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Bioaccumulation and effect of sediment-associated silver in different forms in two marine deposit feeders

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Introduction

• Different behaviour and effects of metal-bearing nanoparticles (NPs) have been found compared to their corresponding metallic ions [1,2].

• Toxicity of metal-bearing NPs isn't easily predicted when comparing to corresponding ionic form

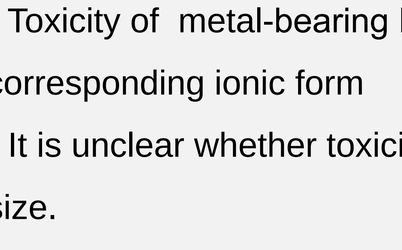
• It is unclear whether toxicity of metal-bearing NPs is dependent on particle size.

The aim of our study is to exam effects at the individual level by measuring typical endpoints in two organisms (i.e., a marine polychaete, ***Capitella teleta*** and a marine bivalve, ***Macoma balthica***) after exposure to sediment amended with different forms and particle sizes of Ag.

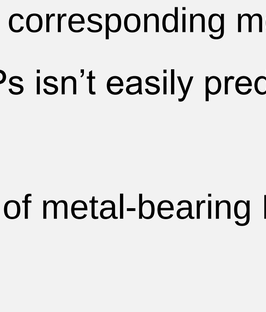
Hypothesis:

Toxicity and biota is metal form/particle size dependent?

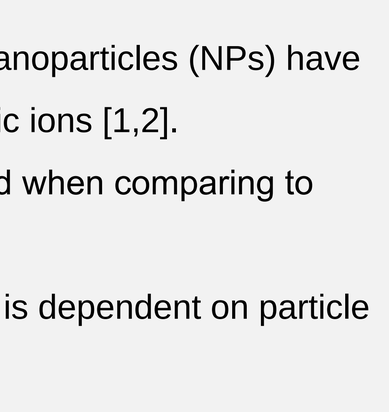
(Here are their relative differences in size)



Ion



Nano-particle



Micron-sized particle

Result – *Macoma balthica*

Toxicity

No negative effects were detected on mortality, condition index or growth of exposed clams for any Ag form (data not shown).

Bioaccumulation

Bioaccumlation of Ag in *M. balthica* decreased signifcantly with increasing particle size (One-way ANOVA, p = 0.03) **(**Figure 1).

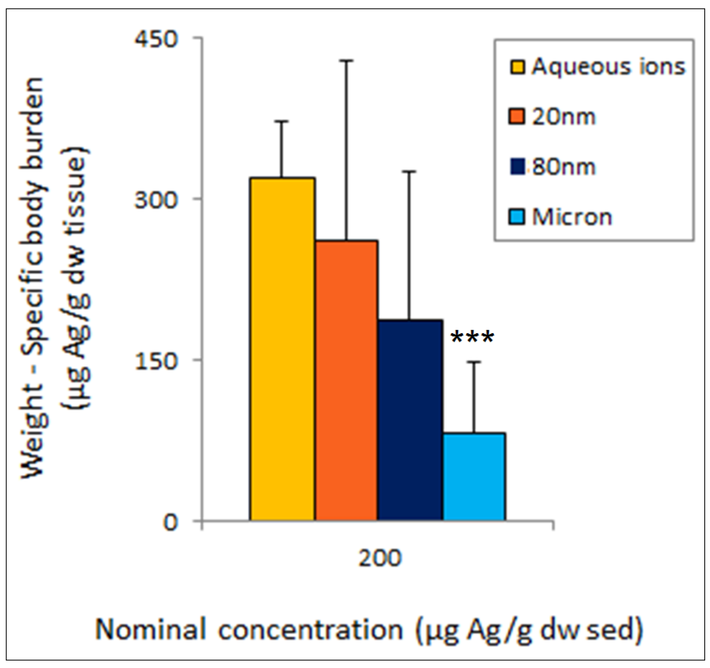
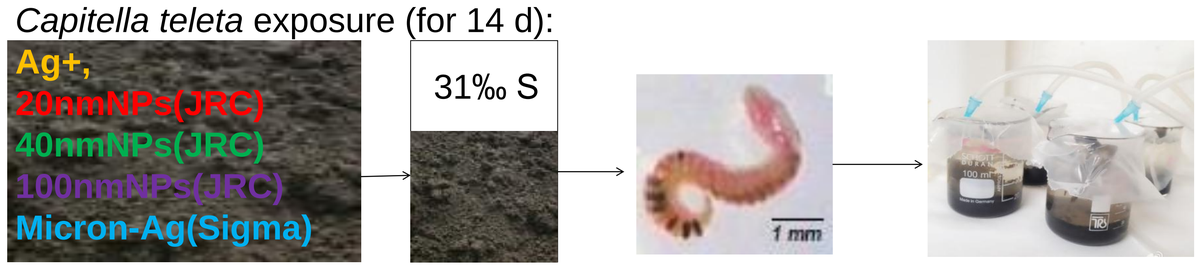


*Figure 1. Silver concentration measured in M. balthica exposed to a nominal conc. of 200µg/g dw sed.*** refers to a significant difference from ionic Ag. Error bars indicated 1 standard deviation (n=5).*

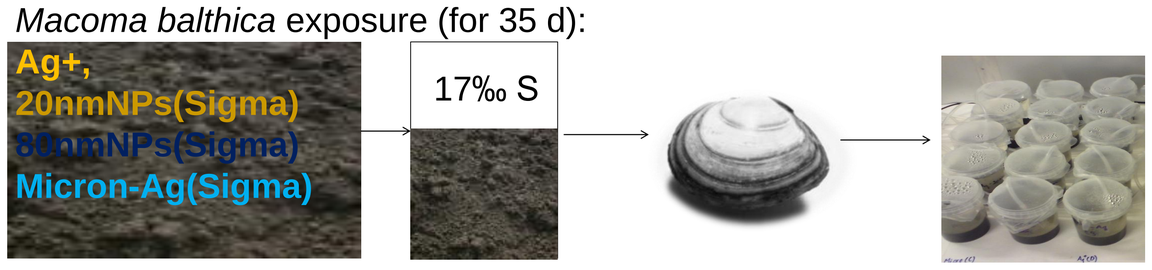
Reference
[1] García-Alonso J, Khan FR, Misra SK, Turmaine M, Smith BD, Rainbow PS, Luoma SN, Valsami-Jones E. 2011. Cellular Internalization of Silver Nanoparticles in Gut Epithelia of the Estuarine Polychaete *Nereis diversicolor*. Environ Sci Technol 45:4630-4636. [2] Cong Y, Banta GT, Selck H, Berhanu D, Valsami-Jones E, Forbes VE. 2011. Toxic effects and bioaccumulation of nano-, micron-and ionic-Ag in the polychaete, *Nereis diversicolor*. Aquatic Toxicology 105:403-411. [3] Cong Y. 2011. PhD thesis of 'Toxic effects and bioaccmulation of nano-, micron- and aqueous-Ag in the estuarine polychaete, *Nereis (Hediste) diversicolor*', Roskilde University.

Experimental design

Capitella teleta exposure (for 14 d):



Macoma balthica exposure (for 35 d):



Endpoints • Mortality • Growth • Health condition • Body burden

Result – *Capitella teleta*

Toxicity

No significant effects on either mortality or specific growth rate were detected for any Ag form or nominal concentration (data not shown).

Bioaccumulation

There was no significant effect of Ag form on Ag accumulation in *C. teleta*, although body burden increased significantly as a function of nominal concentration (One-way ANOVA, p < 0.001) **(**Figure 2).

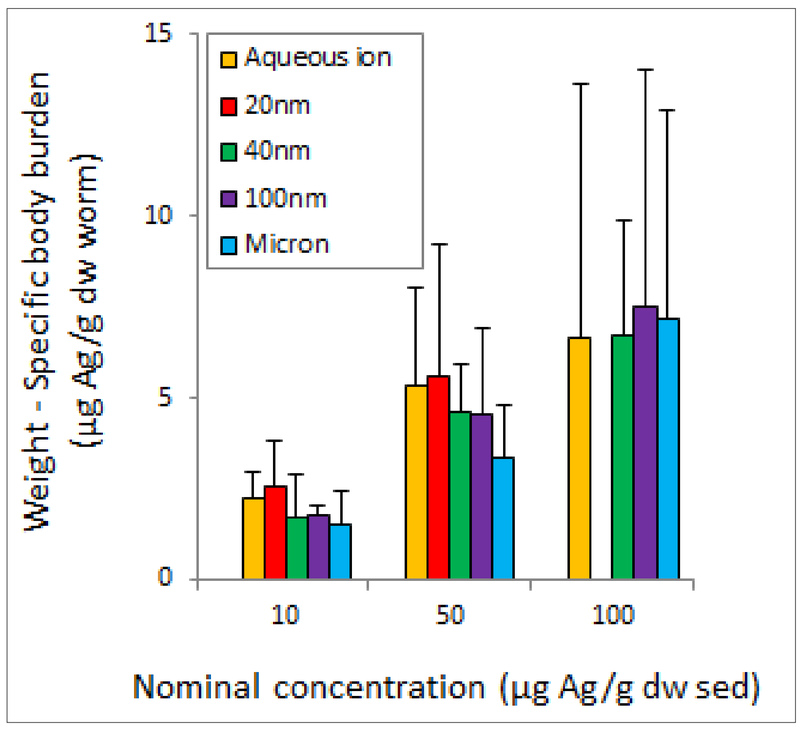


Figure 2. Silver concentration measured in Capitella teleta exposed to nominal conconcentration of 10, 50 and 100 µg/g dw sed. Error bars indicated 1 standard deviation (n=4). 20 nm-nanoparticle at 100µg/g dw sed nominal concentration was removed due to a significant difference in initial measured Ag concentration from the other treatments with the same nominal concentration at day 0.

Conclusions

• No significant effects on mortality and growth of *C. teleta* and *M. balthica*.

• All Ag forms are bioavailalble to both organisms.

• Metal form/particle size dependnence of bioavailability is species specific, possibly due to differences in:

  • gut structure, thus

  • particle sorting mechanisms

Such differences in the bioavailability of metal-bearing particles warrant further investigation and consideration in terms of the impact of them in sediment environments.

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