COMPARISON OF BIOMAGNIFICATION OF PBDEs IN FOOD CHAINS FROM THE BALTIC SEA AND THE NORTHERN ATLANTIC SEA

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Introduction

Polybrominated diphenyl ethers (PBDEs) are highly hydrophobic halogenated aromatic compounds why there is a risk that they may turn out to be environmental pollutants like other such substance groups, e.g. polychlorinated biphenyls (PCBs). In spite of this, PBDEs are used as flame retardants in textiles and plastics in large amounts. Earlier, it has been shown that some PBDE congeners are efficiently absorbed from food in fish[1] and in a study on fish from the Baltic Sea, all investigated PBDEs (tri-hexa-BDEs) were shown to be biomagnified, that is were present at higher lipid weight based concentrations at higher trophic levels[2]. In the present study, we compare the concentrations of PBDEs in food chains from the Baltic Sea and the northern Atlantic Sea. We also calculate the concentration ratio between prey and predator as a measure of the biomagnification potential. According to a biomagnification model used by e.g. Broman et al[3] and by Rolff et al[4], the biomagnification of a persistent substance is independent on the concentration of the substance at the base of the food chain. Our hypotheses in the present study were that the concentrations of PBDEs are lower in the northern Atlantic Sea than in the Baltic and that the biomagnification of PBDEs occur in the same extent, i.e. the ratio between a prey and its predator is the same in spite of different concentrations.

Material and Methods

Baltic Sea: Sprat (*Sprattus sprattus*) (n=6, weight: 7,0-9,8g), herring (*Clupea harengus*) (n=6, weight: 9,7-24,3g) and salmon (*Salmo salar*) (n=10, weight 7,70-13,94kg) were caught in the central and northern part of the Baltic proper in the summer and autumn 1998.
Northern Atlantic Sea: Zoo plankton (mainly *Calanus finmarchius* and other copepods) (3 samples, wet weight: 3,8-6,6g), small herring (*Clupea harengus*) (n=3, weight: 26-41g), large herring (*Clupea harengus*) (n=2, weight:313-339g) and salmon (*Salmo salar*) (n=2, weight: 6,5-8,7kg) were caught in the Atlantic Sea off Iceland in the summer 1998.

For analysing of PBDEs, extraction, clean up and lipid determination was performed according to Jensen et al.[5]. Before extraction, 13C-labelled PCB #180 was added as internal standard. Analyses of PBDEs were performed using a HP 6890 GC coupled to a Micromass AutoSpec Ultima mass spectrometer (EI, 32 eV). A 15m, 0,25mm Supelco PTE-5 column with 0,25 µm film thickness was used and the samples were on column injected. Quantification of the PBDEs were done after calculating the relative response factors of the individual congeners relative to the internal standard. The individual PBDE congeners were synthesised by Åke Bergman's group at the department of Environmental Chemistry at Stockholm University.

Result and Discussion

Tri- tetra- penta- and hexa-BDE were detected in all species. The concentrations of the PBDEs are shown in Table 1. In general, much higher concentrations of PBDEs are present in biota from the Baltic Sea than the Atlantic Sea. The most abundant PBDE congeners are tetra- and penta-BDEs.

Asplund et al[6] reported considerably higher lipid weight based concentrations of PBDEs in Baltic salmon muscle tissue. The difference between the two studies might be explained by the obvious different metabolic status of the animals (4,7% and 14,7% respectively). The lipid content of Atlantic salmon is in the present study 10,5%.

Table 1: Concentrations (ng/g lipid) of PBDEs in the samples

	35	**28**	**51+49**	**47**	**100**	**99**	**155**	**154**
No of Br	3	3	4	4	5	5	6	6
Atlantic Sea								
zoo plankton	0	0	0,1	2,0	0,5	1,4	0	0
small herring	0,2	0,3	0,5	2,2	0,3	0,4	0	0,1
large herring	0,4	0,8	1,6	4,1	0,7	0,4	0,2	0,3
salmon	0,4	1,2	0,9	7.6	1,8	1,5	0,5	1,1
Baltic Sea								
sprat	0,4	0,3	2,6	6,8	2,5	1,7	0	0,3
herring	0,4	0,7	4,3	19.1	5,3	2.8	0	0,8
salmon	1,8	1,0	11,7	45,8	13,0	10,0	0,4	1,6

In the Baltic, the trophic position of the three fish species have been shown to increase in the order sprat-herring-salmon[7,8]. In the Atlantic there is no sprat, but we have included both small and large herring in this study in order to measure the concentrations in both piscivorous and planktivorous fish species.In general, there is a positive correlation between trophic level and PBDE concentration. This indicates biomagnification of these substances which is apparent in Figure 1.

Exceptions to this are PBDEs #100 and 99 that are lower in small herring than in zoo plankton in the Atlantic and PBDE #(51+49) that are lower in salmon than in the average of large and small herring in the Atlantic. The highest predator to prey concentration ratios are present for the hexabrominated PBDEs #154 and 155 between salmon and average herring in the Baltic. It has earlier been shown that the dietary uptake efficiency is negatively correlated with the number of bromine atoms in PBDEs (Burreau et al., 1997). This indicates that the clearance of hexa-BDEs is inefficient compared to the lower brominated PBDEs, probably due to their high lipophilicity. No obvious difference in the predator-prey concentration ratios between the Baltic Sea and the Atlantic Sea could be observed.

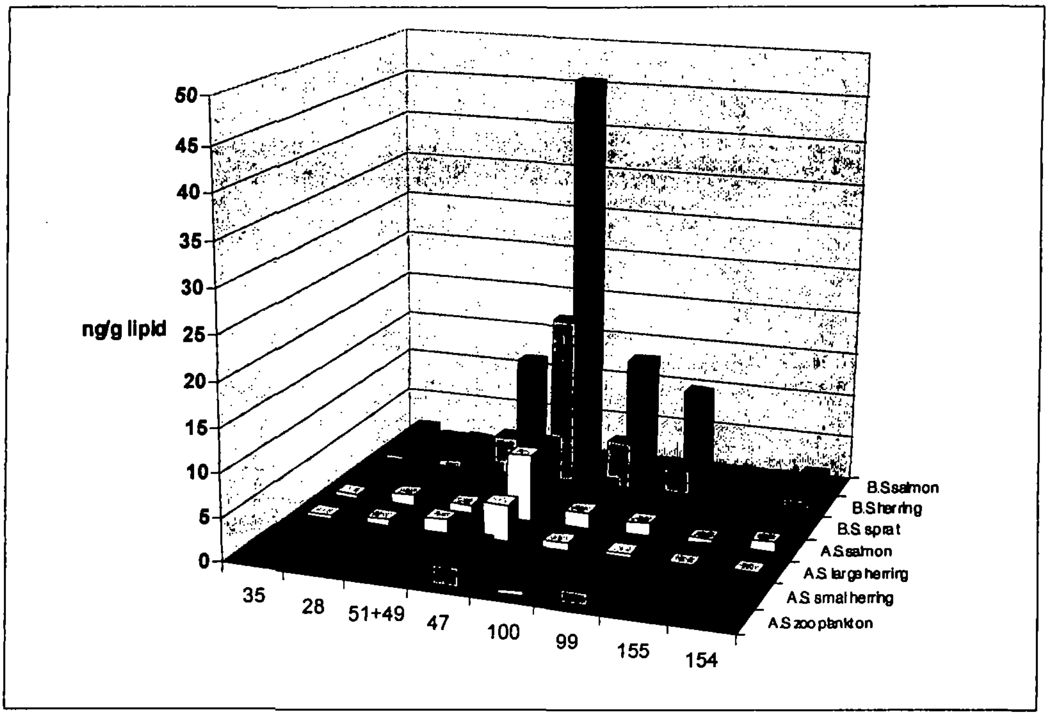

Fig. 1: Mean concentrations of PBDEs in the samples

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