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Long-term variability of peak egg abundance timing of Baltic cod in ichthyoplankton of the southern Baltic Sea.

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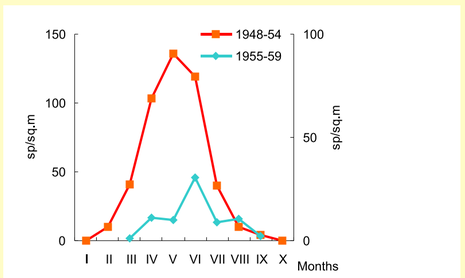

Fig. 1.The seasonal cod egg distribution (sp/ sq.m) in the Gdansk Deep in 1948 - 1954 and 1955-59

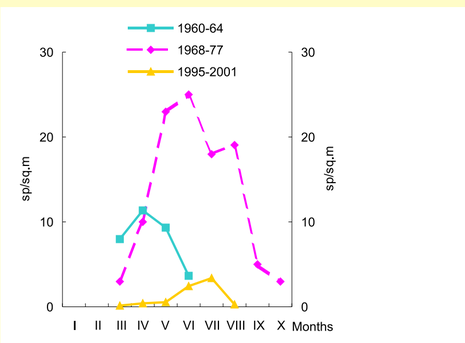

Fig. 2. The seasonal cod egg distribution (sp/sq.m) in the Gdansk Deep in 1960-64, 1968-77 and 1995-2001

Background

In contrast to the most of Atlantic cod populations the eastern Baltic cod is characterized by a prolonged spawning timing. In the Baltic the cod reproduction can be successful only under salinity not less than11psu and oxygen content not less than 2 ml/l (CORE 1997). The goal of this study is revealing possible influence of some environment factors upon the variability of cod spawning timing in the Gdansk Deep.

Materials and Methods

Ichthyoplankton cod egg abundance data in the Gdansk Deep were taken from literature sources (Grauman, 1972, 1980, Mankowski, 1951, 1955, 1959) and AtlantNIRO archives including CORE(1997) and STORE(2002) projects sampling results for1996-1999. A proportion (%) of spawning cod (VI and VII maturation stages according to Maier, 1908, corresponding to V, VI-V stages on Alekseev, Alekseeva, 1996) in April 1948-1979 was used as characteristics of mass spawning beginning (Chrzan, 1954, Grauman, 1958, 1963, 1964, Klimaj, 1966, Kosior, 1967, 1971,1972, 1973,1974, 1975, 1976,1978,1979, 1980,1981 Rutkowich, 1961,1963). It was taken into account the most of Polish maturation stages sampling in SD26 was carried out in the Gdansk Deep in those years (Elwertowski, 1960, Kosior, 1976, Rutkowich, 1963) and Russian sampling was a basin-specific. The oxygen content and reproductive volume data were obtained from AtlantNIRO archives and literatures sources (MacKensie et al, 2000, Zezera, 2002).

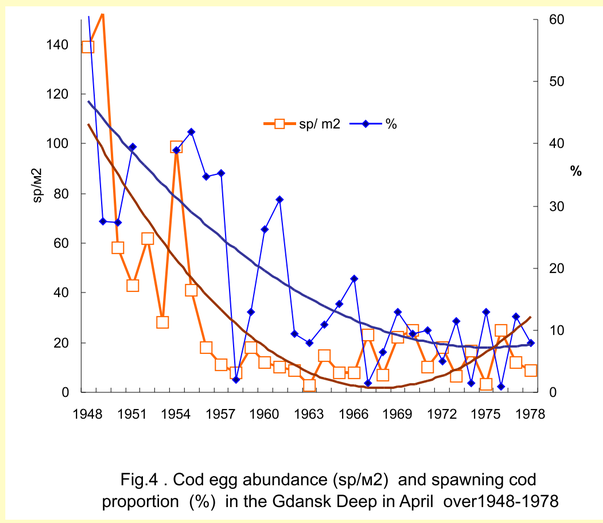

Fig.4 . Cod egg abundance (sp/м2) and spawning cod proportion (%) in the Gdansk Deep in April over1948-1978

Both mean cod egg abundance in ichthyoplankton and spawning cod proportion in April decreased from 1948 to 1978 (Fig. 4). From 1968 to 1978 cod egg abundance began to grow while spawning cod proportion in April continued to drop. It was a consequence of peak spawning shift to later timing.

Results

Over the second half of 20th century a high cod egg abundance evidencing an intensive cod spawning in the Gdansk Deep was observed twice: in 1948-1954 and 1969-1977 (Fig. 1, 2, 3). During the first of these periods individual cod eggs in ichthyoplankton occurred already in late January and to October inclusive. The mass spawning timing was recorded in April-June with a peak in May. This period was a hundred- year maximum of cod egg abundance in the Gdansk Deep. During the second period cod eggs occurred from March to October with a later peak abundance (May-August). Relatively weak and late spawning was observed in 1955-59 and 1995-2001, weak and early spawning, probably, took place in some of early 1960's.

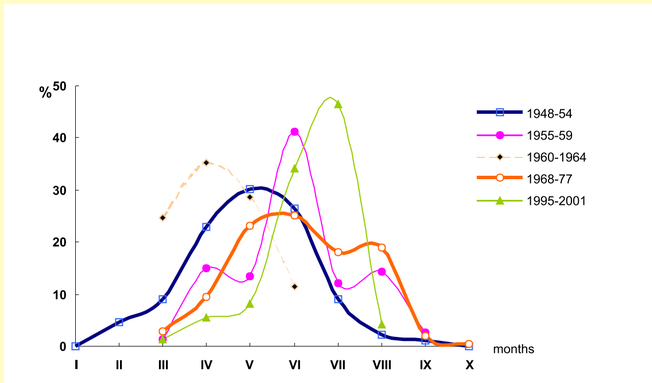

Fig. 3.The seasonal cod egg abundance variability (%) in the Gdansk Deep in different periods

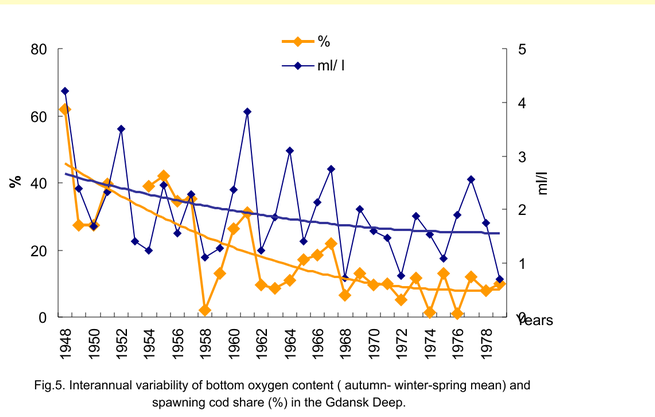

Fig.5. Interannual variability of bottom oxygen content (autumn- winter-spring mean) and spawning cod share (%) in the Gdansk Deep.

Since cod maturation seems to be a prolonged process covered late autumn- next year spring oxygen conditions in the bottom layer influencing on cod maturation can be characterized by mean value for autumn-winter-spring. Over 1948-1979 both oxygen content and spawning cod proportion tended to decline (Fig. 5).

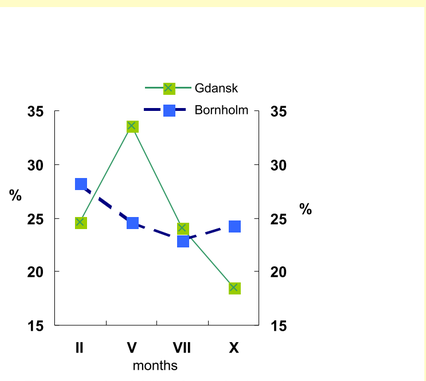

Fig.6. The seasonal variability of reproductive volume (%) in the Gdansk Deep and the Bornholm Basin

Seasonal dynamics of reproductive volume (RV) in the Gdansk Deep seems to be more pronounced stronger than in the Bornholm Basin (Fig. 6).

Discussion

A relative remoteness of the Gdansk Deep from the Danish Straits and accordingly later penetrations of water inflows (as compared to the Bornholm Basin) determine a stronger dependence of cod reproduction timing from interannual and seasonal dynamics of oxygen content and RV. A seasonal variability of cod reproduction can be classified as 4 situation types: 1) early intensive and prolonged spawning due to major inflows in beginning year and a long retention of high RV, 2) early weak spawning quite often occurring next year after inflows as result a rapid oxygen depletion from spring to summer, 3) relatively late intensive spawning due to late penetration of major inflows, 4) weak late spawning due to some improvement of ambient conditions in May-July owing to small spring-summer inflows . The oxygen deficiency in near-bottom layer obviously influences negatively maturation rate of the Baltic cod.

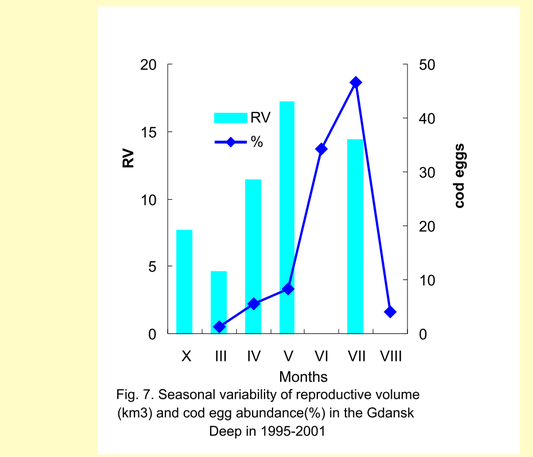

Fig. 7. Seasonal variability of reproductive volume (km3) and cod egg abundance(%) in the Gdansk Deep in 1995-2001

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RV seasonal maximums and minimums were observed in the Gdansk Deep later (May and October) as compared to the Bornholm Basin (February and August respectively). RVs in the Gdansk Deep in 1995-2001 were small with peak timing in May-July. Cod egg abundance was low for these years and characterized by the summer peak timing (Fig. 7).

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