Assessing the Impact of New Emerging Nanomaterials in the Mussel *Mytilus edulis*

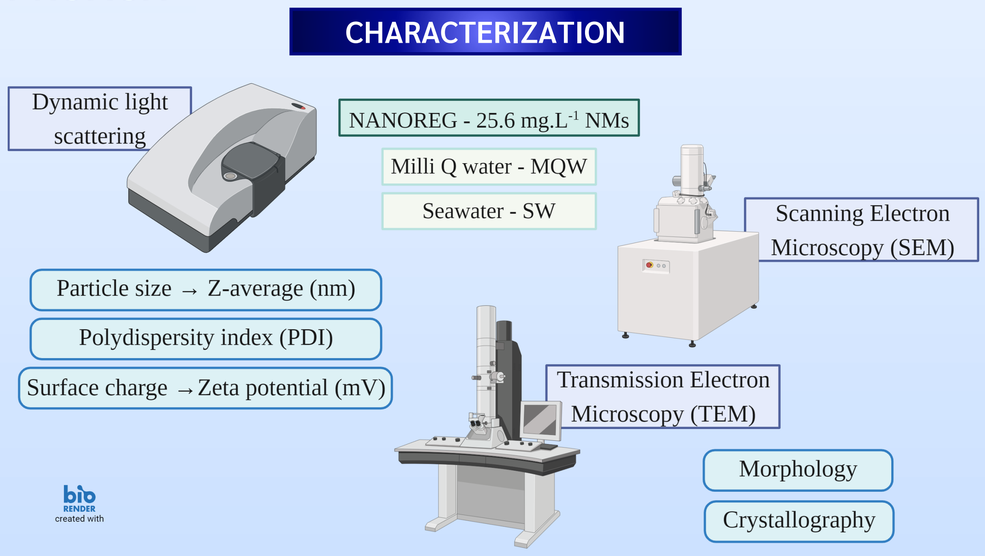
Norwegian Institute for Water Research

Tânia Gomes[1], M. Elisabetta Michelangeli[1], Sebastian Kuehr[1], Ana Catarina Almeida[1], Steven Brooks[1], Samantha Martins[1], Maria T. Hultman[1], Patricia Carvalho[2], Sukdeb Pal[3,4], Pravin Naoghare[3], Deepak Panchal[3,4], Abhishek Sharma[3,4], Ailbhe Macken[1], Anastasia Georgantzopoulou[1]

BACKGROUND

The fast expansion and use of nanotechnology in science and industry has continuously led to the development of new emerging nanomaterials (NMs) with unique properties and diverse applications but unknown impacts in the environment. Layered nanostructures, for example, have shown significant promise for use in environmental technology and remediation due to their specific physicochemical properties. This is the case of defect-rich molybdenum disulfide (MoS_2 NMs) and layered double hydroxides nanosheets (LDH NMs), that have been explored for effective removal of contaminants from water samples[1,2]. However, the impact of these new emerging NMs on aquatic ecosystems are still poorly understood, as well as their potential toxic effects in organisms. Mussels *Mytilus sp.* are widely acknowledged organisms to assess the toxicity and environmental risk of NMs[3]. Thus, the present study aimed to assess and compare the toxicity of MoS_2 and Mg-Al-LDH NMs towards the mussel *Mytilus edulis*.

APPROACH



RESULTS

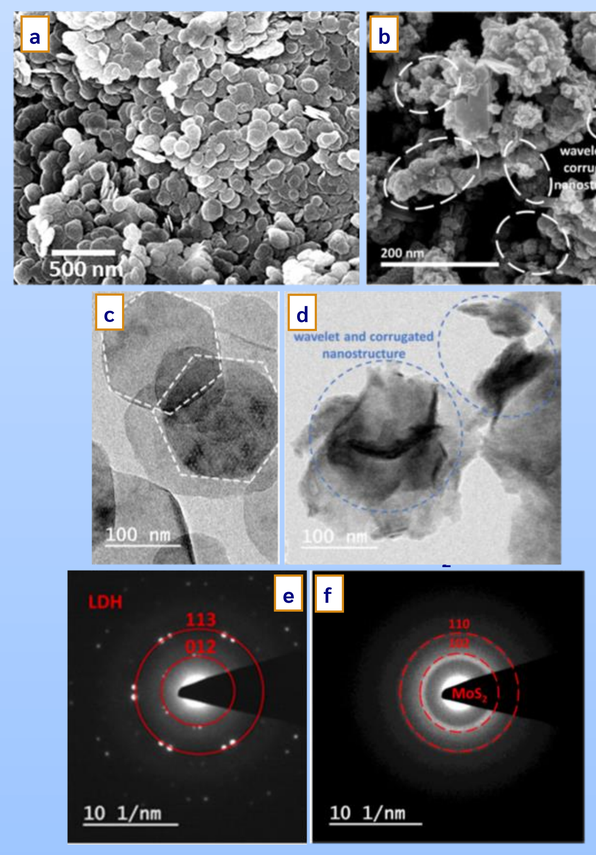


Figure 1 – SEM (a,b) images, TEM (c,d) images and SAED patterns (e,f) showing the morphological characteristics of MoS_2 and Mg-Al-LDH NMs[1,2].

Table 1 – Characterization of Mg-Al-LDH (LDH) and MoS_2 NMs (25.6 mg) in Milli-Q water (MQW) and Seawater (SW) using dynamic light scattering.

NMs	Parameter /Media	Z-average (nm)	PDI	Z-potential (mV)
LDH	MWQ	301 ± 12	0.20 ± 0.03	42.3 ± 0.9
	SW	1979 ± 397	0.33 ± 0.12	4.2 ± 3.7
MoS_2	MWQ	319 ± 19	0.53 ± 0.08	- 43 ± 3.7
	SW	983 ± 360	0.42 ± 0.11	- 15 ± 2.7

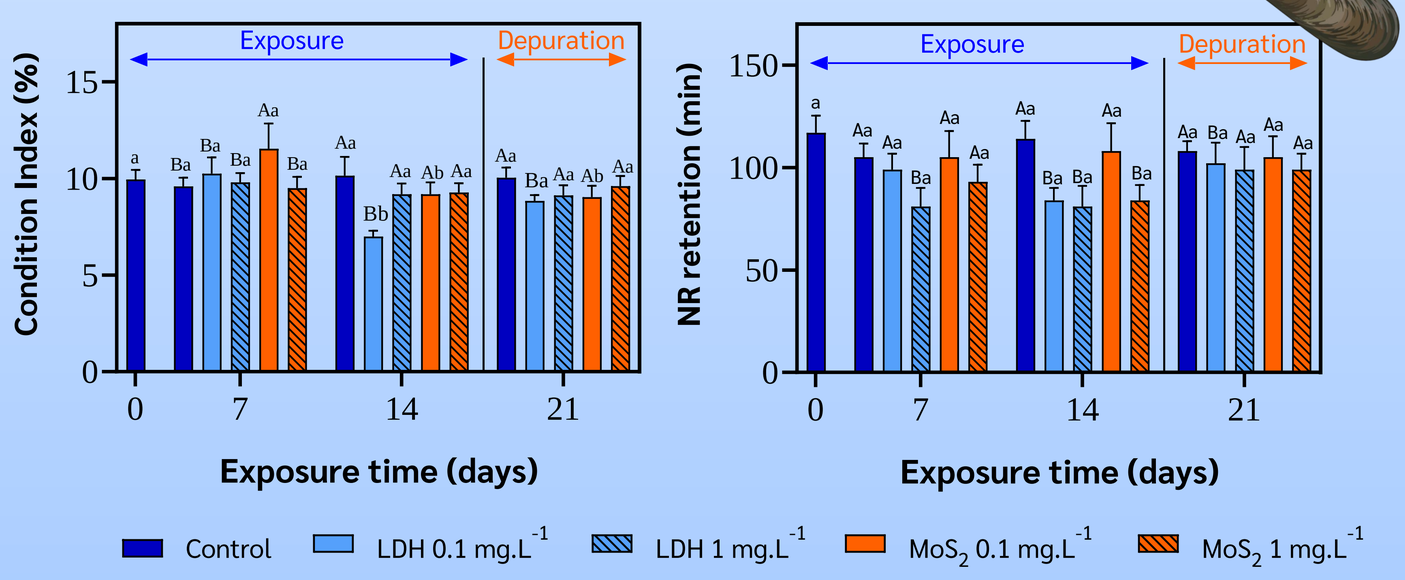


Figure 2 – Condition index (CI) and neutral red (NR) retention in mussels *Mytilus edulis* exposed to Mg-Al-LDH (LDH) and MoS_2 NMs for 21 days. Capital letters represent statistical differences between treatments for each time point and lower letters for each treatment during the exposure duration (p<0.05).

MAIN FINDINGS

- **Mg-Al-LDH NMs:**
  - Platelet like structures with typical hexagonal shape. ≠ behavior in MQW compared to SW ➔ indicative of particle aggregation.
  - **CI** ➔ significant decrease at 0.1 mg.L^{-1} after 14 days exposure, recovery following depuration.
  - **NR retention** ➔ lower retention time at 1 mg.L^{-1} after 7 & 14 days and 0.1 mg.L^{-1} after 14 days exposure, followed by a recovery after depuration.
- **MoS_2 NMs:**
  - Distinctive wavelet and corrugated nanostructures. ≠ behavior in MQW compared to SW ➔ indicative of particle aggregation.
  - **CI** ➔ slight increase at 0.1 mg.L^{-1} at 7 days exposure.
  - **NR retention** ➔ significant decrease for 1 mg.L^{-1} after 14 days of exposure, with recovery after depuration.

CONCLUSIONS

- Analyses are ongoing, but results indicate a significant effect in mussels that is concentration & time dependent ➔ Mg-Al-LDH NMs with a clearer toxic response than MoS_2 NMs.
- This study will provide valuable information on how new emerging NMs could become a potential risk for the aquatic environment and organisms.

tania.gomes@niva.no

Affiliation: [1]Norwegian Institute for Water Research, Oslo, Norway; [2]SINTEF Materials and Chemistry, Materials and Nanotechnology Department, Norway; [3]CSIR-National Environmental Engineering Research Institute, Nagpur, India; [4]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, India.

References: [1] Panchal et al. (2021). Applied Surface Science. 149577; [2] Singh et al. (2024). Applied Materials Today. 102023; [3] Rocha et al. (2015). Marine Environmental Research. 111: 74-88.

This work was supported by the SCANNER Project (#299261) funded by the Research Council of Norway and the Ministry of Science and Technology, Department of Science and Technology, Government of India-Project Number: DST/IC/NOR/RCN/NS/P-02/2019