NanoFATE Deliverable 5.5

Research manuscripts on the toxicokinetics of ENP; addressing uptake into biological tissues of aquatic and terrestrial invertebrates.

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Research Report Summary

D5.5 deliverable consists of a collection of 6 manuscripts that covers bioaccumulation of ENPs and their respective ionic counterparts in biological systems. Bioconcentration Factor (BCF) values and -when possible- uptake (k1) and release (k2) constants were determined according to various mathematical models including the one- compartment model. These studies were carried out on several and distinct biological systems that differ from each other for both structural/mofprohological features and/or their ecological niche: unicellular algae, springtails, daphnids, terrestrial detritivores (Eisenia spp) and marine filter feeding bivalves (Mytilus spp). In general, it appears that ionic forms are accumulated to greater extent than ENPs, however, the emerging picture is rather heterogeneous. Higher BCF values for ions were observed in earthworms exposed to cerium (ms # 4), but less clear effects for silver were envisaged, possibly due to metal speciation in the environment (ms # 3). In springtails, higher ionic BCFs were explained by longer k2 values for silver ENP exposures (ms # 1). In algae, conversely, greater BCF values depend on k1, while k2 does not differ significantly (ms # 2). However, in bivalve molluscs (ms # 5) -taking carefully into account the actual silver dose- the BCF value of ionic silver and those of two different Ag ENP types were very similar. It is likely that feeding strategy is a driving parameter in this sense.

Regarding the ability of tracking nano- objects within cells and tissues, much has been done within the nanoFATE framework in which numerous imaging techniques were experimented. A review of these techniques is presented in ms # 6. Results obtained by means of Coherent Anti-stroke Resonance Spectroscopy (CARS) imaging in algae show virtually no uptake of ENPs in osmotrhrophic eukaryotes (ms # 2). Manuscripts 3 and 6, instead, show interesting applications of X-ray absorption spectroscopy in samples (thick tissue sections of earthworms) irradiated by synchrothrone light. Results do show near edge Ag absorption that is a signature of focal Ag distribution into tissus and might be compatible with the internal presence of ENPs (ms # 3). Moreover, quantitative modelling of X-ray Absorption Near Edge Spectrosocpy (XANES) profiles indicate thats the Zn atomic centres within the matrix of the focal deposits imaged in epidermis and nephridium of earthworms exposed to ZnO ENPs are associated with oxide, a chemical phase distinguishable from the phosphate-associated Zn pool in the chloragogenous tissue (ms #6).

NanoFATE is supported by the European Commission under the Seventh Framework Programme. Theme 4: NMP – Nanosciences, Nanotechnologies, Material and new Production Technologies and Theme 6 – Environment (including Climate Change). Gant Agreement no. CP-FP 247739 NanoFATE

Manuscript list

#	*Organism*	*ENP*	*Kinetic parameters*	*BCF*	*Imaging*	*Leading Beneficiary*	*status*
1	Collembola	Ag	X	X		VUA	submitted
2	Algae	Ag	X	X	X	UA	submitted
3	Earthworm	Ag	X		X	NERC/CU	submitted
4	Earthworm	Ce	X	X	X	NERC	submitted
5	Bivalves	Ag		X		UNIPMN	completed
6	Earthworm	Zn			X	NERC/CU	submitted

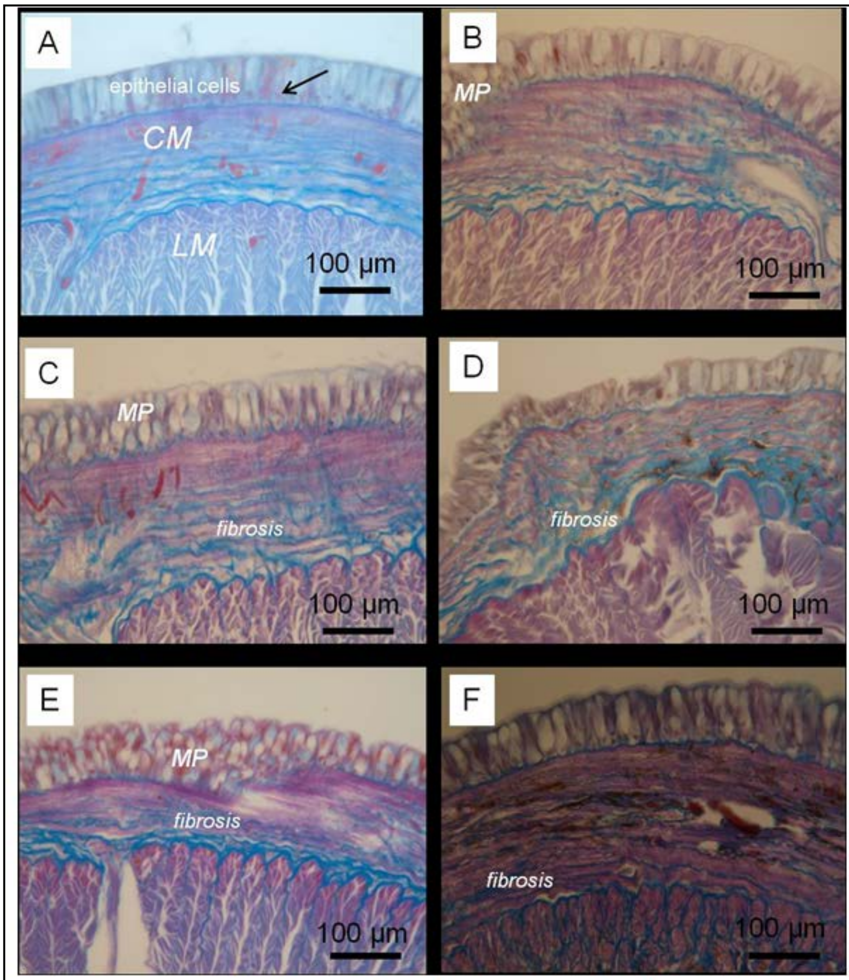

Figure 4: Transverse sections of segments from the anterior region of earthworms exposed to CeO_2 particles (10,000 mg Ce kg-1) and cerium salt (41 mg Ce kg-1): (A) Control (B) CeO_2 (100-300 nm), (C) NM-212 CeO_2 (10-80 nm), (D) NM-211 CeO_2 (10-50 nm), (E) Envirox CeO_2 (5-20 nm) and (F) cerium salt. Controls show normal morphology of the epidermis and underlying muscles (CM, circular muscle, LM, longitudinal muscle), but with some granular lipofuscin-like material in some specimens. Note the normal vesicular activity of the columnar cells (black arrow). Note the erosion of the epithelium in the cerium treatments, often with mucocyte proliferation in the epidermis (MC), fibrosis and diffuse loss of architecture in the circular muscle. Magnification X400.

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March, 2014

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