Defining the bioaccumulation of PAH in mussels: considering time, distance and effects

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In this study, we delineate the spatial bioaccumulation of PAH in mussels collected from the narrowest 6 km section of Halifax Harbour, one of the largest such bodies of water in the world. A previous study of mussels in this harbour indicated high levels of parental and alkylated PAH at site M8 that was correlated with biological effects. Variability in the PAH body burden was associated with dredging, shore-based construction, road runoff, sewage drainage as well as changes in the reproductive cycle of mussels. In 2003, further collections of mussels were made at 5 sites in April and at 12 sites in May around M8. The April samples confirmed the relatively high levels of PAH in mussels at site M8, and also demarcated the eastern boundary of elevated bioaccumulation beside a municipal park. The May samples were from 5 contrasting locations: near a raw sewage outfall, an abandoned navy wharf, a ferry terminal, some creosote pilings and a containers pier.

Levels of PAH overlapped between mussels sampled in April and May; displaying a sum of PAH ranging from 75 to 971 ng/g, wet weight. Seven adjacent sites covering nearly 4 km of shore line had PAH levels above the overall mean 340 ng/g and averaged 600 ng/g. The fingerprint of the more abundant parental PAH was common to all sites, while the signature of alkylated PAH indicated weathering of fossil fuels. The weathering relative to the mussels sampling location pointed to probable land derived discharges of fossil fuels. Our snapshot in time of bioavailable PAH indicated that higher proportions (59 and 66% of the sum compared to 20-55%) and levels of alkylated PAH (226 and 271 ng/g compared to 36-198 ng/g) were detected at two slightly more impacted mussel sites. The PAH signature indicated that mussels can be affected by transient exposure in their habitat. This statement is based on our previous observations where alkylated PAH were detected in higher concentration in water sampled in the summer compared to winter (54-66% compared to 28-44%); on the shorter survival of mussels in summer; and the lower abundance of alkylated PAH in sediments parallel to the mussels' sites (15-27% of sum).

Impact refers to a sensitive, easily performed, cumulative biological effect that measures the survival of mussels in air that is referred to as an immune response. This biomarker along with other biological end points motivated the present study. The analyses of the above two groups of PAH would be expected to represent a good surrogate for the exposure of mussels to other contaminants with similar bioavailability. However, the identification of other stressors playing a synergistic or antagonistic role would be advantageous for the future management of this ecosystem. An aspect briefly followed in this study and lending support to additional contributors to effects and needing more attention is the correlation between water quality, i.e. bacterial counts in water and the bioaccumulation of PAH. With the ongoing construction of sewage treatment plants, fewer particles will be discharged in the harbour; effluents will be relocated centrally within the deeper section of the Central Channel; therefore changes in ecosystem health should be assessed for benthic and inter-tidal organisms. The bioavailability of contaminants in this commercially exploited lobster habitat covering nearly 200 km^2 should be pursued.