Cellular effects of lanthanides on *Mytilus edulis*

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**Introduction**

Lanthanides form a small group of elements included between lanthanum (57) (La) and lutetium (71) (Lu) in the periodic table and they all present similar chemical and electrical properties. Many lanthanides are not very cytotoxic. However, the toxicity also varies according to the affected specie. The purpose of the present study is to determine the cytotoxic effect of some lanthanides on the blue mussel *Mytilus edulis*, a well-known sentinel species.

**Materials and Methods**

**Hemolymph collection and cellularity**

We know from some literature that lanthanides are very cytotoxic. However, the viability was assessed in our experimental set-up because it is a key element. Before doing any functional assay the viability must be determined. Measures were then taken on eight *Mytilus edulis* per lanthanide. Individuals were picked up at Mitis Bay (48°40’ N, 68°00’ W) and punctured blank with sterile 3 mL syringes and 2IG½ needles. Cellularity and viability were measured by flow cytometry with BD Accuri™ C6 (Becton Dickinson, San Jose, CA, USA) and the software used was BD Accuri™ C6 Software (Becton Dickinson; version 1.0.264.21). Hemocyte populations were gated using a density plot (SSC vs FSC) and the fluorescence was recorded on FL3. Measurements were done using 200 L of cells exposed to propidium iodide at 10 µL·mL−1 (Sigma-Aldrich Inc., St. Louis, MO, USA) and those samples with more than 70% of viable cells were processed further.

**Lanthanides exposition**

The exposure with lanthanides was performed *in vitro* with 180 L of cells from organisms with high viability and the cells were exposed for 21 h 20 µL of one of the seven lanthanides studied in a dose response manner. Lanthanum (La 138), Cerium (Ce 140), Neodymium (Nd 144), Samarium (Sm 154), Gadolinium (Gd 157), Erbium (Er 167) and Yttrium (Y 88) were used at final concentrations of 0 M, 10−2 M, 10−3 M, 10−4 M and 10−5 M diluted in distilled water and samples. The cell viability was then reevaluated after the exposure with the same flow cytometry method.

**Statistical analysis**

The effect of the lanthanides cytotoxicity was expressed in mean ± standard deviation and the significance of the results was determined by one-way analysis of variance (ANOVA). The sequences that failed normality test were analyzed by Kruskal-Wallis non-parametrical test. The statistics were calculated using SigmaPlot® version 12.5 software (Systat Software, Inc., San Jose, CA, USA).

**Results**

The results are presented in Figure 1 and expressed in percent of viable cells. The differences in viability between the controls and the most elevated concentrations (10−3 M) of lanthanides are mostly insignificant except for...
samarium and erbium where it decreases significantly. All the lower concentrations do not present significant differences with the control or $10^{-3}$ M of each lanthanide.

**Discussion and Conclusions**

The majority of the lanthanides used showed no effect that is consistent with other studies where lanthanides alone do not induce toxic effects. The concentrations used in this experiment are not far from the ones found in some industrial wastewater like in India where the higher concentration of samarium was around $10^{-5}$ M. However, the amounts generally found are below $10^{-7}$ M. Samarium, which is one of the few lanthanides that showed toxicity in the study even though it was at higher concentration than what is found in the environment, has many uses. It is mainly used in drugs, laser, glass, electronic, nuclear and ceramic industries. Cytotoxicity as used in the present study may be not by itself an optimal marker to assess the potential effects of lanthanides because of other low cytotoxicity. Others parameters such as phagocytosis for instance for the immune system have to be measured in order to better understand the full impact of those elements on aquatic life. The monitoring of those elements also needs to go on, since the environmental concentrations are already high, and the climate changes may increase the release of lanthanides from the sediments and render them more available to aquatic ecosystem.

**References**

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