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Seasonal and spatial distribution of nonylphenol and IBP in Saemangeum Bay, Korea

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Abstract

In order to investigate spatial and temporal distribution of organic pollutants in the Saemangeum Bay, organophosphorus pesticides (10), alkylphenols (8), chlorophenols (2), bisphenol A were analyzed from the surface seawater taken in 2002–2003. Most of the analytes were not detected in all stations except nonylphenol and *S*-benzyl-*O*,*O*-di-isopropyl phosphorothioate (IBP). Concentrations of nonylphenol and IBP ranged from ND to 298 ng/l and from ND to 1840 ng/l, respectively. The high levels of nonylphenol and IBP were found in the estuary areas of Mangyeong and Dongjin River. The levels of nonylphenol and IBP in surface seawater varied through seasons and the high levels of nonylphenol and IBP were in summer season (August). Based on real time monitoring of IBP and on correlation between concentrations of target compounds and contents of salinity in seawater, physical mixing and diffusion of seawater were found to be the major factors that affect the spatial distribution of IBP and nonylphenol in the Saemangeum Bay environment.

Keywords: Pesticides; Organophosphates; Alkyl phenols; Korea

1. Introduction

Although organophosphorus pesticides (OPs) are cholinesterase inhibitors on living organisms (Jamal, 1997; Ray, 1998), it has been widely used in agriculture for crop production in the world due to its excellent insecticidal activity and its relatively low persistence in the environment (Pehkonen and Zhang, 2002; Medina et al., 1999). During the last several decades, it was detected in various matrices such as river (Zhang et al., 2002), seawater (Yu et al., 2001), sediment samples (Liess et al., 1999) and organisms (Sapozhnikova et al., 2004). During the last 14 years, approximately 250 tons of pesticides were used each year in South Korea, in which OPs account for about 60% (Agricultural Chemicals Industrial Association, 2001). Yu et al. (2001) reported that most estuaries were contaminated with moderate levels of OPs in warmer season in Korea.

Nonylphenol is a degradation product of nonylphenol polyethoxylates (NPnEOs) that is used as nonionic surfactant and detergent in industrial and domestic applications in the last five decades (Giger et al., 1984). Although nonylphenol is an endocrine disruptor, many countries consumed large quantity of its parent compound until now because it is inexpensive but powerful in its cleaning property. According to our recent studies, high levels of nonylphenol were found in lake (Li et al., 2004a), rivers (Li et al., 2004b) and vicinity of industrial area (Li et al., 2004a; Li et al., 2004c) in Korea.

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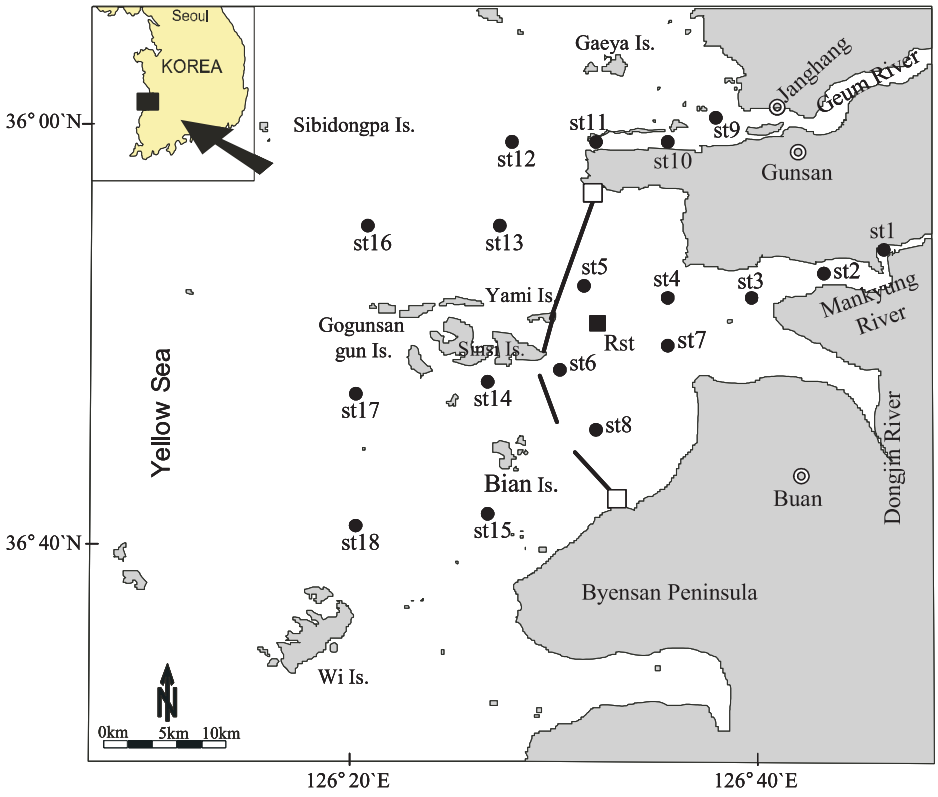

Fig. 1. Location of sampling sites.

Most of OPs and NPnEOs enter water column directly because they are highly water soluble (Ingelse et al., 2001; Ying et al., 2002) chemicals. There is a great concern on the movement of the pollutants in the aquatic system, and several papers appeared in recent years on the distribution (Yu et al., 2001; Isobe et al., 2001; Fries and Püttmann, 2004), accumulation (Tsuda et al., 1997; Ferreira-Leach and Hill, 2001) and degradation (Pehkonen and Zhang, 2002; Hirahara et al., 2003; Yuan et al., 2004) of these compounds.

Saemangeum Bay is located in the west coast of South Korean Peninsula (Fig. 1). In order to establish big industrial complexes and to develop farmland along the Bay, a 33-km dike has been constructed since 1991 and it will be finished by the year 2010. The dike separates Saemangeum Bay from sea and reserves fresh water from the Mangyeong and Dongjin River water. The total area of Saemangeum Bay is 401 km^2, among them the farmland and lake area are 283 and 118 km^2, respectively. It will be the largest manmade lake in Korea after the construction of 33 km sea-dike. In order to protect it from various pollutants as it happened in Lake Shihwa which is an artificial lake polluted heavily by industrial wastewater (Kim et al., 2003; Park et al., 2003; Li et al., 2004a), several programs have been initiated recently by Korean government. One of them is "Integrated Preservation Study on the Oceanic Environments in the Saemangeum Area". Our research group participated in that project with a focus on land based organic pollutants such as organophosphorus pesticides and surfactants.

The purpose of this study was to understand distribution levels of organophosphorus pesticides ($\sum$10OPs), chlorophenols ($\sum$2CPs), alkylphenols ($\sum$8APs) and bisphenol A in surface seawater from Saemangeum Bay. The study was focused on understanding spatial, diurnal, seasonal and annual variation of target analytes. The other purpose was to evaluate correlations between levels of organic pollutants and water quality parameters such as salinity, nitrate and phosphate in the Saemangeum seawater column. Based on those results, modeling studies will be carried out in our laboratory.

2. Materials and methods

2.1. Solvents and standards

Solvents employed (acetone, dichloromethane and hexane) were provide from Burdick & Jackson (USA) and the purity was GC analytical grade. Silylation reagent BSTFA (*N*,*O*-bis(trimethylsilyl)trifluoroacetamide) with 1% of TMCS was purchased from Aldrich (USA). For phenolic compound standards, surrogate standard (bisphenol A-*d*14), gas chromatography