Biological Effects of Activated Carbon are Dependent on Particle Size and the Test Organism

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Background/Objectives. Thin-layer capping with activated carbon (AC) is a proposed in situ method for remediation of contaminated sediments. Though efficient in binding and reducing bioavailability of hydrophobic organic contaminants in both the laboratory and the field, studies have reported adverse effects on benthic organisms, such as weight loss, reduced feeding rates, and mortality. These effects have been associated with dose and particle size of AC, with finer particles and higher doses causing more severe effects. The aim of this study was to compare adverse effects of powdered AC (PAC) and granular AC (GAC) on two deposit feeding marine benthic invertebrates that are common in the Baltic Sea, a heavily polluted brackish-water sea in Scandinavia: the bivalve *Limecola balthica* and the polychaete *Marenzelleria spp*.

Approach/Activities. Anthracite-derived AC of five different particle sizes (15 µm to 1.7 mm) were tested: three powdered AC and two granular AC. Organisms, sediment and overlying water was collected from a non-polluted site in the Baltic Sea. Five and six individuals, respectively, were introduced to 1 L glass units with sediment and water. Thin layer caps (ca 2 mm) of AC were applied at a relatively low dose (600 $g \cdot m^{-2}$) using five replicates of each AC and a control with no capping. Animals were exposed for 3 months and then fed a pulse of ^{14}C-labeled diatom plankton. The animals were permitted to feed on the diatoms for one week, after which the experiment was terminated and the surviving animals were collected, gut purged, weighed, measured for ^{14}C uptake and lipid content, and compared to animals from control replicates.

Results/Lessons Learned. We found a significant loss of weight and strongly reduced ^{14}C uptake in the polychaetae *Marenzelleria spp*. in response to all three PACs. There was, however, no increase in mortality or decrease in lipid content. Conversely, GAC had a positive effect on ^{14}C uptake by the polychaete when GAC treatments were pooled and compared statistically to control. AC was not observed to affect the bivalve *Limecola balthica*: neither PAC nor GAC treatments significantly affected survival, dry weight, ^{14}C uptake, or lipid content of the bivalve. These results confirm previous studies on freshwater species, which have found that adverse effects are dependent on particle size of AC. Furthermore, we show that effects are species-dependent and connected to ingestion: the polychaete was strongly adversely affected by ingestible powdered AC, whereas non-ingestible granular AC had some positive effect. This study highlights potential risks to benthic communities when using powdered AC for sediment remediation and the importance of selecting appropriate test organisms when evaluating biological effects on benthic organisms. Results from this study strengthen the hypothesis that adverse effects of AC on benthic organisms are caused by reduced feeding or reduced assimilation of food by the organism, rather than nutrient sorption to AC outside the organism.