Long-term variation and adaptive relationship between the life cycle parameters of the North-East Atlantic cod *Gadus morhua*

by
Tretyak V.L.

The purposes:

- To study a long-term variation of the basic biological population parameters of the North-East Atlantic cod, totality which determine the population development.

- To study the population mechanism regulating the cod abundance depending on intensive exploitation of the stock.

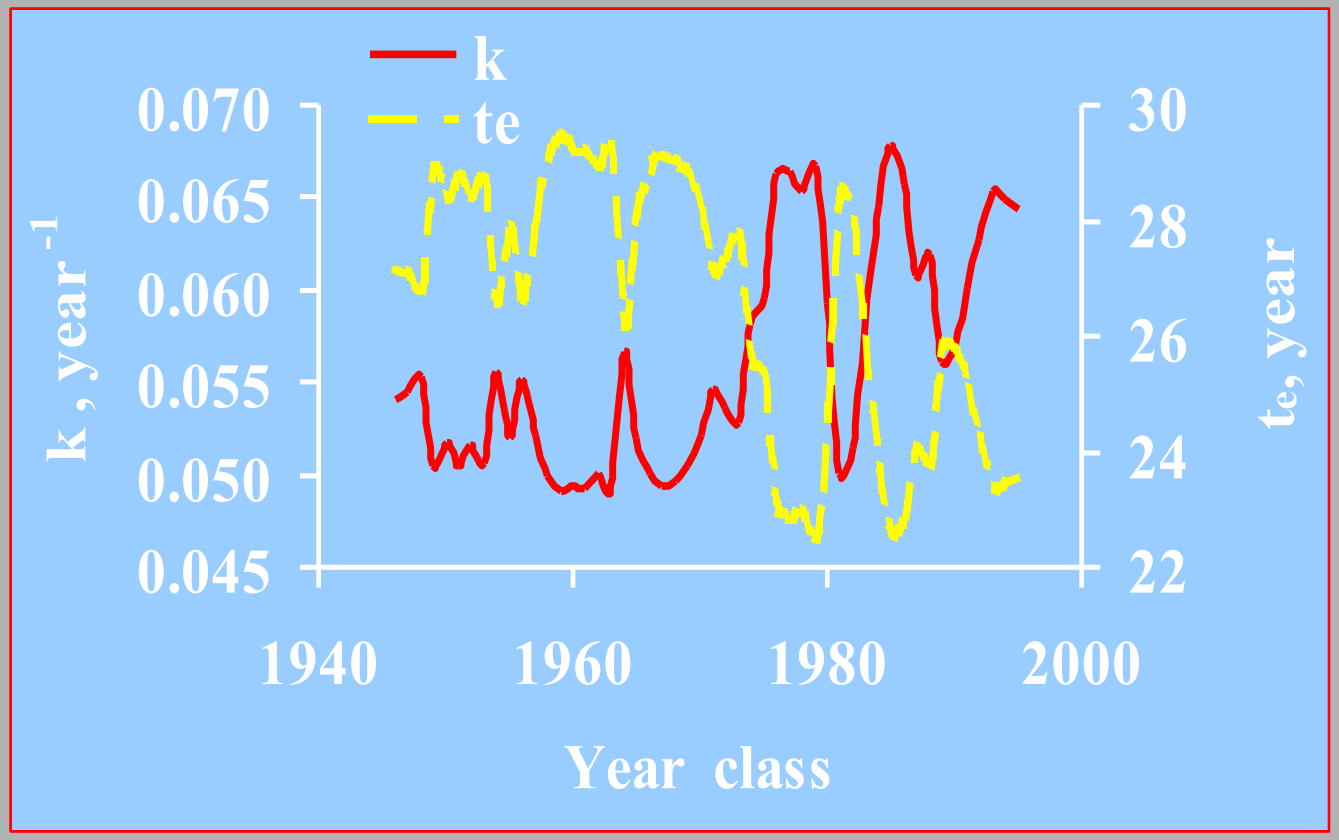
Material and methods

$$\sum_{t=3}^{9} \left(\ell_t - \ell_\infty \cdot \left(1 - \exp\left(-k \cdot \left(t - t_0 \right) \right) \right) \right)^2 \Rightarrow \min \ ;$$

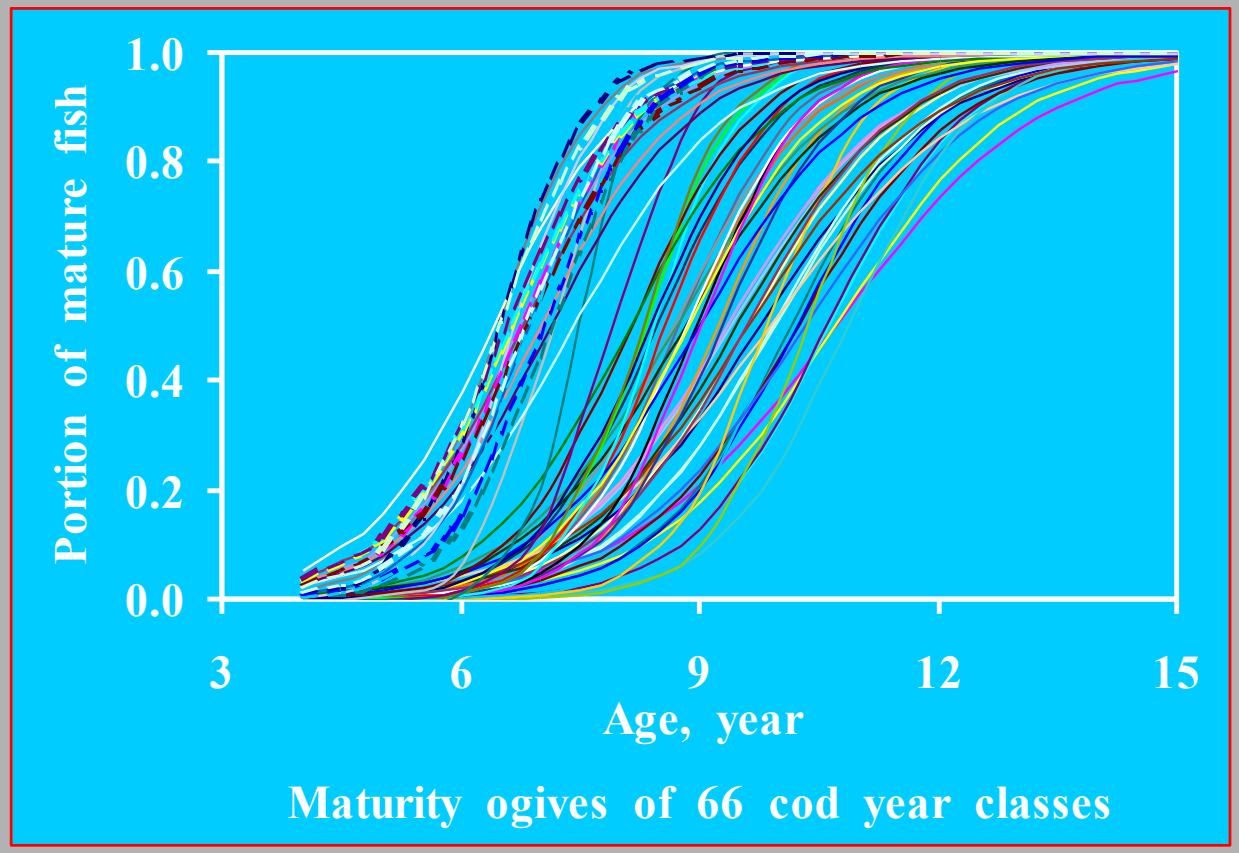
$$t_e = t_0 - \frac{1}{k} \cdot \ln\left(1 - \frac{\ell_{t_e}}{\ell_\infty} \right) ;$$

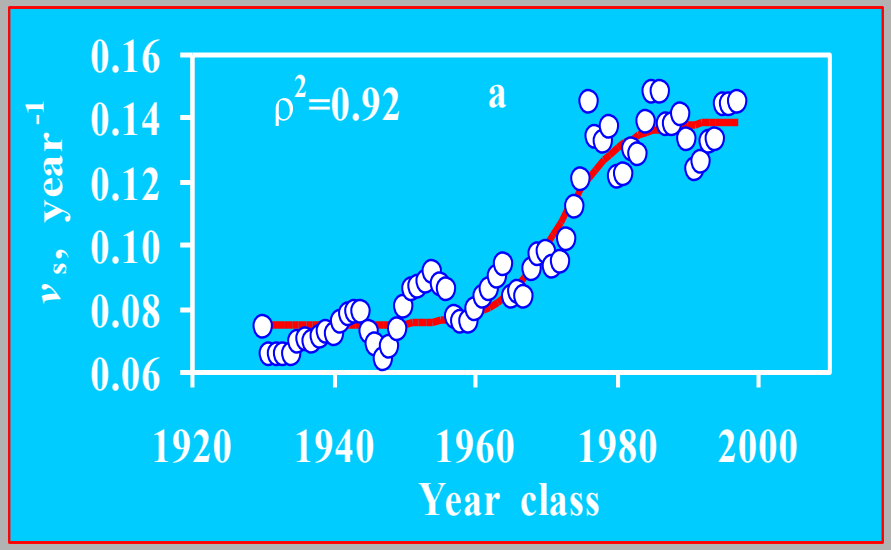
$$\overline{\delta S(t)} = \frac{1}{1 + \exp\left(a_1 \cdot \left(t - t_s \right) \right)} ;$$

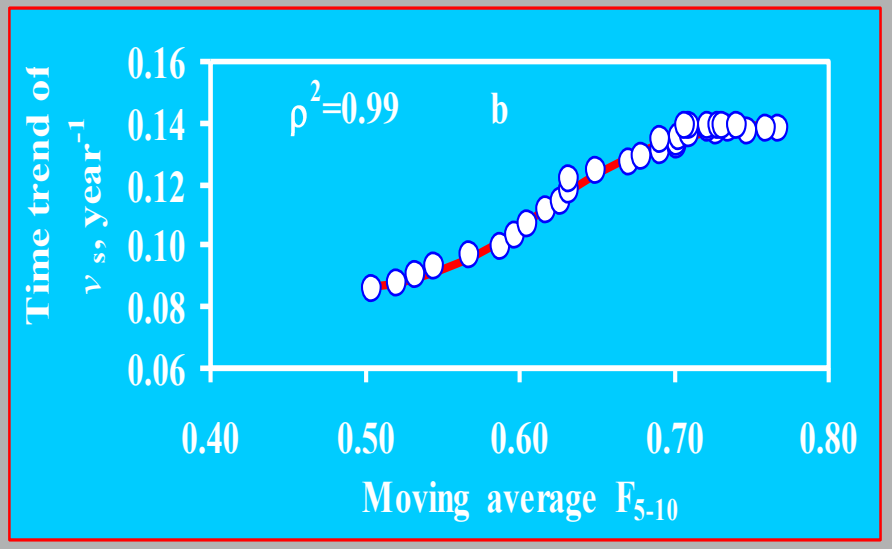
$$\nu_s = \frac{0.5}{t_s - 3} \ .$$

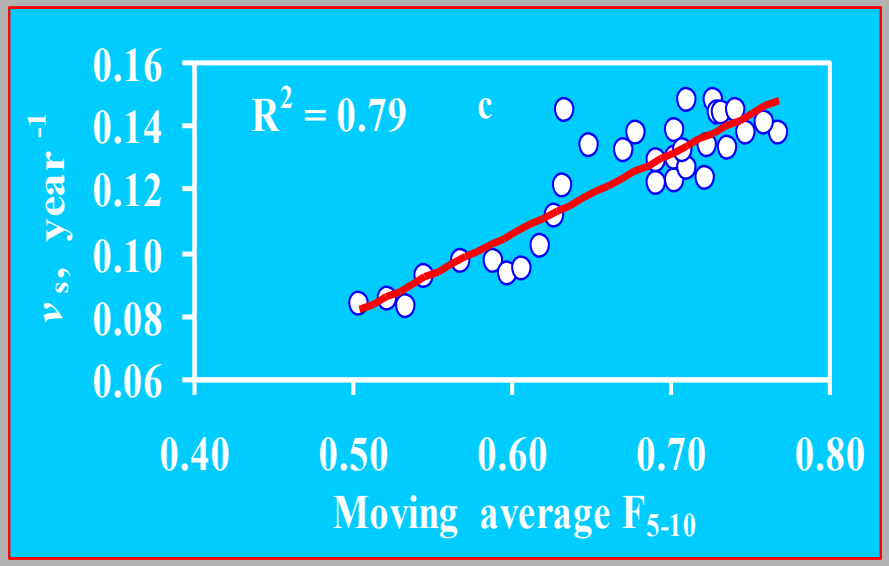


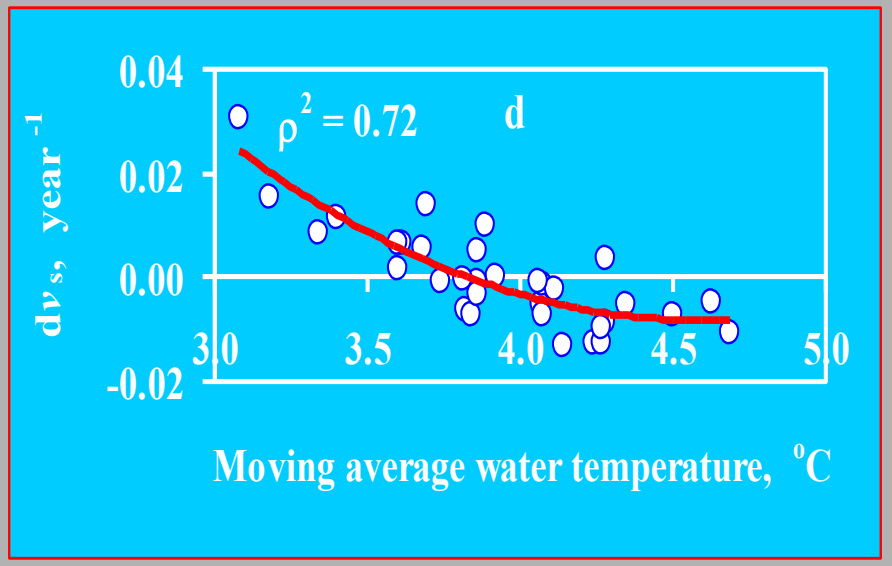
Long-term dynamics of the cod year classes growth rate (k) and maximum possible life span (t_e).


Portion of mature fish
1.0
0.8
0.6
0.4
0.2
0.0
3
6
9
12
15
Age, year
Maturity ogives of 66 cod year classes

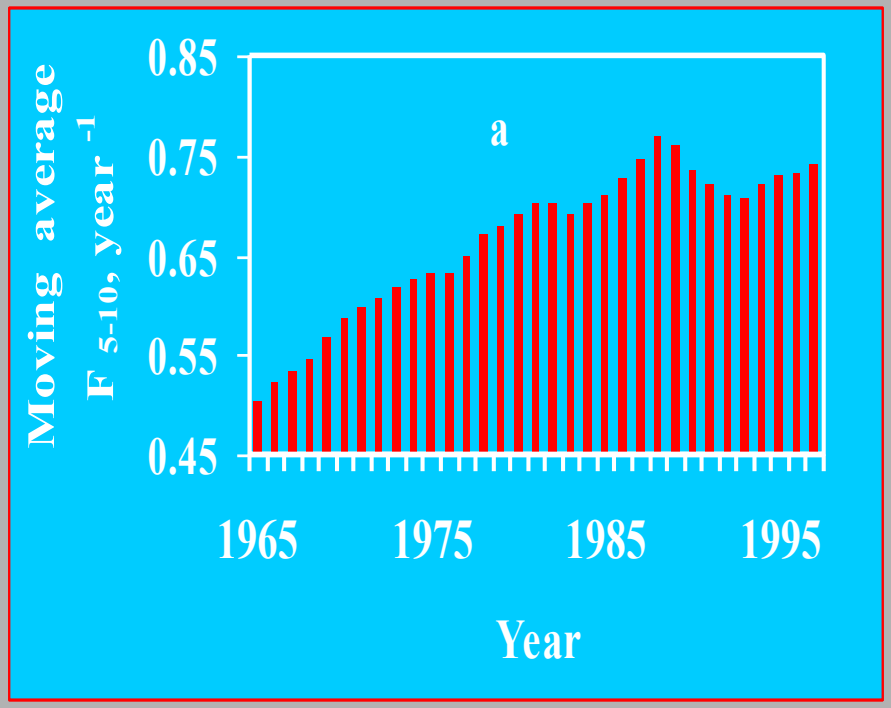


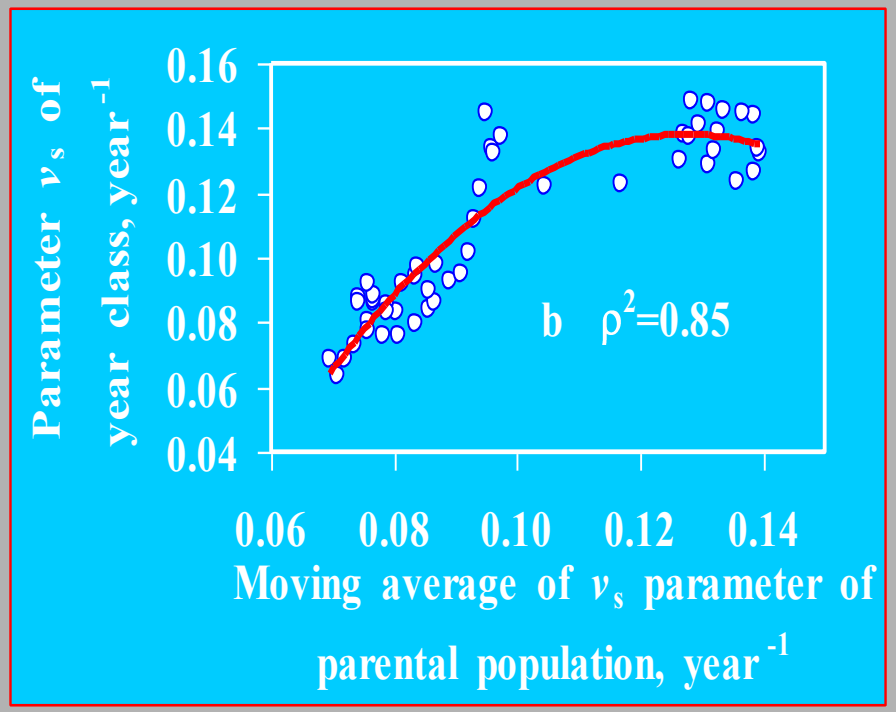




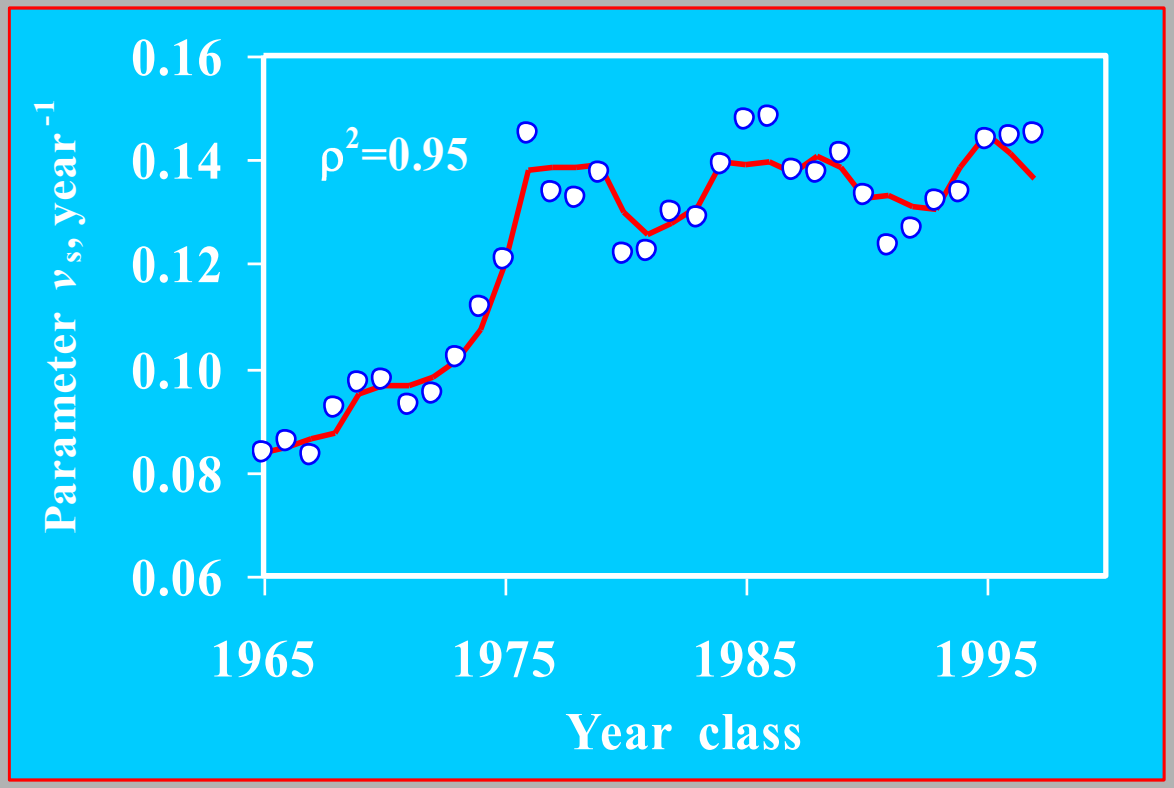


Variation of cod year classes maturation rate

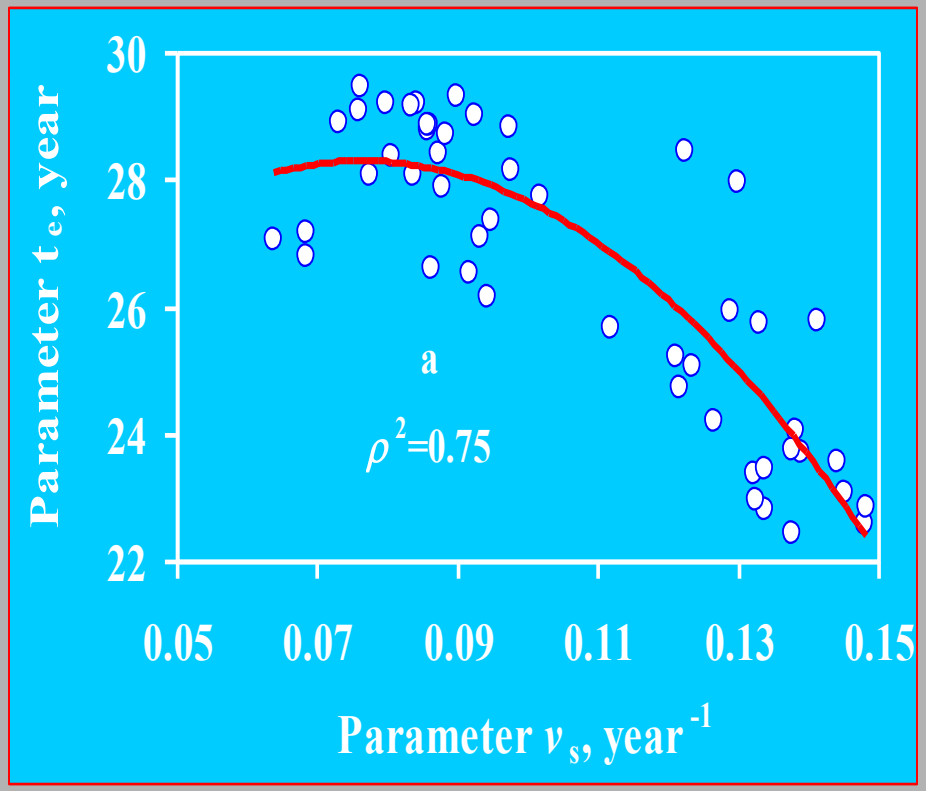


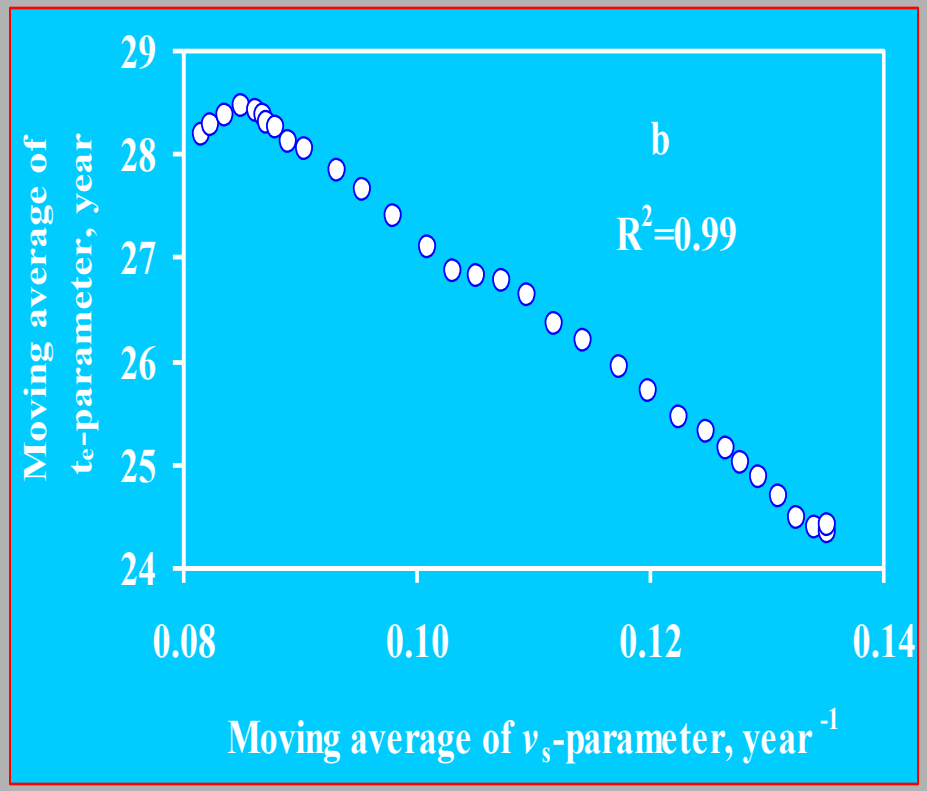


Variation of cod stock historic exploitation rate (a) and cod year-class maturation rate depending on average maturation rate of parental population (b)



Approximation of ν_s-parameter by the regression equation with two independent variables – historic exploiutation rate and moving average water temperature in 0-200 m layer of the Murman Current main branch





Relationship between cod year-classes maturation rate (v_s) and maximum possible cod life span (t_e) –(a), between their moving average by 21-th years –(b)

Conclusions

- The numerical characteristics of the basic biological population parameters of the North-East Atlantic cod are changed after the mid of 1970s. The mathematical expectations of growth and maturation rates increased, life span decreased. Variances in the growth rate and the life span increased, rate of maturation decreased. The adaptive relationship between the maturation rate and life span individuals is reverse and statistically significant (ρ^2=0.75).

Conclusions

- Using a large historic series of observations (1930-1997) it was shown that the main element in reproductiv strategy and cod population abundance dynamics, the rate of year-classes maturation (v_s), had a well-defined time logistic trend to increase (ρ^2=0.92). That process was conditioned by the historic stock exploitation rate in the period, which was close to the year-class life duration and preceding its appearance (ρ^2=0.99). It promotes the increase in mature fish abundance and therefore is aimed at diminishing the negative effect of rising mortality on the population abundance. Nevertheless the year-class maturation rate cannot increase to infinity. It has a threshold value outside the limit of which the collapse of the stock starts.The population mechanism of cod abundance regulation may be the biological basis of this species stock management.