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Title: POTENTIATING TOXICOLOGICAL INTERACTION OF SINGLE-WALLED CARBON NANOTUBES WITH DISSOLVED METALS

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Abstract: The present study explored the ecotoxicology of single-walled carbon nanotubes (SWCNTs) and their likely interaction with dissolved metals, with a focus on the effect of in vivo exposure in marine mussels. Any nano-scale effects were negated by the tendency of uncoated SWCNTs to agglomerate in water, particularly with high ionic strength as is the case in estuarine and full-strength seawater. However, SWCNTs, in combination with natural organic matter, remained suspended in seawater for long enough to become available to filter-feeding mussels, leading to their concentration on and increased contact with gill epithelia during exposure. For the first time, the authors describe a potentiating toxicological effect, expressed as DNA strand breaks obtained using the comet assay, on divalent metals afforded by negatively charged SWCNT agglomerates in seawater at concentrations as low as 5 mu gL(-1). This is supported by the observation that SWCNTs alone were only toxic at concentrations 100 mu gL(-1) and that the SWCNT-induced DNA damage was correlated with oxidative stress only in the absence of metals. If these laboratory experiments are confirmed in the natural environment, the present results will have implications for the understanding of the role of carbon nanotubes in environmental metal dynamics, toxicology, and consequently, regulatory requirements. Environ Toxicol Chem 2013;32:2701-2710. (c) 2013 SETAC

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M.G.J. Hartl devised the experiments, supervised the work, and prepared the manuscript; E. A. Dyrynda cosupervised the hemocyte aspects of the work; M. Al-Shaeri conducted the exposure experiments, chemical analysis, and single-walled carbon nanotube (SWCNT) characterization under exposure conditions; L. Paterson supervised the Raman spectroscopy; G. Turner conducted preliminary experiments to study the SWCNT-gill interaction; D. Ahmed and F. McCluskey performed preliminary experiments that led to the establishment of optimal dispersion and exposure protocols. M. Al-Shaeri is supported by a PhD studentship from the King Abdulaziz University, Department of Biological Sciences, Faculty of Sciences, Jeddah, Saudi Arabia. The transmission electron microscope samples were prepared by evaporating a drop of stock suspension on a membrane grid (carried out by S. Mitchel, the electron microscopy technician at Edinburgh University). The authors also acknowledge support from M. Stobie and S. McMenamy for day-to-day running of the aquarium facility and chemical analysis, respectively, at Heriot-Watt University. We thank Renishaw for the kind gift, to Heriot-Watt University, of the Renishaw inVia Spectrometer.

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