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Forecasting Cod Distribution off West Greenland by means of water temperature

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It is known that the cod distribution in the West Greenland area depends to a considerable extent on the seasonal changes in water temperature. Such a relationship has been recorded in other seas too, e.g. the Barents Sea.

Applying the regularities of the seasonal migrations of the Barents Sea cod, K. G. Konstantinov (1967) suggested a method of forecasting cod distribution according to the temperature factor. In the present paper that method has been used in an attempt to reveal such relationships in the area off West Greenland.

The water temperature at some stations on Fyllas Bank, mainly taken by the Danish research vessels in July 1953-1966 (63°44'N 54°30'W and 63°53'N 53°22'W), was taken as an index of the environmental conditions. Data from F. Herman (1967) were used. Data on water temperature taken in the Godthaab Fjord for the 1953-1961 period (Herman F., 1953-1961), were also used.

The fishery importance of different ICNAF Divisions 1A, 1B, 1C, 1D, 1E, 1F, i.e. the bottom trawl catch in each division for the observed period (month, year) as a percentage of the total annual yield of cod in Subarea 1 according to the ICNAF data (1956-1968), was taken as the index of cod distribution. Data on calculation of this index are given in Table 1.

We considered 26 cases of conjectural relations between water temperature and fishery importance of different divisions. We shall try to express the general relation in the terms of $F=a+bt$. The most striking relationships were found in the comparison between water temperature in the 0-200 m layer on the Godthaab station in October and overall fishery importance of the Div. 1D and 1E in April-June of the following year (Fig.1). The correlation coefficient of this relation is -0.96. The regression equation is $F=57.3-16.2t$, where F= overall fishery importance of Div. 1D+1E in percentage from the annual cod yield in Subarea 1, t = water temperature in the 0-200 m layer in the Godthaab Fjord. If we compare water temperature in the 200-300 m layer in the Godthaab Fjord in October and fishery importance of Div. 1D and 1E in April-June of the following year (Fig. 2), then the correlation coefficient is -0.80, and the regression equation is $F=45.6-10.3t$.

A fairly clear dependence was observed between water temperature on Fyllas Bank (the mean temperature at stations 1 and 2 was used) in the 300-400 m layer and overall fishery importance of Div. 1A,1B, 1C next year (Fig.3). The correlation coefficient of the relation is 0.70 and the regression equation $F=10.7+6.7t$.

Figure 3 shows that if the temperature increases on Fyllas Bank in July, then the overall fishery importance of Div. 1A, 1B, 1C will also increase in the following year. By contrast, the overall fishery importance of the southern Div. 1D, 1E decreases during that period.

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With regard to the period of cod fattening, there was a relationship obtained between the water temperature on the station at 63°53'N 53°22'W in the 0-200 m layer on the Fyllas Bank in July and the overall fishery importance of Div. 1D and 1C in August-October (Fig.4). This relationship has a correlation coefficient of 0.68 and the regression equation is $F=0.12+2.2t$.

There is an incomplete set of observations for characteristics of fishery importance of various divisions for the wintering period of cod. Water temperature in the 0-100 m layer on the Lille Hellefisk Bank in September (data from the Soviet research vessels in 1961-1967) was compared with the fishery importance of Div. 1B in October-December (Fig.5). From Figure 5 it might be seen that if the water temperature is higher, then the fishery importance of Div. 1B increases, but if the temperature is lower, it reduces.

Relations obtained from the analysis of the data collected confirm that, with increasing water temperatures, the cod migrate northward and with decreasing water temperatures cod are distributed far to the south. The same is probably true also for the Labrador area (Konstantinov, 1968).

The equations obtained provide a means of forecasting, from 2 to 6 months and up to one year in advance, the location of the most prospective areas for scouting.

The Tests of the actual and calculated values of the overall fishery importance of Div. 1A, 1B, 1C from the equation $F=10.7+6.7t$ showed that, in 77% of cases, the error was not greater than 20% of the long-term amplitude of the forecasting index. This indicates that the method is a satisfactory one for tentative fishery forecasts.

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Table 1

Fishery importance of ICNAF Div. 1D+1E in April-June in % from annual catch of cod in Subarea 1

Year	Cod trawl catches (tons) in Div.1D+1E in April-June (A)	Annual cod catch (tons) in Subarea 1 (B)	Fishery importance of Div. 1D+1E $\frac{A}{B}$ x 100%
1954	57,740	301,875	19.1
1955	59,478	265,318	22.4
1956	84,588	321,245	26.3
1957	51,384	269,035	19.1
1958	52,010	318,821	16.3
1959	24,278	233,542	10.4
1960	20,440	241,346	8.5
1961	17,661	345,391	5.1
1962	12,661	450,658	2.8
1963	49,517	405,741	12.2
1964	43,993	349,738	12.6
1965	34,237	360,341	9.5
1966	34,226	366,126	9.3

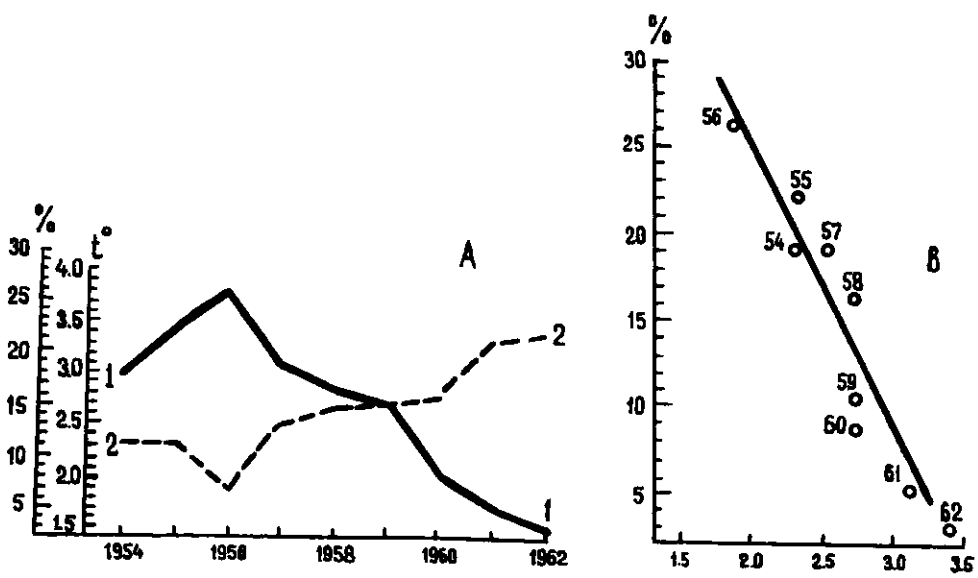

Fig. 1. (a) The overall fishery importance of ICNAF Div. 1D and 1E in April-June (1) and water temperature in the 0-200 m layer in the Godthaab Fjord in October in the previous year (2).

(b) The comparison between the overall fishery importance of Div. 1D and 1E in April-June and water temperature in the 0-200 m layer in the Godthaab Fjord in October in the previous year.

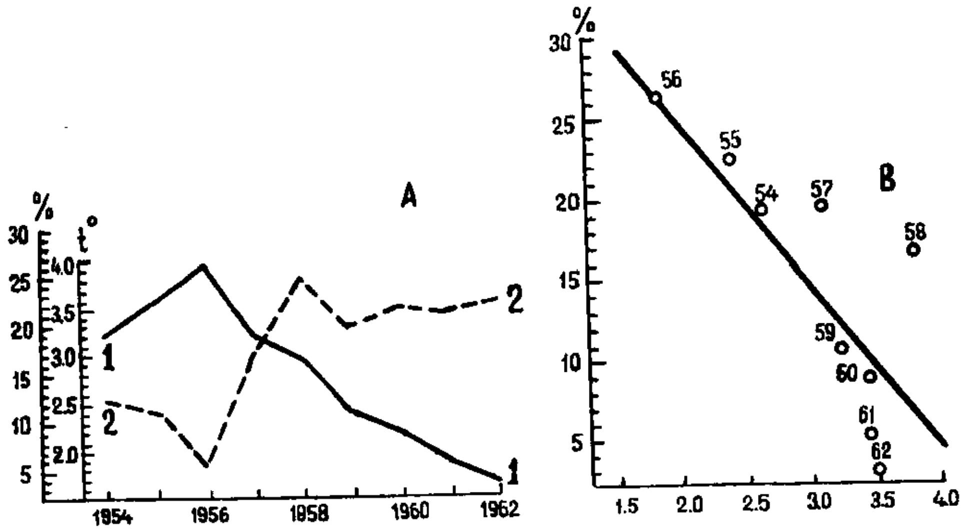

Fig. 2. (a) The overall fishery importance of Div. 1D and 1E in April-June (1) and water temperature in the Godthaab Fjord in the 200-300 m layer in October in the previous year (2).

(b) The comparison between the overall fishery importance of Div. 1D and 1E in April-June and water temperature in the 200-300 m layer in the Godthaab Fjord in October in the previous year.

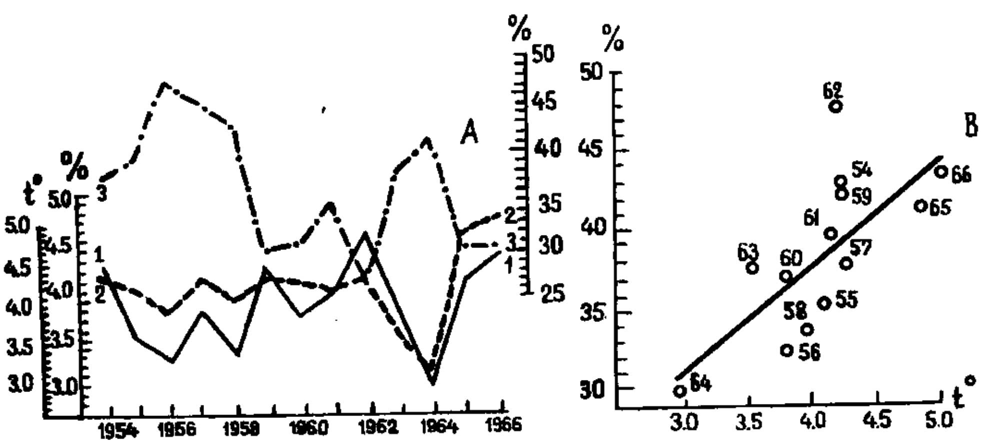

Fig. 3 (a) The overall fishery importance of Div. 1A, 1B and 1C per year (1), water temperature in the 300-400 m layer on the Fyllas Bank in July in the previous year (2), fishery importance of Div. 1D and 1E (3).

(b) The comparison between the overall fishery importance of Div. 1A, 1B and 1C per year and water temperature in the 300-400 m layer on the Fyllas Bank in July in the previous year.

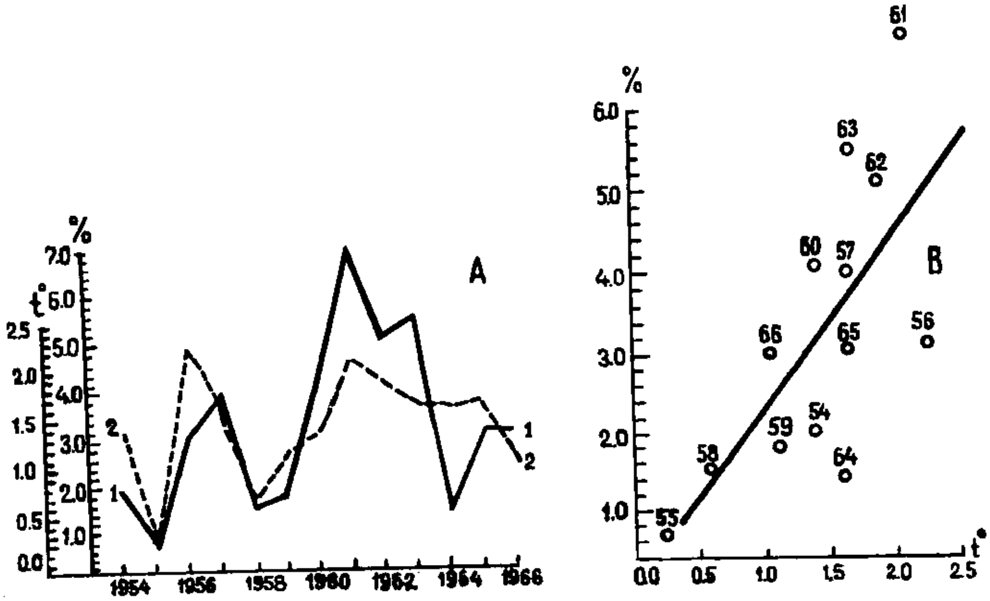

Fig. 4 (a) The overall fishery importance of Div. 1D and 1C in August-October (1) and mean temperature of the 0-200 m layer in July on the Fyllas Bank (2).

(b) The comparison between the overall fishery importance of Div. 1D and 1C in August-October and water temperature in the 0-200 m layer in July on the Fyllas Bank.

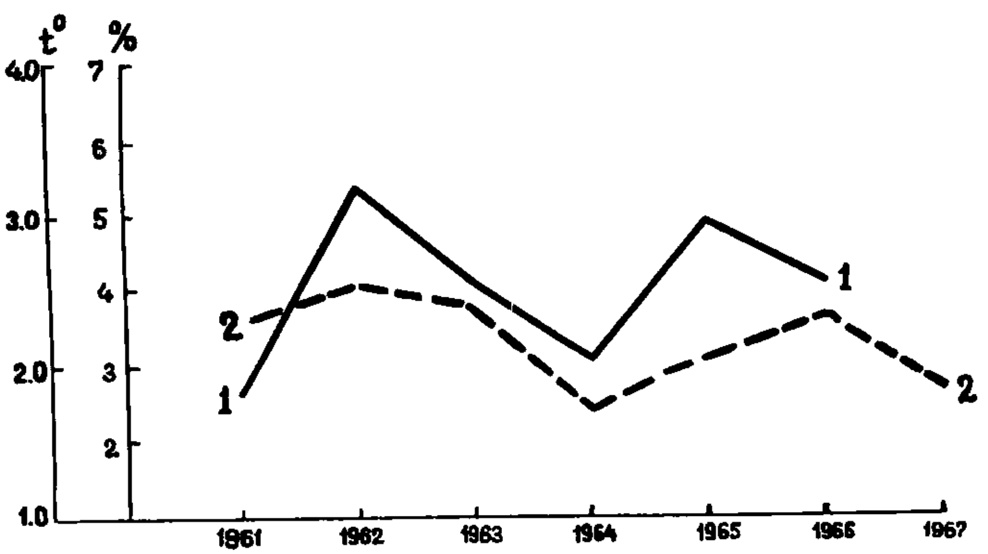

Fig. 5 The comparison between the fishery importance of Div. 1B in October-December (1) and water temperature in the 0-100 m layer on the Lille Hellefisk Bank in September (2) according to the data, collected during the observations, carried out by Soviet vessels.