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# Assessment of genetic risk in fishes inhabiting zones of dumped chemical munitions in the Baltic Sea

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**Extended Abstract:**
In the Baltic Sea, there are exclusive zones – the Bornholm zone, the Gotland Deep and the Little Belt Sea, where dozens thousands tonnes of chemical munitions (CM) were dumped after the Second World War. The goal of the study is assessing environmental genotoxicity levels in different fish species inhabiting dumped CM sites with the aim to assess genetic risk levels, integrating stress and fish population's health. Genotoxicity biomarker responses - formation of micronuclei (cytogenetic and DNA damage), nuclear buds (DNA damage), bi-nucleated cells with nucleoplasmic bridges (radionuclide effects), bi-nucleated, 8-shaped cells (alterations in chromosome segregation and cytokinesis), fragmented-apoptotic cells (elimination of cytogenetic damage) were analyzed in blood erythrocytes of flounder, dab, plaice, turbot, herring and Atlantic cod.

In the paper, we will present mainly data from the analysis of the environmental genotoxicity levels in flounder, plaice and herring inhabiting zones located close to the known CW dumping sites and in those areas, which potentially affected by warfare agents in the Polish economic zone. The monitoring of genotoxicity levels in flounder from southern Baltic Sea in the 2001-2010 period revealed the lowest values of the measured parameters in 2001-2004, and significantly increased response levels in fish collected in 2009 and 2010. Furthermore, in flounder from the Little Belt CW dumping area there were significant differences between induction of micronuclei (MN), nuclear buds (NB), fragmented-apoptotic cells (FA) also bi-nucleated (BN) and 8-shaped cells (cytotoxicity parameters; one way ANOVA). MN, NB and FA values significantly differ between flounder samplings of 2001-2010 in zone of the Bornholm CW dumping (P varied from 0.0271 to <0.0001, F – from 4.0357). Most extensive formation of nuclear buds was detected in all locations located closely to the warfare sites.

Little Belt site (B01) - results from Pearson correlation analysis did not showed any relationships between genotoxicity responses and environmental factors (depth, temperature, salinity, oxygen concentration and oxygen saturation) in 2001-2003. However in 2009-2010, the strong positive correlation was between formation of MN and water temperature ($r=0.978$, $P=0.022$). The frequency of micronuclei and nuclear buds exceeded the background level in all flounder specimens collected in August 2010, and the threshold and higher level of MN and NB (the genotoxicity biomarker responses) was observed in 75% of specimens. Therefore the study location could be attributed to highest genetic risk level where the fish health is altered in 75% of studied specimens.

Bornholm CW dumping area – despite tremendous increase of genotoxicity in 2009-2010, only in flounder from one station the negative correlation between NB and fish condition factor (r= -0.575, P=0.008) was defined. There was no correlation between genotoxicity parameters and environmental variables. The frequency of micronuclei and nuclear buds exceeded the background level in 90-100% flounder specimens collected in 2009-2010, and the threshold and higher MN and NB level was found in 40-80% of specimens. Therefore these study locations could be attributed to highest genetic risk level, where the fish health injures could be suspected up to 80% of studied specimens.

Polish economic zone – in November 2010 and February 2011, analysis of environmental genotoxicity was carried out in flounder, herring and plaice from 26 study stations. Fish from 10 stations were suspected as affected by warfare agents (these stations are located closely to the identified WG dumping sites). The background level of MN and NB was overwhelming in 40-100% of flounder, plaice and herring specimens, and the threshold level indicating fish health disturbances – in 50-100% of flounder specimens. These stations also can be characterized as high and extremely high genetic risk zones.

The main finding of the work was a significant increase of genotoxicity in 2009-2010, compared to 2001-2004, in fishes from the Bornholm Basin (up to 57-times) and the Little Belt (up to 17-times) CM dumping sites. GIS mapping of 2009-2010 data showed the highest level of genetic risk (responses over threshold level in 80-100% of specimens) in herring and flounder from 14 sampling stations in the Bornholm Basin and at station B01, located closely to CM dumping in the Little Belt. The discussion on ecological significance of genetic damage, characterized as long-term irreversible process, will be presented in relation to genetic risk for the wildlife populations.

Keywords: genotoxicity, fish, dumped chemical munitions, Baltic Sea

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