Do laboratory toxicity tests replicate "real world" exposures?

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Exposure to metals can be difficult to assess because of: the range of exposure routes (water, sediments, and food); differences in the biological availability of metals associated with different environmental media; and, individual and species differences in the metabolic pathways used to sequester or eliminate metals depending on their essentiality or toxic potential. All these processes affect the amount of metal which enters organisms and reaches critical molecular targets. Seasonal changes, feeding habits, reproductive status, or metabolic activity can modify the nature and extent of exposure. Effects of exposure to metals cannot be readily quantified by measuring body burdens because the relationship between body burden and toxic response is complex and not fully understood (McCarthy 1990).

Metal uptake and effects in benthic organisms can be assessed by exposure in laboratory microcosms with either metal spiked sediments or field collected contaminated sediments, and through transplantation experiments in which organisms are placed *in situ* into contaminated environments (Burt *et al.* 2007; Taylor and Maher 2012a,b,c). Exposures to sediments spiked with single or multiple metals do not represent reality but are useful for establishing biomarker techniques and exploring *exposure-dose-response* relationships (Taylor and Maher 2010). Laboratory microcosms are widely used for sediment toxicity testing and standard procedures using a variety of organisms are available (ASTM 2008). These tests are limited, however, in that they do not represent real world environmental conditions as they cannot replicate prevailing physiochemical conditions (flow, temperature, pH, variable salinity, REDOX profiles), biology (e.g., biofilms), and biological processes (e.g., bioturbation) that influence the transfer of metals from sediment to biota.

We have been examining *exposure-dose-response* relationships in *Anadara trapezia*, the Sydney cockle, exposed for two months to a gradient of contaminated sediments from Lake Macquarie, NSW. The bioaccumulation of metals and sub-lethal effects (total antioxidant capacity, lipid peroxidation, lysosomal destabilisation, and organism condition) were compared in organisms exposed to lake sediments in laboratory microcosms and in caged lake transplantations. We found that bioaccumulation of metals by *A. trapezia* in the laboratory microcosm experiments was higher than in the field for the same sediment metal exposure (Figure 1). Laboratory exposed organisms at the higher metal exposures showed greater perturbations to the antioxidant system and lysosomes than the equivalent field exposed organisms. Transplanted organisms had better condition at all exposures than those exposed in the laboratory microcosms (Figure 1). *A. trapezia* is highly sensitive to salinity ± 5 ‰ and temperature ± 10 ^{0}C changes (unpublished data); this sensitivity has the potential to further influence metal accumulation and effects in field

exposures. The differences in response to varying metal exposure conditions highlight the need to establish for each organism and each effect end point the efficacy of using laboratory microcosms in place of the logistically more difficult transplantation experiments.

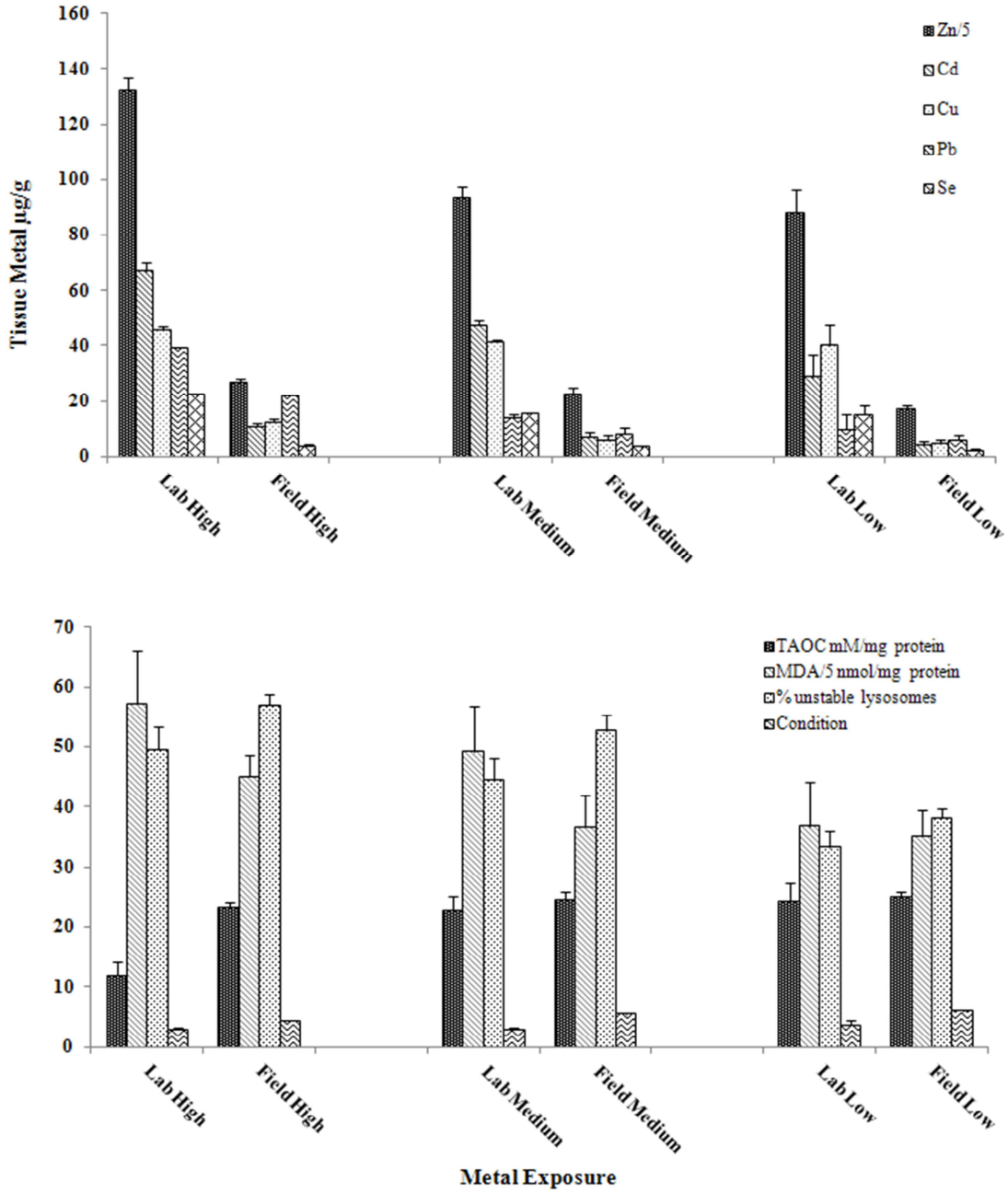

Figure 1: Tissue metal accumulation and subcellular effects of laboratory and field exposed *A. trapezia*. Total antioxidant capacity (TOAC), lipid peroxidation (MDA).

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