cod-end. A plastic collecting bucket was attached to the cone. With the modified IKMWT great amounts of fish-larvae as well as adult sprats were caught during a 30 min tow.

The IKMWT was tested at various depths during day-time and at night. A few experiments showed that the main part of the herring larvae occurred at night in the upper 10 meters. Herring larvae were found in hauls down to 32 meters in the Gullmar fiord. However, the IKMWT is open when going down and up in the water column and it is therefore impossible to know where the larvae occurred. Experiments in the open sea showed that herring larvae occurred in the surface water even during day-time. When the same experiments were made at night at the same station we got as many herring larvae in the surface tow as from 5 tows together at various depths from surface down to 150 m. Hence it was decided that all tows should be done in the surface during night. With this type of IKMWT this means that the water from surface down to 4 m depth was sampled. The towing speed was 3 knots.

The larvae were preserved in 5 % formalin. After about 1 month the larvae were measured and weighed. The larvae were placed at a disc for 15 before the weighing. During that time the formalin evaporated from the surface of the larvae.

RESULTS

In 1972 28 night hauls were made. The main part of the hauls were carried out just north of Skagen, where the main concentration of larvae occurred (fig.1, table 1). The total number of larvae was 1170 and the mean value was 106.4 larvae per haul. Inside this statistical rectangle the number of larvae per station varied from 5 to 627. This indicate that many stations have to be sampled in order to get accurate data for comparisons between

different statistical squares. Inside statistical square 1439 the greatest number of larvae was found at stations in two separate areas with 627 resp. 189 larvae. Between these two stations the number of larvae amounted to 14-64 larvae.

Close to the Swedish west-coast very few larvae were found. In the innerfiords a moderate number of larvae occurred. The total number of larvae caught was 1393 and the mean number for all stations in 1972 was 49.8 larvae. The range of mean length values were 38-41 mm and the mean weight values 0.20-0.28 g wet weight.

In 1973 51 night hauls were made. The investigation area was enlarged a bit to the north (fig.2, table 2). The density of larvae was less than the previous year. In the area north of 58°30' (stat.sq. 1639) the greatest amount of larvae was found and the mean value of 78.6 larvae per haul was about 75 % of the maximum number larvae caught north of Skagen in 1972. Unfortunately this northern area was not investigated in 1972 and no comparisons can be made. As in 1972 there were very few larvae in the open sea close to the Swedish west-coast and also very few in the inner fiords. The total number of herring larvae caught during the whole cruise was less than previous year, although the number of stations were nearly doubled. The mean value was only 19.2 larvae per station.

It is interesting to note that the size of herring larvae was less in 1973 in comparison to 1972. In 1973 the mean size of the larvae off the coast was around 32 mm and in 1972 38-41 mm. In the innerfiords the size was similar the two years or 37-39 mm. To a certain extent the difference may be explained by the fact that the samples were taken about 10 days earlier in 1973 than in 1972.

In 1973 herring larvae investigations were also carried out in the beginning of June. Not a single herring larvae were found at that cruise. Probably the herring larvae had metamorphosed and we were then not able to catch the larvae with this method.

In 1974 the number of herring larvae in the beginning of April was greater than ever. We caught 10842 larvae during 30 night hauls and the mean number larvae was as high as 361.4 per station. The greatest density was found in the areas north of Skagen. 290.3 and 614.7 herring larvae per station were caught in area 1439 resp. 1539. Even close to the Swedish west-coast in the open sea the number of larvae was very high. No samples were taken in the inner fiords. The total mean length of the larvae was 39.7 mm or about the same as in 1972 and very different from the values in 1973 when the mean length was 32 mm. The sampling time was later than in 1973 but in the same time period as in 1972.

The weight of the larvae was also different during the various investigations. In 1972 and 1974 the mean weight was 0.21 g. In 1973 when the length

of the larvae was 7-8 mm shorter, the mean weight was 0.10 g.

DISCUSSION

The diurnal migration of herring larvae has been studied in the Kattegat by Johansen (1925), Höglund (1938; in Höglund, 1968) and Jensen (1949). Johansen (1925) showed that small herring larvae (8-19 mm) were most abundant during night in the surface water layers between midnight and 2 o'clock in April. The larvae were supposed to be the result of winter spawning herring in the middle of February. In the hauls from the surface layers, bigger larvae (20-43 mm) of autumn spawning herring were only taken during night.

Höglund (1938; in Höglund, 1968) found the opposite thing during autumn in the Kattegat. His investigations in October 1936 and in 1937 indicate that it is an upward migration during the day and a downward migration during the night. His explanation to this phenomenon was that the herring larvae tend to concregate in the surface layer in the day-time, where the optimum light intensity is assumed to be. A strongly marked halocline in 1937 prevented the larvae to migrate up close to surface as they did in 1936 but they were even then higher up in the water column during day than night.

The results from Johansen's investigations during April is thus confirmed by this investigation carried out at the same time of the year. According to Jensen (1949) three size-groups of herring larvae can be found in April in the Kattegat. Herring larvae 30-40 mm length (autumn spawners) and larvae 10-22 mm length (winter spawners) can be obtained in the beginning of April. Later in April herring larvae less than 10 mm can be caught. The latter larvae are supposed to be the results of the spawning from the end of March to the middle of May (spring spawners).

The information given by both Johansen (1925) and Jensen (1949) indicate, that the herring larvae caught in these investigations in April in the Skagerrak must be the results of the autumn spawning herring.

The possibility to catch herring larvae with IKMWT might be a good supplement to the international young herring surveys in February. The new year-class can be sampled about 10 months before the investigations with herring trawls in February when the herring are about 1 1/2 years old. The results in 1972 and 1973 from these investigations and the results from the young herring surveys in 1973 and 1974 are not comparable. The area sampled in 1972 and 1973 is too small to get accurate results for comparisons with the young herring surveys in the Kattegat, Skagerrak and North Sea. The results from these investigations indicate that 1973 year-class is the strongest one of the three year-classes 1971-1973 (cf. tables 1-3).

The relation between the strengths of the year-classes according to the methods used in these investigations is 1:0.4:7.2. It would be interesting

to make a more comprehensive investigation on international basis to see if it is possible to predict anything about year-class strengths based on the results of 30-40 mm long herring larvae.

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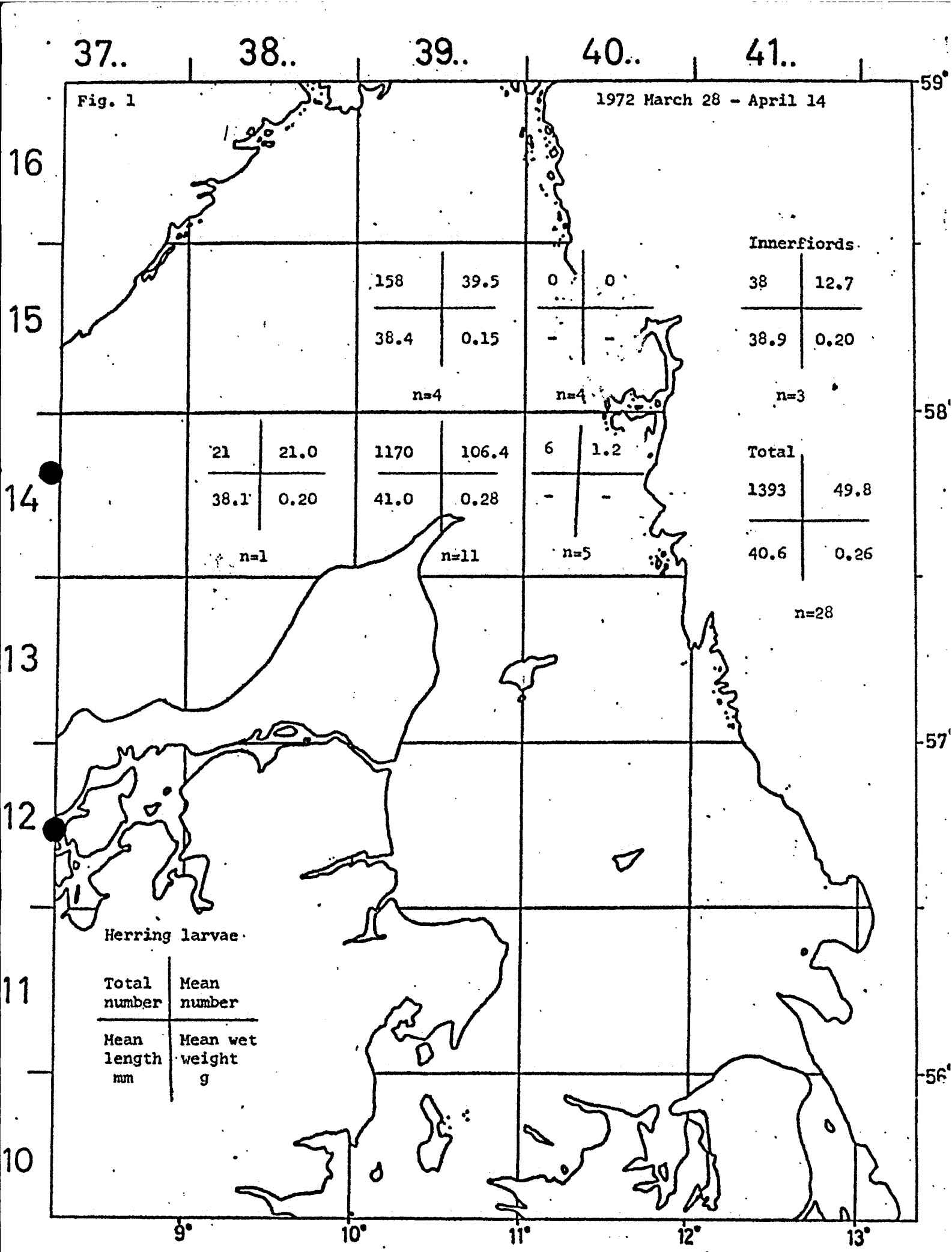
LEGENDS

Fig. 1. Herring larvae caught with Isaacs-Kidd Midwater Trawl (IKMWT) from March 28 to April 14, 1972, during night at surface in the Skagerrak (cf. table 1).

Fig. 2. Herring larvae caught with IKMWT from March 19 to April 4, 1973, during night at surface in the Skagerrak (cf. table 2).

Fig. 3. Herring larvae caught with IKMWT from April 1 to April 10, 1974, during night at surface in the Skagerrak (cf. table 3).


37..
38..
39..
40..
41..
Fig. 1
1972 March 28 - April 14
16
15
14
13
12
11
10
59°
58°
57°
56°
9°
10°
11°
12°
13°
Innerfiords
158 | 39.5
38.4 | 0.15
n=4
0 | 0
- | -
n=4
38 | 12.7
38.9 | 0.20
n=3
21 | 21.0
38.1 | 0.20
n=1
1170 | 106.4
41.0 | 0.28
n=11
6 | 1.2
- | -
n=5
Total
1393 | 49.8
40.6 | 0.26
n=28
Herring larvae
Total number | Mean number
Mean length mm | Mean wet weight g

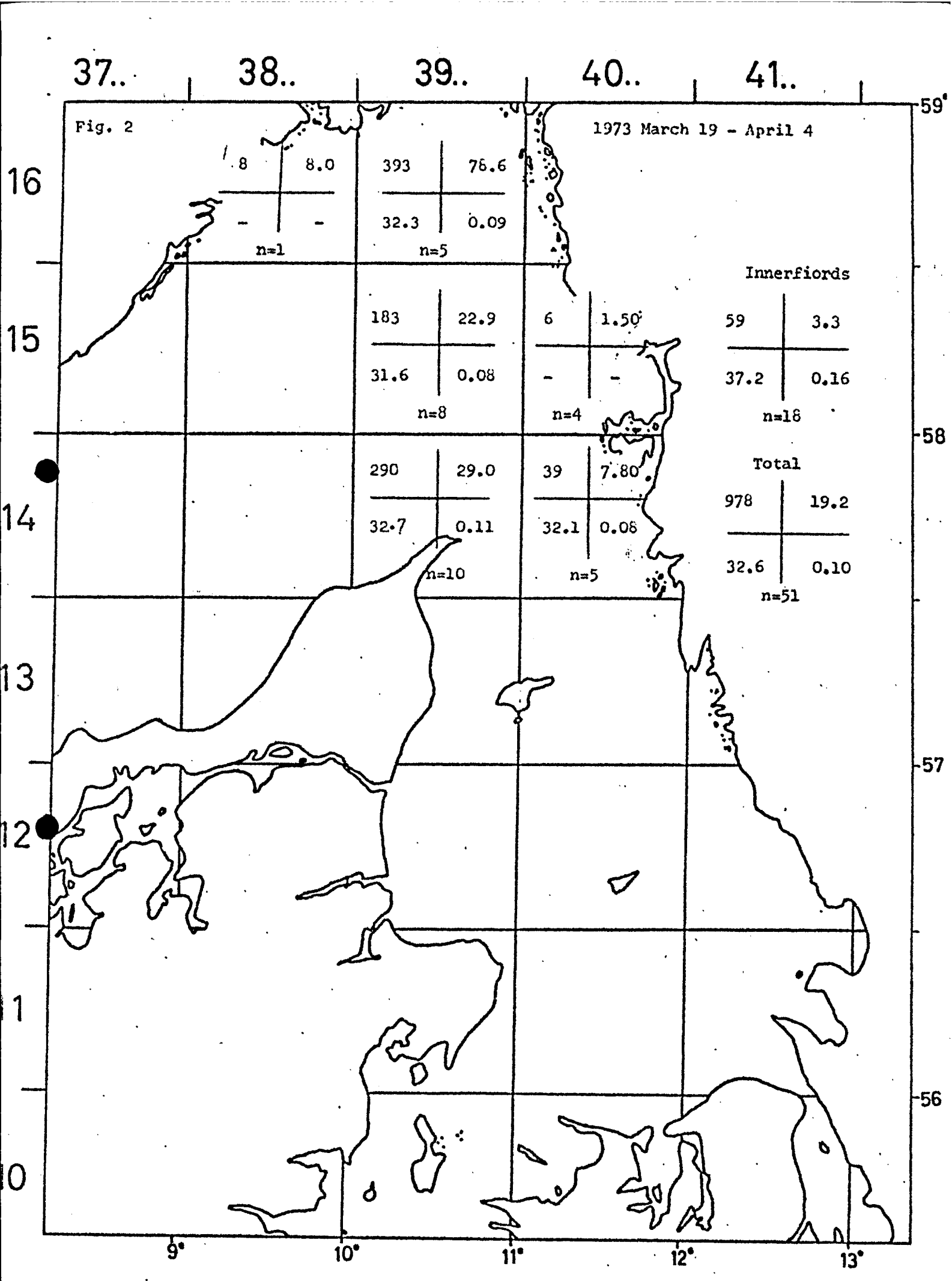


Fig. 2
1973 March 19 - April 4
37..
38..
39..
40..
41..
59°
58
57
56
16
15
14
13
12
1
10
9°
10°
11°
12°
13°
8
8.0
-
-
n=1
393
76.6
32.3
0.09
n=5
Innerfiords
183
22.9
31.6
0.08
n=8
6
1.50
-
-
n=4
59
3.3
37.2
0.16
n=18
290
29.0
32.7
0.11
n=10
39
7.80
32.1
0.08
n=5
Total
978
19.2
32.6
0.10
n=51

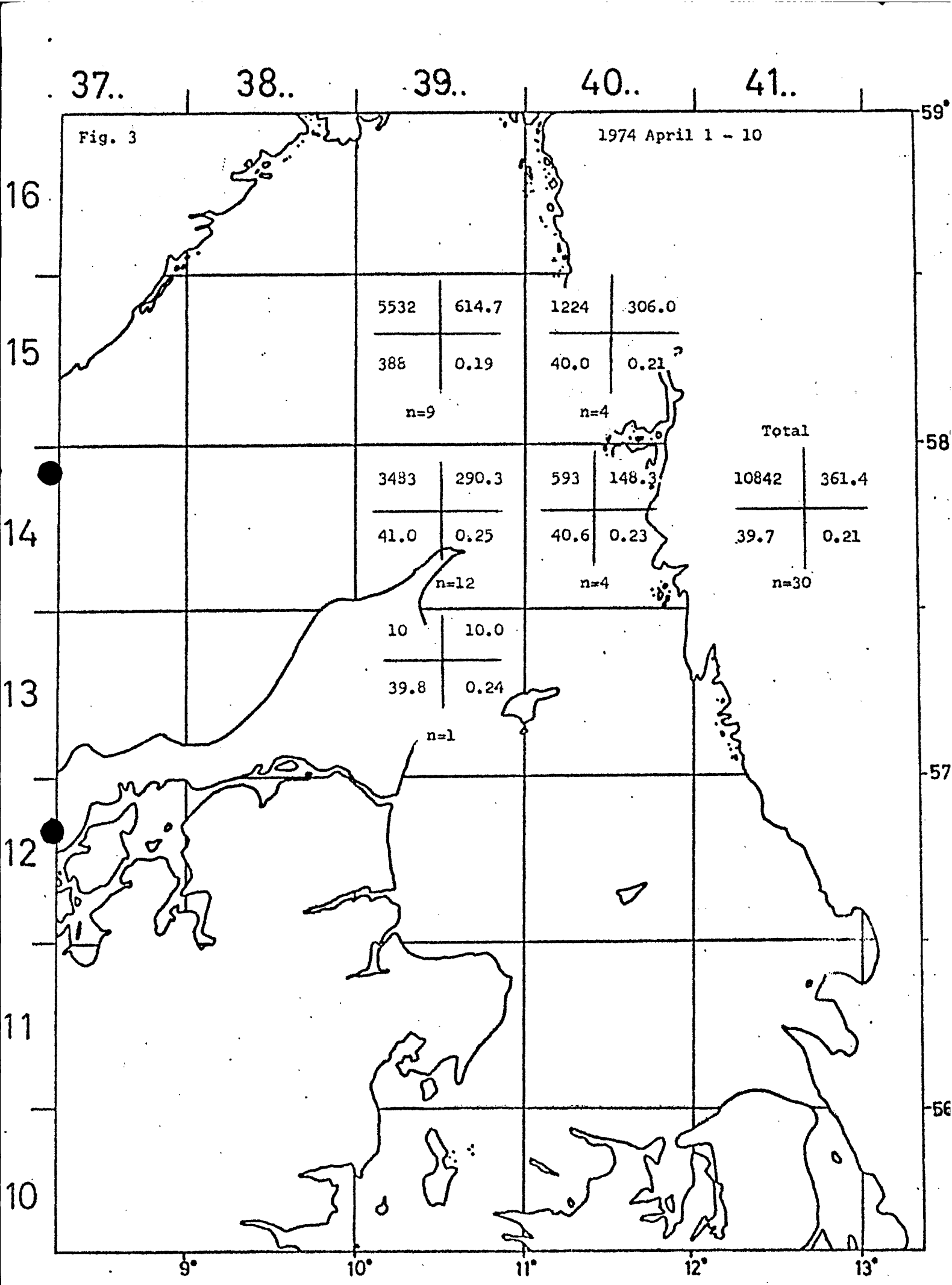

37..
38..
39..
40..
41..
59°
58°
57°
56°
16
15
14
13
12
11
10
9°
10°
11°
12°
13°
Fig. 3
1974 April 1 - 10
5532 | 614.7
388 | 0.19
n=9
1224 | 306.0
40.0 | 0.21
n=4
Total
10842 | 361.4
39.7 | 0.21
n=30
3483 | 290.3
41.0 | 0.25
n=12
593 | 148.3
40.6 | 0.23
n=4
10 | 10.0
39.8 | 0.24
n=1

Table 1. Herring larvae caught with IKMWT from March 28 to April 14, 1972, during night at surface in the Skagerrak, cf. fig. 1.

Area	Number hauls	Total number larvae	Mean number larvae	Range number larvae	Mean length mm	Mean weight g
Innerfiords surface	3	38	12.7	2-28	38.9	0.20
1440	5	6	1.2	0-4	-	-
1540	4	0	0	0	-	-
1439	11	1170	106.4	5-627	41.0	0.28
1539	4	158	39.5	9-92	38.4	0.15
1438	1	21	21.0	21	38.1	0.20
Total	28	1393	49.8	0-627	40.6	0.26

Table 2. Herring larvae caught with IKMWT from March 19 to April 4, 1973, during night at surface in the Skagerrak, cf. fig. 2.

Area	Number hauls	Total number larvae	Mean number larvae	Range number larvae	Mean length mm	Mean weight g
Innerfiords	18	59	3.3	0-16	37.2	0.16
1439	10	290	29.0	2-89	32.7	0.11
1440	5	39	7.8	0-36	32.1	0.08
1539	8	183	22.9	11-59	31.6	0.08
1540	4	6	1.5	0-5	-	-
1638	1	8	8.0	8	-	-
1639	5	393	78.6	19-181	32.3	0.09
Total	51	978	19.2	0-181	32.6	0.10

Table 3. Herring larvae caught with IKMWT from April 1 to April 10, 1974, during night at surface in the Skagerrak, cf. fig. 3.

Area	Number hauls	Total number larvae	Mean number larvae	Range number larvae	Mean length mm	Mean weight g
1339	1	10	10.0	10	39.8	0.24
1439	12	3483	290.3	0-1561	41.0	0.25
1440	4	593	148.3	13-445	40.6	0.23
1539	9	5532	614.7	37-2649	38.8	0.19
1540	4	1224	306.0	18-1016	40.0	0.21
Total	30	10842	361.4	0-2649	39.7	0.21