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The Effect of Oceanographic Conditions on the Spatical Distribution of Redfish in the Irminger Sea

by

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Abstract

Long-term investigations on redfish (*Sebastes mentella*) from the upper (0-500 m) and lower (500-900 m) layers of its distribution in the open Irminger Sea have shown the absolute similarity of the parasite fauna. These include similar infections with the majority of parasite species, similar peculiarities in the infection with copepod *Sphyrion lumpi*, similarity in the occurrence of pigmented patches, and considerable similarity of linear and weight growth and maturation rates. The decrease of occurrence of the redfish with pigmented patches on the skin and inclusions of melanin in the muscle tissue at depths >500 m is caused by changes related to ageing of the redfish, variations in their habitat and evident pathology of the first of these phenomena.

Immature *S. mentella* prefer to feed on plankton crustaceans. The occurrence of small fish, shrimps and squids in the diet increases with age and they are dominant in the older fish.. Such selectivity in food consumption by the redfish of different age groups is sustained by vertical feeding migrations. In summer (feeding period) the formation of the redfish concentrations at depths >500 m is accounted for by a movement of some individuals of ages 5-18 years from the upper layer and a movement of the redfish older than 18 years to the lower layer. The latter occur in the upper layer in other seasons when feeding does not appear a factor determining the distribution of redfish.

The data obtained indicate the unity of the commercial redfish stock in the pelagic layers of the Irminger Sea. Concentrations of the redfish of older age that are distributed in the lower layer during the feeding period are a deep-sea component of a single reproductive stock of *S. mentella* in this area and not a separate stock or type ("pelagic deep-sea type *S. mentella*") as has been suggested by Icelandic scientists (Magnusson *et al*., 1994, 1995).

Introduction

The study area covered the Irminger Sea and the eastern Labrador Sea. These are the distribution areas of pelagic redfish *Sebastes mentella,* the most abundant redfish species in the North Atlantic, the annual catch of which in the late 1990s amounted to 120-180 thou. tons.

Russia pioneered investigations of redfish stock in 1982. Presently, the stock is monitored by the trawl acoustic survey (TAS) method under the ICES supervision. By the data of International TAS of 1994 and 1996, the redfish stock in the Irminger Sea and adjacent waters is estimated at 1.6-2.2 mill. tons.

The International TAS of redfish stock conducted in June-July of 1999 brought rather surprising results. By acoustic estimates, its biomass in the upper 500 m layer of the area of ca. 300 000 sq. miles made up only 0.6 mill. tons, and most aggregations had shifted to the southwest of the “traditional” feeding area.

The objective of this study is to define the dependence of spatial distribution of redfish on the variations in oceanographic conditions in its feeding area, as well as to identify possible reasons behind the estimated stock decline in 1999.

Materials and Methods

The study was based on acoustic, biological and oceanographic data gathered in 1994-2001 during Russian and international surveys of feeding redfish aggregations in the Irminger Sea and adjacent waters of the Labrador Sea.

Results of investigations

As known, foraging and oceanographic conditions are the decisive factor determining the distribution of feeding fish aggregations. Within the large feeding area, commercial aggregations of redfish were observed over the entire water column from 150 to 850-900 m depth at the temperature of 2.9-6.0°C and salinity of 34.70-35.05. Distribution depths are related to the variations in the position of Subarctic intermediate waters (SAIW), increasing with the distance from the centre of Sub-Polar Gyre to its eastern boundary (Fig. 1). Maximum distribution depths were observed over the Reykjanes Ridge.

With the seasonal warming of waters over the Reykjanes Ridge, redfish migrate to the west and southwest where feeding conditions are better, inhabiting mainly 100-400 m depths (Fig. 2). However, a certain part of the aggregations, primarily older fish, stayed on the spawning grounds and were distributed deeper than 500 m in the areas and under the conditions similar to those observed in spring.

Along with the seasonal peculiarities of the distribution pattern, some interannual trends were revealed. Warming of the surface layer of North Atlantic waters, a part of which is the Irminger Sea, started in 1994 and reached the maximum in 1998 (Fig. 3). The 4°C isotherm adequately indicates the location of major redfish aggregations and can be used for analysis of their year-to-year variations. In 1999, with a temperature rise in the upper 200 m layer of the Irminger Sea, most aggregations shifted unusually far to the southwest of the "traditional" feeding area and the densest aggregations were observed south of Greenland between 54 and 58°N (Fig. 4). Variations in the vertical structure of waters increased the range of vertical fish distribution and caused both horizontal and vertical re-distribution of redfish aggregations (Fig. 5).

The investigations showed the even distribution of redfish over the foraging area. Commercial aggregations were located in the areas with a well-pronounced horizontal gradient of temperature and generally near the areas of intermediate water upwelling. The size of local redfish concentrations varied from 2 to 20 sq. miles according to the intensity of upwelling. Values of area back scattering strength in some cases exceeded 500 m^2/nm^2 (Fig. 6).

Length growth of redfish was found to correspond with an overall temperature rise in its distribution depths from the west to the east (Fig. 7).

Conclusions

The data gathered during trawl acoustic surveys carried out in summer of 1982-2001 indicated that feeding aggregations of redfish were distributed within the Sub-Polar Gyre.

Year-to-year variations in the dynamics and temperature of North Atlantic waters to a large degree determine the spatial distribution of feeding redfish aggregations in the Irminger Sea and adjacent Labrador Sea waters.

In 1996-2001, warming of the upper 200 m layer of the "traditional" redfish feeding area caused a considerable shift of its commercial aggregations to the south and southwest and an increase of distribution depth, which entailed the under-estimation of redfish stock in 1999.

The preliminary results of the International TAS on pelagic redfish undertaken in an area of ca. 460 sq. miles in June-July 2001 allows to make a conclusion about the stable state of redfish stock in the Irminger Sea.

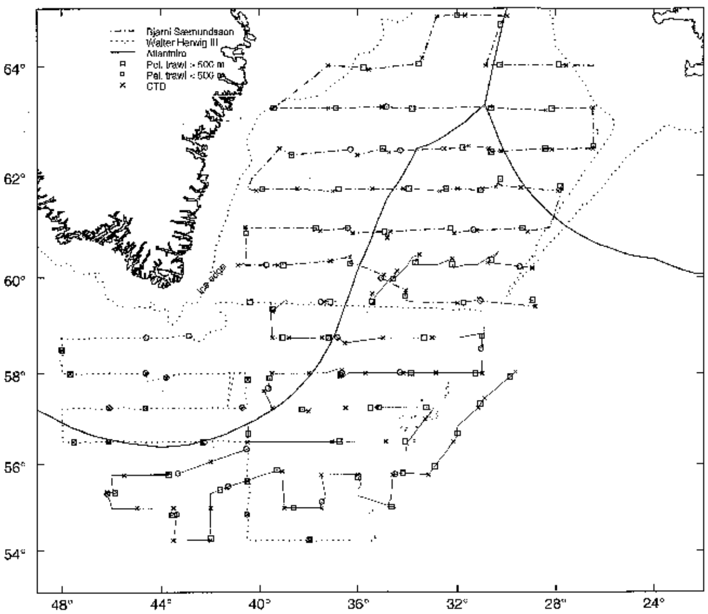

Fig. 1. Cruise tracks and stations taken in the Joint International Redfish Trawl-Acoustic Survey in June/July 1999.

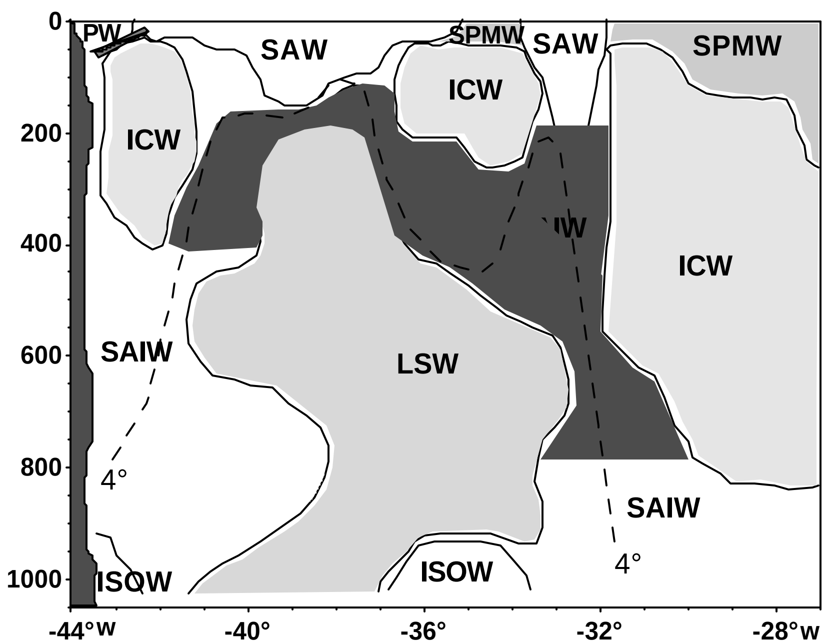

Fig. 2. Vertical distribution of water mass, Redfish concentrations (diagonal cross) and 4°C isotherm along 60° N in June 1997 (from Pedchenko, 2000). Polar Water, SAW – Subarctic Water, SPMW – Subpolar Modified Water, ICW – Irminger Current Water, SAIW – Subarctic Intermediate Water, LSW – Labrador Sea Water, ISOW – Iceland Shetland Overflow Water.

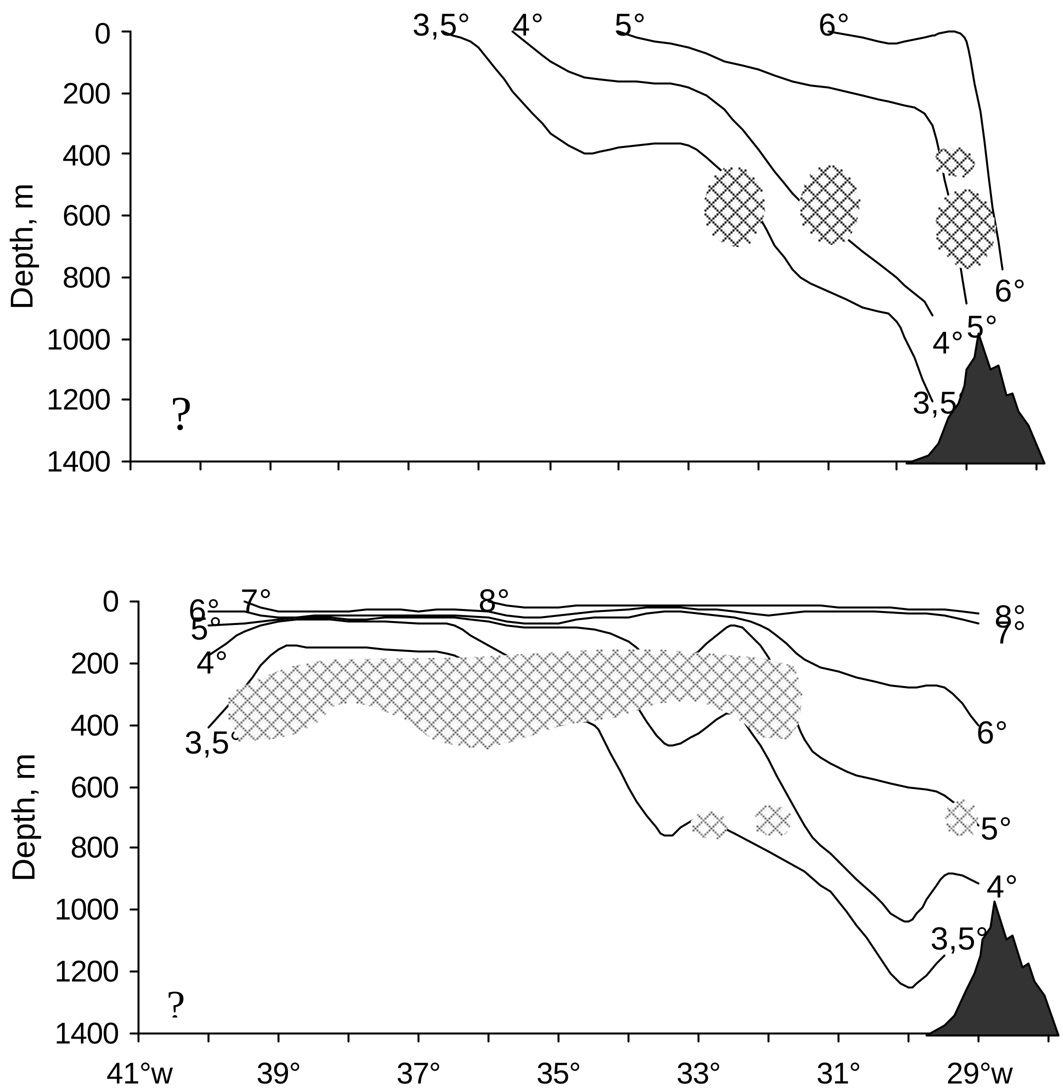

Fig. 3. Temperature and location of Redfish concentrations in the spawning (a) and feeding (b) periods on a vertical section along 60°30’N in the Irminger Sea in 1995.

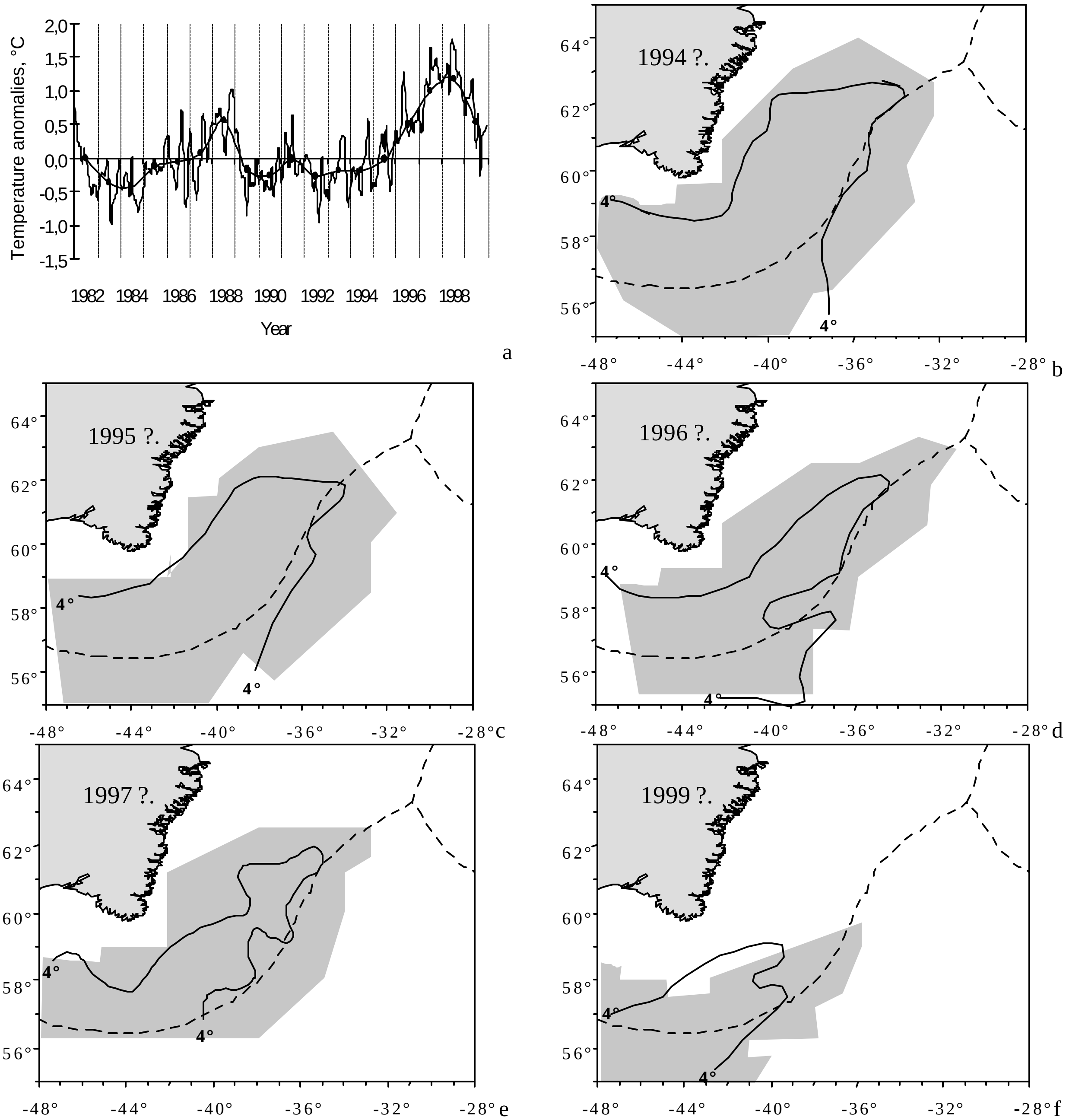

Fig. 4. Monthly averages and annual (marked) anomalies SST on the feeding ground (a). Locations of mean values of area back scattering strength of Redfish more then 10 m^2/nm^2 at depths between 0-500 m and 4°C isotherm at the depth of 200 m in the Irminger Sea in June/July 1994-1999 (b-f).

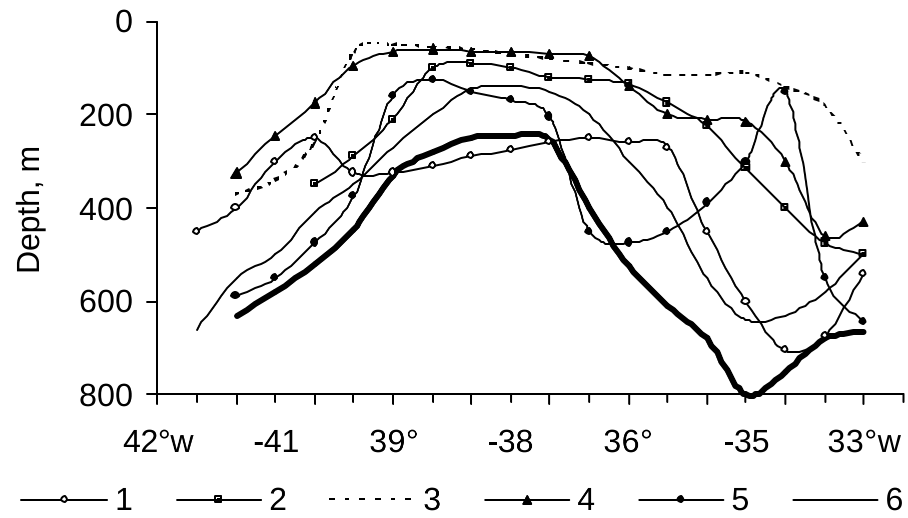

Fig. 5. Depth of the 4°C isotherm on a vertical section along 60°30'N in the Irminger Sea in June, 1991 (1), 1992 (2), 1993 (3), 1995 (4), 1996 (5), 1997(6) and 1999 (7).

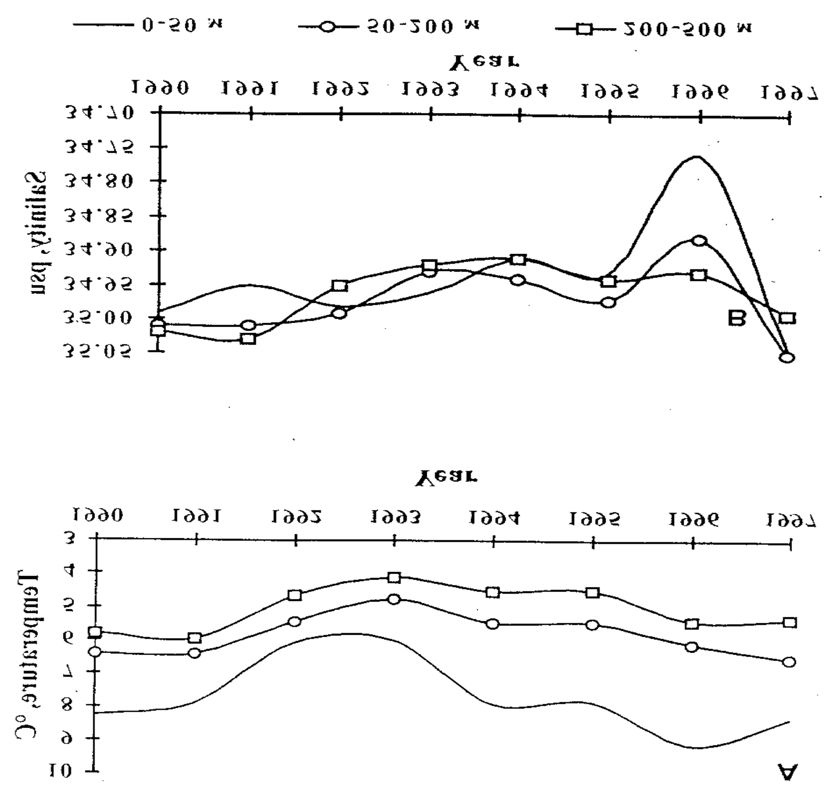

Fig.6. Time variation of mean temperature (A) and salinity (B) by layers along the Russian section 3-K (stations 1-5) in July 199O-1997 (Melnikov, Mamylov, Shibanov, Pedchenko, 1998).

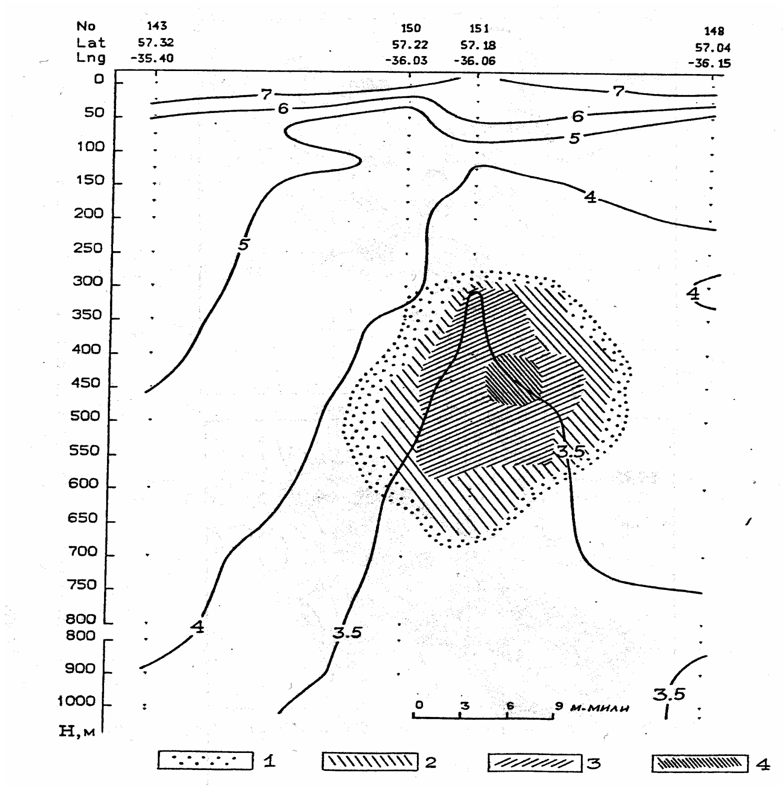

Fig. 7. Temperature (°C) and densities of Redfish concentrations on a vertical section in the area of local upwelling in June, 1993 (Pedchenko *et al*., 1996): 1 – 50-100, 2 – 100-200, 3 – 200-500, 4 – over 1000 t/nm^2.

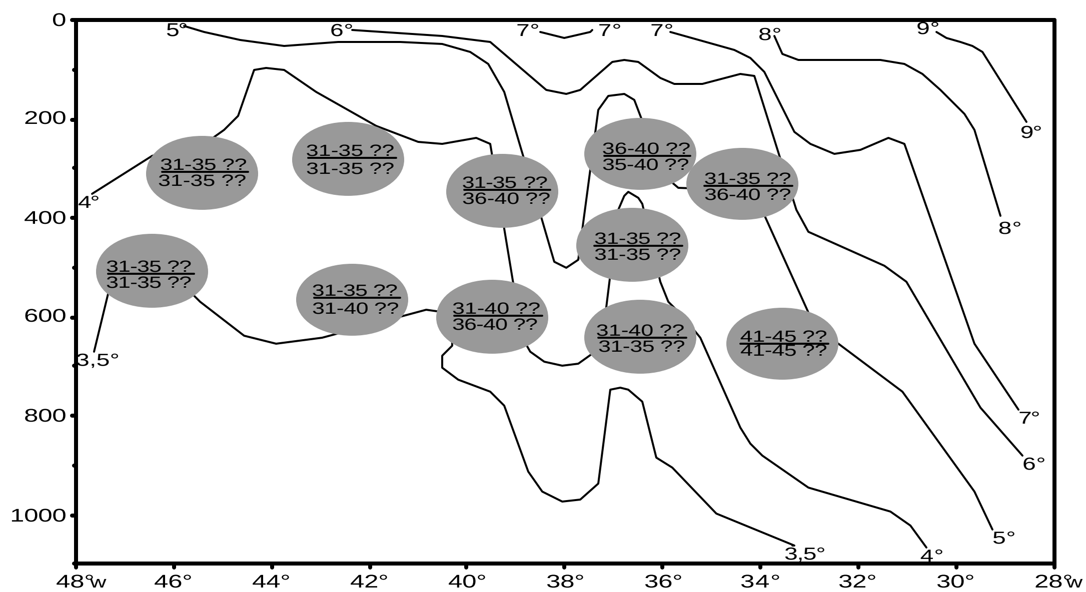

Fig. 8. Specification of vertical distribution of Redfish modal length (males/females) and temperature (°C) along the section 58°N in the Irminger Sea in June 1999.

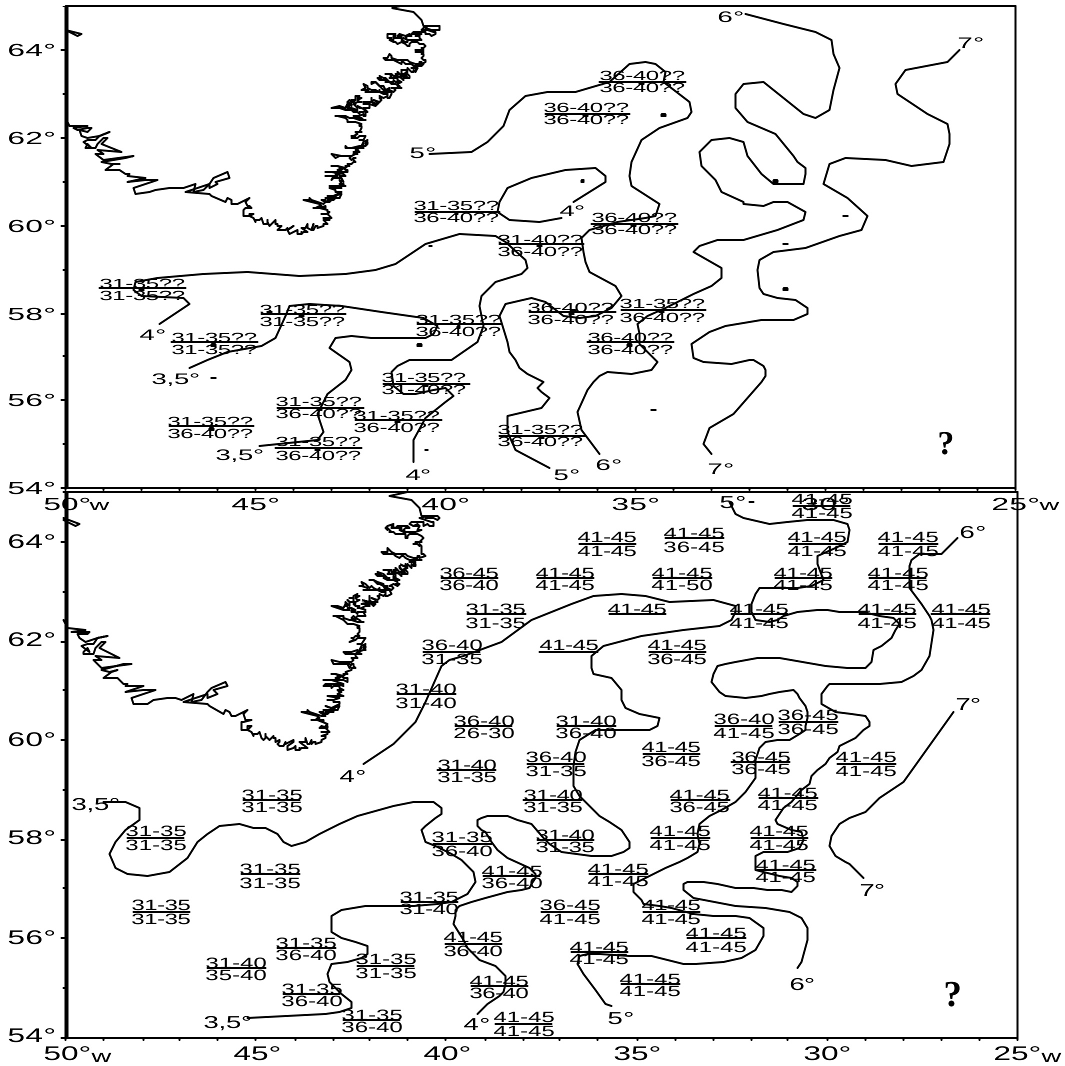

Fig. 9. Modal length of Redfish (males/females, cm) and averadge temperature in the layers: 200-500 m (a) and 500-800 m (b) in the Irminger Sea in June/July 1999.