

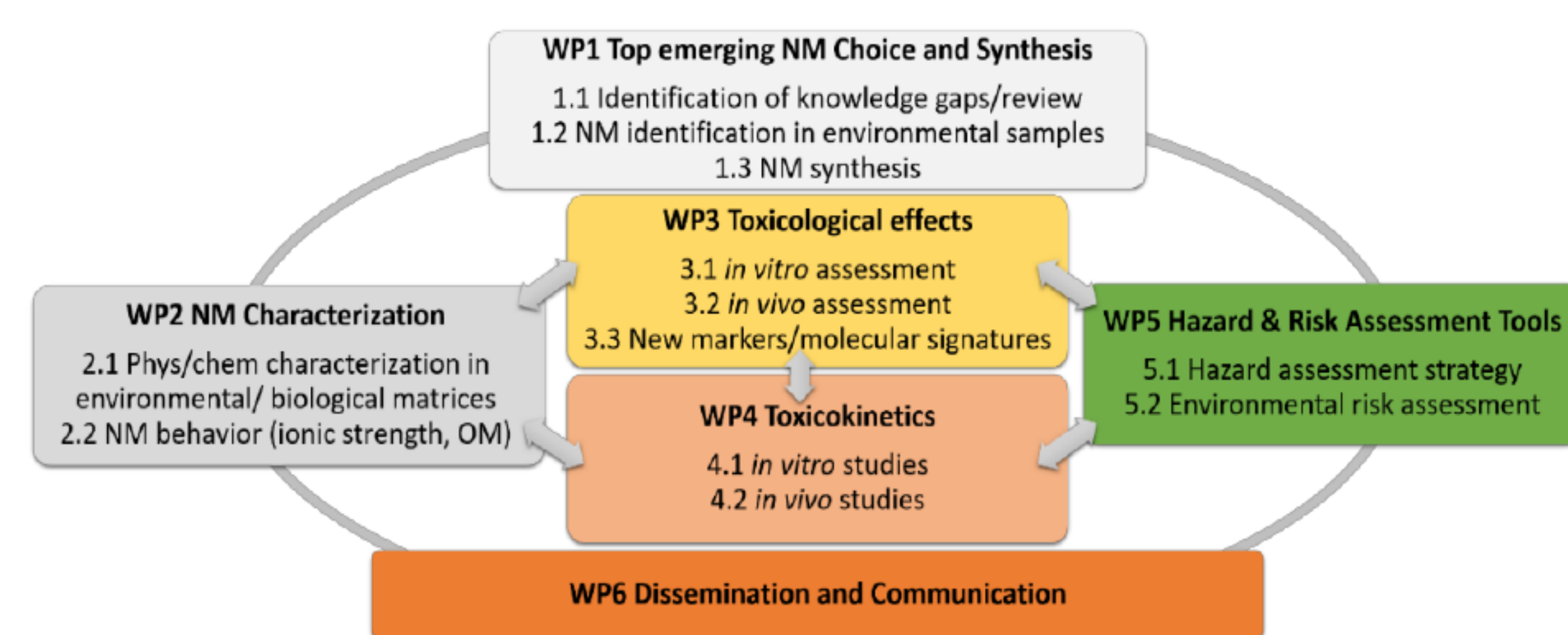
# Toxicity of the New Emerging Nanomaterials LDH and MoS<sub>2</sub> to Aquatic Organisms: First Results from the Project SCANNER

## Background

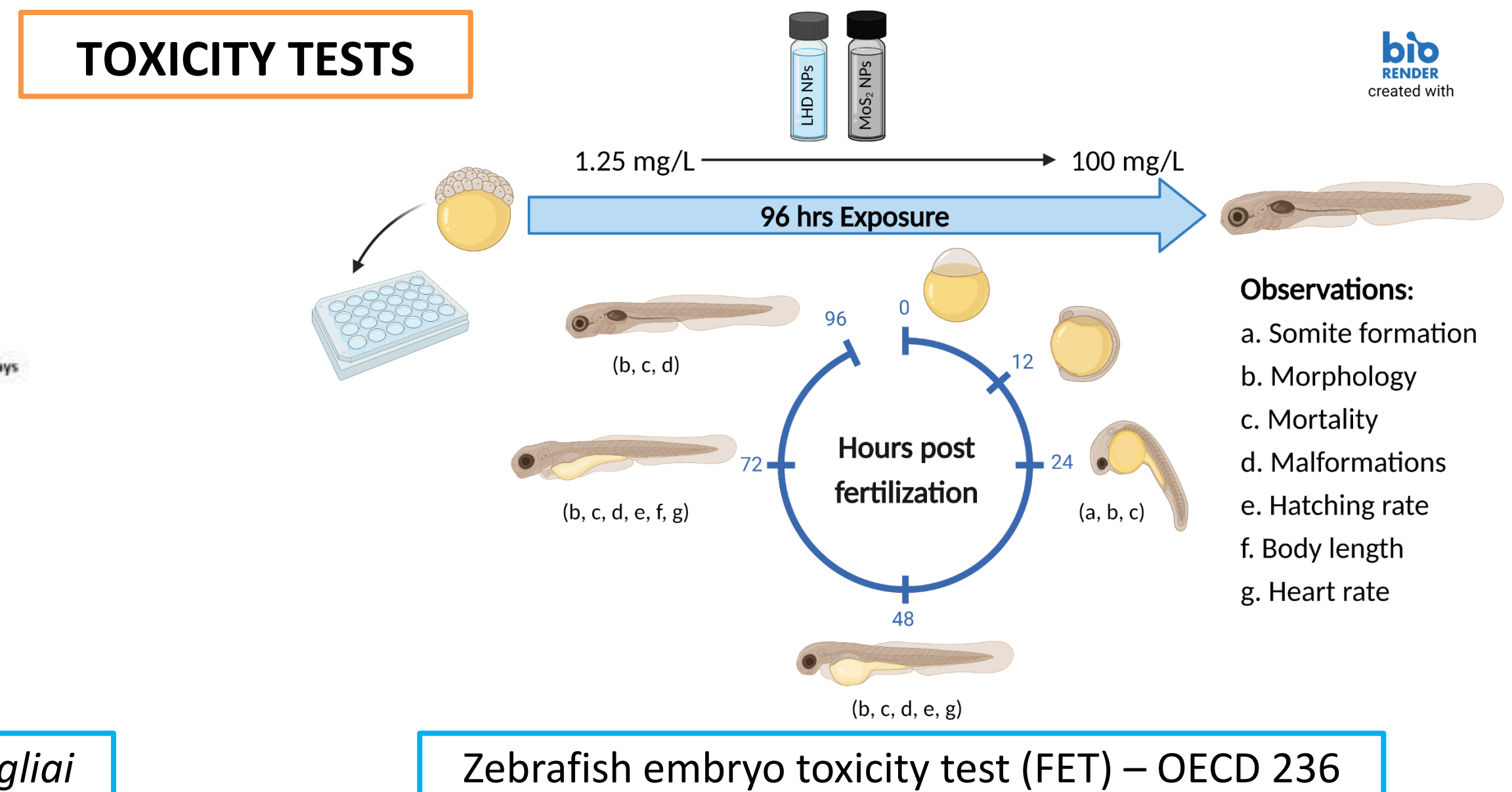
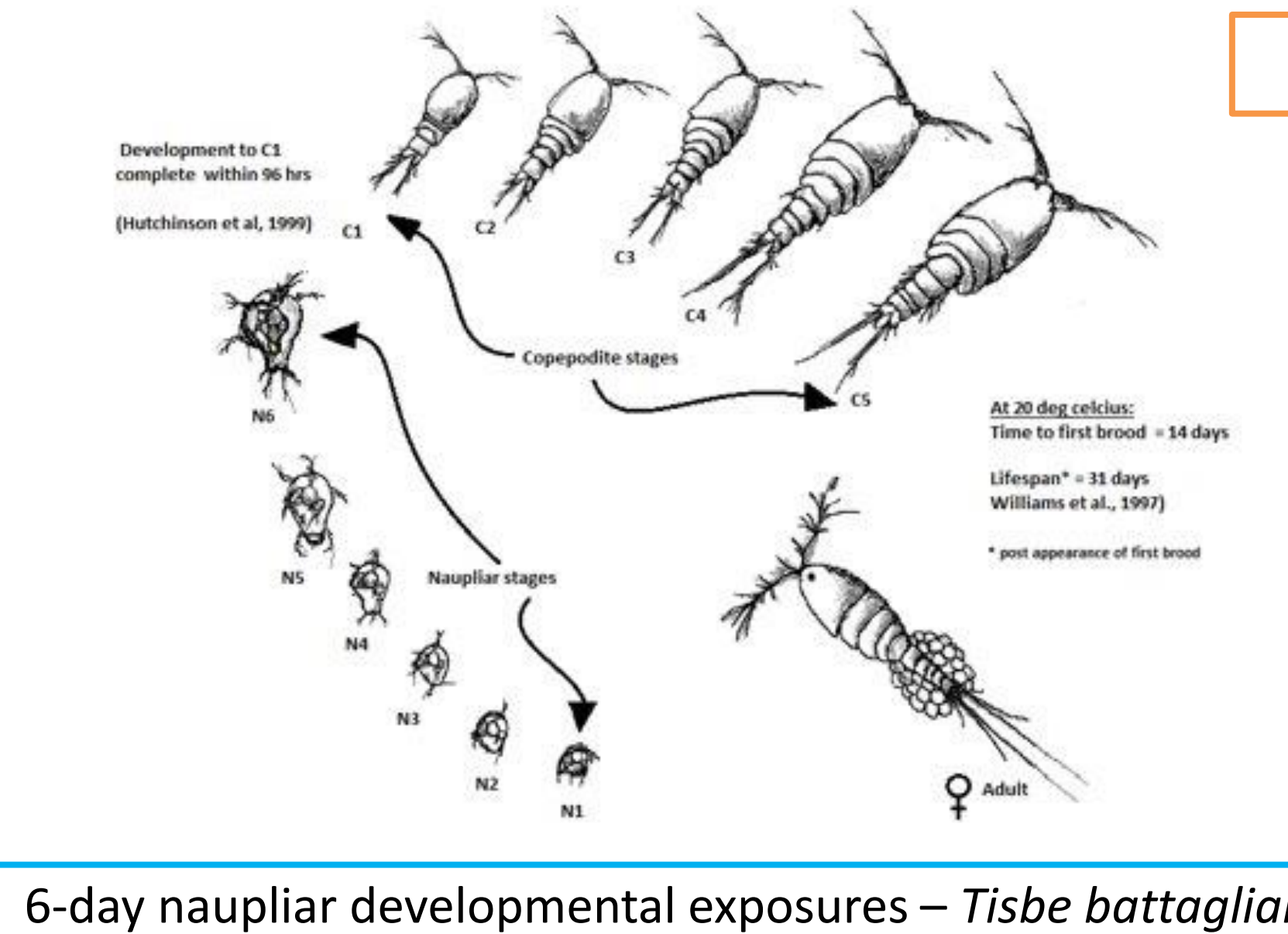
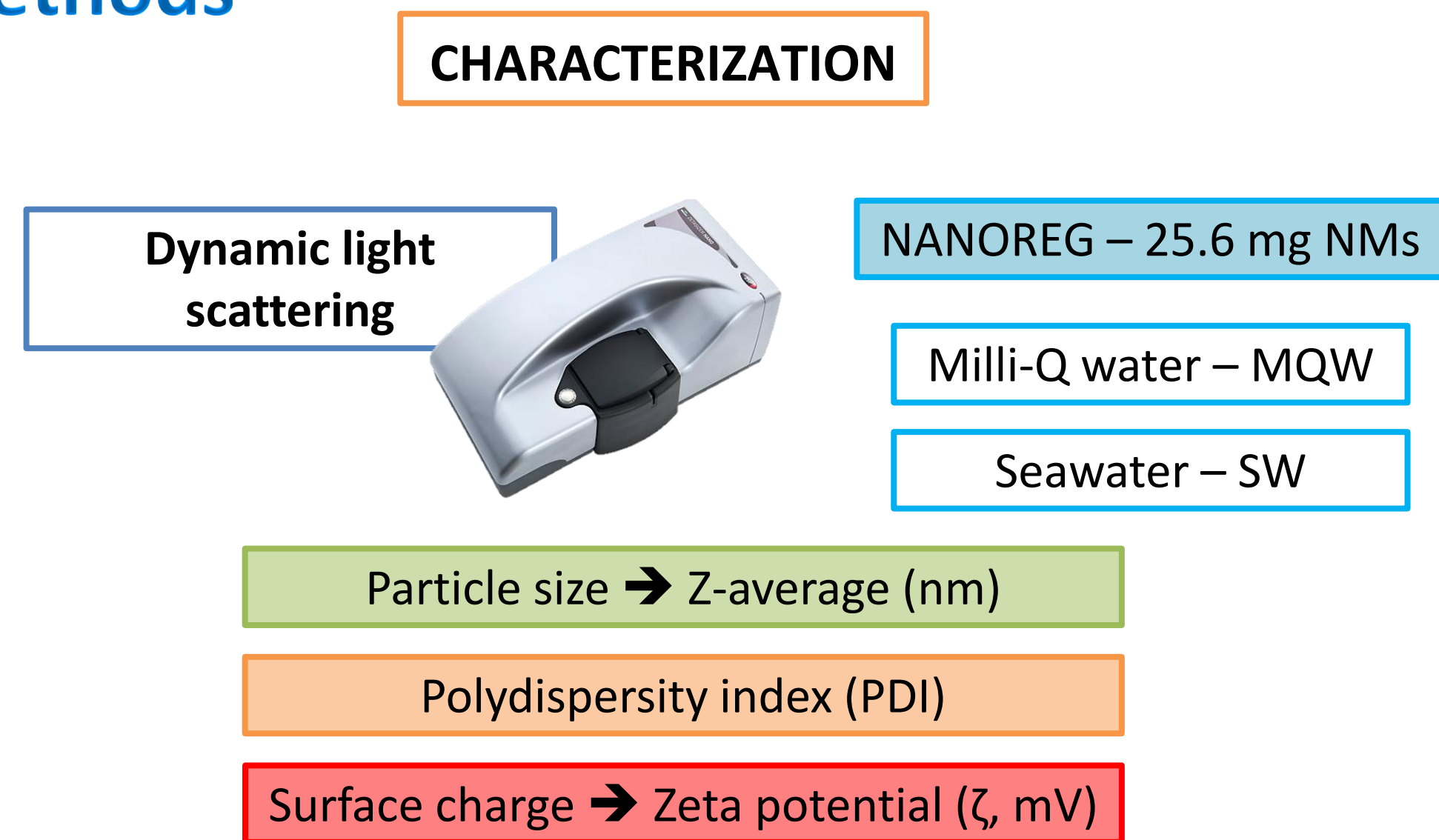
SCANNER is a 4-year collaborative project between India and Norway focusing on the development of tools for hazard and risk assessment of new emerging Nanomaterials (NMs). Initially, the partners identified two NMs of interest, Layered double hydroxides (LDH) and Molybdenum disulphide (MoS<sub>2</sub>). The Indian partners were responsible for synthesizing the NMs and supplying them to the partners to be used in *in vitro* and *in vivo* studies to understand the impacts on human health (India) and the environment (Norway). SCANNER aims to conduct controlled exposure experiments to obtain detailed knowledge on the mode of action (MoA) and effects of NMs under realistic environmental conditions (on humans, freshwater (FW) and marine species). Characterisation of behavior of NMs in various exposure media is conducted alongside the various assays. A battery of effect-based tools from cells (both human and fish) to organism level (e.g. copepods, mussels, oysters, chironomids, amphipods, zebra fish embryos (FET)) are being applied to assess MoA and to identify new effect biomarkers. The bioavailability, uptake and transport mechanisms of NMs will also be studied (cell, tissue and organism level). The data generated will be integrated into a hazard and risk assessment approach that can be used for NMs.

## Objectives

- Develop tools for hazard and risk assessment of NMs relevant to the Norwegian and Indian environments.
- Identify knowledge gaps and emerging NMs in India and Norway – LDH and MoS<sub>2</sub>.
- Synthesize selected NMs, followed by physicochemical characterization to elucidate behaviour in environmental samples and biota.
- Study impacts of NMs using *in vitro* and *in vivo* assays, establish dose-response relationships and aquatic life criteria. Evaluate acute, chronic and sublethal effects and modes of action and identify new toxicological markers for NMs exposure and effect.
- Toxicokinetics: characterize and quantify uptake, accumulation and elimination of NMs at the cell, tissue and organism level.
- Integrate physical, chemical and biological descriptors to develop human health and environmental risk assessment models for safer use of NMs.



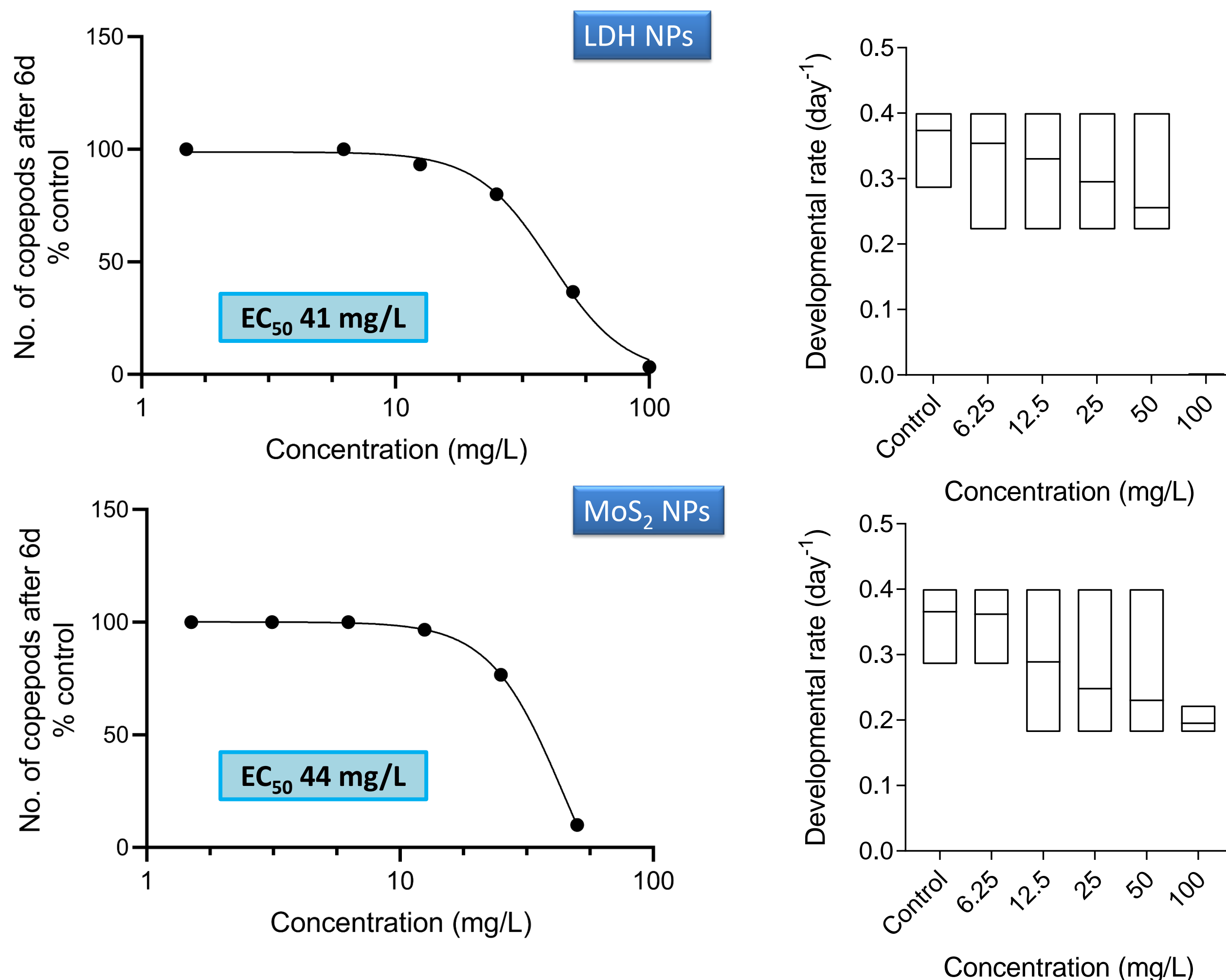
## Methods



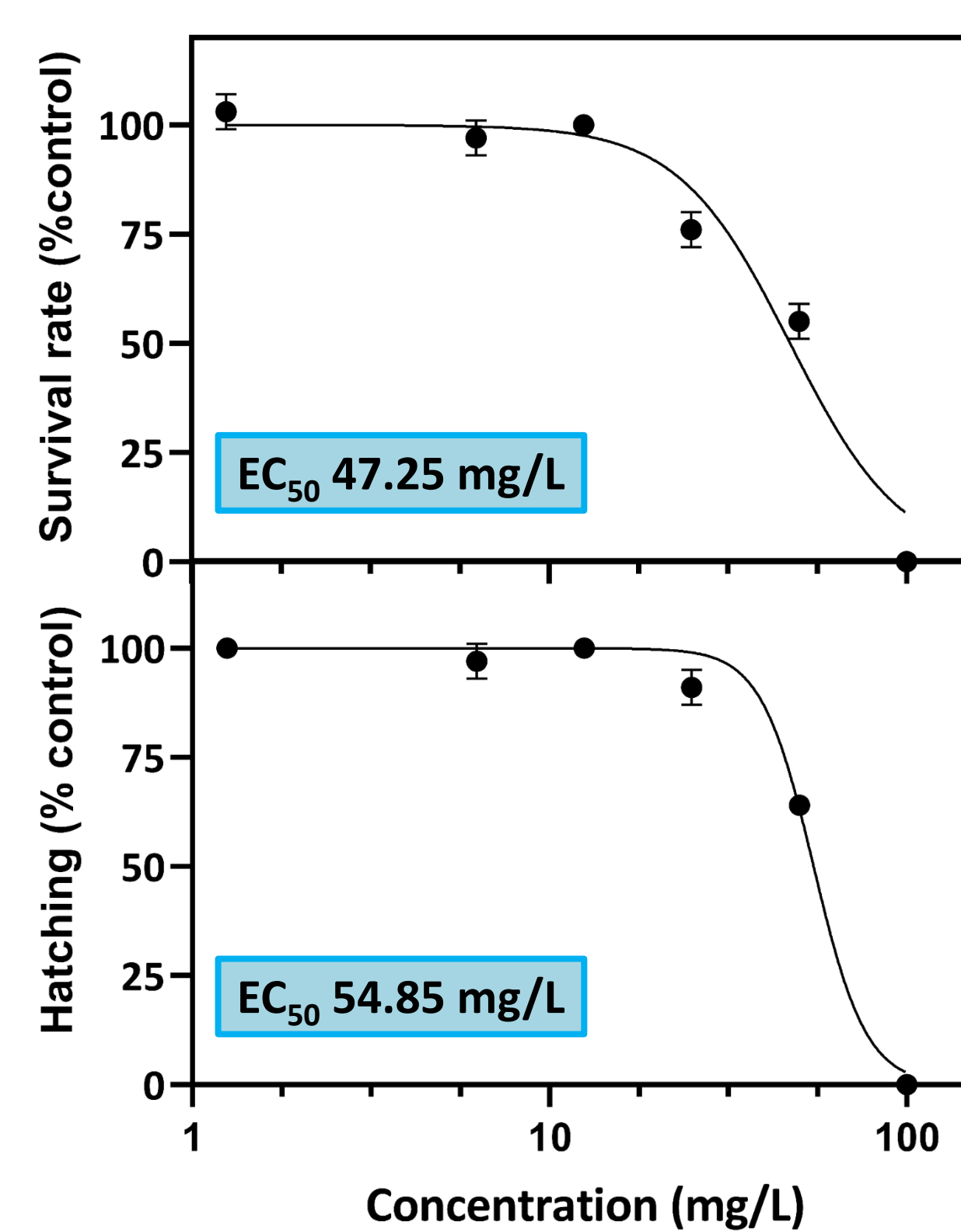
## Results

**Table 1.** Characterization of LDH and MoS<sub>2</sub> (25.6 mg) in Milli-Q water and Seawater using dynamic light scattering.

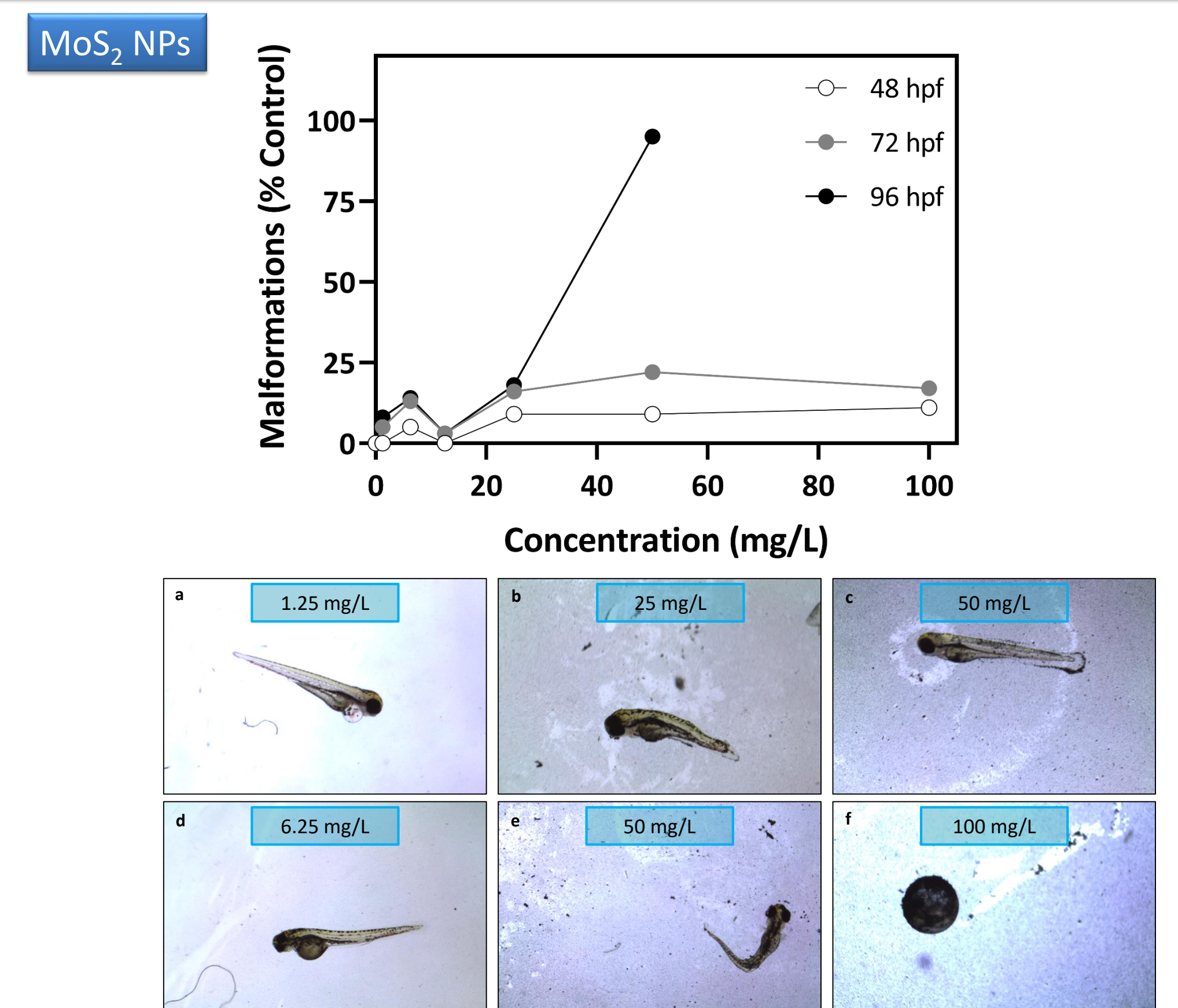
NPs	Parameter /Media	Z-average (nm)	PDI	Z-potential (mV)
LDH	MWQ	387 ± 72	0.31 ± 0.08	47.8 ± 1.5
	SW	1,979 ± 397	0.33 ± 0.12	4.2 ± 3.7
MoS <sub>2</sub>	MWQ	319 ± 19	0.53 ± 0.08	- 43 ± 3.7
	SW	983 ± 360	0.42 ± 0.11	- 15 ± 2.7



**Figure 1** – 6-day naupliar developmental exposures with *Tisbe battagliai*.



**Figure 2** – Survival and hatching rate of zebrafish embryos exposed to MoS<sub>2</sub> NPs for 96 hours.



**Figure 3** – Malformations of zebrafish exposed to MoS<sub>2</sub> NPs. Larvae showing pericardial (a) and yolk sac (d) edemas, spinal deformities (b,e) and delayed development (b,c). Unhatched egg covered with MoS<sub>2</sub> NPs (f).

## Overview

- Significant differences in behavior of MoS<sub>2</sub> in MQW compared to SW.
- Tisbe battagliai* exposed to LDH → Significant developmental delay and mortality at 25-100 mg/L.
- Tisbe battagliai* exposed to MoS<sub>2</sub> → Mortality at 50 and 100 mg/L → probably caused by a shading effect of NMs or clumping of microalgae (given as food) → limitation food availability for developing nauplii.
- FET tests with LDH → No significant effects observed.
- FET tests with MoS<sub>2</sub> → Significant mortality, delayed development and decreased hatching with increasing concentrations → Increased aggregation of NPs in wells and around eggs.

## Conclusions

- So far, MoS<sub>2</sub> and LDH are not acutely toxic at low concentrations and effects were only observed at concentrations unlikely to be found in the environment.
- The next stage of the project will focus on lower concentrations of NMs to look at sublethal and chronic effects in the various systems.

