Bioassays in framework of a triad assessment method for brackish sediments

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1. Introduction

In sediment risk assessment, analysis of the pollutant concentrations is essential in determining the degree and nature of sediment contamination. However, chemical analyses provide no evidence of biological effects as, for example, mixture effects are not accounted for. Bioassays provide valuable information on the toxic effects of sediments, but are carried out under lab conditions and are limited to the testing of a few organisms. An evaluation of the benthic community structure can provide evidence of effects in situ [1,2]. The sediment quality triad method, which was developed by Long and Chapman in de mid-1980s [3] incorporates measures of various chemical parameters, toxicological effects and benthic community structure in view of conducting an integrated assessment of sediment quality [1]. In Flanders a triad method is being applied by the Flemish Environment Agency for the assessment of freshwater sediments [4]. Reference values for pollutants were defined for freshwater systems and the salinity tolerance of the bioassay test organisms is inadequate for application in the assessment of brackish and saline sediments. Moreover, brackish systems harbor naturally a lower diversity of macrofauna. Hence, an adapted triad method is needed for the assessment of brackish and saline sediments. The Scheldt estuary makes up the largest part of the brackish and saline aquatic systems in Flanders. Estuaries are among the most productive systems in the world, providing a wide variety of ecosystem services [5], while also subject to a wide variety of stressors such as industrial, transport and dredging activities, environmental pollutants and sediment contamination [6,7]. Hence integrated sediment risk assessment is of large importance for the sustainable management of these systems. In the framework of developing a triad assessment method for the quality evaluation of brackish sediments, 30 sediment samples were taken along the Scheldt estuary (Lower Scheldt (Flanders) and Western Scheldt (the Netherlands)) and other brackish aquatic systems in Flanders. For these samples, chemical variables (metals and organic pollutants), sediment characteristics (particle size, organic content), toxicological effects and benthic community structure are being assessed, of which the toxicological effects are discussed here.

2. Materials and Methods

Sediment mixture samples of six subsampels were taken from 30 locations along the Scheldt estuary (subtidal and intertidal) and other brackish aquatic systems in Flanders (e.g. canals, brackish polder streams, docks of the Port of Antwerp) in the period March-November 2015. Two sediment contact bioassays and a pore water bioassay were carried out to test their suitability for uptake in a quality triad method for brackish sediments as indicator of ecotoxicological effects. A 28-day sediment contact bioassay with the polychaete worm *Hediste diversicolor* was performed on a selection of the samples, with growth and mortality being evaluated. A 10-day sediment contact bioassay with the amphipod *Corophium volutator* and a 24h pore water test with the rotifer *Brachionus plicatilis*, evaluating mortality, were carried out on all the samples. *H. diversicolor* , *C. volutator* and reference sediment were collected at two locations at the Eastern Scheldt (the Netherlands). The pore water test with *B. plicatilis* was carried out with the bioassay Rotoxkit of Microbiotests Inc. Micropollutant concentrations (metals and organic micropollutants) and sediment characteristics (particle size, organic content) of the sediment samples were analyzed by the Flemish Environment Agency and the Port of Antwerp.

3. Results and Discussion

For the sediment contact tests observed mortalities varied between 0%-33% for *H. diversicolor*, between 1%-22% for *Corophium volutator* and between 10%-43% for *B. plicatilis*. Specific growth rate for *H. diversicolor* ranges from 3 to 4.3% day^{-1} (Figure 1). Control tests with reference sediment showed for the 3 tests mortalities lower than 10%, and for *H. diversicolor* an average growth rate of 5% day^{-1}. For the Scheldt estuary, the 3 tests showed significantly higher mortalities for sediments from the upper part of the estuary in the Sea Scheldt, which was characterized by higher levels of micropollutants, than for the lower part of the estuary (Western Scheldt). Chemical concentration data will further be evaluated and compared with existing Sediment Quality Guidelines to assess the expected potential of sediment pollutant concentrations to influence sediment toxicity, and compared with the bioassay results.

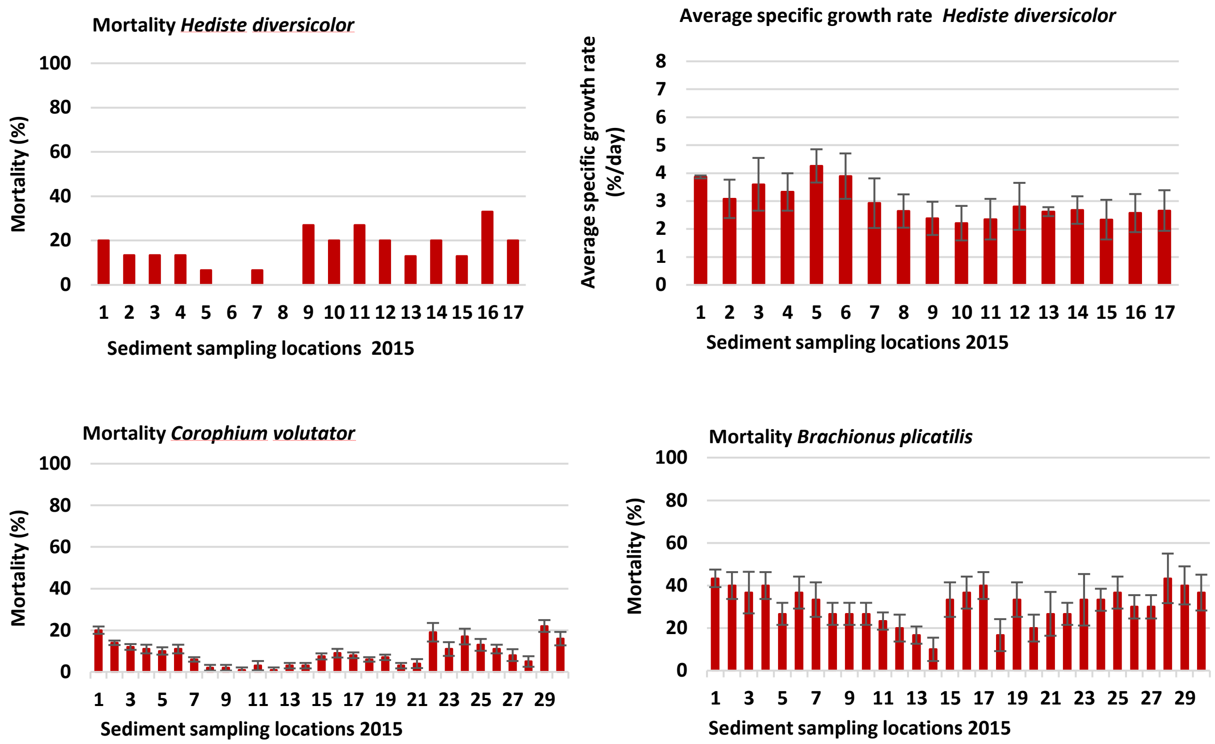

Figure 1: Results (mortality and growth) of the 3 sediment bioassays with H. diversicolor, C. volutator and B. plicatilis

4. Conclusions

The 3 performed bioassays show to be applicable for the ecotoxicological evaluation of brackish and saline sediments. A multivariate analysis of the micropollutant concentrations and ecotoxicological measures will need to determine the correspondence among the two components in more detail, to assess to what degree the bioassay results reflect the degree of chemical contamination in situ, and to possibly identify groups of micropollutants most associated with the toxic effects. Furthermore chemical concentration data and corresponding toxic effects will be evaluated and compared with existing Sediment Quality Guidelines.

5. References

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Acknowledgement - The authors thank the Agency for Innovation by Science and Technology (IWT), the Flemish Environment Agency and the Port of Antwerp for their contributions.