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Quantitative distribution of blue whiting in relation to the hydrography in Faroese waters March-May 1979.

by

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Abstract.

Five echoabundance surveys in Faroese waters in March-May 1979 indicate that more than 2,5 X 10^6 tons of blue whiting were found in the area during the peak period in May. The distribution of blue whiting was quite similar to that found in 1978 with the highest mean densitys on the western side of the plateau and with significant amounts dispersed over a wider area in the Faroe Shetland Channel. Compared to 1978, however, the areas with very high densities of blue whiting on the western side were significanly less. It is also a slight indication that compared to 1978 a higher proportion of the blue whiting migrated north through the Faroe Shetland Channel in 1979.

The migration route chosen has a great influence on the availability of blue whiting for the industrial fishery and the distribution of blue whiting around the Faroes is discussed in relation to the hydrography in the area.

Introduction.

The fishery for blue whiting in Faroese waters on postspawners migrating north in May takes place almost exclusively along the southern and south-western shelf edge of the Faroe Plateau. In an acoustic abundance estimate investigation in 1978 (Jákupsstovu 1978) it was shown that although the highest mean densities of blue whiting were found in this area, significant amounts of blue whiting were also recorded in the Faroe Shetland Channel. Further it was shown, that while the concentrations on the western side of the plateau were very dense on a limit area, they were on the eastern side dispersed over a much wider area. A possible reason for this difference might be the current system around the Faroes. If so annual variation might be expected.

In view of this, investigations of the hydrography was incorporated in an acoustic abundance investigation monitoring the postspawning migration of blue whiting through Faroese waters.

In this paper a preliminary report of the investigations in 1979 is given.

General hydrography. The large scale hydrographic features of the area are shown in Fig. 1, as they are presently understood. The uppermost parts (down to 300-500 m) of the sea surrounding the Faroe plateau are dominated by water of Atlantic origin. Two different branches of the North Atlantic circulation system contribute, however, with slightly different watermass-characteristics ; NA Water (North Atlantic) which enters along the Scottish continental shelf is warmer and more saline than MNA Water (Modified North Atlantic) which seems to enter the area north of Faroe Bank.
The flow pattern for the upper layers shown in Fig. 1 is based on current measurements on the Faroe Plateau and hydrographic evidence (Hansen 1979).
Except for the north western region lying in the Atlantic Ocean proper, the deepest waters are dominated by the Deep Norwegian Sea Water, NS, througout the area. The fourth significant water mass NI/AI is found at intermediate levels although traces of it are found widely dispersed through the water column by mixing. This watermass derives from North Icelandic winter water and intermediate subarctic water and sinks along the front east of the Iceland Faroe Ridge. Together with the NS Water it forms the "overflow" of cold water into the Atlantic which has been intensively studied in recent years.
The temperature and salinity characteristics of these watermasses vary with season and author. The values listed in the table below are based on observations during the Overflow expedition in August-September 1973 (Müller, Meincke and Becker 1979).

Watermass characteristica during Overflow 73.

Watermass	Temperature °C	Salinity °/₀₀
NA	$\geq$ 9,0	$\geq$ 35,32
MNA	$\leq$ 8,5	~ 35,24
NS	$\leq$-0,5	~ 34,92
NI/AI	2,5-3,0	~ 34,88

Material and methods. The same method was applied for the acoustic investigations as used in 1978 (Jákupsstovu 1978). In conjuction with a Simrad Ek 38 echosounder a Simrad echointegrator with two channels integrated the recordings from 100 to 500 m. The identification of the records was based on information from the fleet fishing in the area. The integration was done only in the daylight period.
During the investigation a total number of 78 hydrographic stations were worked with a Neill Brown CTD-system.
An intercalibration run was performed together with R/V "Explorer" on 9/4-1979 from 58°00 N and 09°00 W to 57°50 N and 09°57 W. The integrators were reset manually at 15 minutes intervals. The setting on "Jens Chr. Svabo" was the same

as during the surveys. The output from the integrator on "Explorer" is tons/ square kilometer, and in Fig. 2 these values are plotted against the corresponding mm deflection values from "Jens Chr. Svabo". This gives a regression line of the form

$$\text{Tons/km}^2 = 5{,}01 \cdot (\text{mm deflection}) - 11$$

with a correlation coefficient of 0,99. The line is based on only 12 observations and of these 10 on concentrations less than 200 t/km^2. The noise level on board "Jens Chr. Svabo" is very high and the mm deflection values given are based on advanced scrutinizing of the recordings. Hence the very good correlation coefficient calculated most probably is only an artifact, and the regression line indicates only the relations between the vessels equipment.

Results.

Survey track, relative fish density and hydrograhpic stations are shown in Fig. 3 a-e. Absolute abundance in statistical rectangles calculated from the ship to ship calibration in Fig. 4 a-e.
Unfortunately the survey pattern and area coverage differ somewhat from the 1978 surveys making a direct comparison difficult. The general distribution of blue whiting during May (the main season) in 1979 is, however, quite similar to that found in 1978 with the highest concentrations found along the Southern and Southwestern shelf edge of the Faroe plateau, and with a significant amount of blue whiting dispersed over a wider area in the Faroe Shetland Channel.
As indicated later a North-South boundary was observed due south through st. 62 (Fig. 3) which may be decisive for the route chosen by blue whiting migrating north through Faroese waters, either west of the Faroe plateau or through the Faroe Shetland Channel.
For an absolute abundance calculation a Western and Eastern area was defined as West and East of 06°30´W, North of 60°15´N and bounded by the heavy lines in Figs. 4 a-e. While using the mean density found in each area to calculate the aboslute abundance within each area the following figures are obtained in thousand tons.

Period	Western area	Eastern area	Total
25/4-27/4	-	521	
7/5-10/5	1540	1031	2571
21/5-25/5	349	-	
28/5- 1/6	577	405	982

This shows as in 1978 that using the Aberdeen calibration constant of 34 dB/kg, that more than 2 millions tons of blue whiting is found in the Faroe area during the peak period in May. The highest figure when correcting for differences in area width is comparable with the figure found in 1978. Compared to 1978, however, the areas with very dense recordings of blue whiting on the western side of the plateau were significantly smaller. There is also a slight indication that during the peak period in May this year there was a higher total abundance in the eastern area and a lower total abundance in the western area. The industrial fishery for blue whiting is confined to the areas of very high density, and when these shrink, the availability of blue whiting for this fishery is less even if the total abundance is the same in the total area. This has also been observed by the fishermen who claim that the density of blue whiting in the Faroe area was less in 1979 compared to 1978.

In Fig. 5 a-m the temperature measurements from the CTD stations are shown as sections. On these the blue whiting recordings observed on the echosounder have also been indicated. As the station spacing was rather coarse on some of the sections, these sections exhibit only the main features of the temperature field. This is especially the case for the upper slope regions where often a thin cold bottom layer has been observed to extend far up onto the slope.

The cold bottom layer may have decisive influence on the blue whiting distribution but determination of it requires a very dense stationnet and CTD casts ending within a few meters from the bottom with the resulting risk of damage. Nevertheless this layer is observed on several of the sections but the material is not large enough to warrant any definite conclusions as to its effect on the blue whiting.

When considering possible relationships between the blue whiting migration path and hydrographic feature a central question is the difference in distribution East and West of the Faroe plateau.

The temperature sections (Fig. 5 a-m) clearly show a difference in the hydrography between the two regions. The difference is evident in Fig. 6, which shows that the Eastern waters had a mean temperature gradient in the uppermost 300-400 meters more than 5 times larger than the mean gradient in the Western waters, and although the temperature profiles had a certain variation within each of the two regions as indicated by the hatchings in Fig. 6, the two regions were stil quite distinct.

The explanation of this difference probably is that although the waters of the two regions have the same primary origin, the Eastern waters have been in closer contact with the colder masses in the Iceland Faroe Ridge area and larger amounts of NI/AI Water have been mixed into the upper water masses.

The boundary between the two regions is seen in Fig. 5 k to have been due South of the Southern corner of the Faroe plateau and is identified as the front in Fig. 1.

It is reasonable to expect this boundary to have a decisive influence on the migration path of the blue whiting and this will be an object for further study. Furthermore the circulation pattern in the basin between the Wyville-Thomson Ridge and the Faroe plateau may branch out so that the MNA Water passing south through the western part of the channel divides with one branch recirculated into the F-B Channel flowing north in the eastern part while the other branch

continues into the F-S Channel joining the NA Water.
If this is indeed the case, the relative strength of these branches and their location may be variable and hence explain the variability in blue whiting migration which has been observed.

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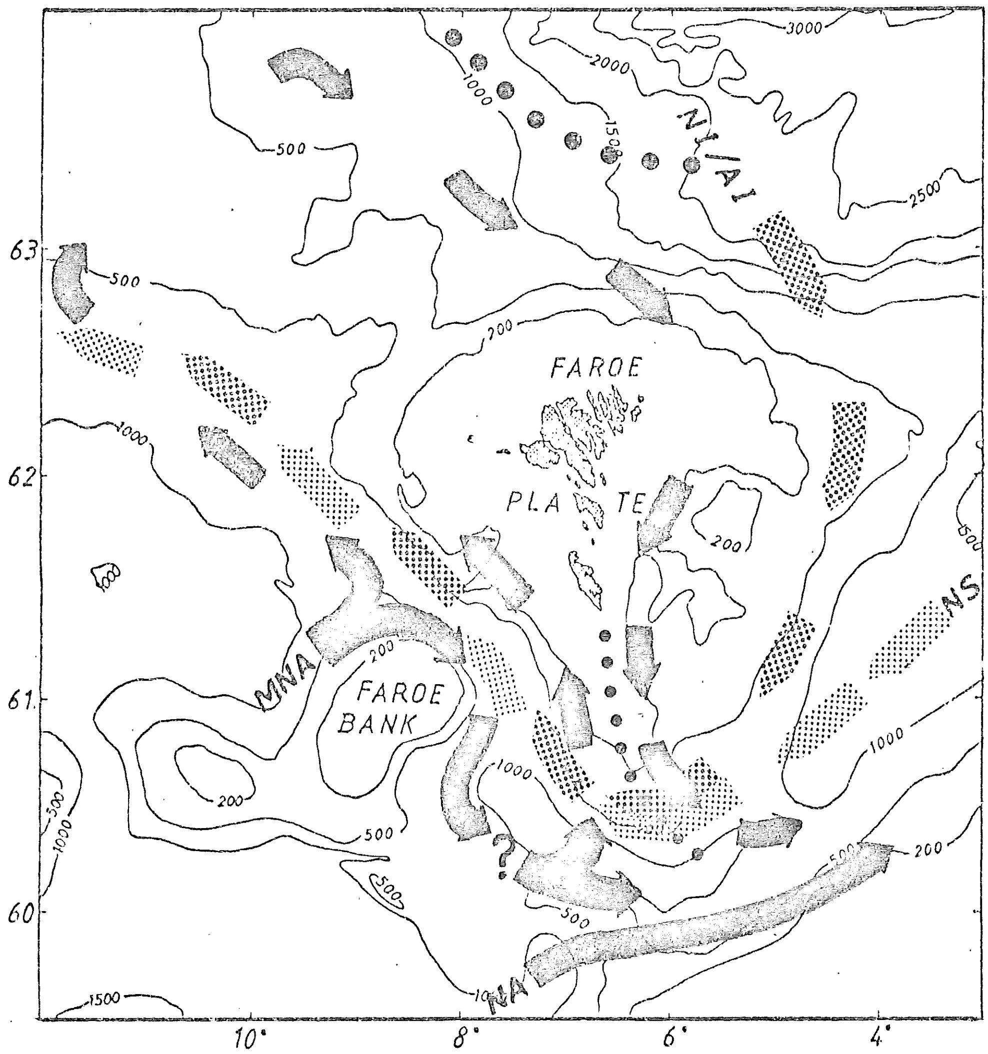

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Fig. 1. Water masses and flow pattern in upper (black), intermediate (heavy dots) and deeper layers (light dots) around the Faroes. Front areas are indicated by the dotted lines.

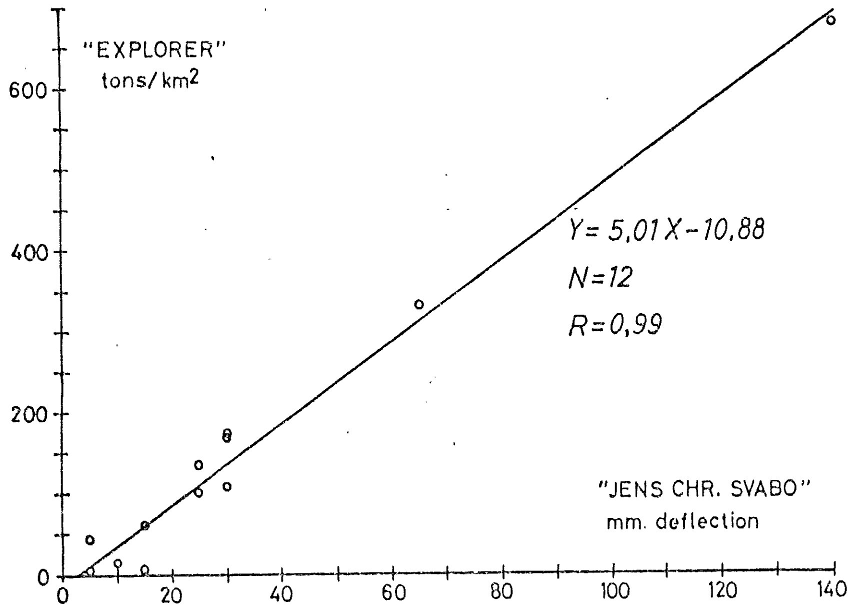

Fig. 2. Ship to ship calibration. "Explorer" - "Jens Chr. Svabo" 9/4-1979.

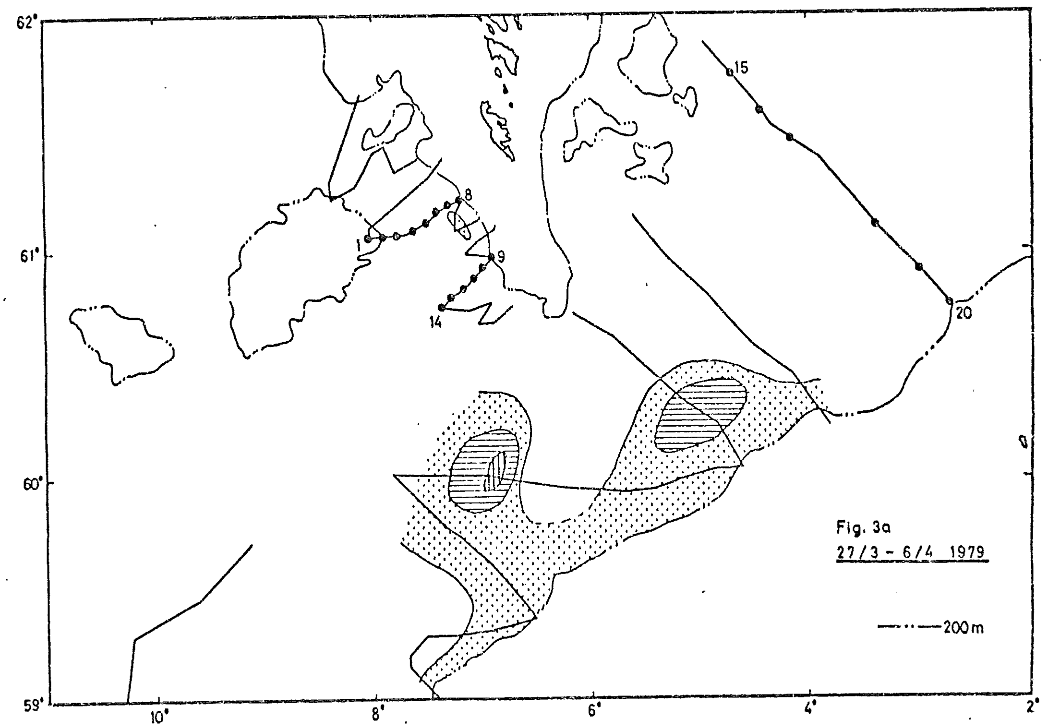

Fig. 3 a. Survey track, hydrographic stations and relative density of blue whiting 27/3-6/4-1979.

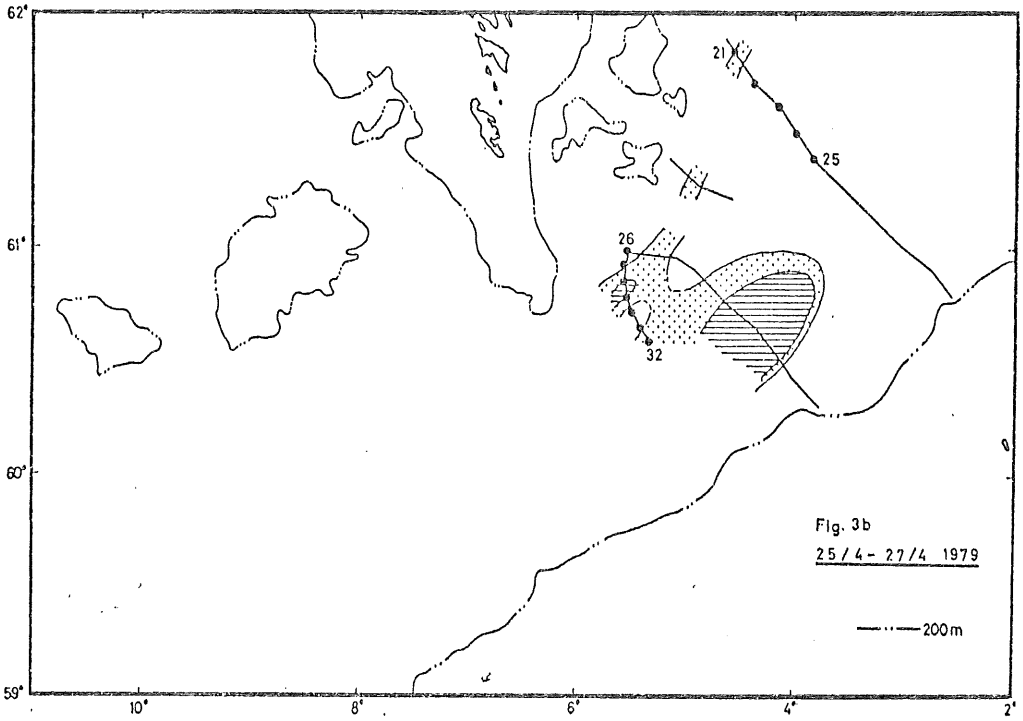

Fig. 3 b. Survey track, hydrographic stations and relative density of blue whiting 25-27/4-1979.

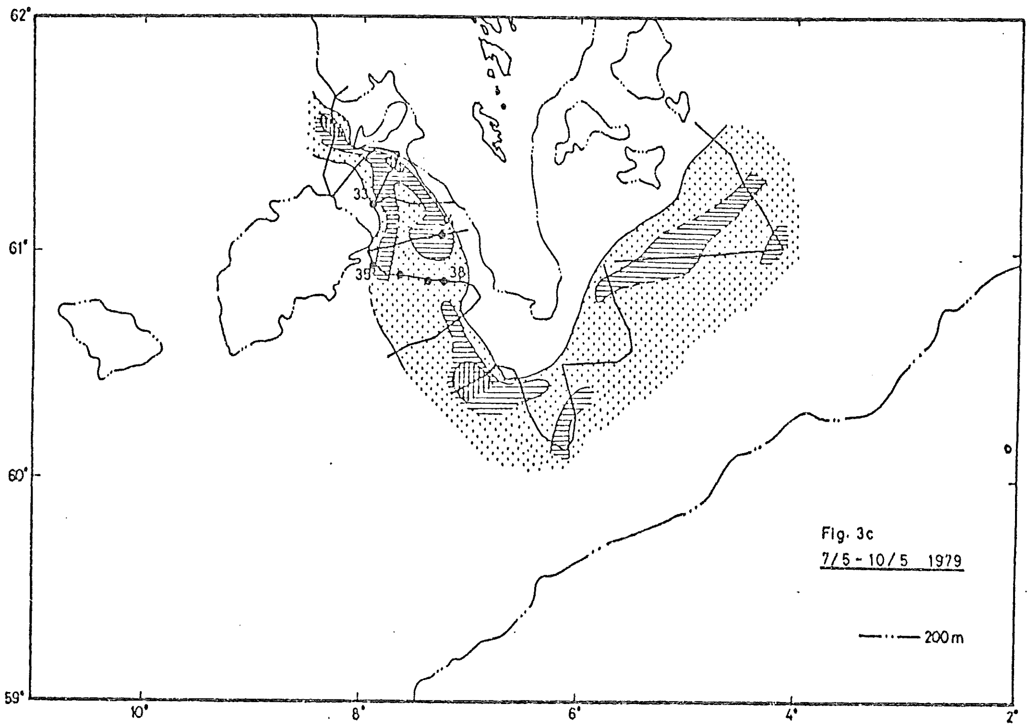

Fig. 3 c. Survey track, hydrographic stations and relative density of blue whiting 7-10/5-1979.

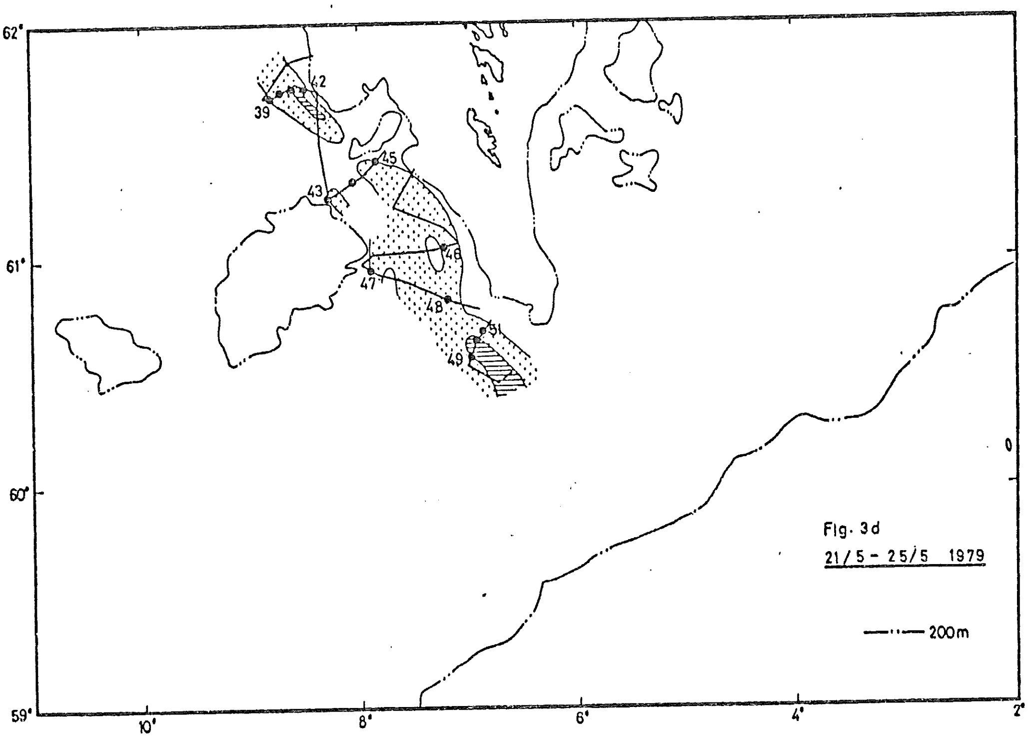

Fig. 3 d. Survey track, hydrographic stations and relative density of blue whiting 21-25/5-1979.

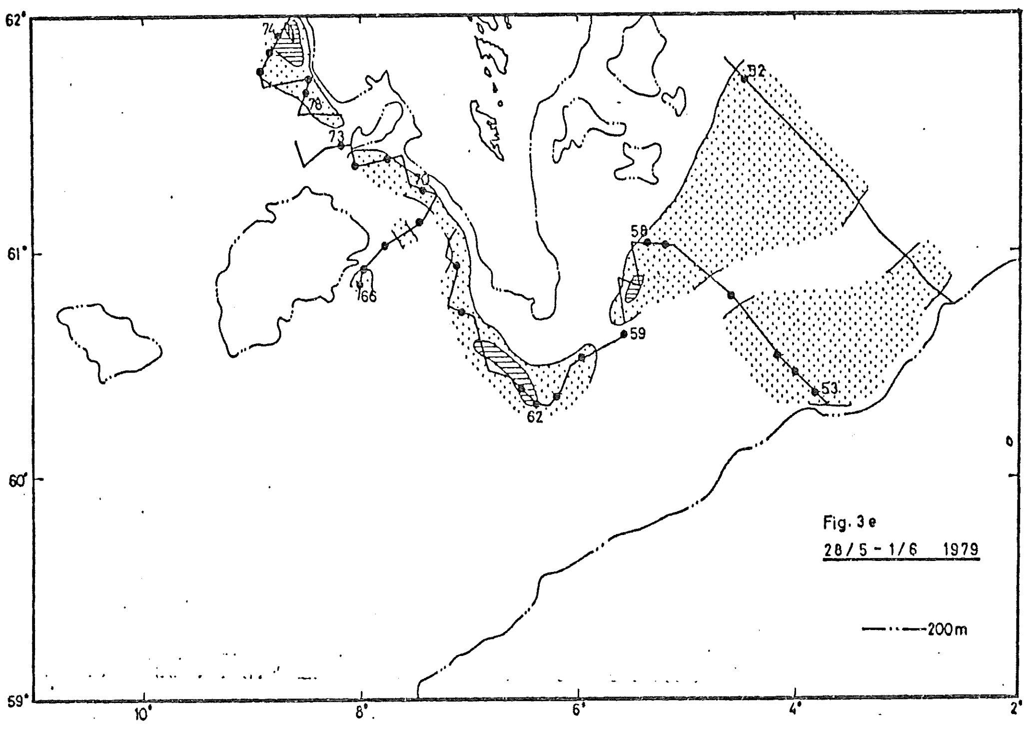

Fig. 3 e. Survey track, hydrographic stations and relative density of blue whiting 28/5-1/6-1979.

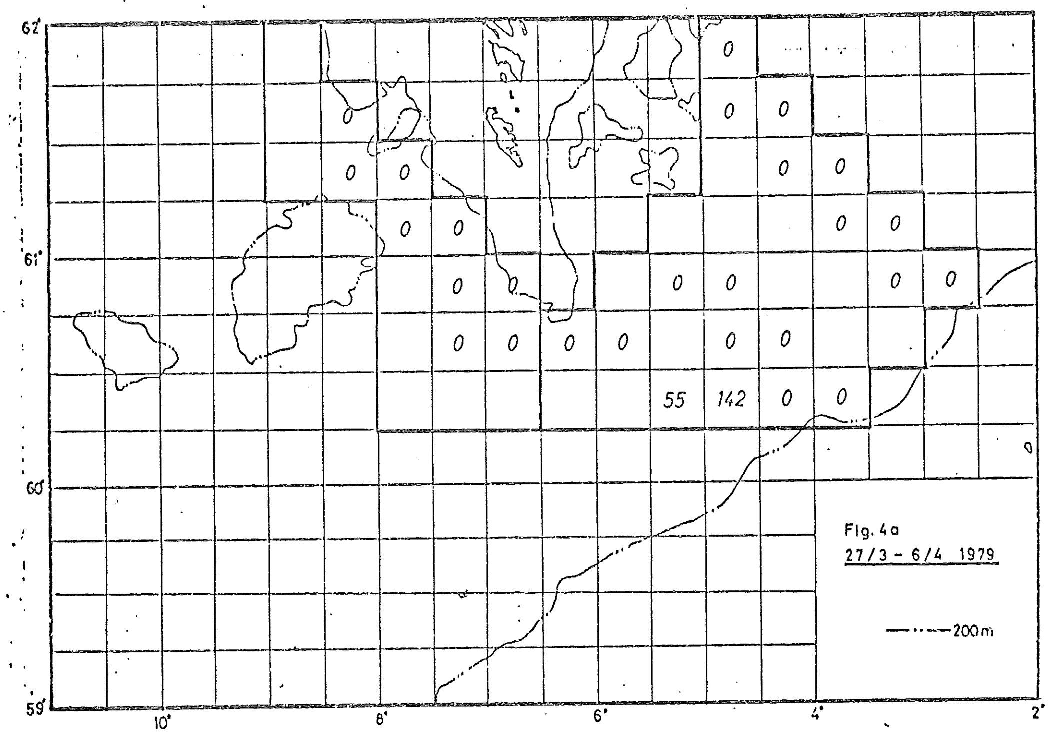

Fig. 4 a. Absolute abundance X 10^{-3}t of blue whiting in statistical rectangles 27/3-6/4-1979.

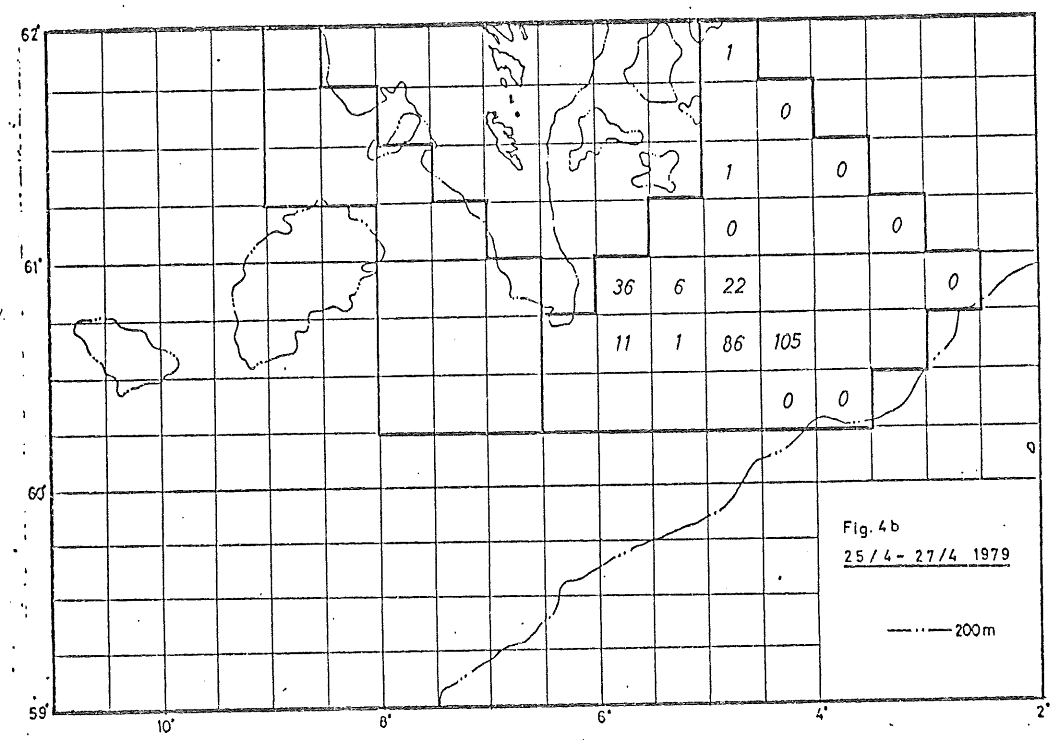

Fig. 4 b. Absolute abundance x 10^{-3}t of blue whiting in statistical rectangles 25-27/4-1979.

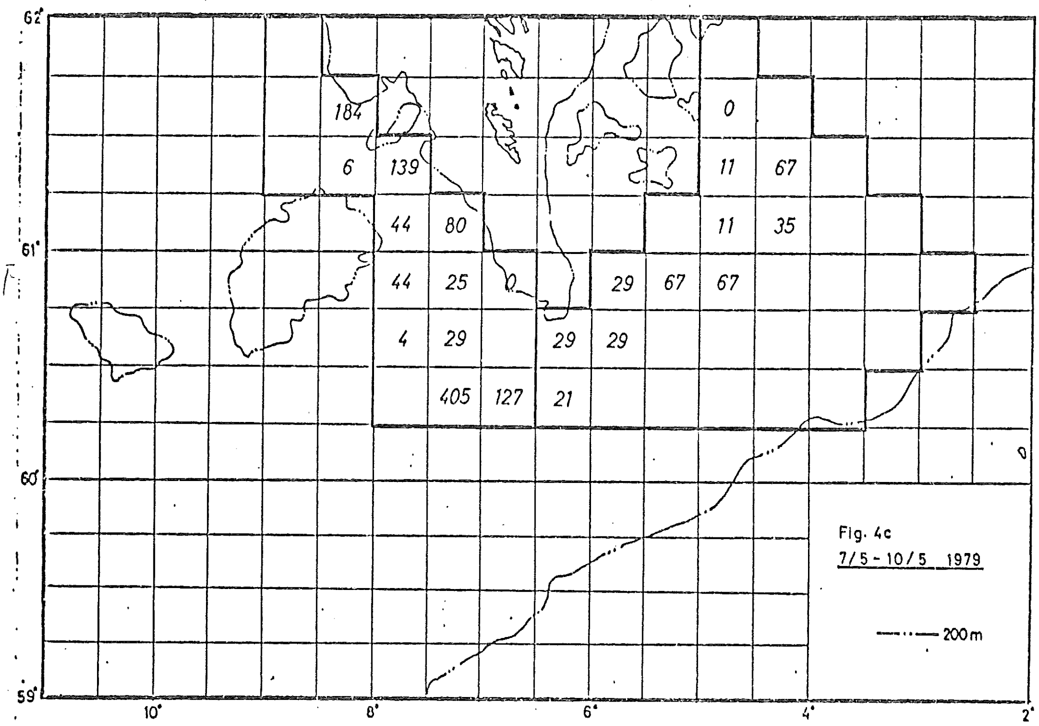

Fig. 4 c. Absolute abundance X 10^{-3}t of blue whiting in statistical rectangles 7-10/5-1979.

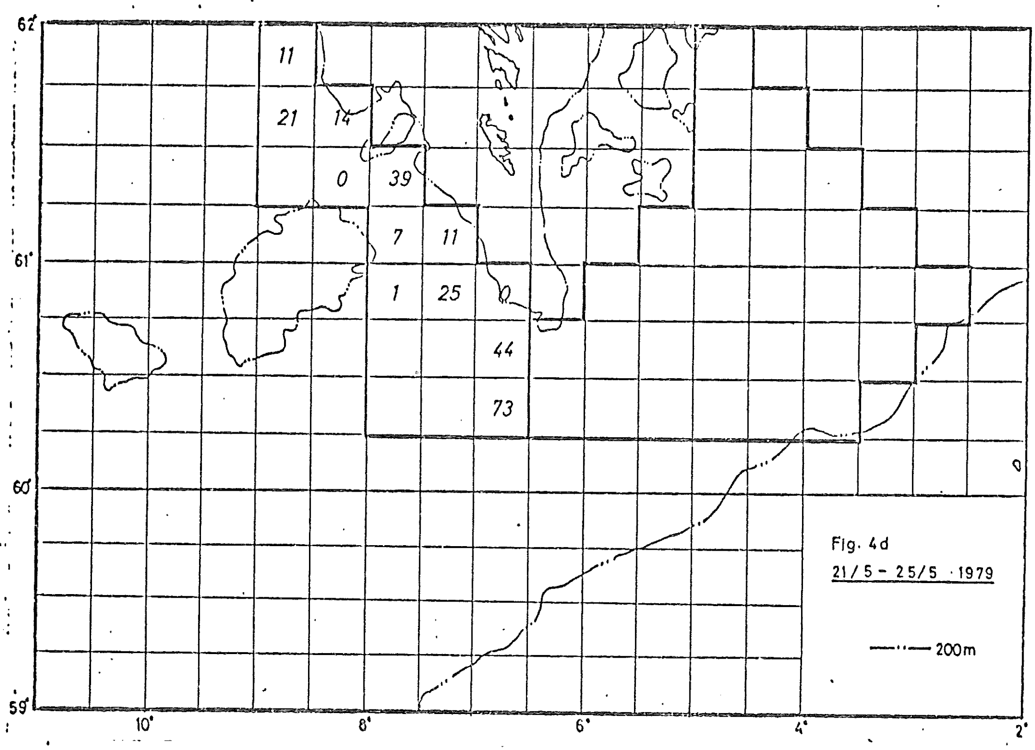

Fig. 4 d. Absolute abundance X 10^{-3}t of blue whiting in statistical rectangles 21-25/5-1979.

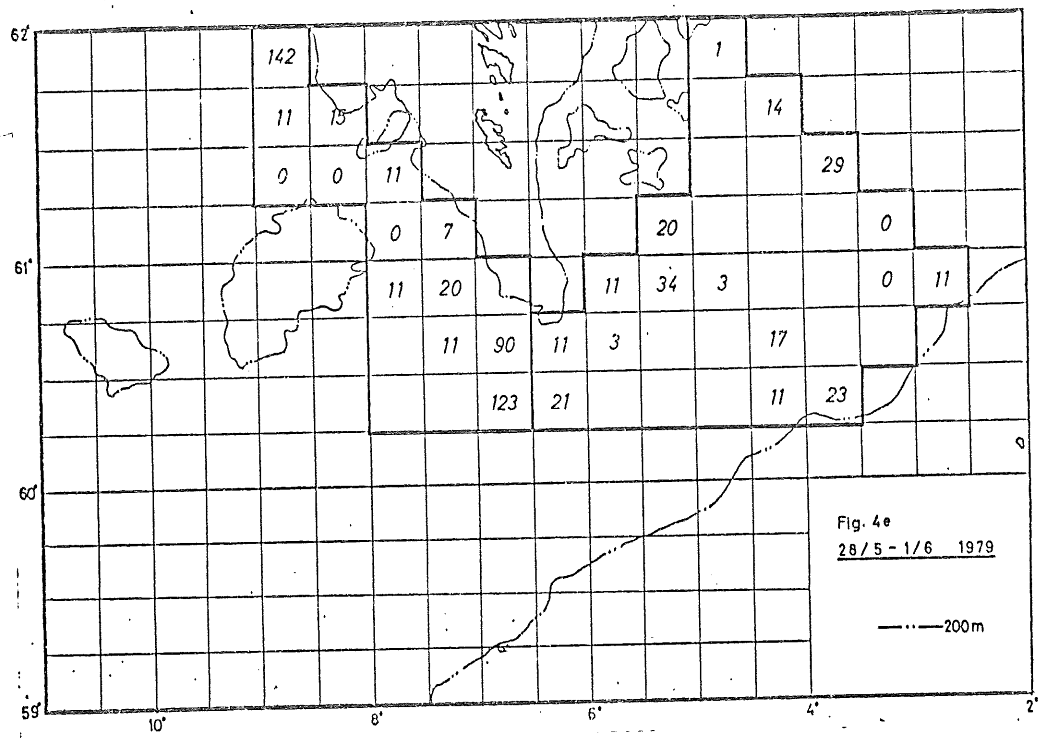

Fig. 4 e. Absolute abundance X 10^{-3}t of blue whiting in statistical rectangles 28/5 - 1/6-1979.

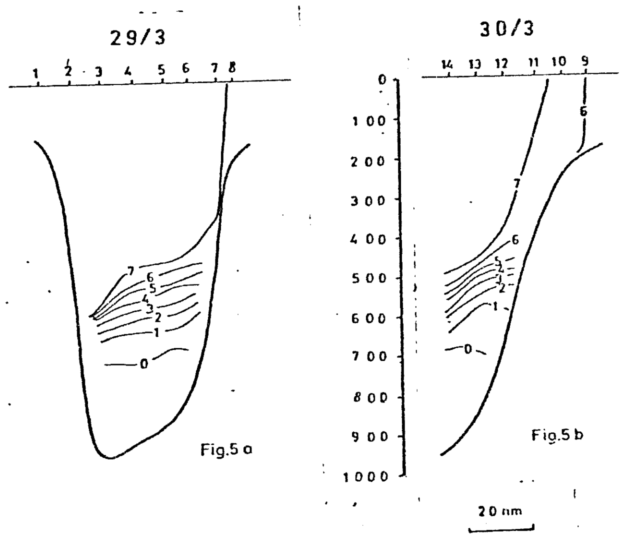

Fig. 5 a-b. Temperature measurements from theCTD stations 29/3 - 1/6-1979 in the Faroe area shown as sections. Blue whiting recordings observed on the echosounder between the stations is also indicated.

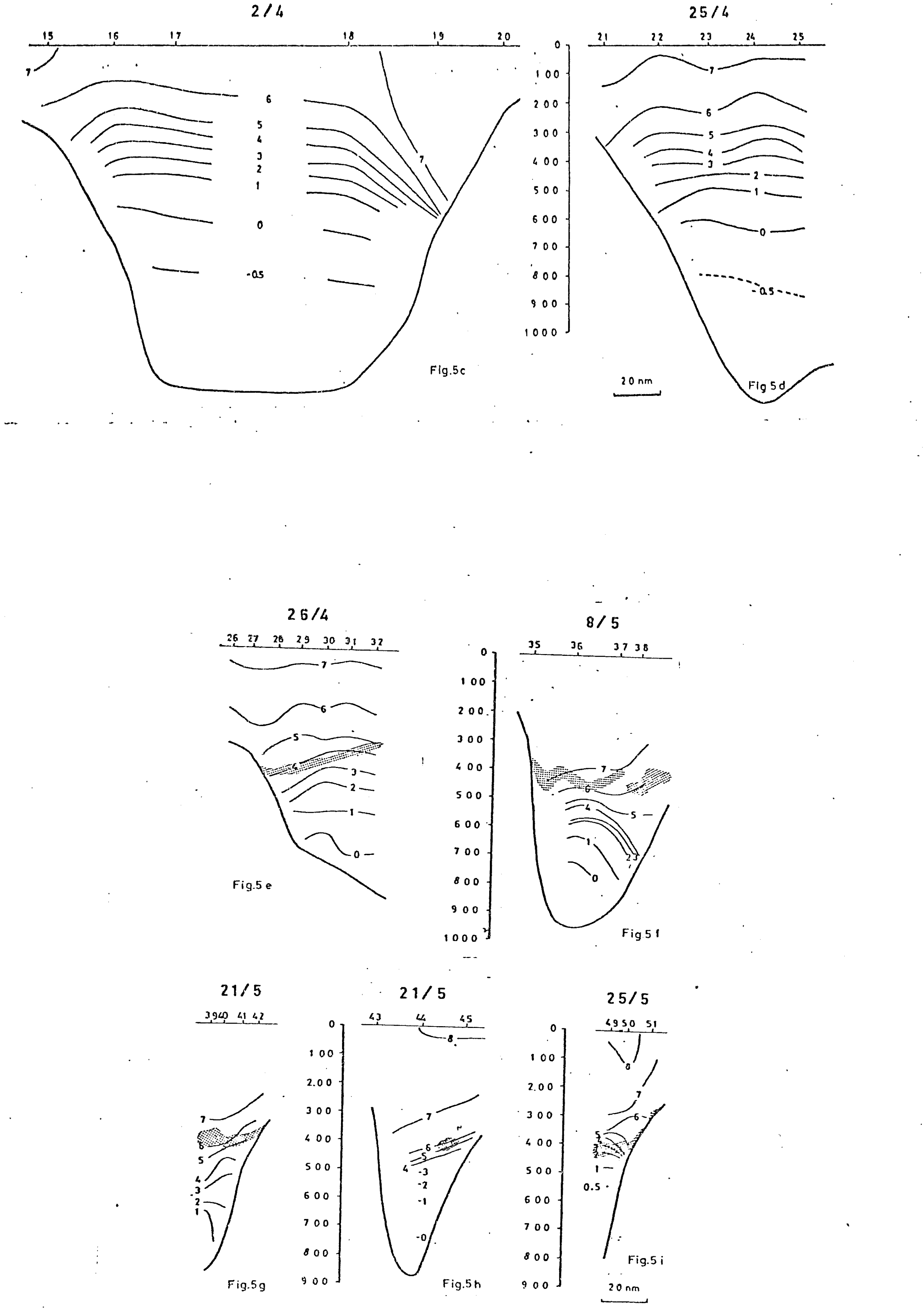

Fig. 5 c-i. Temperature measurements from the CTD stations 29/3-1/6-1979 in the Faroe area shown as sections. Blue whiting recordings observed on the echosounder between the stations is also indicated.

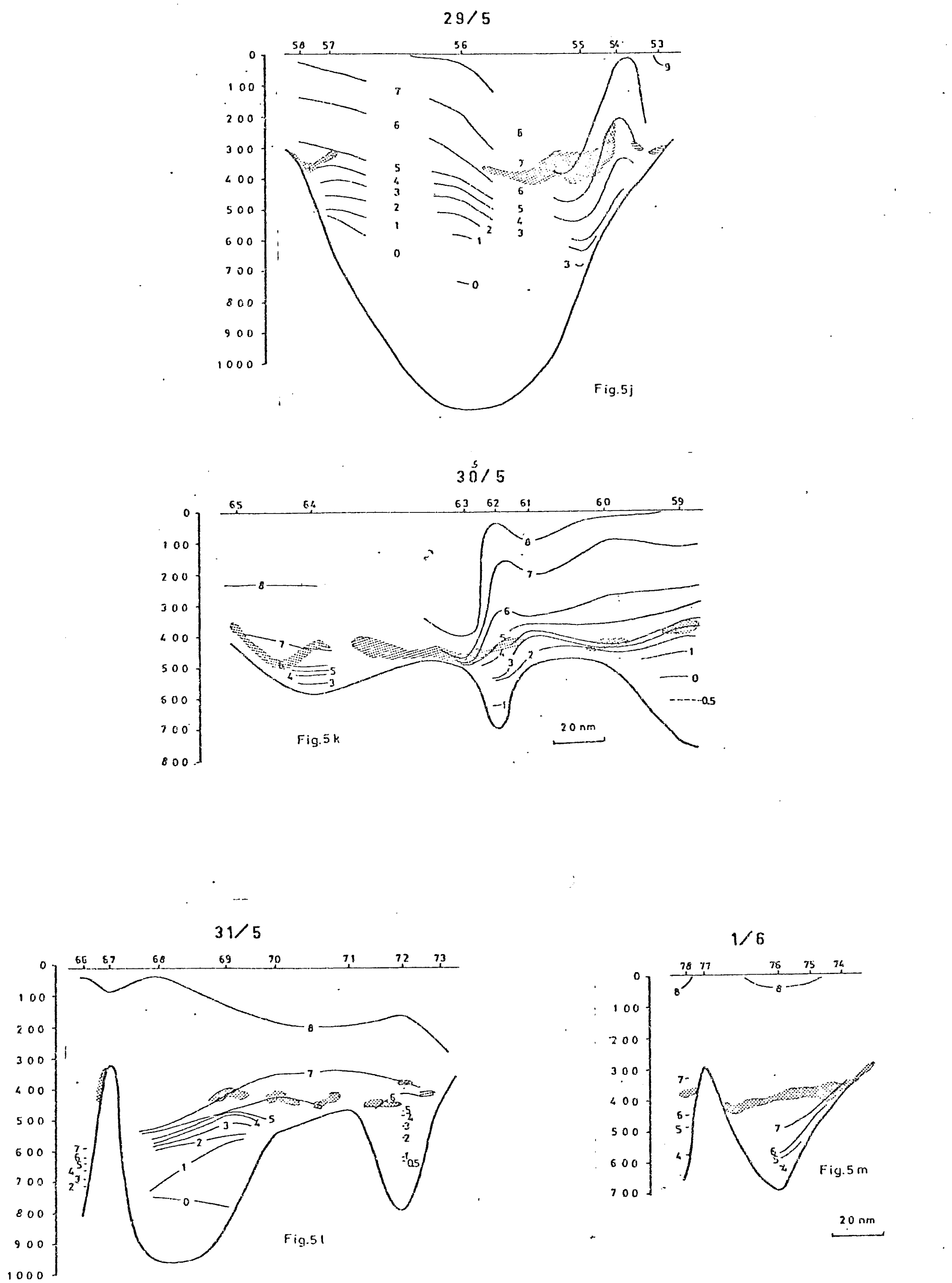

Fig. 5 j-m. Temperature measurements from the CTD stations 29/3-1/6-1979 in the Faroe area shown as sections. Blue whiting recordings observed on the echosounder between the stations is also indicated.

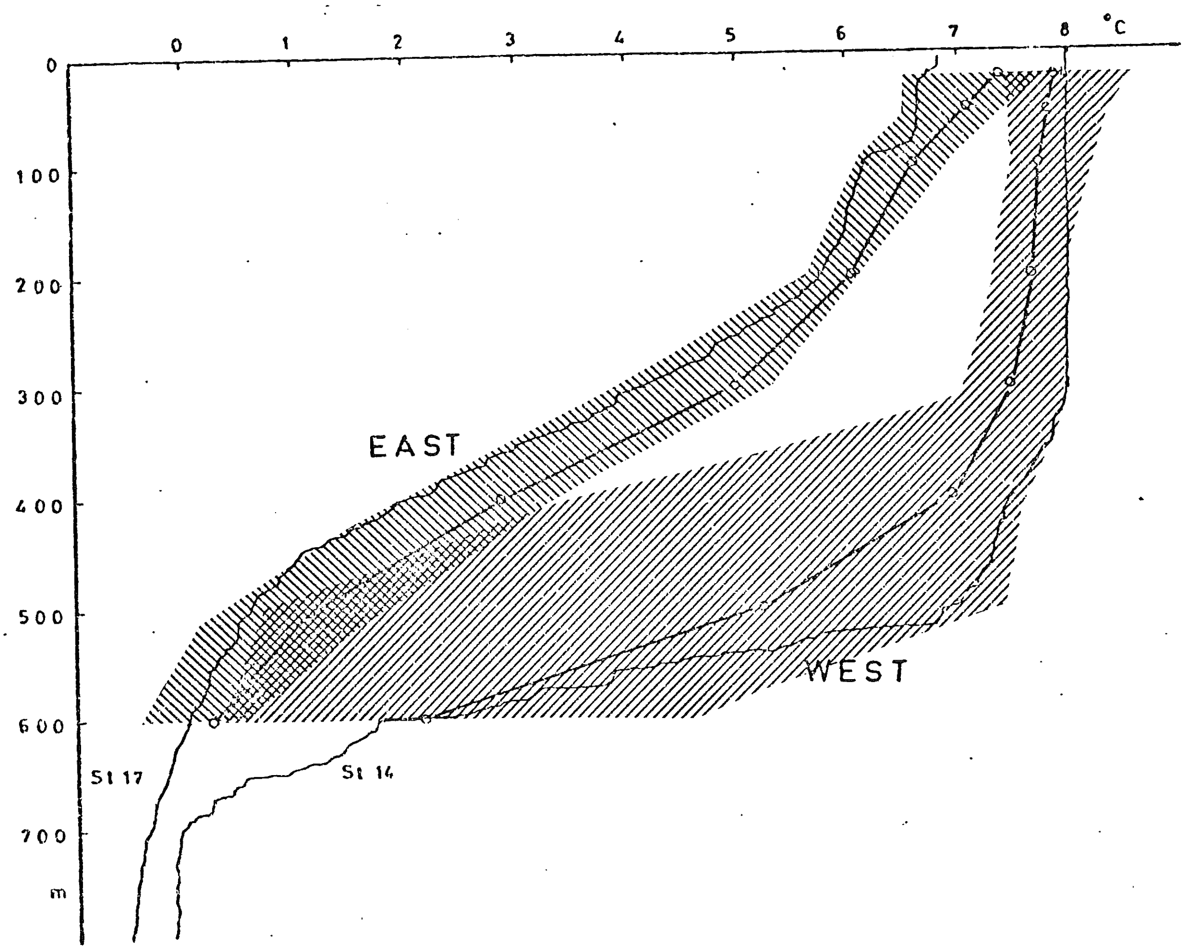

Fig. 6. Temperature profiles East and West of the Faroes respectively for waters with bottom depth larger than 700 meters March-May 1979. Light traces exemplity typical profiles, heavy traces show mean profile for each area and hatchings define the absolute regions within which profiles were found.