

PAHs concentration and toxicity of atmospheric particulate matters and sea sediments

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Atmospheric and aquatic polycyclic aromatic hydrocarbons (PAHs) pollution has been measured extensively for decades, but the relation of PAHs concentration and risk is unclear. The majority of PAHs are emitted by incomplete combustion processes, and the toxicity of specific chemicals compounds may be unknown. USEPA has proposed different methods of toxicity evaluation for PAHs (Flowers, *et al.*, 2002). The correlation of toxicity and PAHs concentration should be considered.

Anthropogenic atmospheric particulate matter (APM) may pollute air and ground surfaces. Here we investigated the toxicity of PAHs to marine bacteria (*Vibrio fischeri*), the concentration of PAHs in marine sediments in an urban watershed area (Hiroshima Bay), and compared this data with PAH derived from APM.

APM was sampled on the roof of an eight storey building (30 m) in the Saijo campus of Hiroshima University, about 3 km from the city center. Particles were collected using a high-volume air sampler with an impactor system followed by a glass fiber filter. The impactor system collected particles > 7 μm (coarse particulate matter; CPM); the glass fiber filter collected (0.6 ~ 7 μm) (fine particulate matter; FPM). Samples were collected during the warm season (September – October 2002 and Aug. 2008; n = 10 for FPM and n = 3 for CPM) and cold seasons (December 2002 – Jan. 2003 and Dec. 2009; n=10 for FPM and n = 3 for CPM).

The watershed and sample sites for atmospheric and sea sediment are shown in Figure 1. The area is 1,710 km^2 and the population is 9.8×10^5 (population density: 570 person km^{-2}), and includes Hiroshima City. Hiroshima Bay is 230 km^2 and the maximum depth is 28 m. Samples were taken from seven sampling stations (St. W1~3 and E1~4; Figure 1) using a core sampler in September and November 2004. Core samples were cut into 2 cm slices and PAHs in the first three (6 cm) slices measured giving three samples per station, 21 samples in total. PAH in FPM concentration was highest in cold season (Figure 2). The concentration pattern in sediments was similar to that in atmospheric particles.

The toxicity unit (TU) is defined as the reciprocal of half-death concentration of extraction of particulate matters in water ($1/\text{EC}_{50}$ (L g^{-1})). APM TU was 10~100 L g^{-1} and sea sediment TU was ~0.1 L g^{-1} in the West sample sites and ~1 L g^{-1} for East sample sites (Figure 3). The East sampling area is more enclosed than the West sampling area and toxic substances may be easily retained. The ratio of PAHs concentration and TU (TU/PAHs) was stable for all the sea sediment samples (Figure 3; 0.1~1 $\text{L } \mu\text{g}^{-1}$). This ratio was similar to that found for FPM and CPM samples taken in warmer seasons. Considering that the mass loading is generally higher for FPM than CPM, the similarity between FPM and sea sediments was reasonable. The results suggest the major toxicity of sea sediments is derived from atmospheric particulate matter (especially FPM) or PAHs-related particles (e. g. biomass burning residues).

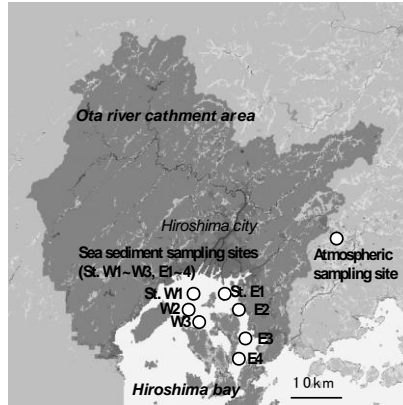


Figure 1 Sampling sites.

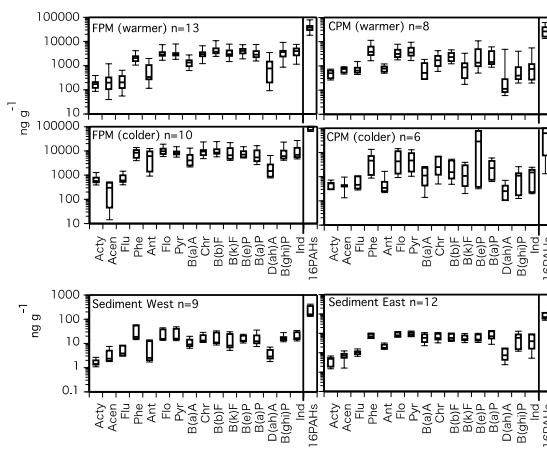


Figure 2 PAHs concentrations of atmospheric particulates and sea sediments.

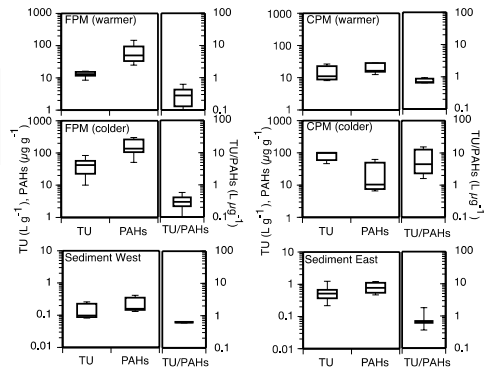


Figure 3 Relation of toxicity and 16PAHs concentration.

References

Flowers, L. et al. (2002) Health assessment of polycyclic aromatic hydrocarbon mixtures: current practices and future directions. *Polycycl. Aromat. Comp.* **22**, 811-821.