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US-EU CoR Meeting, Arlington, USA, December 2013

Ecotoxicology and Predictive Models; Summary of Discussions on 2nd December 2013

Chair: Richard Handy (Plymouth, UK)

Rapporteur: Elijah Petersen (NIST)

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Ecotoxicology Progress - What's New?

- Soil organisms and ecosystem services
  - Need more work on ecologically-relevant soil microbes.
  - Earthworms: life long sub-lethal pathologies, but with not much genomic or biochemical change.
  - Mesocosm studies: plant biomass and soil functions are altered.
- Aquatic invertebrates
  - Altered development and toxicity to marine larvae/planktonic stages.
  - More understanding of particle behaviour in marine systems.
  - More marine/freshwater mesocosm studies needed.
- Fishes and amphibians
  - Effects on unexposed off spring (Zebrafish)
  - Amphibian data set remains small. UV effects?
  - Animal behaviour: neurotoxicity may or may not translate into an effect locomotor behaviours (consider bioenergetics).
- Lots of data gaps on vertebrate species.

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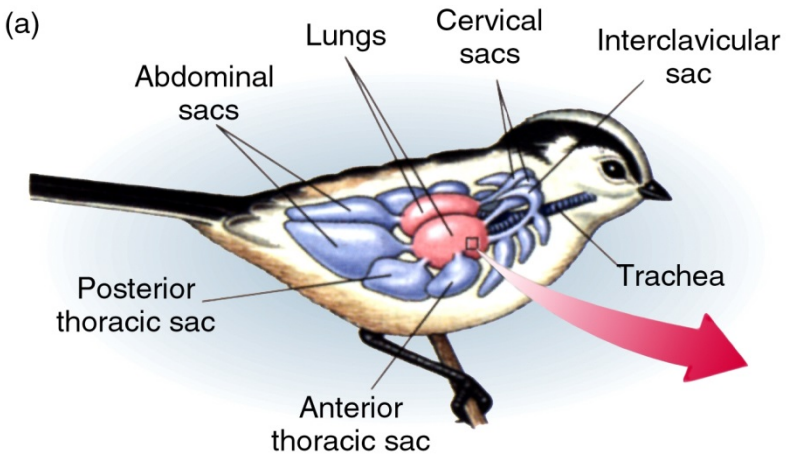
Knowledge Gaps on Species



US – EU
Bridging nanoEHS research efforts

Ecotoxicology Testing COR

Panel Discussion

Assessing Bioavailability and Toxicity in Soils and Sediments

Panelists (present and virtual)

- Richard Handy, University of Plymouth
- Elijah Petersen, National Institute of Standards & Technology
- Claus Svendsen, Centre for Ecology & Hydrology
- Teresa Fernandes, Heriot-Watt University
- James Ranville, Colorado School of Mines
- Henriette Selck, Roskilde University

Discussion Points

- media effects, natural vs artificial, pore water, etc.
- exposure duration/ageing and concentration,
- identification of sensitive endpoints,
- potential for long term effects,
- standardizing test methods,
- identification of artifacts,
- how dosing is performed (settling onto sediments, mixing, etc.),
- quantification methods especially for carbon nanomaterials; and use of single particle ICP-MS.

Media Effects; Reflections on the original purpose of soil/sediment tests

- Originally with pesticides/agrochemicals in mind.
- Differences between chemicals and nanoparticles can impact applicability of standard test methods.
- Example of ranking nanoparticles as compared to those for similar dissolved metals.
- Effects may be material-specific and the soil properties also impact on particle behaviour. Example of dissolution of ZnO.
- Ranking nanoparticles is important and may be best conducted by standardized test media (reference soils and sediments) but studies using natural soils and sediments with additional properties are important for modeling.

Media

- The factors that alter nanomaterial toxicity are not necessarily the same as traditional chemicals.
- The assumptions/logic may also be different.
- Pore water concentrations may not be an indicator of bioavailable or toxic fractions of NPs. Zn- pore water concentration goes up over time, while toxicity decreases.
- Simple soil/sediment tests may not be enough for risk assessment.
- More in depth testing similar to pesticide evaluations.

Artifacts in soil/sediment tests

- Nutrient depletion due to adsorption.
- Mixing/dosing method effects on test results.
- The robustness of the test protocols for nanoparticles are not necessarily well understood.
- Critical aspects of the test method that might have the biggest effect on the results not really identified systematically.

Sources of variability/uncertainty in current test methods

- The dosing method and exposure protocol.
- Heterogeneity of the soils or sediments.
- Use of own soil/sediments.
- Complaints about artificial or reference soil/sediment recipes not being suitable for test organism.
- Artificial media “not fit for purpose” and need to derive a new one for nano.

Metrics for Exposure

- The pore water may be challenging to measure for NPs and may not be the most important metric.
- Measure the concentration in the organism.
- Ecological relevance and regulatory need.
- Agreed that providing information about the internal concentration in the organism is definitely desirable.
- Single particle ICP-MS discussion for detecting particles in the organism, and in fractions from the gut/external media.
- Nanoparticle characteristics and the complexity of the digestive tract of the organisms. There were some impacts on feeding rates for some nanoparticles.
- Feeding behaviour and biology as a factor. Selection of particle sizes by the organism.

Time and “Ageing” Effects

- Increasing toxic effects with aging as a result of increased dissolution with time.
- This contrasts to what is observed with metals.
- Dissolution of AgNPs and ZnO is substantially slower in soils as compared to water.
- Time matched controls, but need to understand particle-specific aspects of ageing.
- Test duration – OK?

Recommendations

- Comparison of different metrics for ecological endpoints in future studies.
- Long term effects; thoroughly characterize test media for informatics evaluations.
- spICPMS method for body burden in the test organism, and potentially as a tool to explore particle behaviour in test media/extracted fractions from organisms.
- The original OECD test may not be “fit for purpose”. New recipe for reference soil/sediment.
- Next CoR meeting?
  - SETAC meetings in North America and Europe
  - 9th International Conference on the Environmental Effects of Nanoparticles and Nanomaterials (USA)