ISOMER SPECIFIC BIOACCUMULATION OF HEXABROMOCYCLODODECANE (HBCD) IN A MARINE FOOD WEB FROM ÅSEFJORDEN, WESTERN NORWAY

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Faeces piles from lugworm, *Arenicola marina*

Blue mussel, *Mytilus edulis*

Shore crab, *Carcinus maenas*

Common eider, *Somateria mollissima*

Great black-backed gull, *Larus marinus*

INTRODUCTION

Brominated flame retardants (BFRs) are fire preventive chemicals used in industrial products. 1,2,5,6,9,10-hexabromocyclododecane (HBCD) is globally the third most used BFR (BSEF 2006). The environmental levels of HBCD have increased during the last decade concomitantly with the restrictions on the use of polybrominated diphenyl ethers (PBDEs). Due to its stability and persistence, HBCD has been found widely distributed over the northern hemisphere. The three HBCD isomers α, β and γ behave differently in the environment, and there are indications of a selective biomagnification of the α-isomer in aquatic food webs (Morris et al. 2004, Tomy et al. 2004, Law et al. 2006, Sørmo et al. 2006). The present study is an assessment of a defined littoral food web in a contaminated fjord on the west coast of Norway. Species investigated include blue mussel (*Mytilus edulis*), lugworm (*Arenicola marina*), shore crab (*Carcinus maenas*), common eider (*Somateria mollissima*) and great black-backed gull (*Larus marinus*)

OBJECTIVE

The main objective of this study was to assess the isomer specific bioaccumulation potential of HBCD in a marine food web with a point source of exposure

MATERIALS AND METHODS

Sampling

All organisms were collected in inner parts of Åsefjorden during spring/summer 2006 and 2007. One area close to the source (Spjelkavika) and one approximately 5 km from the source (Tørla/Humla) were identified for sampling (Fig.1). Compound samples were obtained from blue mussels and individual specimen samples of lugworm, crab and seabird eggs

Figure 1:
The study area, Åsefjorden, with the two sampling sites Spjelkavika (red arrow) and Tørla/Humla (red circle)

Chemical analyses

All samples were subjected to cold column extraction followed by clean-up with silica and sulphuric acid. Extracts were analyzed for α-, β- and γ-HBCD using HPLC/MS. Lipids were determined gravimetrically. All samples were analysed for stable nitrogen isotopes ($^{15}N/^{14}N$) using IRMS for determination of trophic level.

RESULTS

- The area close to the source (Spjelkavika), displayed the highest ΣHBCD concentrations for all five species (Fig. 2a). Mean concentrations (ng/g lw) of ΣHBCD increased in the order common eider (137) < great black-backed gull (151) < shore crab (314) < blue mussel (1376) < lugworm (7238)
- ~5 km from the source (Tørla/Humla), ΣHBCD showed the same pattern of increase, except that the great black-backed gull held the highest mean concentration (ng/g lw): common eider (42.3) < shore crab (54.1) < blue mussel (79.3) < lugworm (80.1) < great black-backed gull (160) (Fig. 2b)
- The relative isomer contribution showed indications of an increase in α-HBCD and a concomitant decrease in γ-HBCD with trophic level in both areas (Fig. 2)
- Redundancy analyses (RDAs) demonstrated that trophic level could significantly explain 57.8 and 43.6 % of the total variance of HBCD concentrations in Spjelkavika and Tørla/Humla, respectively (Fig. 3)

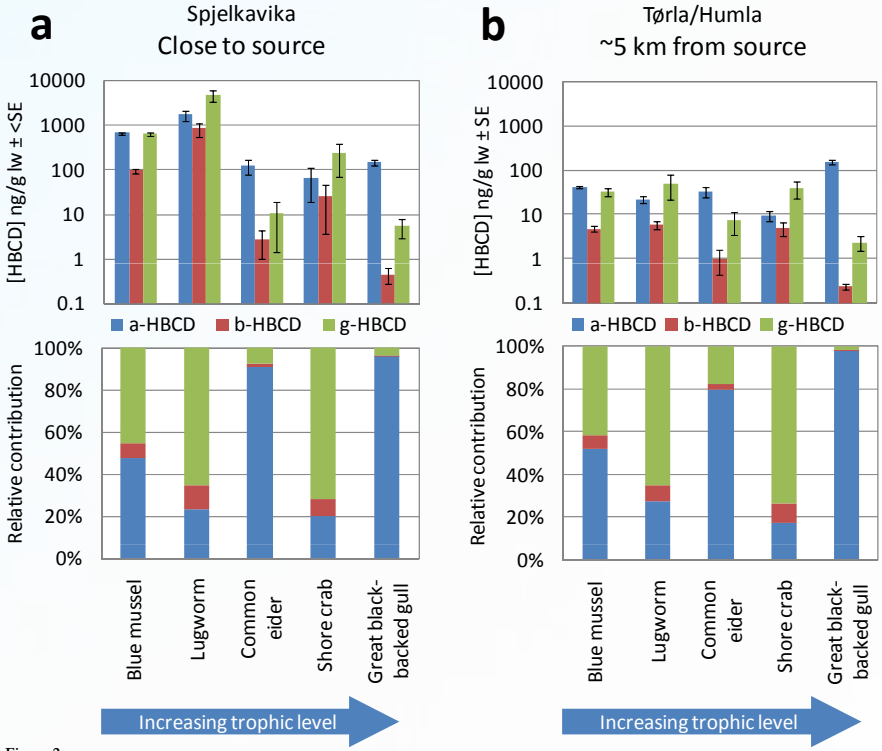

Figure 2:
Species-specific concentrations (ng/g lipid weight) and relative isomer contribution of α-HBCD (blue), β-HBCD (red) and γ-HBCD (green) in Spjelkavika (a) and in Tørla/Tumla area (b). The species are arranged by increasing trophic level

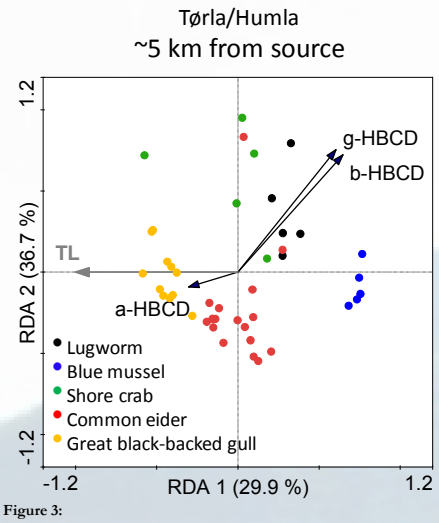

Figure 3:
Ordination diagrams based on redundancy analyses of the relationship between trophic level (TL) and α-, β- and γ-HBCD in the Tørla/Tumla area

- In Spjelkavika, the three HBCD isomers were significantly positively intercorrelated, but showed negative relationship with trophic level. The Tørla/Humla food web displayed no linear relationship between α-HBCD and the two other positively correlated isomers (Fig. 3). The β- and γ-isomers showed a significant negative relationship with trophic level, whereas the α-isomer displayed a positive , but not significant, correlation with trophic level

CONCLUSIONS

- Food web concentrations of all three HBCD isomers were higher close to the point source, especially for the low trophic level species blue mussel and lugworm
- Despite the difference in concentration between the two sampling sites, the relative isomer contribution did not change with distance from the contamination source
- The shift in relative isomer contribution, from a technical mixture-like pattern with predominance of γ-HBCD in the invertebrates, to a majority of α-HBCD in the seabirds suggests that species- and isomer-specific metabolism of HBCD might be present
- Results from the RDAs indicate that α-HBCD has some potential for biomagnification, whereas β- and γ-HBCD appear to be reduced with increasing trophic level

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