WATER, AN IMPORTANT MEDIUM FOR INTRODUCING POLYCHLORINATED BIPHENYLS (PCBs) INTO THE FOOD WEB

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Introduction

Polychlorinated biphenyls (PCBs) are lipid soluble environmental contaminants. Due to their hydrophobic properties only a small fraction of the PCBs present in the aquatic environment is dissolved in water. The partitioning between the dissolved phase and that which is bound to particulates will depend on intrinsic properties of PCBs and on external parameters such as the amount of organic matter suspended in the water column. The octanol/water partitioning coefficient is often used as a measure of solubility in water and is found to increase with higher degree of chlorination[1].

The low concentration of PCBs in water, estimated to be of the order of pico to ng/l, has brought several scientists to conclude that water is an insignificant source of PCB exposure for the pelagic fauna[2] and therefore that contaminated food is the most important source of contamination[3]. Other authors, however, consider water as the most important source of exposure.[4,5] The disagreement is most likely due to the two factors involved in bioaccumulation. One factor is the ability of the PCB congeners to accumulate in organisms. This ability is found to increase with the octanol/water-partitioning coefficient[6]. The other factor is the ability to be bioavailable, which in contrast to the accumulation factor decrease with the octanol/water-partitioning coefficient[7]. The different conclusions depend on which of these two factors is attached the greatest importance.

When assessing human health and environmental risks and remedial action for PCB contaminated sites it is important to know whether water or sediments/particles is the most important source of exposure. In order to study water as a source of PCB exposure for aquatic organisms, Blue Mussels (*Mytilus edulis*) and lipid containing Semipermeable Membrane Devices (SPMDs) were placed in a cage one meter above the contaminated sediments at Haakonsvern Naval Base. After different periods of exposure the mussels and SPMDs were collected and analysed for individual PCB congeners.

Methods and Materials

Blue Mussels were collected in a reference area with low levels of PCBs. The SPMDs were supplied by Origo HB, Sweden and were of the type low-density polyethylene[8]. The Blue Mussels and the SPMDs were placed in their respective cages and lowered down in the water column to one meter above the contaminated sediments[9]. Three different stations, characterised as low, moderately and highly contaminated were used in the present study. About 25 Blue Mussels were collected and homogenised in each sample. The Blue Mussels were analysed by a congener specific method using microwave extraction, sulphuric acid cleanup and analysis by GC/ECD. The SPMDs were also analysed by a congener specific method using solvent extraction, sulphuric acid cleanup and analysis by GC/ECD.

Results and Discussion

As shown in figure 1, the PCBs in the different areas are accumulated by the mussels and are close to equilibrium after one month of exposure. When compared on a wet weight basis, the mussels and SPMDs reflect the levels of the congeners present in the sediment (Fig. 2). Since the mussels and the SPMDs are located one meter above the sediments this show clearly that water is a significant route of exposure to aquatic organisms. The SPMDs have a surface area that can be compared to the surface area of the gills of a fish. It is therefore likely that a fish could be contaminated to a similar degree[10]. The distribution of PCB congeners is different in the sediments, the SPMDs and the mussels (Fig. 3). There is a higher fraction of the low chlorinated biphenyls in the SPMDs and the mussels compared to the sediments. The fact that the low chlorinated biphenyls, which are more water soluble is accumulated despite their lower lipophilicity, indicates that it is the fraction of PCB dissolved in water that determines the bioavailability. It is important to be aware of that SPMDs concentrate only contaminants that are dissolved in the water[11], while mussels are filter feeders and thus also accumulate contaminants sorbed onto suspended particulates[12]. The distribution of congeners was also different in mussels exposed to high and moderate contaminated area compared to mussels exposed to low contaminated area (Fig. 4). This is most probably due to the fact that it is the low chlorinated biphenyls that are most soluble and volatile and thus to a wider extent are transported dissolved in water or by air.

The results indicate the significance of the dissolved PCBs for bioaccumulation in organisms. Even for benthic fauna the PCBs have to cross a barrier of water in order to be taken up. This should been taken into account when risk assessments are made and remedial actions are decided. A solution were the disposed PCB is in contact with water should be avoided.

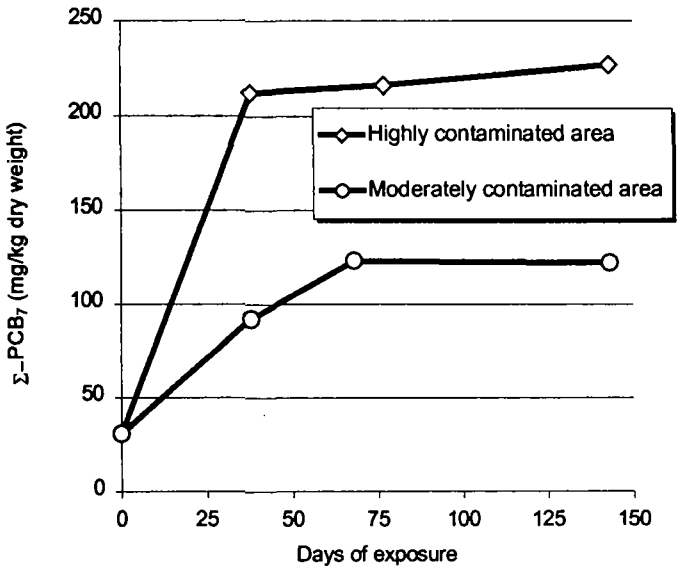

Fig. 1. Accumulation of PCB_7 (Seven Dutch) in Blue Mussel exposed in a highly contaminated area and a moderately contaminated area.

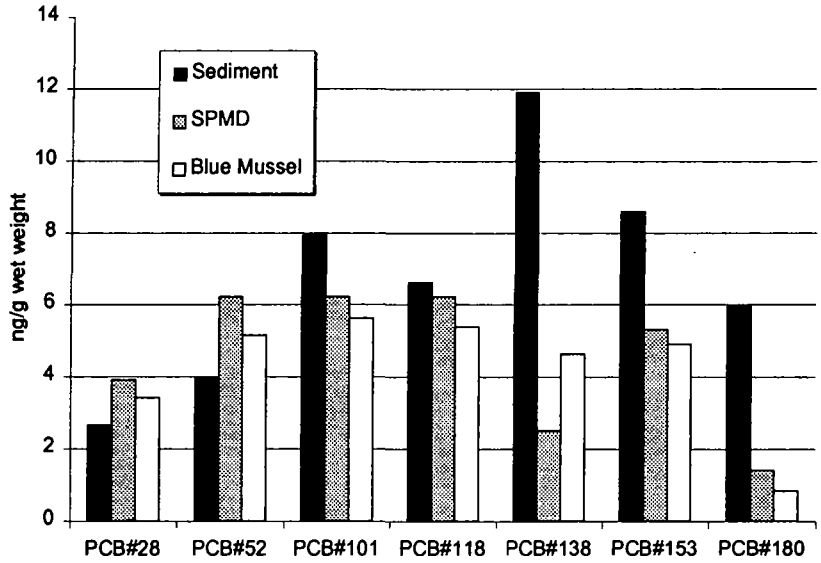

Fig. 2. Concentrations of 7 different PCB congeners in sediment, Blue Mussel (*Mytilus edulis*) and SPMD after 38 days of exposure in a moderately contaminated area.

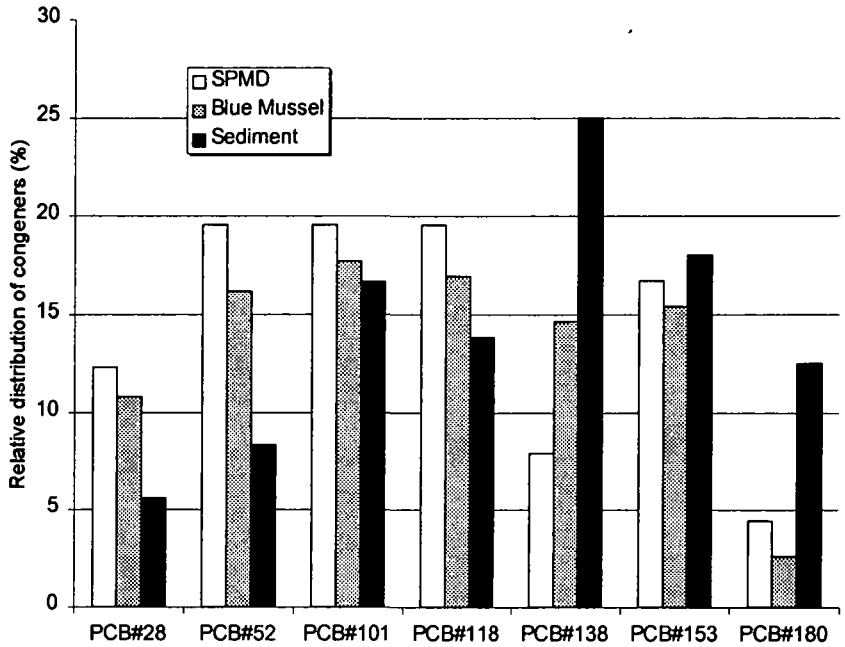

Fig. 3. Distributions of 7 different PCB congeners in sediment, Blue Mussel (*Mytilus edulis*) and SPMD after 38 days of exposure in a moderately contaminated area.

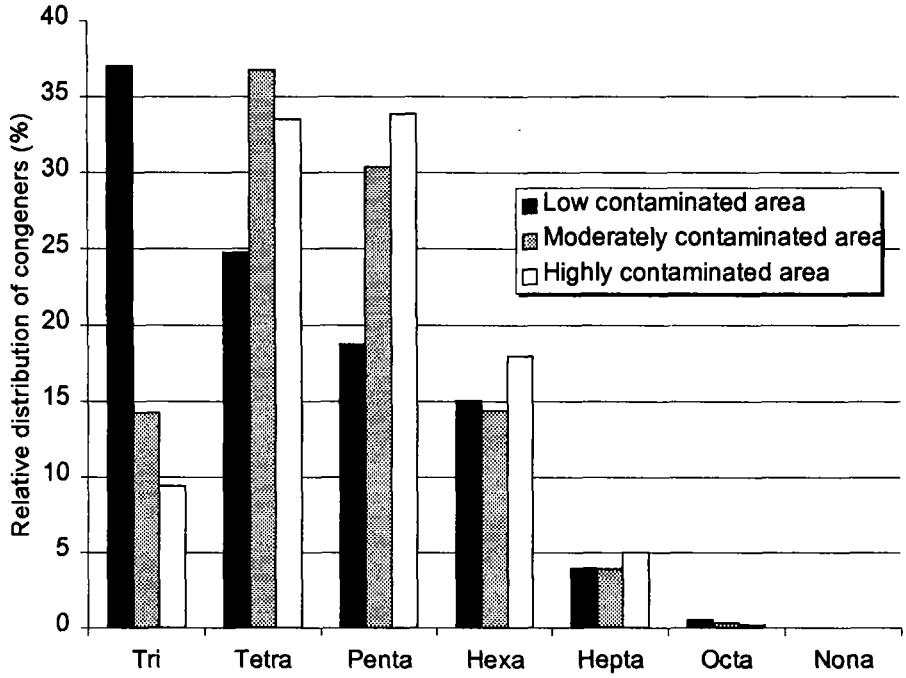

Fig. 4. Distribution of different classes of PCB congeners in Blue Mussel after 38 days of exposure in a low, moderately and highly contaminated area. The result is based on an analysis of 31 congeners.

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