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# RESULTS FROM RUSSIAN TRAWL-ACOUSTIC SURVEY ON *SEBASTES MENTELLA* STOCK OF THE IRMINGER SEA IN 1997

by

S.P.Melnikov, V.S.Mamylov, V.N.Shibanov and A.P.Pedchenko

Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 6 Knipovich St., Murmansk, 183763, Russia

## ABSTRACT

Annual trawl-acoustic survey of oceanic redfish was carried out both in the Irminger Sea off shore areas and within 200-mile zone of East Greenland onboard the RV "Atlantida" from 21 June to 21 July 1997.

The survey was carried out in 0-500m layer, using latitudinal tracks, in general direction from north to south and in accordance with the recommendations of the ICES Study Group on Redfish Stocks.

During the trawl-acoustic survey the oceanographic and ichthyoplankton observations were done and biological data were obtained from catches taken by mid-water trawl.

Biomass of redfish over the area surveyed (158.9 thou.mile$^2$) constituted 1.24 mill.t and abundance - 2.4 bill.spec.

In 1997, decrease in commercial stock of oceanic redfish, compared to 1996, results from a less area surveyed and probable redistribution of redfish to deep waters.

## INTRODUCTION

*Sebastes mentella* is one of the most important fishing objects in pelagial of the North Atlantic. Annual international catch of redfish taken by trawlers from most countries makes up around 150 thou.t. Intensive exploitation of redfish commercial stock specifies a growing interest of a number of states and international fishing organizations to it.

Regular investigations on redfish stock in the Irminger Sea pelagial have been carried out by Russia since 1982 - the year of exploration of the object commercial aggregations (Pavlov, Mamylov, Noskov, 1989; Pavlov, Shibanov, 1991). Data on redfish stock status, peculiarities of its biology and environmental conditions are presented by results from trawl-acoustic surveys annually conducted by PINRO during summer (Ermolchev et al., 1984; Pavlov et al., 1989; Shibanov, Melnikov, Pedchenko, 1996; Pedchenko, Melnikov and Shibanov, 1996). During the years of investigations, with allowance for new information about the object, methods for conducting surveys has steadily been improved (Pedchenko, Shibanov and Melnikov, 1997). In 1996, trawl-acoustic survey was

first carried out by Russia, Iceland and Germany, which has reliably assessed the stock over the whole redfish feeding area (Magnusson et al., 1996).

The materials obtained by results from the Russian trawl-acoustic survey in 1997 will be the basis of further improving of methods to study the Irminger Sea redfish stock.

## MATERIAL AND METHODS

Trawl-acoustic survey for the redfish stock in the Irminger Sea was carried out onboard the RV "Atlantida" (KI-839O) from 21 June to 21 July 1997. During the survey performed by latitudinal tracks in general direction from north to south the area of 158.9 thou. mile$^2$ was covered both in the Irminger Sea off shore areas and within 2OO-mile zone of East Greenland (Fig.1).

Hydroacoustic observations were done with EK 5OO echosounder the parameters of which are given in Table 1. To process acoustic data in O-5OOm a standard method was used (Mamylov, 1989; Methodical recommendations, 1993). Redfish abundance and biomass were calculated applying a constant TS per 1 kg of weight:

$$TS_{kg} = -38.3 \text{ dB/kg}$$

Mean TS for redfish in O-5OOm over a whole area surveyed made up: TS = -41.25 dB at mean length of fish being 33.3cm.

It should be noted that TS for redfish calculated by PINRO methods (TS= -4O.O dB agrees with 37.Ocm) agrees with that used by Icelandic specialists (TS = -4O.O dB for redfish with mean length being 36.7-37.Ocm) (Reynisson, 1992).

Acoustic and biological data were averaged by four conventionally isolated subareas a, b, c and d, differentiated by length-weight composition of redfish, its density of distribution (Fig.1).

Biological analysis was done for all catches taken by a mid-water trawl. Hauls were done at 5O-75Om depth 1-2 times/24 hours both in the day time and at night. A total catch, its species composition, a proportion of redfish, as well as other fish objects and jellyfish were determined from each trawl. Besides, length-weight composition, maturity and food composition were analyzed. The materials were collected in accord with the PINRO methods (Instructions and recommendations, 198O) and age samples of redfish - by the methods used by NAFO.

Ichthyoplankton observations were performed with a BONGO plankton net (3Ocm diameter opening) with a flow meter and conical nets. Samples were collected according to methods of oblique fishing off O-5Om during 6-8 min at vessel's speed 3.O-3.5 knots.

Oceanographic observations were performed to study spatial variability in conditions for redfish distribution. Stations were occupied with CTD-sonde at acoustic tracks in 45-55 miles and, without fail, in points of setting trawls and turning to another track (Fig.1). According to the ICES recommendations (Anon., 1995), to study year-to-year variability of conditions off the Irminger Sea the measurements were done at standard stations along the section 3-K (9 stations) to 1OOOm depth and to the bottom. Position of stations along the section 3-K is steady:

| | | |
|---|---|---|
| Station 1 | 62°20' N | 33°30' W |
| Station 1a | 62°00' N | 33°00' W |
| Station 2 | 61°00' N | 32°10 'W |
| Station 3 | 61°15' N | 31°15 'W |
| Station 4 | 60°55' N | 30°20 'W |
| Station 5 | 60°45' N | 29°30' W |
| Station 6 | 60°27' N | 28°45' W |
| Station 7 | 60°10' N | 27°55' W |
| Station 8 | 59°55' N | 27°05' W |

Amount of the material collected during trawl-acoustic survey is given in Table 2.

## RESULTS

### Trawl-acoustic survey of redfish

By results from the trawl-acoustic survey the abundance of oceanic redfish over the area covered constituted 2.4 bill.spec. (in off shore area - O.5 bill.spec. and 1.9 bill.spec. within the zone of Greenland) and biomass - 1.24 mill.t (in off shore area - O.28 mill.t and O.96 mill.t within the zone of Greenland) (Table 3).

### Peculiarities of redfish distribution

In June-July, redfish aggregations were registered over the whole area covered. Fish were distributed from 15O to 3OO-4OOm, partially intermingling with an upper sound-scatterring layer. By results from check hauls a most proportion of redfish inaccessible to acoustic estimation was directly inside a dense sound-scatterring layer which was mainly represented by jellyfish (2O-97%), lanternfishes (to 5%), as well as by zooplankton of small crustaceans. At night, in the area southward 6O°N the sound-scatterring layer was pronounced in a subsurface 2OO-3OOm that made essentially difficult to register redfish. The highest densities of redfish were recorded within 2OO-mile zone of East Greenland, which included 78% of the biomass assessed. Maximum density of redfish distribution attained 8O-11Om$^2$/mile$^2$ (or 4O-6O t/mile$^2$) and were registered to the south of Farewell Cape along 58°N (Fig.2). In 1997, maximum densities of redfish were recorded in more southern areas compared to those pronounced along 58°45' - 6O°3O'N in June-July 1996.

### Redfish biology

During surveying a O-5OOm layer, hauls were done in each 1OOm- interval. Main redfish biological parameters were found to be close to those during recent years with allowance for a period of conducting the survey. An upward trend has been noted in a portion of males from catches (64.9%) since mid-8Os. Mean length and weight for males made up 33.5cm and 535 g and 33.Ocm and 556 g, respectively, for females. Decrease in mean length and weight of redfish has been noted to continue over the whole area surveyed since 1994 (Fig.3). A proportion of mature fish amounted to 75.5%. Redfish fed on intensively, with the mean degree of stomach fullness being 2.1 in females and 2.3 in males. Food composition of fattenning redfish was typical of that period. *Themisto* - 31.3%, young squid - 24.6%, *Calanus* - 15.2% and euphausiids - 14.5% were preponderant in fish stomachs. Larger specimens were on the whole fished off in 5OO-8OOm. Redfish males (63.1%) were predominant in catches. Mean length and weight in males were 38.Ocm and 766 g, and 38.4cm and 8O9 g in females. A proportion of mature fish was much

higher than in upper layers and reached 91.2%. Mean degree of stomach fullness in females and males made up 1.2. Young squid (33.0%), shrimp (15.6%), euphausiids (12.8%) and *Calanus* (10.6%) constituted a bulk of catches; a proportion of fish objects has grown to 15.1%.

Oceanographic conditions in the area investigated

Among the peculiarities of hydrometeorological conditions in the Northeast Atlantic for a current year the following should be noted, i.e. predominance of positive anomalies of atmospheric pressure; maintaining of an upward trend in positive anomalies of temperature in atmospheric boundary layer of atmosphere and of the sea surface temperature (SST), commenced in 1994.

High positive anomalies of SST in the area of the Irminger and North Atlantic warm currents in late 1996, intensive radiation heating and prevalence of moderate winds contributed to an accumulation of heat in active layer of the ocean. As a result, a value for SST anomaly by the beginning of period of active larval extrusion (April-May) exceeded those for 1996 and attained maximum values both in the area of cold waters of subpolar divergence and in the warm currents mentioned above (Fig.4). It was noted that intensity of advection of subpolar mode of Atlantic waters (SPMW) into the Irminger Sea basin did not vary and was analogous to that observed in summer 1996. This conclusion has been drawn by the data on spatial distribution of temperature and salinity at 200m depth in the area surveyed (Fig.5) and by results from observations at the historical section 3-K. It is typical that in 1997 maximum mean values for salinity by layers at the temperatures similar to those for 1996 or exceeding them were noted at the section (Fig.6).

Results from oceanographic obsrevations allow to suggest that in 1997 the main portion of flow of these waters was not transported along the eastern slope of Greenland and further westward but distributed in the northern Irminger Sea and along the eastern and northern slopes of Iceland.

If the results from trawl-acoustic survey for 1996 and 1997 are compared, the mentioned above variations in temperature and salinity over the area have to a great extent influenced the spatial than vertical distribution of redfish. 200-350 and 600-800m layers were typical of redfish aggregation during a feeding period. No fishable aggregations of oceanic redfish in 0-500m were found to the north of 61°N and only local patches formed. Most proportion of fish was distributed in the fishing zone of Greenland (between 56° and 60°N) where fishable aggregations formed along periphery of subpolar divergence from 100 to 500m depth at 3.1-4.2°C and salinity 34.82-34.90 psu. Redfish aggregations at large depth (500-950m) were denser and were mainly distributed over the Reykjanes Ridge slopes. Fishing aggregations of fish at these depths were registered at 3.5-4.1°C and salinity - 34.89-34.97 psu.

Ichthyoplankton observations

By results from the ichthyoplankton observations in the area of trawl-acoustic survey the densities of redfish fry varied from 0.7 to 6.3 spec./$m^2$ (Fig.7). Length of larvae and fry varied from 6 to 35mm and mean one- 16.9mm. The largest fry of redfish 22-35mm long were observed in the south of the area surveyed. The main fry concentrations of redfish after their extrusion in April-May in the Irminger Sea off shore area were established to shift northwestward towards 200-mile zone of East Greenland. Three main areas of the densest concentrations of redfish fry have been revealed. A formation of these areas was probably related to origination of cyclonic gyres which concentrated larvae and prevented from their wide scatterring.

# CONCLUSION

According to results from the Russian trawl-acoustic survey carried out in O-5OOm in June-July 1997 the abundance of redfish made up 2.4 bill.spec. (in off shore area - O.5 bill.spec. and 1.9 bill.spec. in the zone of Greenland), the biomass was 1.24 mill.t (in off shore area - O.28 mill.t and O.96 mill.t in the zone of Greenland).

Estimate for oceanic redfish commercial stock, obtained by results from the trawl-acoustic survey for 1997, well agrees with the results from the international survey for 1996.

An upward trend in proportion of redfish males from catches was noted to be maintained. Length-weight composition, sex structure of concentrations and food composition of redfish at different depth are inhomogeneous. Larger mature specimens are in 5OO-8OOm, with young squid, fish objects and shrimp prevaling in feeding. Further decrease in mean length and weight of redfish in a layer to 5OOm, observed since 1994, goes on.

Rise in temperature in the ocean active layer has been noted compared to the same period of 1996. Active radiation heating of surface layers and advection of SPMW, the intensity of which corresponded to the level of 1996, were the reason for that.

Abnormally high mean values for salinity along the section 3-K, registered in summer 1997, indirectly indicate an enriching the SPMW with salter waters of the North Atlantic Current.

In 1997, the most portion of SPMW, entering the Irminger Sea basin, was distributed in the northern area, as well as along the eastern and northern slopes of Iceland, and did not run along the eastern slope of Greenland further westward.

Comparing the results from the trawl-acoustic surveys for 1996 and 1997, it should be noted that variations in temperature and salinity revealed in the area have to a great extent influenced spatial than vertical distribution of redfish.

Conditions for distribution of redfish commercial aggregations in different layers of water column were similar over the area surveyed. In the upper 5OOm-layer fish were aggregated at the temperature 3.1-4.2°C and salinity - 34.82-34.9O psu; in deep waters its aggregations were recorded at the temperature and salinity 3.5-4.1°C and 34.89-34.97 psu, respectively.

# REFERENCES

ANON., 1995. Report of the Study Group on Redfish Stocks. ICES C.M. 1995/G:1, Ref.Assess.

ERMOLCHEV, V.A., MAMYLOV, V.S., PAVLOV, A.I. and A.A.GLUKHOV. 1984. State of redfish *Sebastes mentella* stock in the open part of the Irminger Sea in hydroacoustic surveys in 1982-1983. - ICES C.M./G:8O.

INSTRUCTIONS AND RECOMMENDATIONS. - Murmansk, PINRO Press, 198O. 247 p.

MAGNUSSON, J., MAGNUSSON, J.V., SIGURDSSON, T., REYNISSON, P., HAMMER, C., BETHKE, E., PEDCHENKO, A., GAVRILOV, E., MELNIKOV, S., ANTSIFEROV, M., and V.KISELEVA. Report of the Joint Icelandic/German/Russian Acoustic Survey of Oeanic Redfish in the Irminger Sea and Adjacent Waters in June/July 1996.//ICES C.M.1996/G:8 Ref.H.-27 p.

MAMYLOV, V.S. 1988. Results of estimation on TS *in situ* at a frequency of 38 kHz for main commercial objects of the North Atlantic//Instrumental methods for stock assessment of commercial objects.- In:PINRO/VNIRO Selected Scientific Papers. Murmansk, pp.3-18.

METHODICAL RECOMENDATIONS for organizing and performing the hydroacoustic surveys on stocks of marine organisms. - Murmansk, PINRO Press, 1993. 132 p.

PAVLOV, A.I., MAMYLOV, V.S., NOSKOV, A.S., ROMANCHENKO, A.N. and A.V.IVANOV. 1989. Results of the USSR Investigations of *Sebastes mentella* Travin in 1981-1988 (ICES Subareas XII, XIV). ICES C.M./J:17. - 25 pp.

PAVLOV, A.I., MAMYLOV, V.S. and A.S.NOSKOV. Distribution, peculiarities of biology, stock status of redfish *(Sebastes mentella* Travin) in the Irminger Sea. Biological resources of mezo-and bathypelagial of the off shore area of the North Atlantic. - In: PINRO Selected Scientific Papers, Murmansk, 1988. P. 166-198.

PAVLOV, A.I.and V.N.SHIBANOV. Investigations on biological resources in pelagial and thallassobathyal of the off shore area of the North Atlantic. Comprehensive fisheries investigations of PINRO in the Northern basin: Results and perspectives.- PINRO Selected Scientific Papers. - Murmansk, 1991. P.1O4-117.

PEDCHENKO, A.P., MELNIKOV, S.P. and V.N.SHIBANOV. Regularities of Feeding Concentrations of Redfish (*Sebastes mentella*) formation in the Irminger Sea..ICES C.M. 1996/G:45.-17 p.

PEDCHENKO, A.P., SHIBANOV, V.N. and S.P.MELNIKOV. Spatial distribution of deepwater redfish, *Sebastes mentella*, in the Irminger Sea: characteristics of biology and habitat conditions. ICES C.M.1997/CC03 - 15 p.

REYNISSON, P. Target strength measurements of oceanic redfish in the Irminger Sea. - ICES C.M.1992/B:8. - 13 p.

SHIBANOV, V.N., MELNIKOV, S.P.and A.P.PEDCHENKO. Dynamics of Commercial Stock of Deepwater Redfish from the Irminger Sea in 1989-1993 by the results of Russian summer trawl-acoustic surveys.//ICES C.M. 1996/G:46.-19p.

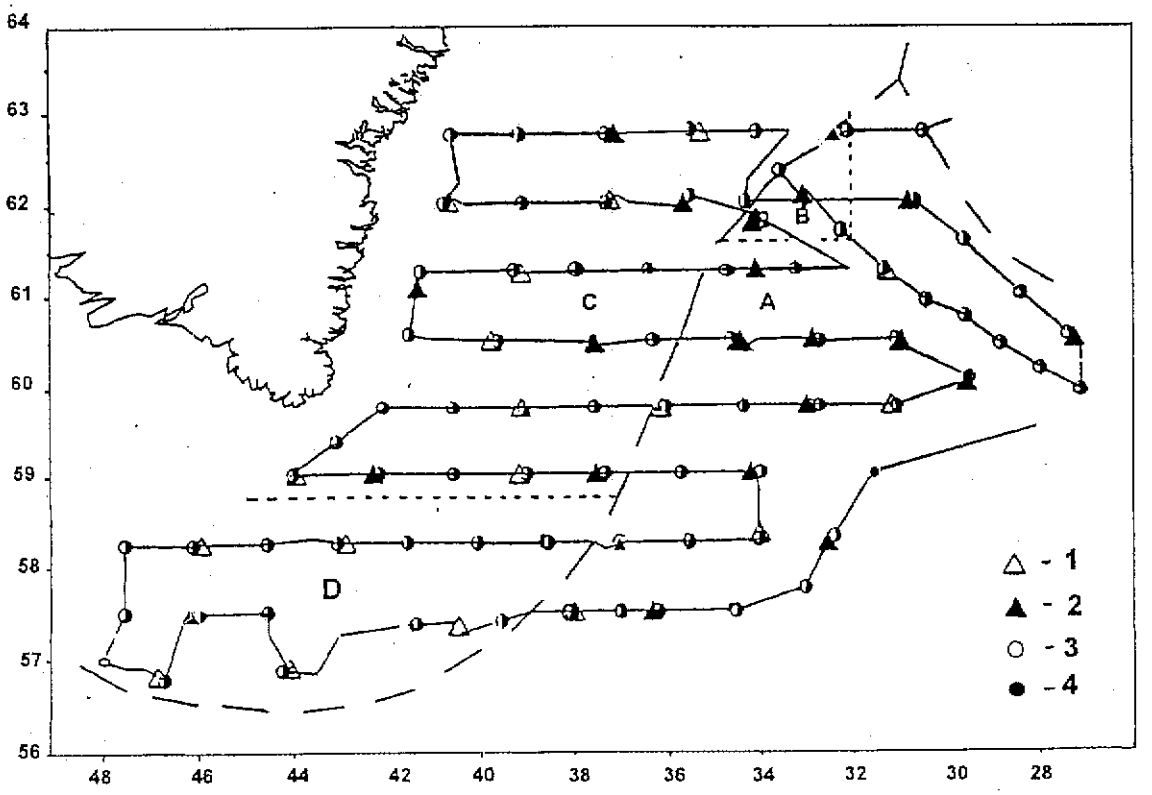


Fig. 1. Cruise track of trawl-acoustic survey on redfish, position of trawls in a layer above (1) and below (2) 500 m , hydrologic (3) and ichthyoplancton (4) stations in June-July 1997.

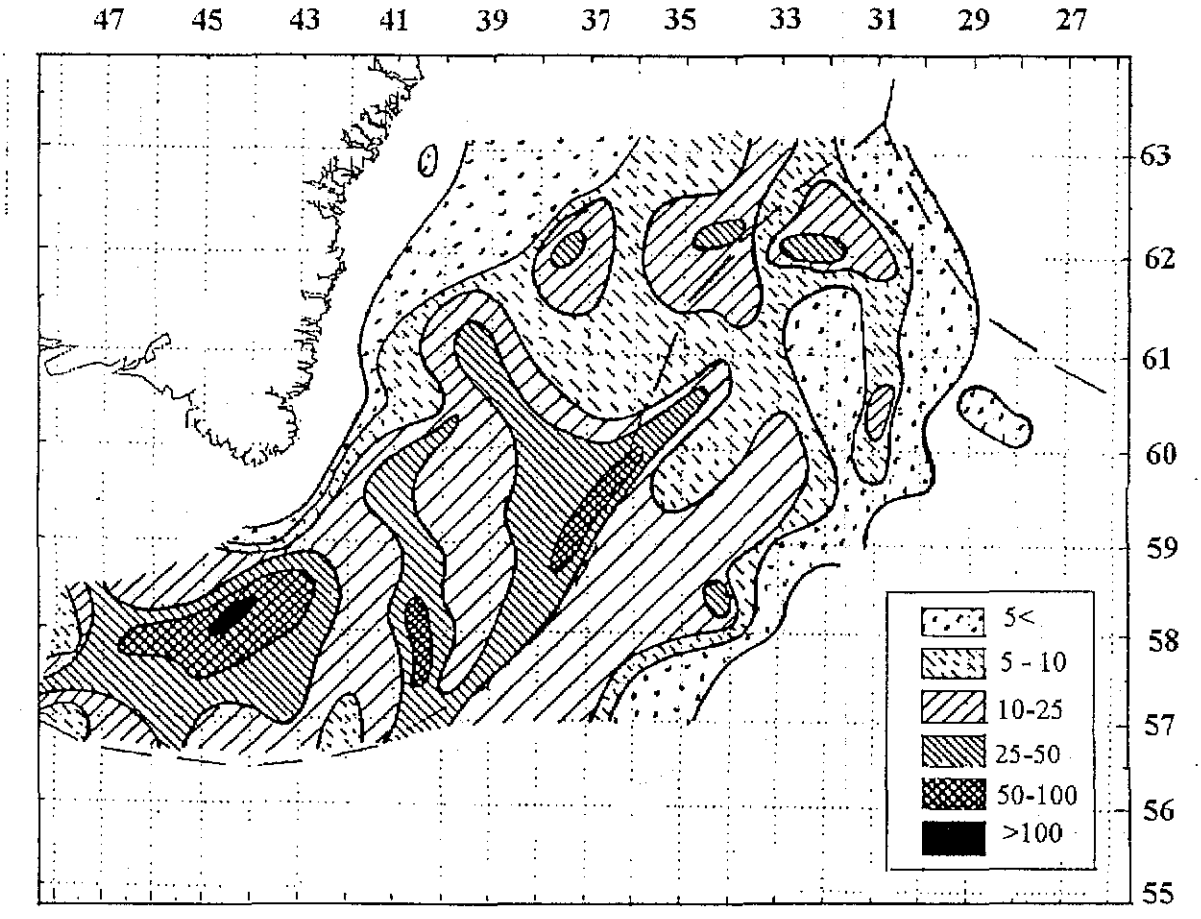


Fig. 2. Density of redfish aggrregations in 0-500 m layer in SA units ($m^2$/$mile^2$) by results from trawl-acoustic survey in June-July 1997.

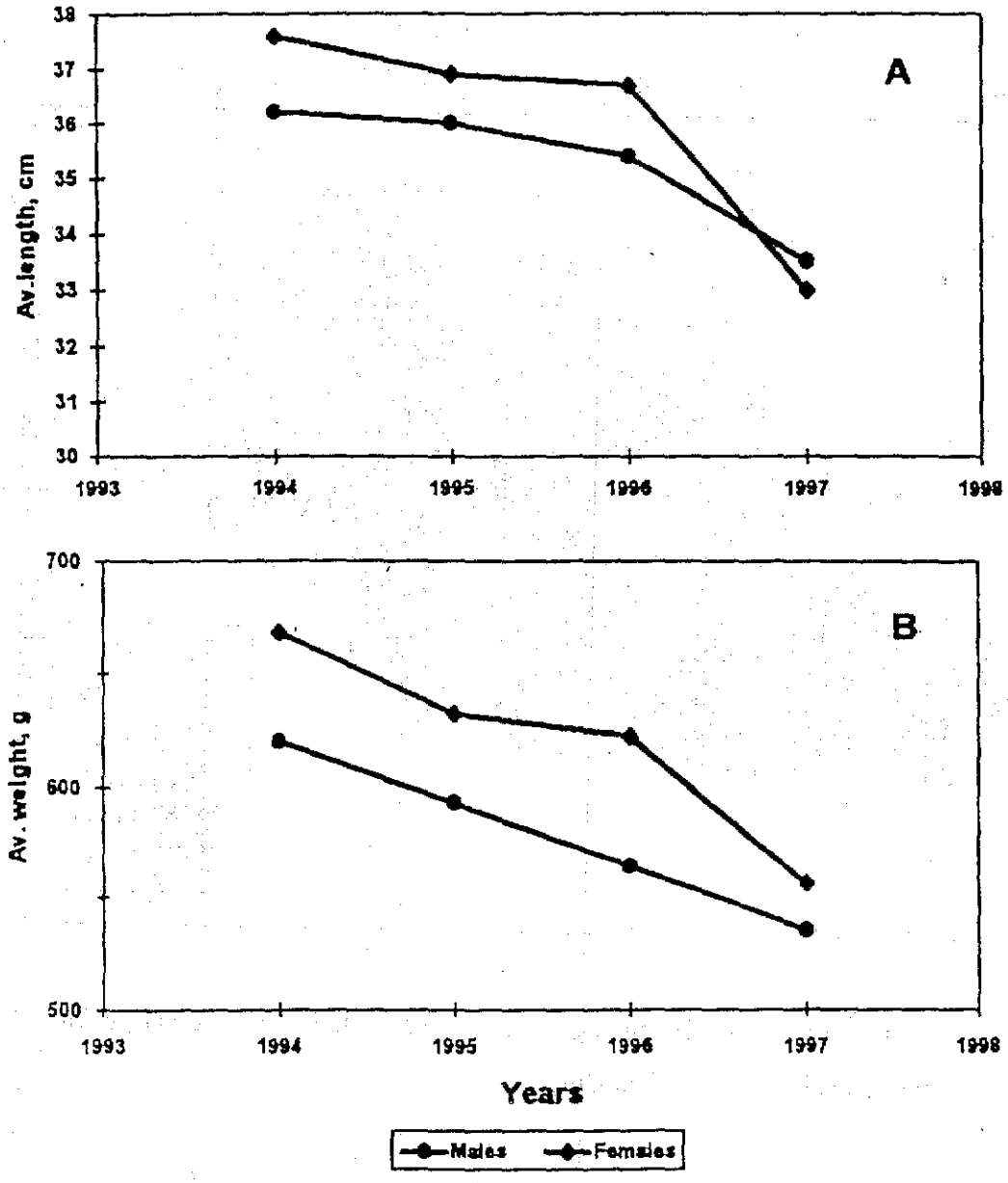


Fig. 3. Variation in mean length (A) and weight (B) of redfish in the feeding area in 1994 - 1997.

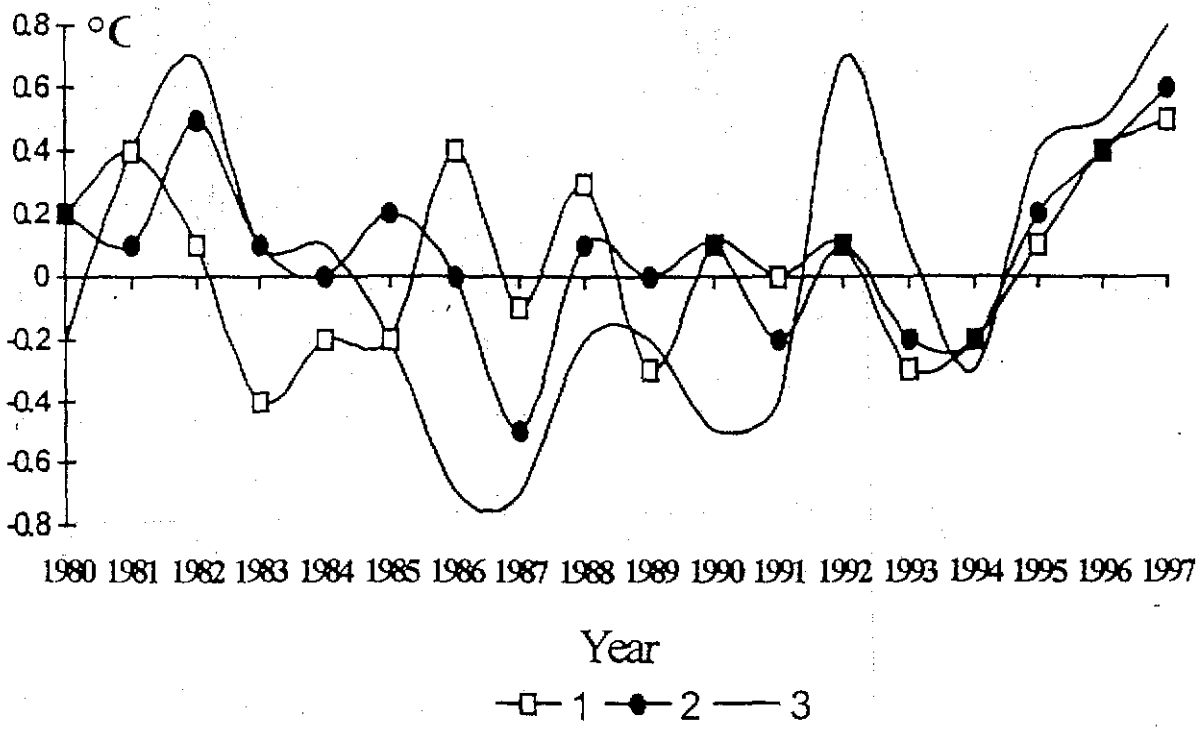


Fig. 4. Anomalies of sea surface water temperature in the area of subpolar divergence (1), the Irminger Current (2) and North Atlantic Current (3) in January - March 1980-1997.

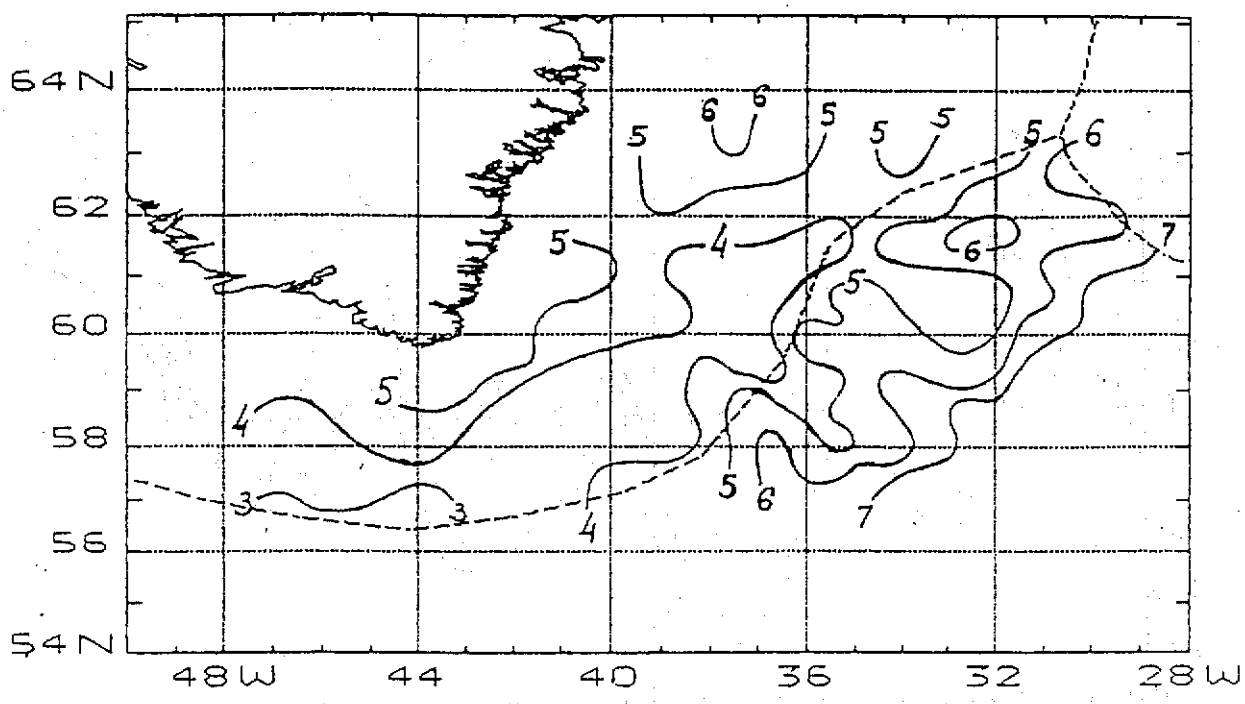


Fig. 5. Water temperature distribution (T°C) at 200 m depth

in June-July 997.

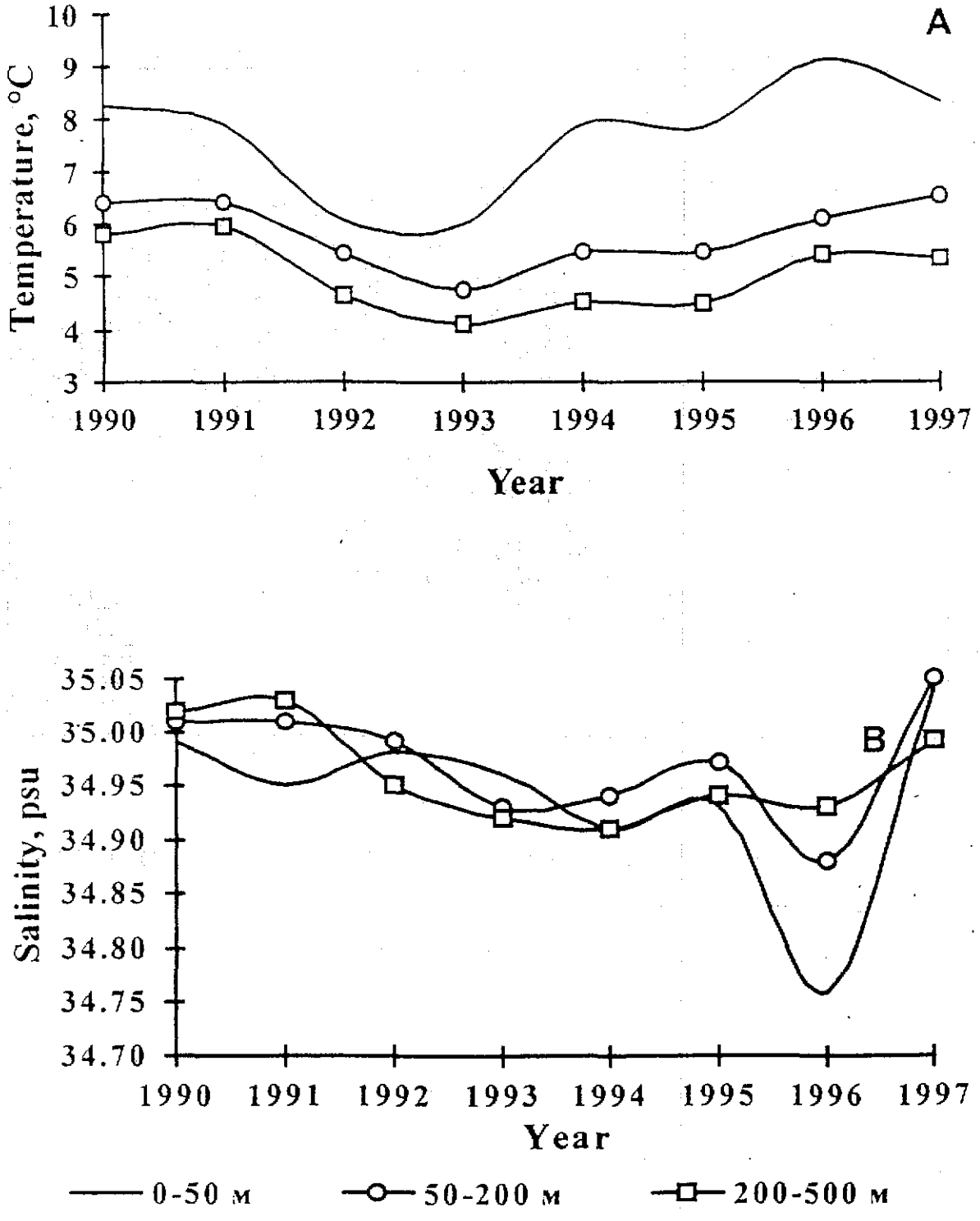


Fig. 6. Year-to-year variability in temperature (A) and salinity (B) by layers along the section 3-K (stations 1 - 5) in July 1990 - 1997.

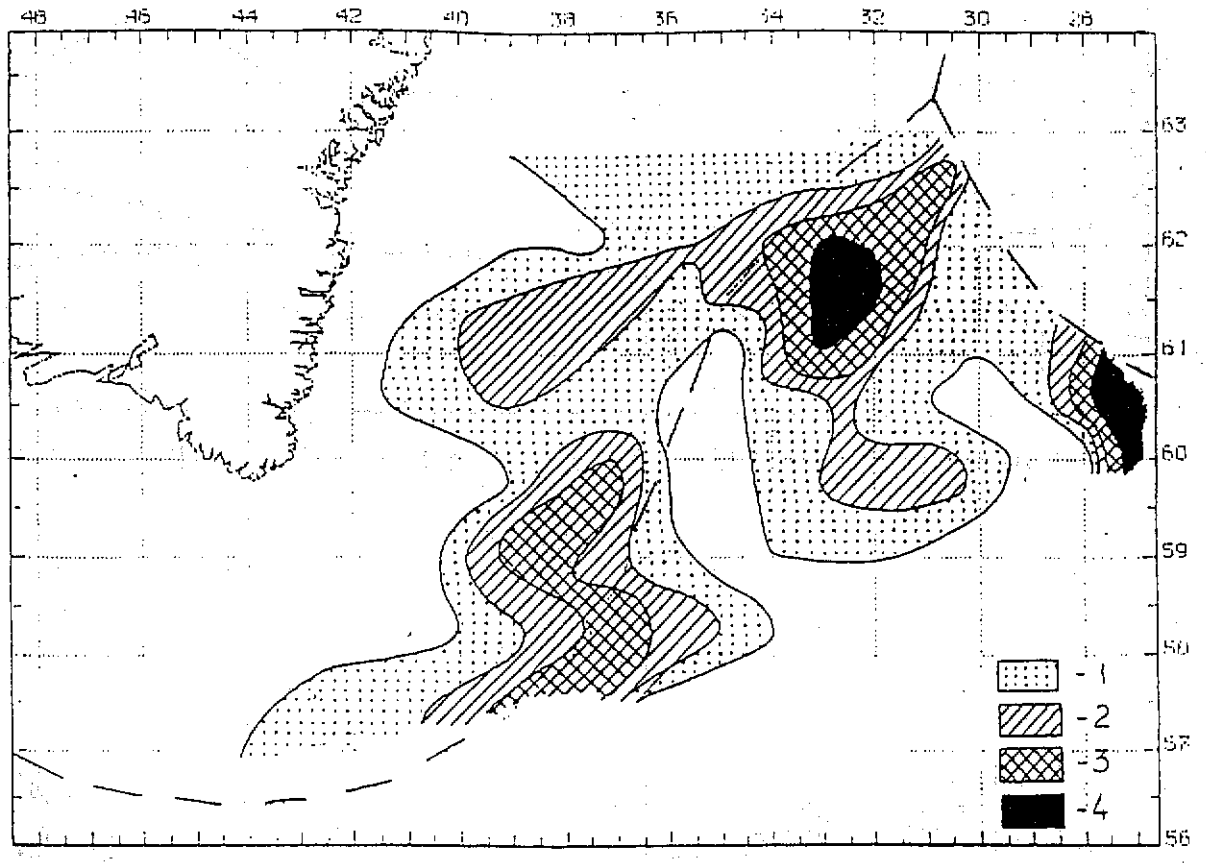


Fig. 7. Distribution of densities of redfish larvae and fry (spec./m²) in 0 -50 m in June - July 1997:

1 - 1.0; 2 - 1.1-2.0; 3 - 2.1 - 3.0; 4 - > 3.1.

Table 1. Instrument setting of the acoustic equipment on board r/v "Atlantida" in the trawl-acoustic survey in the Irminger Sea in 1997.

| Parameter | Value |
|---|---|
| Echosounder | EK-500 (ver. .01) |
| Frequency, kHz | 38 |
| Transmitter power, W | 2000 |
| Transducer type | ES-38 B |
| 2-way beam angle, dB | -21,2 |
| Absorbtion coefficient, dB/km | 10 |
| 3 dB beamwidth, deg | 6,7 |
| Sound speed, m/s | 1470 |
| Pulselength, ms | 1,0 / 3,0 |
| Bandwidth, kHz | 3,8 / 1,0 |
| SV-transducer gain, dB | -24,7 / -24,7 |
| TS-transducer gain, dB | -24,5 / -24,5 |
| Integration threshold, dB | -75 / -80 |

Table 2. Value of work done and data collected in June-July 1997.

| Items | Material of survey |
|---|---|
| Total track distance (miles) | 4351 |
| Area covered (sq. n. miles) | 158,888 |
| Number of CTD stations | 81 |
| Number of Ichthyoplanrton stations | 81 |
| Pelagic net hauls | 47 |
| Fish measured (spec.) | 4828 |
| biological analys (spec.) | 3132 |
| Age samples (spec.) | 1085 |
| Measured larvae (spec.) | 47 |

Table 3. Oceanic S. mentella biomass from the results of Russian trawl-acoustic surveys in 1982-1997.

| Year | Area suveyed, thou. sq. miles | | | Abundance, mill. sp. | | | Biomass, thou. t | | |
|---|---|---|---|---|---|---|---|---|---|
| | E-Green EEZ | Intern. area | Total | E-Green EEZ | Intern area | Total | E-Green EEZ | Intern. area | Total |
| 1982 | - | 40 | 40 | - | 790 | 790 | - | 560 | 560 |
| 1983 | - | 50 | 50 | - | 960 | 960 | - | 700 | 700 |
| 1984 | - | 55 | 55 | - | 660 | 660 | - | 526 | 526 |
| 1985 | - | 71 | 71 | - | 1122 | 1122 | - | 700 | 700 |
| 1986 | 74 | 43 | 117 | 989 | 923 | 1912 | 610 | 570 | 1180 |
| 1987 | 59 | 156 | 215 | 682 | 1212 | 1903 | 437 | 783 | 1220 |
| 1988 | 72 | 91 | 163 | 796 | 714 | 1510 | 504 | 452 | 956 |
| 1989 | 70 | 79 | 149 | 570 | 1040 | 1610 | 336 | 582 | 918 |
| 1990 | - | 73 | 73 | - | 1495 | 1495 | - | 848 | 848 |
| 1991 | 45 | 60 | 105 | 387 | 274 | 661 | 227 | 169 | 396 |
| 1992 | 40 | 150 | 190 | 950 | 1600 | 2500 | 600 | 1000 | 1600 |
| 1993 | 55 | 65 | 120 | 2493 | 1693 | 4186 | 1557 | 999 | 2556 |
| 1994* | - | - | 190 | - | - | 3496 | - | - | 2190 |
| 1995 | 88 | 79 | 167 | 2514 | 1577 | 4091 | 1640 | 841 | 2481 |
| 1996** | - | - | 256 | - | - | 2639 | - | - | 1625 |
| 1997 | 89 | 70 | 159 | 1875 | 527 | 2402 | 959 | 276 | 1235 |

* - results of the joint Icelandic-Norwegian survey.

** - results of the joint Russian-Icelandic-German survey.