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Distribution and Abundance of Redfish Larvae against Thermal Conditions
on Flemish Cap in April 1978

by

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Abstract

As a part of the International Flemish Cap Experiment, during April 1978 fish larvae were collected on Flemish Cap. Nearly 99% of larvae caught were newly released Sebastes sp. An estimate of total abundance is calculated. The character of the water masses found over the Bank resulted from the mixing of Labrador Current water with "slope water" of the North Atlantic Current which occurred along the western and eastern slopes of Flemish Cap. The presence of warm-water species over the central shallows of the Cap and cold-water species over the southern slopes, support this concept of mixed waters.

Introduction

In accordance with the recommendation of the ICNAF Working Group meeting held in Murmansk (Akenhead, 1978), the R.V. Wieczno conducted ichthyoplankton investigations as a part of the Flemish Cap Experiment. Distribution of water temperature in the investigated area was described. Templeman (1976), summarizing previous works on cod and redfish, stated that there is a small stock of Sebastes marinus on the Cap and the main population of redfish consisted of a mixture of S. fasciatus and S. mentella. During the routine identification of over 16 thousand larvae at the Sorting and Identification Center in Szczecin, all redfish larvae identified to be S. marinus, according to the guide of Moser et al. (1976). However, there is presently some doubt concerning the identification of larval redfish species. On present knowledge it is not possible to distinguish between extruded larvae of S. marinus and those of S. mentella (W. Templeman, pers. comm.). In view of the much larger numbers of S. mentella than of S. marinus on the Flemish Cap, the larvae are probably mainly S. mentella. Due to these uncertainties, our Sebastes larvae are called redfish larvae in this paper.

Materials and Methods

Plankton was collected during 18-30 April 1978 by means of 61 cm bongo net (505/505 micrometer mesh) at 56 stations distributed in a regular station grid along eight sections (Fig. 1). Double oblique hauls to 200 m

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or 5 m off bottom were performed, deploying at 50 m cable/min and recovering at 30 m cable/min at a ship's speed of 3.5 knots. A time depth recorder was used to accept or reject tow profiles. A 100 kg lead depressor was used.

Because of unreliable flowmeter observations, the volume of filtered water was calculated from the speed of tow x time of deploying and retrieving x area of entrance of net. Samples were preserved in 5% formalin with sodium borate buffer. Fish larvae were sorted, identified and measured (standard length) at the Sorting and Identification Center of the Sea Fisheries Institute in Szczecin, Poland.

Measurements of temperature were carried out at all stations shown on Fig. 1 with reversing thermometers and XBT's. Water samples for salinity determination were taken only at stations lying on selected sections.

Vertical distributions of temperature and - partially - of salinity, as well as their horizontal distribution at the sea surface and bottom were analyzed. The vertical distribution of temperature and salinity is represented on the section running along the 47°N parallel from 47°N 52°W to 47°N 42°W. In order to make comparisons of temperature changes and their extent, the anomalies of bottom water temperature down to 400 m depth were taken into consideration.

Results

Hydrology:

The temperature of the surface water over the greater part of the Flemish Cap Bank was nearly constant in the range of 3-4°C. However, the sea surface temperature observed to the south and southwest was markedly higher (Fig. 2). The temperature minimum (1.7°C) at the surface was noted at Station No. 8.1, whereas the maximum (14.5°C) was observed at Station No. 8.5.

In the temperature distribution at the sea surface the 4°C isotherm showed a peculiar pattern, the shape of which was probably caused by the occurrence of strong winds and surface currents. From the vertical distribution of temperature and salinity on the section along 47°N (Fig. 3) one might infer that there existed a strong mixing of waters over the central part of Flemish Cap Bank. Strong temperature gradients were observed at the edges of the Bank indicating well stratified water around the periphery of Flemish Cap Bank. The waters with temperature from 3° to 4° and salinity from about 34.4‰ to about 34.8‰ that were found over the central part of the bank are the effect of mixing of two water masses - one of them: the cool waters of the Labrador Current the temperature of which was from -1 to 0°C the salinity being of 32.8 to 33.2‰ and the other: the warm "slope waters" with temperature from 4° to 14°C and salinity higher than 34.8‰. Over the periphery of the bank horizontal gradients of temperature and salinity were observed from the sea surface down to 400 m depth (Fig. 3 and 4).

In the bottom layer the temperature ranged from 3.4° to 8.9°C. The lowest values of temperature (less than 4°C) were found over the central part of the bank along the northeastern slope and the highest temperature (greater than 8°C) was found on the southeastern part of the Bank.

Similar to the sea surface temperature, the 4° isotherm at the bottom showed a peculiar slope that encompassed most of the investigated area. This isotherm formed a boundary between the colder waters inflowing along the slopes in the southeastern direction and the warmer ones that were flowing to northeast at about 100 m depth and to north at depths of 80-300 (Fig. 3 and 5). From the collected data and long-term means of temperature (Hayes et al., 1977), the temperature anomalies for the bottom water at depths down to 400 m were calculated (Fig. 6).

The distribution of temperature anomalies indicated that along the eastern slopes of the bank cooler waters with temperature anomalies less than -2°C were present, whereas waters with temperature anomalies greater than 2°C were found on the southern slope. The maximum temperature anomaly was observed at Station No. 8.5.

In all likelihood this situation resulted from more intense inflow of cooler waters that had pushed off the warmer waters in the southeastern direction.

Ichthyoplankton:

A list of identified taxons given in Table 1 shows that larvae found in samples belonged to 20 taxonomic groups. Redfish larvae dominated at 45 stations (Fig. 7). They were distributed over the whole investigated area, except for a few stations in the eastern part of Flemish Cap. The highest concentrations of redfish larvae were noted at northern stations with a maximum number of 4971 specimens per 10 m² at Station No. 1,4. The second area where the extrusion of redfish larvae had taken place was in the southwest part of Flemish Cap. A maximum of 1093 larvae/10 m² was found at Station No. 6,1. Estimating that each station represents an area of about 1.4 x 10⁹ m², the total number of redfish larvae that occurred in the investigated area is estimated to be 3.26 x 10¹². The length of redfish larvae was 5-9 mm with a mean length of 7.6 mm (Fig. 8). occurrences of warm-water species on the southern slope of Flemish Cap, especially at stations along sections 7 and 8, indicate the extent of the North Atlantic Current which was washing the southern slope and mixing with a current moving in a clockwise direction around the Flemish Cap. The southern elements such as Notolepis rissoi, Chauliodus sloani and some myctophids occurred there with northern elements such as Benthosema glaciale, Lumpenus lumpretaeformis or Batylagus euryops, indicating a mixing area of two different water masses (Fig. 9).

Summary

During the period of investigation, the occurrence of three different water masses was observed. These had an essential influence on forming the hydrological conditions in the Flemish Cap region. Labrador Current waters occurred over the Newfoundland Bank. These waters were characterized by negative temperature and by low salinity ranging from 32.8‰ to 33.2‰. The water masses of the warm North Atlantic Current occurred as "slope water" at 80-300 m depths along the western slopes of Flemish Cap Bank and along its eastern slopes - from the sea surface to 400 m depth. These waters were characterized by temperatures from 4° to 14°C and by salinity values higher than 34.8‰. The character of the water masses found over the bank resulted from mixing of the two first mentioned water masses. The mixed waters were only slightly different with respect to temperature and salinity, ranging from 3° to 4°C and from 34.4‰ to 34.8‰, respectively. The waters along the eastern slopes of Flemish Cap Bank were 2°C lower than the long-term means, whereas, along its southern and western slopes higher water temperatures - by at most 2°C - were found.

Redfish larvae were dispersed over the Flemish Cap with the highest concentration on the northern slopes where the main extrusion had presumably taken place. Distribution of other larvae consisting of northern and southern elements support the hydrological "water masses mixing" observation.

Acknowledgments

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Table 1. List of larval fish families, genera and species collected on R. V. Wieczno during 78 - Flemish Cap Experiment.

T A X O N	S T A T I O N S
BATHYLAGIDAE	
<i>Bathylagus euryops</i>	1.6, 1.7, 2.7, 3.1, 3.6, 4.1, 5.1, 8.15, 8.3
GONOSTOMATIDAE	
<i>Vinciguerria poweriae</i>	8.5
CHAULIODONTIDAE	
<i>Chauliodus sloani</i>	8.5
PARALEPIDIDAE	
<i>Notolepis rissoi</i>	6.4, 8.4, 8.5, 8.7
MYCTOPHIDAE	
<i>Electrona arctica</i>	7.7, 8.3, 8.4, 8.5, 8.7
<i>Notoscopelus elongatus</i>	7.7
<i>Protomyctophum</i> sp.	8.4, 8.5
<i>Benthosema glaciale</i>	1.7, 3.6, 7.4, 7.6, 8.15
	1.4, 1.5, 3.6, 4.1, 7.5, 7.6, 7.7, 8.3, 8.4, 8.5
NEMICHTHYIDAE	
	7.6
GADIDAE	
<i>Gadus morhua</i>	2.2, 2.3, 3.4
<i>Pollachius virens</i>	2.3, 6.6
<i>Rhinonemus cimbrius</i>	1.6, 8.5
<i>Urophycis</i> sp.	2.7, 3.7
SCORPAENIDAE	
<i>Sebastolobus</i> sp.	1.7
<i>Sebastes</i> sp.	1.2, 1.3, 1.4, 1.5, 1.6, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 5.1, 5.2, 5.3, 5.4, 5.6, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 8.1, 8.15,
AMMODYTIDAE	
<i>Ammodytes</i> sp.	8.2, 8.3, 8.4
STICHAEIDAE	
<i>Lumpenus lumpretaeformis</i>	8.3
ANARHICHADIDAE	
	4.3, 4.4, 6.4, 6.5, 6.6, 8.4
	4.6

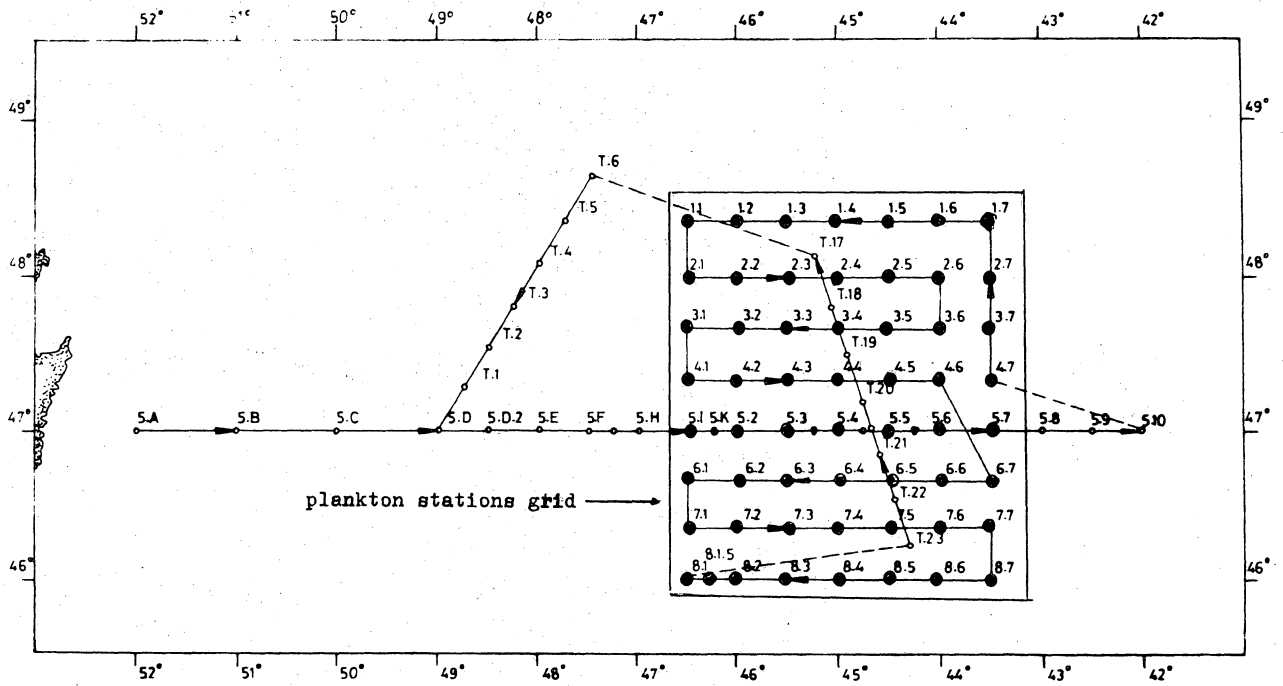


Fig. 1. Cruise track and location of hydrological and plankton stations on Flemish Cap, 14-30 April 1978.

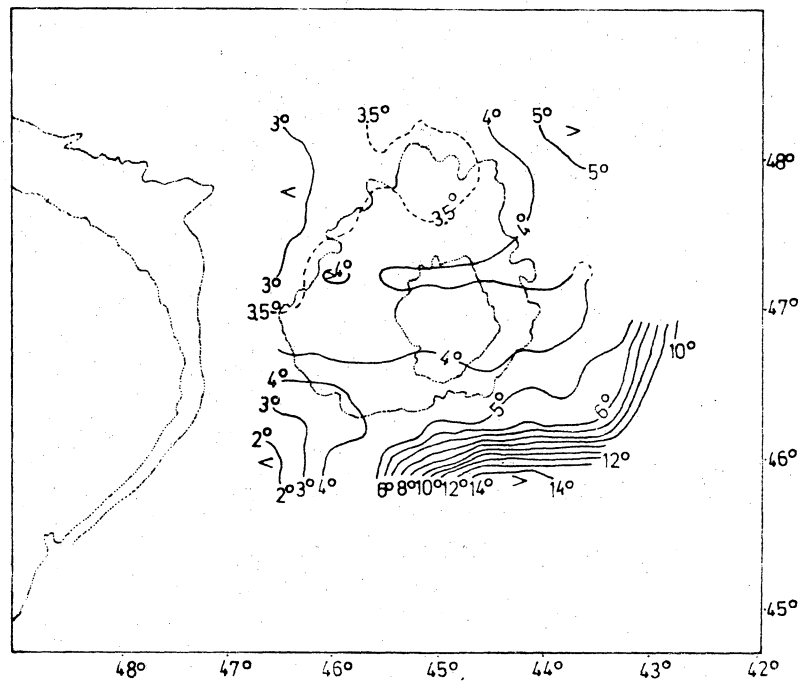


Fig. 2. Surface temperatures on Flemish Cap, 18-30 1978.

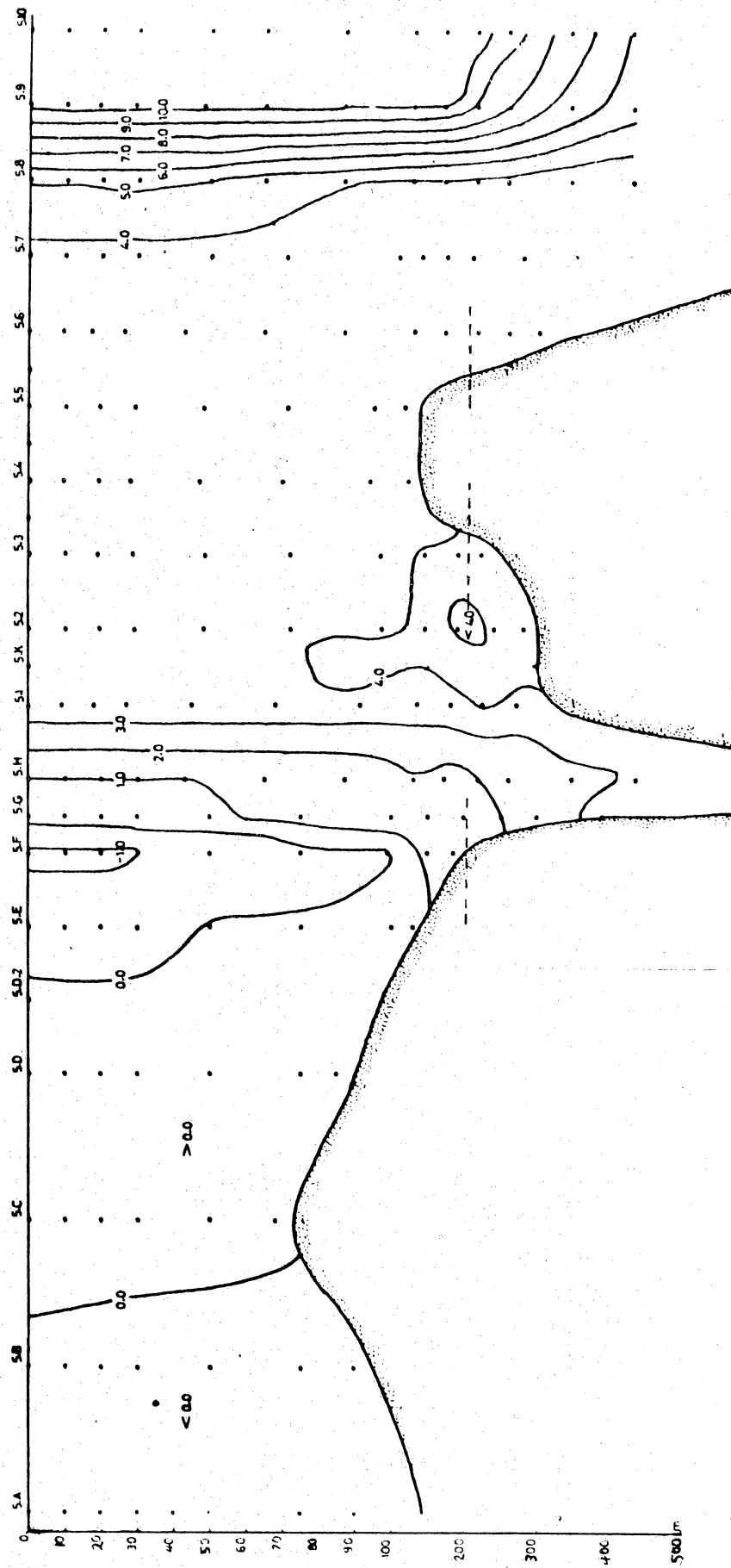


Fig. 3. Vertical distribution of temperature (°C) between Stations 5A (47°00'N, 52°00'W) and 5.10 (47°00'N, 42°00'W), 18-30 April 1978.

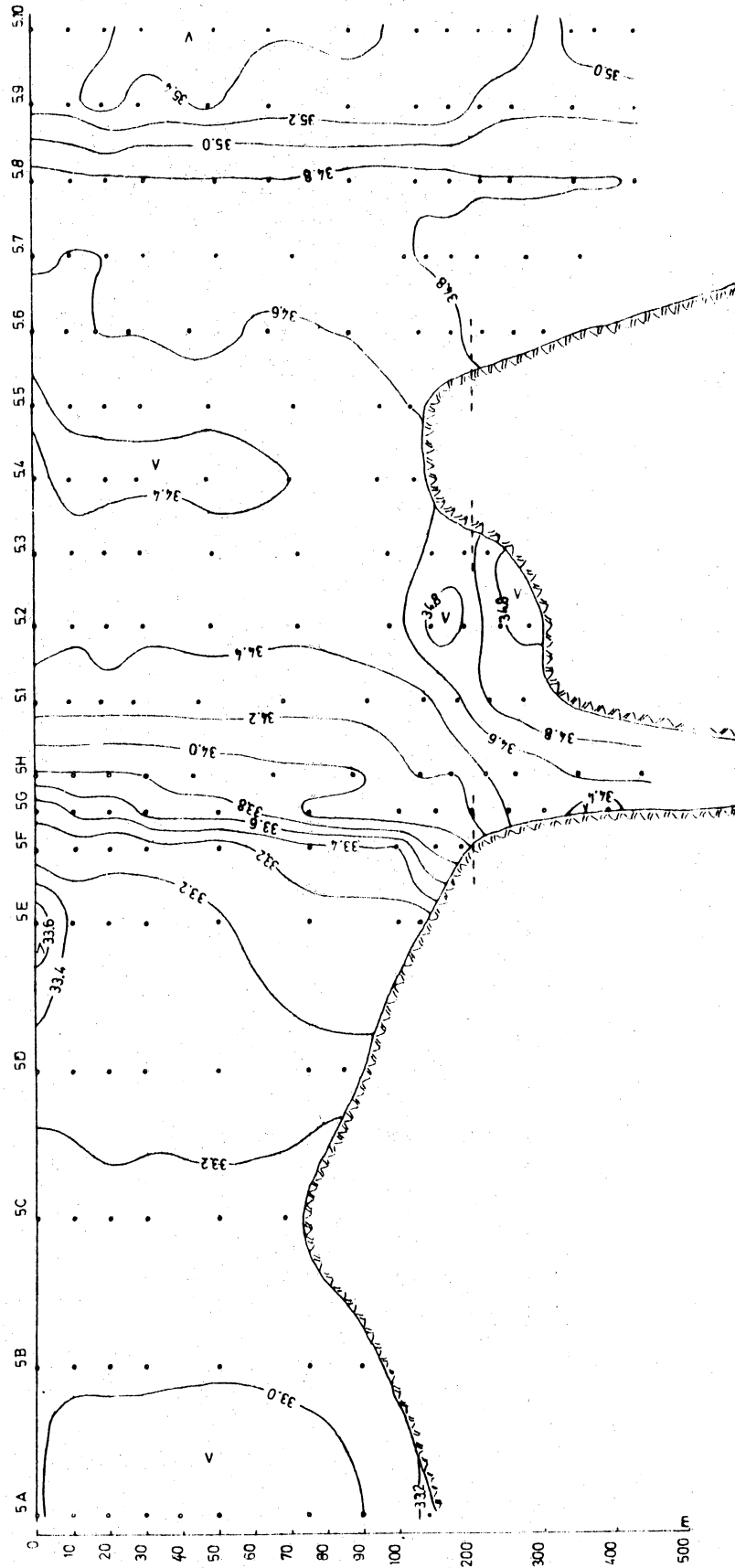


Fig. 4. Vertical distribution of salinity (‰) between Stations 5A and 5.10, 18-30 April 1978.

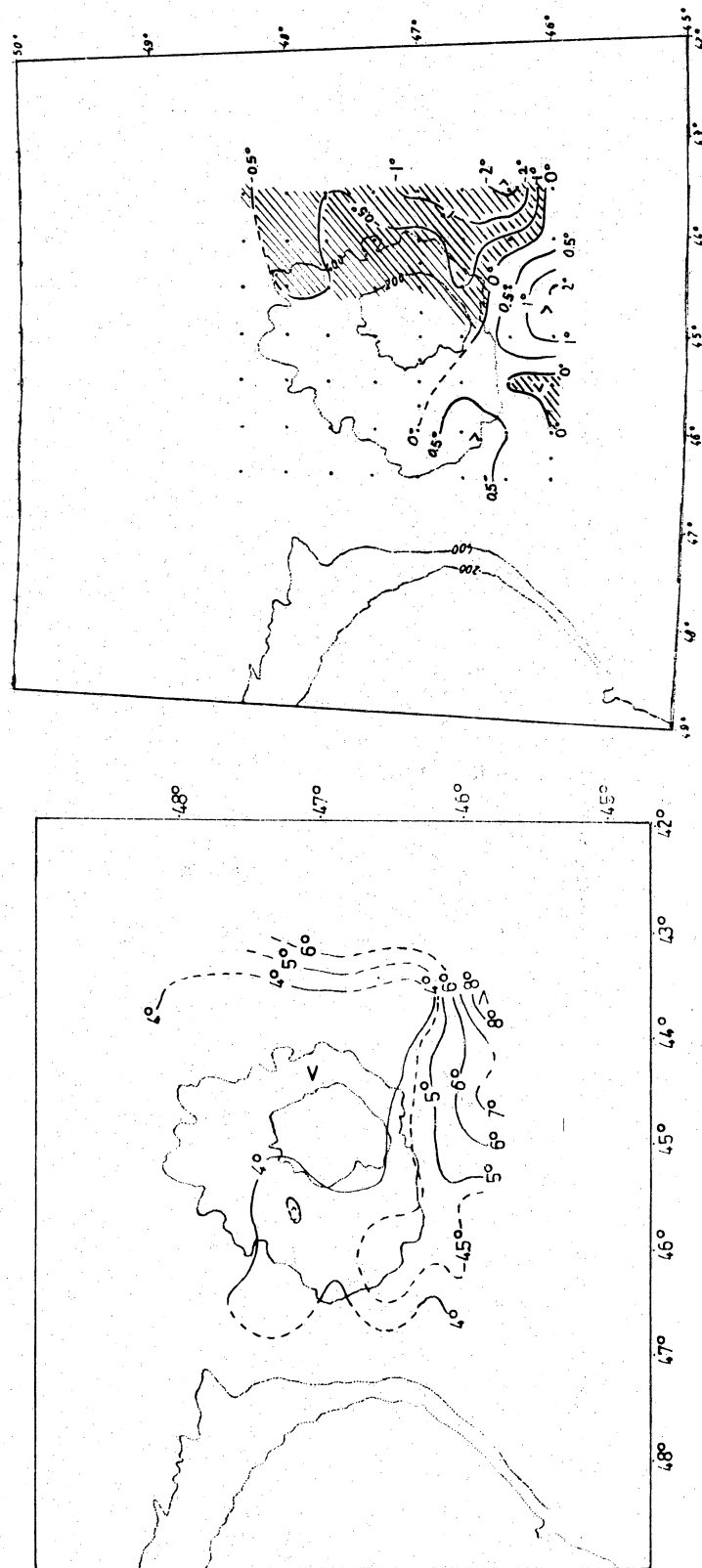


Fig. 5. Bottom water temperature to depths of 400 m on Flemish Cap, 18-30 April 1978.

Fig. 6. Anomalies of bottom temperature ($^{\circ}\text{C}$) on Flemish Cap, 18-30 April 1978. (Shaded area represents negative anomalies.)

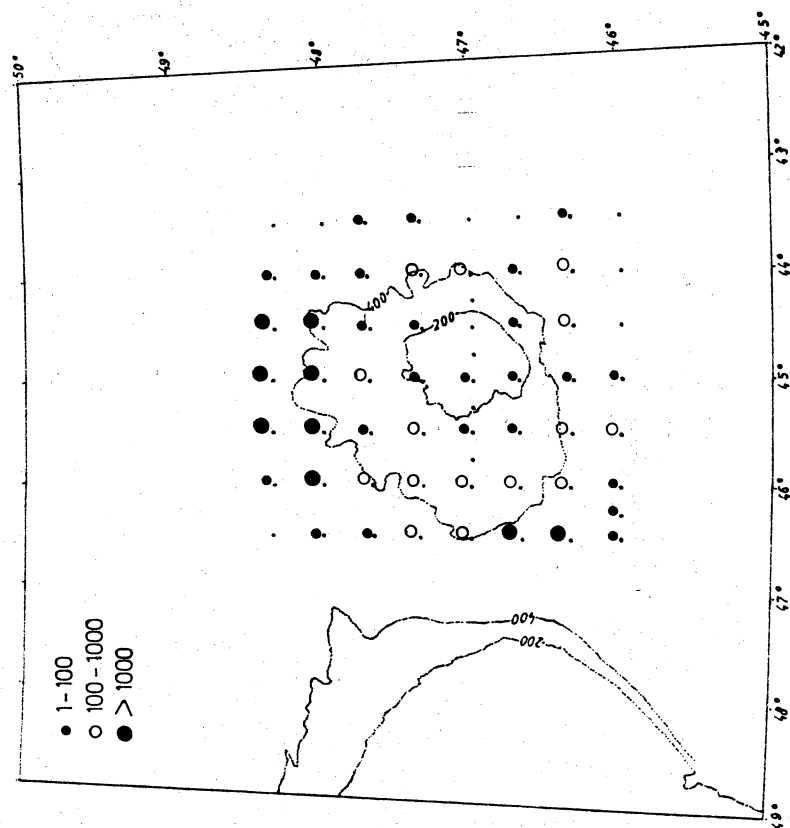


Fig. 7 Distribution and abundance of redfish larvae on Flemish Cap, 18-30 April 1978

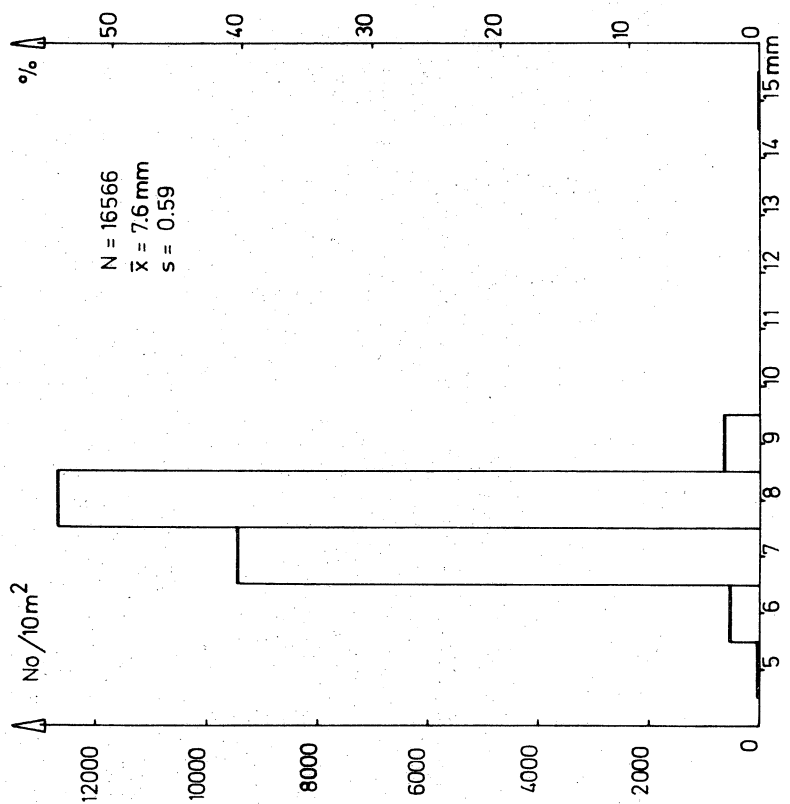


Fig. 8 Redfish larvae size frequency and abundance on Flemish Cap, 18-30 April 1978

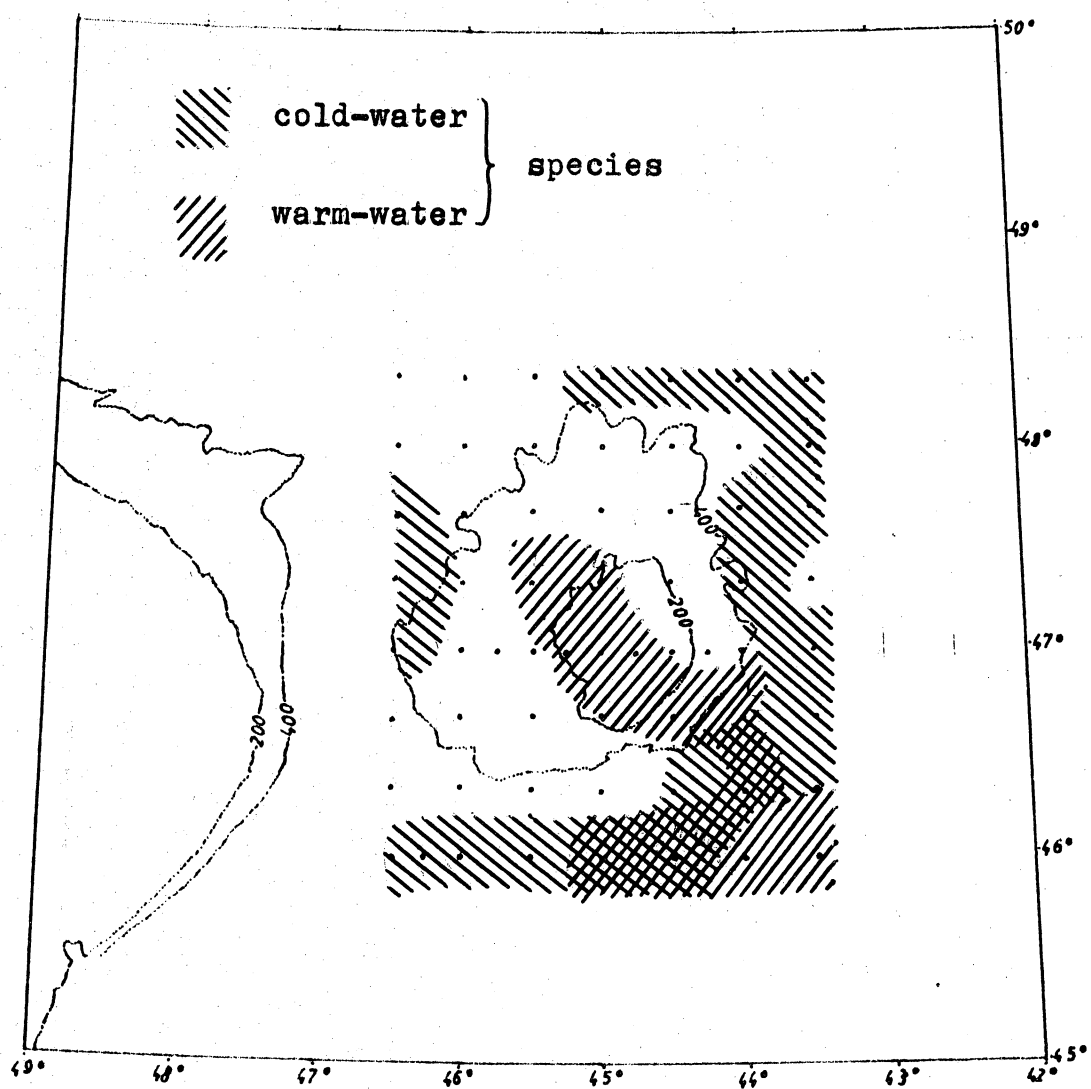


Fig. 9 Distribution of warm- and cold-water species
excluding redfish larvae