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Influence of water temperature on cod year classes strength on the Flemish Cap Bank

by

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Abstract

The relationship between water temperature on the standard hydrological section 4-A and cod year classes strength on the Flemish Cap Bank is refined. A new equation permitting to predict year classes strength is proposed.

Methods, results and discussion

A regular relationship between water temperature and cod year classes strength on the Flemish Cap Bank was characterized in the previous papers of the author (Konstantinov, 1975, 1977, 1980). The equations were proposed which in the author's opinion could be used when predicting the abundance of the future cod year classes. The temperature of the 0-200 m layer on the standard hydrological section 4-A in May, i.e. in the period of mass hatching and development of larvae was considered as an initial premise for the prediction (Serebryakov, 1967).

The mean catch of yearlings and two-year-olds per trawling hour by a fish-counting trawl was taken as an index of cod year classes strength. The data of such kind are collected annually and published by ichthyologists of PINRO (Konstantinov & Noskov, 1980).

The last of the author's papers (Konstantinov, 1980) contained the prediction of abundance of two cod year classes which have not yet been assessed by the fry survey. Judging by the temperature registered on the section 4-A in May 1978 it was predicted that the 1978 year class would be poor. Later on the abundance of this year class yearlings (in summer 1979) and that of two-year-olds (in summer 1980) was determined. The averaged index of yearlings and two-year-olds abundance $\frac{n_1+n_2}{2}$ was equal to only 2.5 specimens (Table 1). Thus, the 1978 year class proved to be really poor. In May to July 1978 only some developing cod eggs and larvae were caught on the Flemish Cap Bank during the ichthyoplankton survey (Postolaky, 1980).

The question arises whether it is more reasonable to take the temperature in the 0-50 m layer for the initial premise for the prediction. It is just there that cod eggs and larvae are developing. It should be noted that sometimes in May a marked difference was observed between the water temperature in the 0-50 m and 0-200 m layers on the section 4-A (Table 2).

We compared the temperature in the 0-50 m layer and cod year classes strength in 1968 to 1978 (Fig.1). The section 4-A was selected because it is located not far from the south-western slope of the Bank where in March to early April an intensive spawning of cod occurs (Mankevich and Prokhorov, 1962; Serebryakov, 1967). The relative abundance abundance of yearlings and two-year-olds was taken for an index of year classes strength as the three-year-olds were sometimes fished partially.

It is easy to notice that the higher water temperature is, the poorer, as a rule, cod year classes strength. This regularity is successfully expressed by the equation

$$Y = \frac{96.5}{x+0.5}$$

where x - water temperature in the 0-50 m layer on the section 4-A in May,

Y - index of cod year classes strength (mean catch of yearlings and two-year-olds per trawling hour).

It may seem strange that lower (rather than higher) water temperature favours the appearance of strong cod year classes. I still remind that the Flemish Cap Bank is located in the southern part of cod fishing area. Cod are found, of course, further south, as far as the coast of the North Caroline State (Wise, 1958) but only as secondary in size species. Lower temperature (in comparison with the long-term mean) provides near southern boundaries of cod distribution the environmental conditions close to optimal which are typical of the central part of the area.

In the North-East Atlantic the abnormal drop of water temperature in the southern part of cod distribution favoured as well the appearance of strong year classes, recruitment of the commercial stock. For example, in some recent decades there was observed a tendency toward cooling of water masses in the North Sea with the concurrent growth of the abundance of cod and other bottom boreal species too (Dickson, Pope & Holden, 1974; Daan, 1975; Southward, Butler, Pennycuik, 1975; Hempel, 1978). The interesting facts and considerations on the influence of temperature on fluctuations of the North Sea cod abundance have been stated earlier by Holden (Holden, 1972). The average annual number of two-year-olds caught per 100 trawling hours in the Grimsby area was taken by him for an index of year classes strength. Comparing this index with temperature on the hydrological section Hull-Hanstolm in May Holden concluded that positive anomalies resulted in the appearance of stronger year classes. However, it is difficult to agree with this conclusion (especially as the long-term observations on temperature in May were ceased in 1957). Considering the spawning terms of the North Sea cod and having compared the anomalies of water temperature in April with the year classes strength we believe that there is an inverse relationship between these indices with the coefficient of correlation being about -0.5. Thus, according to Holden's data the lower water temperature favoured the appearance of strong cod year classes in the North Sea.

The contrary was the case in the northern part of cod distribution - for example, in the Barents Sea the lower temperature resulted in the appearance of poor year classes (Izhevsky, 1961).

The equation (1) permits to conclude that cod year class of rather a high abundance must have appeared on the Flemish Cap Bank in 1979; the mean number of yearlings and two-year-olds per trawling hour must have reached 45 specimens. Unfortunately, in 1979 hydrological observations on the section 4-A were carried out earlier than usually. By mid-May the temperature in the 0-50 m layer seemed to change considerably having predetermined the formation of the poor year class. In 1980 a regular assessment of young cod abundance was carried out on the Flemish Cap Bank (by the RV "Nikolai Kononov", under the leadership and with participation of the author of this paper). No cod yearlings were in fact found (Table 1). However, the final estimate of the 1979 year class strength will be made after the survey of two-year-olds in 1981.

Judging by temperature on the section 4-A the 1980 year class must be below the long-term mean level.

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Table 1. Cod year classes strength according to the results of young fish survey on the Flemish Cap Bank in 1969-1980

Year class	Number of spec. per trawling hour		
	Yearlings	Two-year-olds	Arithmetic mean
I968	I0	I06	58
I969	0	2	I
I970	0	I	0,5
I97I	22	87	54,5
I972	3	29	I6
I973	303	350	326,5
I974	I33	50	9I,5
I975	5	I7	II
I976	0	2	I
I977	8	5I	29,5
I978	3	2	2,5
I979	0	-	-
Mean for 1968-1978	40,6	63,4	53,8

Table 2. Water temperature (°C) on the hydrological section 4-A (between 45°57'N 48°30'W and 45°20'N 47°22'W) in 1968 to 1980

Year	Hydrological vessel	Date	Temperature in layers, m	
			0-200	0-50
I968	"Rossiya"	16 May	2,04	I,38
I969	"Rossiya"	15 May	3,93	4,80
I970	"Protsion"	22 May	2,40	2,62
I97I	"Protsion"	18 May	2,05	2,49
I972	"Protsion"	19 May	I,37	I,28
I973	"Protsion"	19 May	-0,80	0,03
I974	"Gemma"	22 May	0,6I	0,68
I975	"Evergreen"	31 May	I,6I	I,67
I976	"Persey III"	11 May	0,68	0,83
I977	"Persey III"	23 May	I,40	I,99
I978	"Protsion"	12 May	3,40	3,23
I979	"Gemma"	27 Apr	I,73	I,64
I980	"Protsion"	17 May	I,46	2,35
Long-term mean			I,8I	I,92

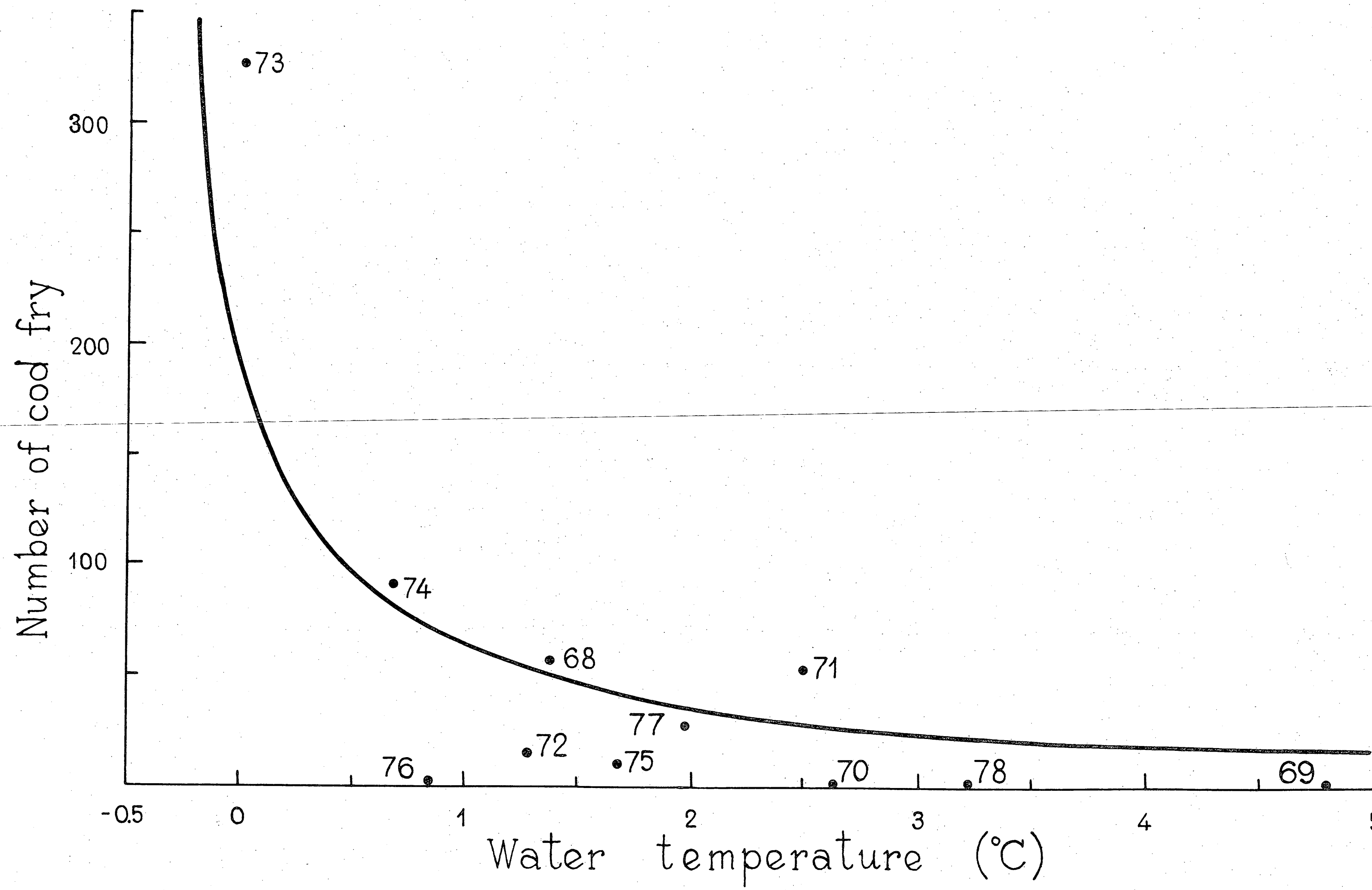

Figure 1. Water temperature in the 0-50 m layer on the hydrological section 4-A and index of cod year-classes strength on the Flemish Cap Bank (Arithmetic mean of average catches of yearlings and two-year-olds per trawling hour) in 1968 to 1978.