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Digestive solubilization of nanoparticles by a model terrestrial invertebrate *Porcellio scaber*

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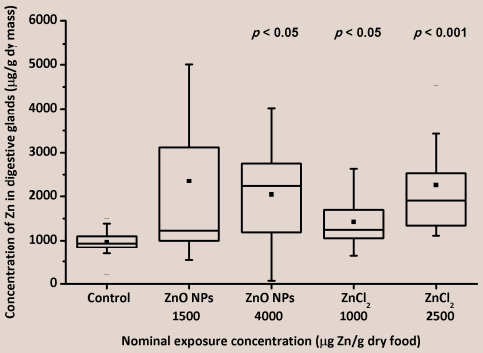
Background: when exposed to metal/metal oxide (Cu, Ag, ZnO) nanoparticles (NPs) or corresponding metal salts, terrestrial isopods *Porcellio scaber* assimilate similar amounts of metals in their digestive glands.

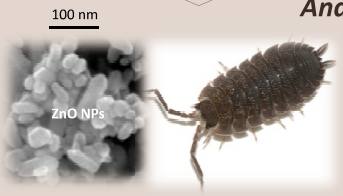


Phenomenon: mass balance calculations show that the amounts of metals assimilated from NPs by *P. scaber* are higher than the ones initially consumed with the NP-spiked food. ?

NPs in particulate form are not assimilated. !

Example: results from a feeding experiment with *P. scaber* exposed to ZnO NP-spiked or $ZnCl_2$-spiked hazelnut leaves for 14 days.

Indices from the literature: digestive juices from representatives of various invertebrate taxa (Cnidaria, Mollusca, Annelida, Echinodermata, Echiura, Sipuncula, Priapulida) solubilize metals bound in soil and marine sediments by complexation with proteins and surfactants.



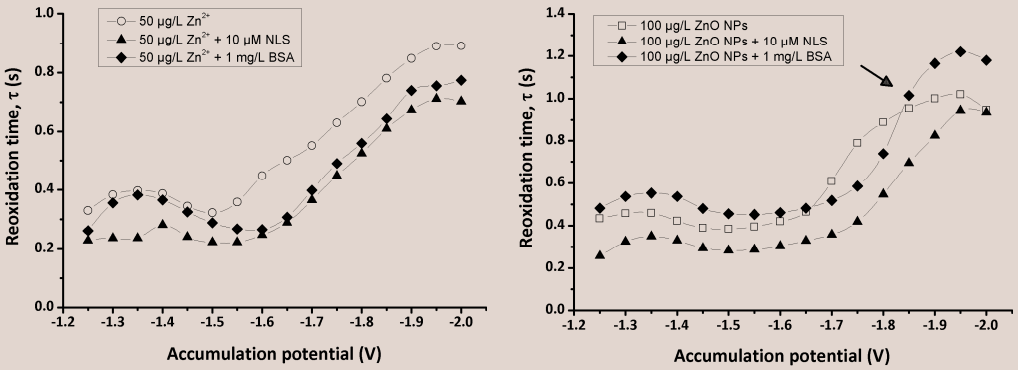
Do NPs dissolve in contact with *P. scaber* digestive juice?

Analysis of P. scaber digestive juice composition

- Total protein concentration: **≈ 300 mg/mL** (BCA Pierce protein assay)
- Total surfactant concentration: **≈ 9 mM** (surfactant ion-selective electrode)
- Critical micellar concentration: **≈ 90 µM** (pyrene fluorescence intensity method)

EXAMPLE OF Zn^{2+} IONS AND ZnO NPs

P. scaber digestive juice was modeled with **bovine serum albumin** (BSA) and a **commercial surfactant**, sodium N-lauroylsarcosine (NLS). Speciation of Zn^{2+} and ZnO NPs in the presence of NLS and BSA was tested with an electrochemical method, namely **scanning stripping chronopotentiometry** at *in-situ* bismuth film electrode.



A shift towards more negative potentials denotes the existence of metal complexes. τ is proportional to the degree of complex lability.

SSCP measurements were performed in the supporting solution consisting of 500 mg/L Bi, 10 mM PIPES buffer and 10 mM KNO_3, with pH adjusted to 6.5 (as in the *P. scaber* hindgut).

CONCLUSION: In contact with ZnO NPs, NLS reduces and BSA enhances the (electro)lability of Zn^{2+}.

SPECULATIONS: Proteins (but not surfactants) in the digestive juice of *P. scaber* may cause the dissolution of ingested NPs by complexation and etching of surface atoms. However, surfactants may enhance the dispersion of NPs *via* steric stabilization and/or incorporation into micelles and consequently increase the NP surface exposed to complexation by proteins.

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