The combined effects of DOC and salinity on the accumulation and toxicity of copper in mussel larvae

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The biotic ligand model (BLM) is widely used to predict the toxicity of metals. There are two main principles underlying this model: 1) the concentration at the biotic ligand (BL) is directly related to the adverse effects and 2) the concentration at the BL depends on the dissolved metal concentration and the water chemistry. The latter determines the complexation of the metals with dissolved organic carbon (DOC), anions or other ligands and the competition of the metals with cations at the BL. However, recent studies indicate that in marine or estuarine environments, a changing salinity (ion concentration) can also affect metal toxicity by influencing the physiology of organisms.

The goal of the present study was: 1) assess the combined effects of DOC and salinity on the accumulation and toxicity of Cu in mussel larvae and 2) evaluate if these results are in agreement with the BLM principles. Mussel embryos were exposed to 9 different DOC/salinity combinations. For each combination a Cu concentration response curve was constructed and an EC50 for normal development was calculated. The internal Cu concentration and distribution in a subset of larvae from each DOC/salinity treatment was determined by synchrotron radiation X-ray fluorescence spectroscopy.

Cu in the larvae was homogeneously distributed. Both DOC concentration and salinity had a significant effect on the toxicity of Cu. The toxicity and accumulation of Cu decreased significantly when DOC concentrations increased. Salinity had a non linear effect on the Cu EC50 with a maximum EC50 at 28psu, while Cu accumulation increased with increasing salinity. This indicates that salinity does not only influence the water chemistry, but may also influence the physiology of the larvae. When relating the internal Cu concentration directly to the toxicity, no significant influence of DOC concentration nor salinity was detected. This result indicates that the critical body burden (CBB) concept might be a useful basis to predict copper toxicity, i.e. that the whole larval body could be considered as the BL. Concentration response analysis resulted in a CBB EC50 of 10.5µg $Cu.g^{-1}$ larvae. In conclusion, a larva can be regarded as a BL, in which the Cu concentration is directly related to toxic effects. In agreement with the BLM principles DOC reduces the accumulation and the adverse effect. However salinity influences both accumulation and toxic effects in a way that is not accounted for in classical BLM type models.