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Baseline

Water concentrations of PAH, PCB and OCP by using semipermeable membrane devices and sediments

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ABSTRACT

Water concentrations of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) were estimated from semipermeable membrane devices (SPMDs) and from sediment pollutant concentrations. SPMDs were deployed in the Istanbul Strait and Marmara Sea and retrieved after 7 and 21 days. Performance reference compounds (PRCs) were used to determine the site-specific sampling rates of the compounds. Water concentrations (C_w) of the analyzed compounds estimated by using two different calculation methods for SPMDs were found similar. C_w of total PAHs estimated from SPMDs ($C_{w\text{-}spmd}$) were found between 13 and 79 ng L^{-1} and between 7.0 and 68 ng L^{-1} for 7 and 21 days of deployments respectively. Water concentrations of PCBs using sediment data was found as between 0.001 and 11.0 ng L^{-1}. The highest value of $C_{w\text{-}spmd}$ for two deployments were 2.8 ng L^{-1} for OCPs. C_w estimated from sediment concentrations were generally higher than those estimated from SPMDs.

Lipophilic environmental contaminants such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) have been frequently identified in several compartments of the global ecosystems (Zhu et al., 2011). Because of their low water solubility, most of these organic pollutants accumulate in sediments and organisms while they exist very low levels in the water phase. As a consequence, the analysis of those pollutants in water samples is still very difficult. Several passive samplers have been developed in the past decades to estimate the freely dissolved organic pollutants in water (Hofelt and Shea, 1997; Booij et al., 1998; Meadows et al., 1998; Huckins et al., 1999). However lipid-containing semipermeable membrane devices (SPMDs) have been most commonly utilized for sampling organic contaminants in water (Ellis et al., 1995; Herve et al., 1995; Prest et al., 1995; Huckins et al., 2006). SPMDs have also an advantage over grab sampling and organisms in that they provide time weighted-average concentrations and they do not metabolize chemicals (Rantalainen et al., 2000). Furthermore, SPMDs may be installed to highly polluted sites where biomonitoring programmes can not be applicable. Accumulation of organic pollutants in SPMDs is driven by passive diffusion and thermodynamic partitioning between surrounding water and LDPE membrane + triolein in the samplers. The sampling rate of SPMDs is affected by the environmental parameters such as the temperature, water flow or fouling on the samplers (Williamson et al., 2002). To overcome those problems relating the fluctuations of the environmental factors in the sampling sites, a method involving use of SPMDs containing performance reference compounds (PRCs) was introduced (Huckins et al., 2002, 2006). The dissipation kinetics of performance reference compounds (PRCs) spiked into the passive samplers during their preparation were used to estimate the site-specific sampling rate of the chemicals for each SPMD. Theoretically, the rate of PRC losses is proportional to the rate of analyte uptake. Recently, Booij and Smedes (2010), suggested an improved method (nonlinear least-square method) to use all PRC retention data for estimation of sampling rates.

The primary aim of the present field study is to evaluate the pollution status of the sampling sites by using the data obtained from two different sampling materials; the sediments and SPMDs. Furthermore, the water concentrations estimated by using the sediment and SPMD data were compared and water pollutant concentrations from SPMD data, calculated by using the methods presented by Huckins et al. (2006) and Booij and Smedes (2010) were evaluated. For that aim, the sediments were collected from and SPMDs were installed in the five sites of the İstanbul Strait. It is one of the busiest waterways in the world and has been reported to be contaminated by organic pollutants (Karacik et al., 2009; Okay et al., 2009).

Surface sediments (0–10 cm) were collected from the coastal sites of the Istanbul Strait (Fig. 1) by SCUBA and/or free diving methods during the period of March–April 2009. Station 6 is a

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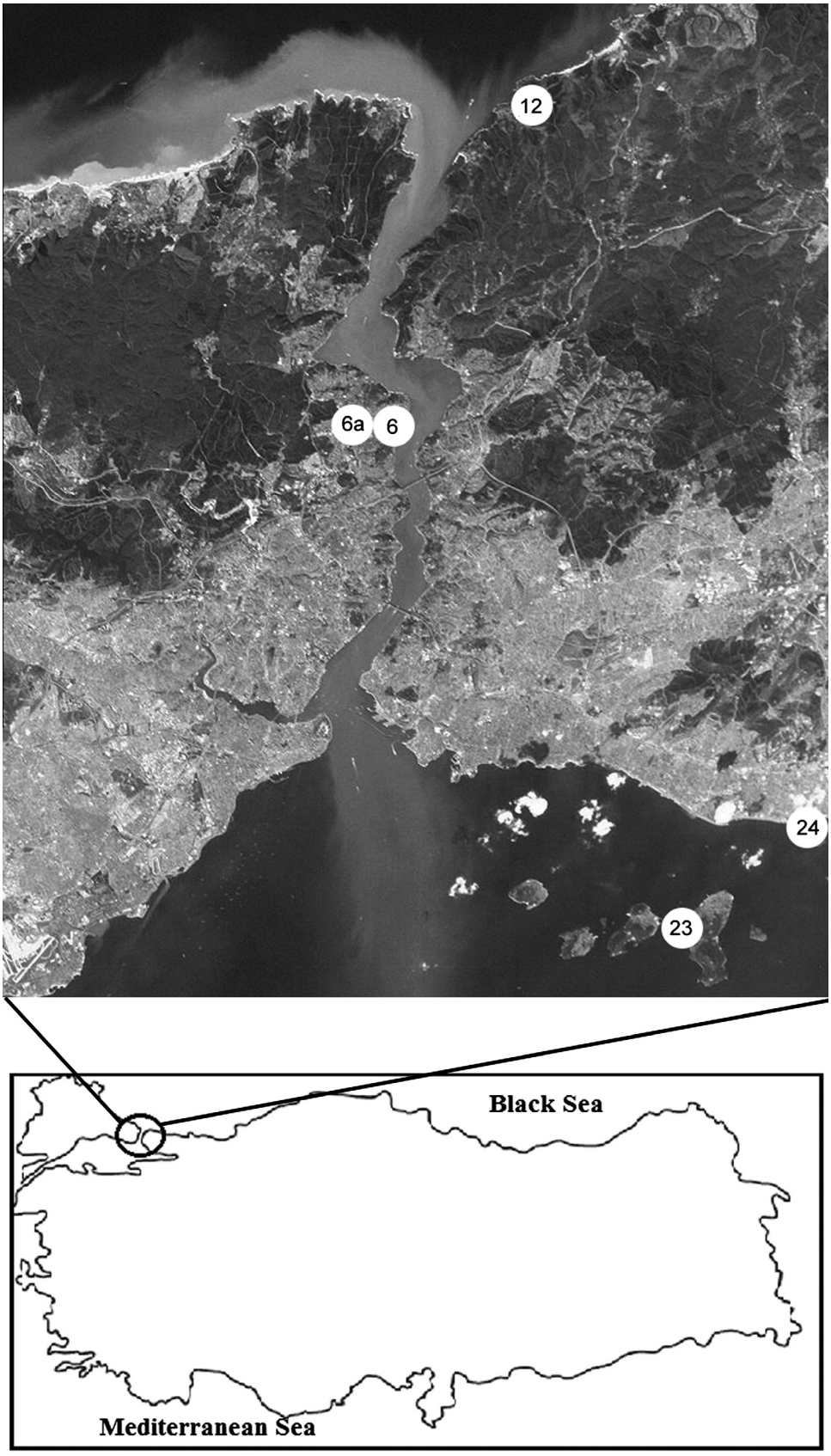

Fig. 1. Sampling and SPMD deployment sites in the İstanbul Strait and Marmara Sea.

historical shipyard area located in an enclosed bay in the middle part of the Strait, whereas 6a is situated at the mouth of a small stream entering to the same bay. Station 12 is an unpolluted station at the entrance of Black Sea. Stations 23 and 24 are situated at the coastal part of an island in the Marmara Sea and on the coast of the main shipyard area of Turkey, respectively. Sampling water