Metal Accumulation in Two Species of Seaweed After Waterborne Metal Exposure

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Abstract

Marine environments are commonly exposed to metal pollutants from anthropogenic activities such as agriculture, mining, and stormwater runoff, as well as natural inputs from volcanoes and forest fires. In excess, metals may accumulate in marine biota and potentially cause toxicity. The goal of this experiment was to measure metal accumulation in two species of marine seaweed after 48 hours of waterborne exposure to 100 µg/L of cadmium, copper, lead, nickel, and zinc. *Ulva lactuca* and *Agardhiella subulata* were ideal for use in this study because they occupy a variety of coastal habitats such as inner bays and estuaries, and are therefore commonly exposed to polluted environments. Metal accumulation in the seaweed varied between species and among metals, however, significant copper accumulation was observed in both species. This study provides important information concerning metal accumulation in sensitive lower trophic levels, which serve as vital constituents in many food chains.

Introduction

- Elevated levels of Cd, Cu, Ni, Pb, and Zn can be toxic in marine environments.
- Assessing metal accumulation in seaweed is beneficial in showing the introduction of metals into sensitive food webs.
- Accumulated metal has been shown to cause detrimental effects on grazers (Bielmyer et al. 2012).
- The objective of this experiment was to quantify metal accumulation in the seaweed species, *U. lactuca* and *A. subulata,* after waterborne metal exposure.

Methods and Materials

- Metal solutions were prepared with 2L of 32 ppt salt water and 100 µg/L of the following metals: cadmium (Cd), copper (Cu), nickel (Ni), lead (Pb), and zinc (Zn).
- Control solutions were also made for each type of seaweed.
- 2 grams of *Ulva lactuca* and *Agardhiella subulata* were placed in each replicate 2 L glass culture dish for a period of 48 hours. There were two replicates per treatment.
- After two days, the seaweed was dried in the oven for 24 hours, and the dry weight of each seaweed was then recorded.
- The dried seaweed was digested in 2 mL of nitric acid, the samples were diluted 10-fold with 18 mΩ Milli-Q® water, and then the diluted samples were analyzed for metal content using atomic absorption spectrophotometry.

Results and Discussion

Fig. 1 shows that the Cd-exposed *A. sublata* accumulated significant tissue Cd as compared to the controls; whereas no significant increase in Cd accumulation was observed in the Cd-exposed *U. lactuca.* Cu significantly accumulated in both species after 48 h exposure to 100 µg/L and concentrations were higher than any other metal tested (Fig. 2). This pattern of accumulation has been demonstrated in other studies (Bielmyer et al. 2012) and could be due to the essentiality of Cu. Like Cu, Ni significantly accumulated in both species (Fig. 3). Although the average Pb concentrations appeared higher in the Pb-exposed treatments, due to control variability, significant differences were only observed in *A. subulata*, as compared to the controls (Fig. 4). Zn accumulation was slightly elevated in the Zn-exposed treatments; however, no significant differences were observed in either species (Fig. 5). In other studies, Zn has been shown to be highly regulated by aquatic organisms (Bielmyer et al. 2012).

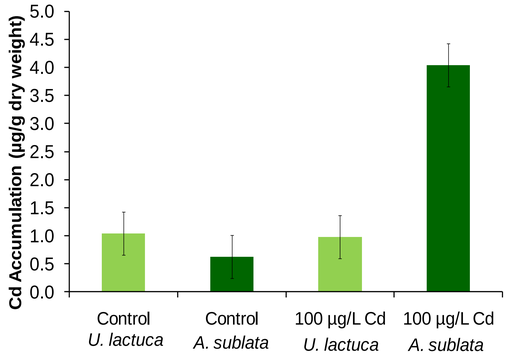

Fig. 1 Cd accumulation in *U. lactuca* and *A. sublata* after 48 h of waterborne Cd exposure.

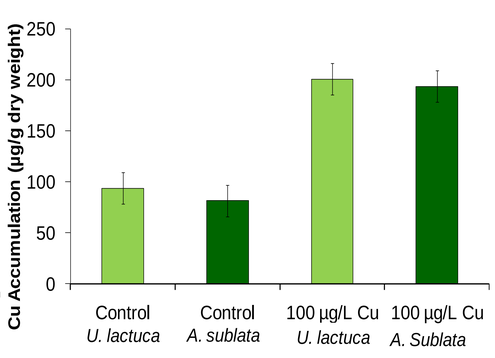

Fig. 2 Cu accumulation in *U. lactuca* and *A. sublata* after 48 h of waterborne Cu exposure.

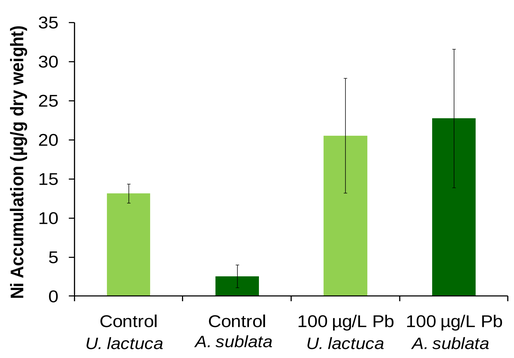

Fig. 3 Ni accumulation in *U. lactuca* and *A. sublata* after 48 h of waterborne Ni exposure.

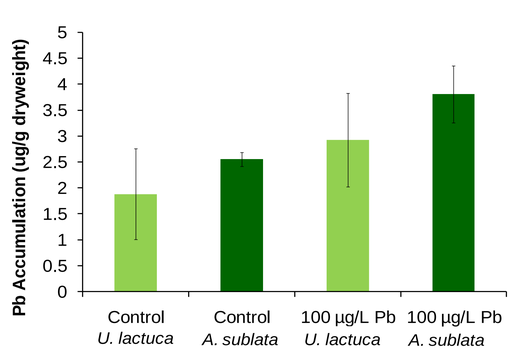

Fig. 4 Pb accumulation in *U. lactuca* and *A. sublata* after 48 h of waterborne Pb exposure.

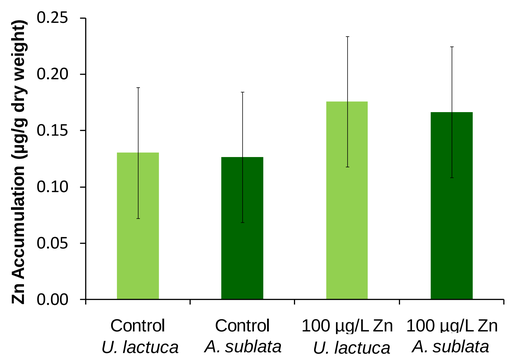

Fig. 5 Zn accumulation in *U. lactuca* and *A. sublata* after 48 h of waterborne Zn exposure.

Conclusions:

Metal accumulation occurred in both seaweed species as a consequence of waterborne metal exposure at environmentally realistic exposure concentrations. In general, metal accumulated similarly in both seaweed species, with the exception of Cd, where higher concentrations were observed in *A. subulata*. Cu accumulation was most significant in both species of seaweed. The accumulated metal in this sensitive lower trophic level may have implications for grazers.

Reference:

Bielmyer, G.K., T. Jarvis, B.T. Harper, B. Butler, L. Rice, S. Ryan. 2012. Metal Accumulation from Dietary Exposure in the Sea Urchin, *Strongylocentrotus droebachiensis. Arch Environ Contam Toxical* DOI: 10.1007/s00244-012-9755-6.