Measurement and modeling of polychlorinated biphenyl bioaccumulation from sediment for a marine polychaete and response to sorbent amendment

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Introduction: We investigated the rate of bioaccumulation of polychlorinated biphenyls (PCBs) for the marine polychaete *Neanthes arenaceodentata*, including PCB uptake rates from water and contaminated sediment, and the effect of sorbent amendment to the sediment on PCB accumulation and organism growth and lipid content. PCBs are persistent and bioaccumulative contaminants. Despite being banned in the USA thirty years ago, PCBs are widely distributed and are among the most troublesome contaminants in sediments, accounting for the second-leading cause of fish consumption advisories [1]. Managing PCB-contaminated sediments is challenging both scientifically and technologically. Typical approaches for dealing with PCB-contaminated sediments entail dredging and/or capping [2]. While these approaches will continue to be applied and modified, ecological risk assessment tools are needed to measure remediation success.

Methods: We used a modified biodynamic modeling approach to predict contaminant uptake in a marine polychaete based on physiological parameters as a mass balance of efflux and influx rates [3]. Organism ingestion rates were measured using a novel procedure that combines pulse-chase feeding and multi-labeled stable isotope tracers [4]. Microcosm studies with contaminated and amended sediment were conducted to establish the respective uptake rate constants. Further physiological parameters as growth rate and lipid content were monitored.

Results and Discussion: Results of ingestion rates, lipid contents, and growth rates obtained for the polychaete *N. arenaceodentata* indicate rapid PCB uptake from contaminated sediment and significant organism growth dilution during the exposure studies. After 14 days of exposure the tissue concentration exceeded the concentration in the sediment. Activated carbon (AC) amendment could reduce PCB uptake by 95 % in laboratory experiments with no observed adverse growth effects on the marine worm. We confirmed that the PCB uptake from the aqueous phase only accounts for five percent of the total uptake for this deposit-feeder. Proportional increase of gut residence time (GRT) and assimilation efficiency (AE) as a consequence of the organism's growth was demonstrated by a chemical reactor theory. The GRT is increasing over time because the growing volume of the gut, V_{gut}, increases faster relative to the mass ingested [5].

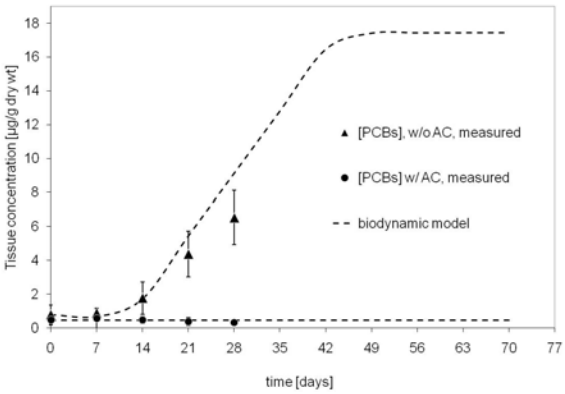

Fig. 1: Measured and modeled PCB tissue concentrations for sediment w/ and w/o AC-amendment.

The biodynamic model based on mass balance of influx and efflux could predict the observed body burden for *N. arenaceodentata* when accounting for the growth rate and related time-dependent assimilation efficiency (Figure 1).

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