

## **Long-term trends for blue mussels from the German Environmental Specimen Bank show first evidence of munition contaminants uptake**

Strehse J.S., Bünning T.H., Maser E.

Institute of Toxicology and Pharmacology for Natural Scientists, University Medical School Schleswig-Holstein Campus Kiel, Kiel, Germany

Submerged munitions are present in marine waters across the globe. They contain energetic compounds (EC) such as TNT and metabolites thereof. EC may cause threats to the marine flora and fauna as well as human health even decades after the disposal. Several studies have shown that TNT and its metabolites are carcinogenic [1] and exhibit other acute and chronic toxic effects in a wide range of marine organisms [2]. The aim of our study was to investigate the occurrence and trends of EC and TNT metabolites in blue mussels from the annual collections of the German Environmental Specimen Bank (ESB) sampled in the North Sea and Baltic Sea over the last 30 years.

Blue mussels were sampled at three different locations – one at the coastline of the Baltic Sea and two in the North Sea region. The mussel homogenates were retrieved from the German ESB archive and lyophilized at the Fraunhofer IME. Samples were extracted in the lab and analysed by GC-MS/MS for their concentrations of the EC 1,3-DNB, 2,4-DNT, TNT, and its metabolites 2- and 4-ADNT.

While EC were not detected in blue mussels from any of the sampling regions before the year 1999, first signals indicating trace levels of 1,3-DNB were observed in the years 1999 and 2000 in samples from one of the North Sea regions. EC were also found below the limit of detection (LoD) in mussels from the other sampled regions in subsequent years. From 2012 onwards, signals just above the LoD, but below the limit of quantification (LoQ) were detected in blue mussels from one of the North Sea regions. In the other regions EC remained below the LoD for the subsequent years, with the exception in the years 2013, 2015, 2017, and 2019, where the LoD was just exceeded. The highest concentrations of 2-ADNT and 4-ADNT, just below the LoQ (0.14 ng/g d.w. for 2-ADNT, 0.17 ng/g d.w. for 4-ADNT), were measured in one of the North Sea regions in 2019 and 2020 [3].

This study clearly shows that corroding submerged munitions are gradually releasing more and more toxic EC into the waters; and that toxic EC can be detected in randomly sampled blue mussels. Even though the concentrations measured are still in the non-quantifiable trace range, it has been clearly observed that the concentrations and abundances of these EC are increasing. It can therefore not be ruled out that contamination will worsen in the coming years if the munitions are not removed from the seas.

### References:

[1] H.M. Bolt, G.H. Degen, S.B. Dorn, S. Plöttner, V. Harth. Genotoxicity and Potential Carcinogenicity of 2,4,6-Trinitrotoluene: Structural and Toxicological Considerations. *Rev. Environ. Health* 2006, 21, doi:10.1515/REVEH.2006.21.4.217.

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[3] J.S. Strehse, T.H. Bünning, J. Koschorreck, A. Künitzer, Long-term trends for blue mussels from the German Environmental Specimen Bank show first evidence of munition contaminants uptake. Manuscript accepted in *Toxics*