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Uptake and effect of nano- and ionic gold on the polychaete, *Capitella teleta*

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Introduction

The fate and effects of engineered (produced or manufactured) nano-particles (ENPs, d<100nm) have received a lot of attention due to their rapidly increasing production and application. Compared to metals in conventional forms, metal ENPs may be different in their fate and toxicity in the aquatic environment.

① **Fate**: The smaller particle size and higher reactivity may lead to uneven dispersion and aggregation of ENPs as well as association, flocculation and sedimentation with natural organic matter in the aquatic environment.

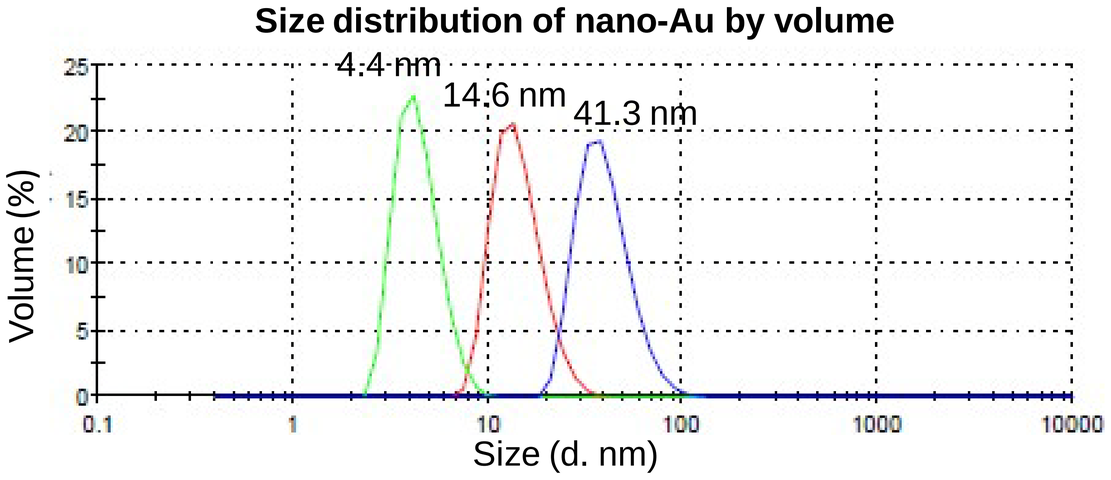
② **Toxicity:** We hypothesize that toxicity of metals for deposit feeders to be particle size dependent.

However, studies of the bioavailability of metal ENPs in the aquatic environment are limited and their toxic mechanisms in aquatic invertebrates are not yet clearly understood.

Experimental setup

4 forms of gold added to sediment (0, 50 and 100µg/g dw sed)

- Mortality and growth were detected on day 14.



Particle size distributions were measured on a Malvern Zetasizer Nano ZS instrument. The measured size distributions (intensity and volume basis) show peak maximums at 4.4, 14.6 and 41.3nm (volume basis)-all Au NPs were synthesized and characterized by JRC.

Aims

To test whether the bioavailability and the toxicity of Au nano-particles are dependent on size.

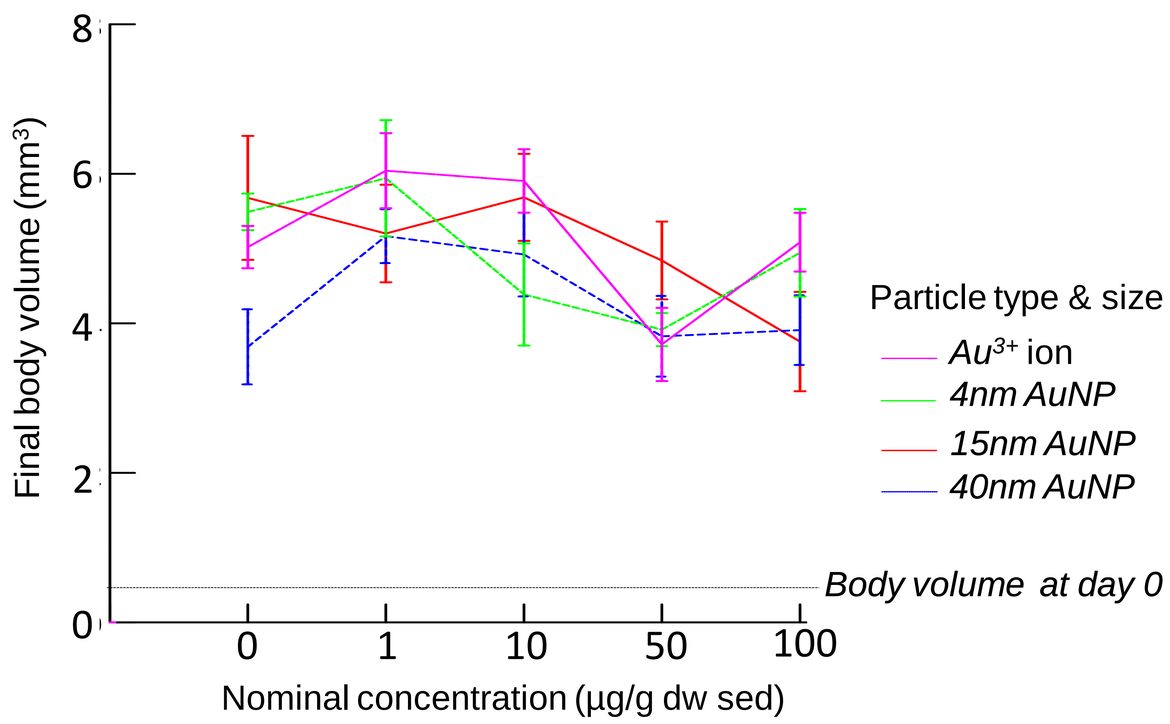
Three different nano-sized Au particles were selected. In addition, the ionic Au^{3+} form was also tested to gain insights into the uptake and toxicity mechanisms of nano-sized Au.

Results-Toxicity

1.Mortality: no significant mortality was observed (data not shown) as a function of either particle size or exposure concentration.

2.Growth: worms from all treatments had positive growth. The concentration-response curves were not monotonic, however, and there were no significant effects of either Au concentration or Au form (i.e., 4nmAuNP, 15nmAuNP, 40nmAuNP and Au3+ ion) on growth rates.

Growth of *C. teleta* after 14 days exposure



Results-Bioavailability

Table 1. Primary bioavailability of Au by *C. teleta* (n=1) at exposure concentrations based on per worm. Quantification limit=4ng/g dw tissue.

Particle	Nominal conc.*	Bioavailable Au¶	Accumulated Au¶	Egested Au¶
Au^{3+} ion	50	3.2	0.16	1.5
4nm AuNP	50	3.8	NQ	1.2
15nm AuNP	50	2.3	0.01	0.6
40nm AuNP	50	3.5	0.06	0.8
Au^{3+} ion	100	6.7	0.30	3.0
4nm AuNP	100	6.0	NQ	2.1
15nm AuNP	100	7.0	NQ	2.3
40nm AuNP	100	7.0	NQ	1.7

•Unit of **Nominal conc.** is µg Au/g dw sed. ¶ Units are µgAu/worm. **NQ**: under quantification limit. **Bioavailable Au**: pooled 10 replicates. Since no data yet on the actual Au conc. in sediment at start and end of the experiment. Therefore, interpretations are based on nominal conc.. **Egested Au**: pooled 3 replicates data. It was measured in fecal pellets of *C.teleta*.

1. Accumulation highest from ions which is reflected in the accumulated Au in per worm;
2. NP was egested less than ionic form of Au into fecal pellets.

Conclusions

Nano Au particles are bioavailable to *Capitella teleta*, though seemingly less so than Au^{3+}. Neither particle-size dependent nor concentration dependent lethal or sub-lethal effects of Au were observed in the selected concentration range.

What's next...

A mass balance budget will be estimated based on the fate and concentrations of Au in different compartments (i.e., fecal pellets and un-ingested sediment) after 14 days.

Experiment will be optimized in worm tissue rinsing at collection date and Au analytical quantification method.

May, 2010