CHANGES OF PCBS, PBDES AND HBCD IN BREAST MILK DURING UP TO TEN MONTHS OF LACTATION

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Abstract
Eight primiparous mothers and one mother breast feeding her second child collected breast milk samples monthly from from about two weeks after birth to up to ten months (n = 67). Seventeen polychlorinated biphenyls (PCBs), 12 polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane (HBCD) were determined in the breast milk samples. Both PCBs, PBDEs and HBCD breast milk concentrations were found to change little throughout the lactation period, while the levels of BDE-209 were more variable. The concentrations measured were in close agreement with what has been found in other studies in Norway. For the secondiparous mother, breast milk PBDE concentrations were almost exactly the same as those found during nursing of her first child. The PCB levels on the other hand, were somewhat lower during the second breast feeding period.

Introduction
Breast milk is the natural and optimal food for infants. In addition to meeting nutritional needs, breast milk provides numerous immunologic, developmental, psychological, economic and practical advantages. However, questions have been raised whether environmental chemicals in breast milk might adversely affect infant development and health. Although extensive information on the presence of the well known persistent organic pollutants (POPs) PBDEs, HBCD and PCBs in breast milk is available, there are at present few time dependent data. Past studies have shown that concentrations of persistent lipophilic chemicals typically, but not always decline during the course of lactation[1]. However, Hooper et al.[2] recently reported that the concentrations of PBDEs and PCBs in breast milk from primiparous mothers not were substantially reduced after 6 months of breast-feeding. Preliminary data from another ongoing study also suggests low depuration rates for PBDEs and PCBs [3]. Norwegian mothers are among the most persevering breast-feeders in the world, and more than 80% of all babies are breast fed at the age of six months. The aim of this study was to investigate the elimination rates for PBDEs and PCBs during the lactation period by measuring concentrationS in longitudinally collected breast milk samples from Norwegian mothers.

Materials and Methods
Study subjects
Eight mothers living in the Oslo area donated breast milk for this study. One mother provided samples from the nursing periods of both her first and second child. Informed consent was obtained from all the mothers. The breast milk samples were collected monthly by hand expression from about two week after birthfor to up to ten months; the number of samples for each mother was from n = 5 to n = 10 (n = 67 in total). Three mothers sampled breast milk during 2001 and 2003, while six sampled during 2005 and 2006. The mothers also filled in a questionnaire regarding dietary habits and personal background data. The mothers were 27 to 32 years old.

Chemicals
HBCD, PBDE and PCB standards (both native and labelled) were obtained from Wellington Laboratories (Guelph, Ontario, Canada), CIL (Andover, MA) or AccuStandard (New Haven, CT). All solvents used were of pesticide grade from sds (Peypin, France) and sulphuric acid, silica gel and sodium sulphate were from Merck (Darmstadt, Germany).

Chemical analysis
In brief; five grams of milk were extracted using 15 ml of methanol/diethyl ether/n-heptane (1/1/1), and the extracts subsequently cleaned up on sulphuric acid-silica columns with a layer of silica on top, using an automated solid phase extractor (ASPEC XL4, Gilson, Middleton, WI). The lipid content was determined gravimetrically. Separation and quantitative determination were performed by LRGC-MS in the electron capture mode with methane as buffer gas as previously described[4]. The quality of the determinations in the study was controlled by analysing in-house quality control samples of breast milk. Nine procedural blanks were included in the analysis series, in which BDE-47, 99 and 209 were found in almost all, and the measured concentrations of BDE-47, 99 and 209 in the breast milk samples were corrected by subtracting the mean blank level (half the mean blank level for BDE-209). The amounts of PCBs in the procedural blanks were negligible. The total uncertainty of the analytical method was found to be about 20%.

Results and Discussion
Up to 11 BFRs (BDE-28, 37, 47, 85, 99, 100, 153, 154, 183, 209 and HBCD) and 17 PCBs (CB-101, 105, 114, 118, 123, 128, 138, 153, 156, 157, 167, 170, 180, 183, 187, 189, 194 and 209) were determined in the 67 breast milk samples. The sum of the 7 most abundant tri-to heptabrominated PBDEs (BDE-28, 47, 99, 100, 153, 154 and 183) ranged from 1.7 to 13 ng/g lipids, BDE-209 and HBCD were found in concentrations ranging from <LOQ to 3.3 ng/g lipids and <LOQ to 3.0 ng/g lipids, respectively. BDE-209 and HBCD were observed >LOQ in 45 of 47 and 32 out of 67 samples. These BFR concentrations are within the ranges that were found in a large study on breast milk from background exposed Norwegian mothers[5]. On a ng/g lipid basis, BDE-47 was dominant in all but nine samples (five of which were from the same mother) in which BDE-209 was found at highest concentration.The sum concentration of PCB-101, 118, 138, 153 and 180 ranged from 53 to 157 ng/g lipids which is in the lower part of the concentration range for the corresponding PCBs found in serum from Norwegian men and women[6]. The highest concentration was observed for CB-153, followed by CB-180, 138, 118, 170, 156 and 183 etc. The mean lipid content in the breast milk samples was 3.2% (range 0.61 to 7.67%).

As can be seen from Figure 1, the concentration of BDE-47, BDE-153, BDE-209, HBCD and CB-153 varied differently throughout the lactation period for the individual mothers. (The same patterns were observed for the other PBDEs and PCBs.) With the exception of mother 3, the BDE-47 and 153 levels were quite stable during the individual sampling periods. The variation was in general below 20% RSD. Even less variation was observed for CB-153 (RSD ~10%). In contrast, BDE-209 concentrations were more variable (RSD 16-148%). If comparing the levels in the first breast milk samples collected after birth with the samples about six months later, the PBDE and PCB levels had decreased in six and seven of the sample sets, respectively, indicating a slow depuration. This is in accordance with the results in the recent study by Hooper et al.[2], where a monthly depuration rates for PBDEs and PCBs were estimated to be 1-3%. A distinct decrease in BDE-47 concentration through the lactation period was observed for mother 3 who had the highest breast milk BDE-47 concentration in the data set. The reason for this difference is unknown. Hooper et al. (2007) observed very similar depuration slopes for BDE-47 during about six months of lactation irrespective of the initial levels.

One mother (mother 2) sampled breast milk when nursing both her first and second child. The concentrations of the five most abundant PBDEs (except BDE-209) and PCBs relative to the number of days after birth (DAB) the breast milk was sampled, are shown in Figure 2. The PBDE levels were almost exactly the same in the two sample series, except for BDE-99, which was lower during breast feeding of the second child. Thus, the lactational PBDE-exposure for the second child is about the same as for the first child. The PCB levels on the other hand, were somewhat lower in the second sample set. It is interesting to note that there was a change in BDE pattern in the first phases of nursing the first and the second child. Concentrations of BDE-153 were higher than those of BDE-99 for the first child, but the reverse order was observed for the second child

Findings in this study indicate that the PBDE and PCB concentrations in breast milk change only very slowly during the breast feeding period. Thus, breast feeding does not reduce the mothers' body burden of these pollutants to a large extent, and the first and second child seems to be almost equally exposed through lactation. This is advantageous for breast milk monitoring studies since the choice of sampling time point is less crucial, and thus such studies easier to perform.

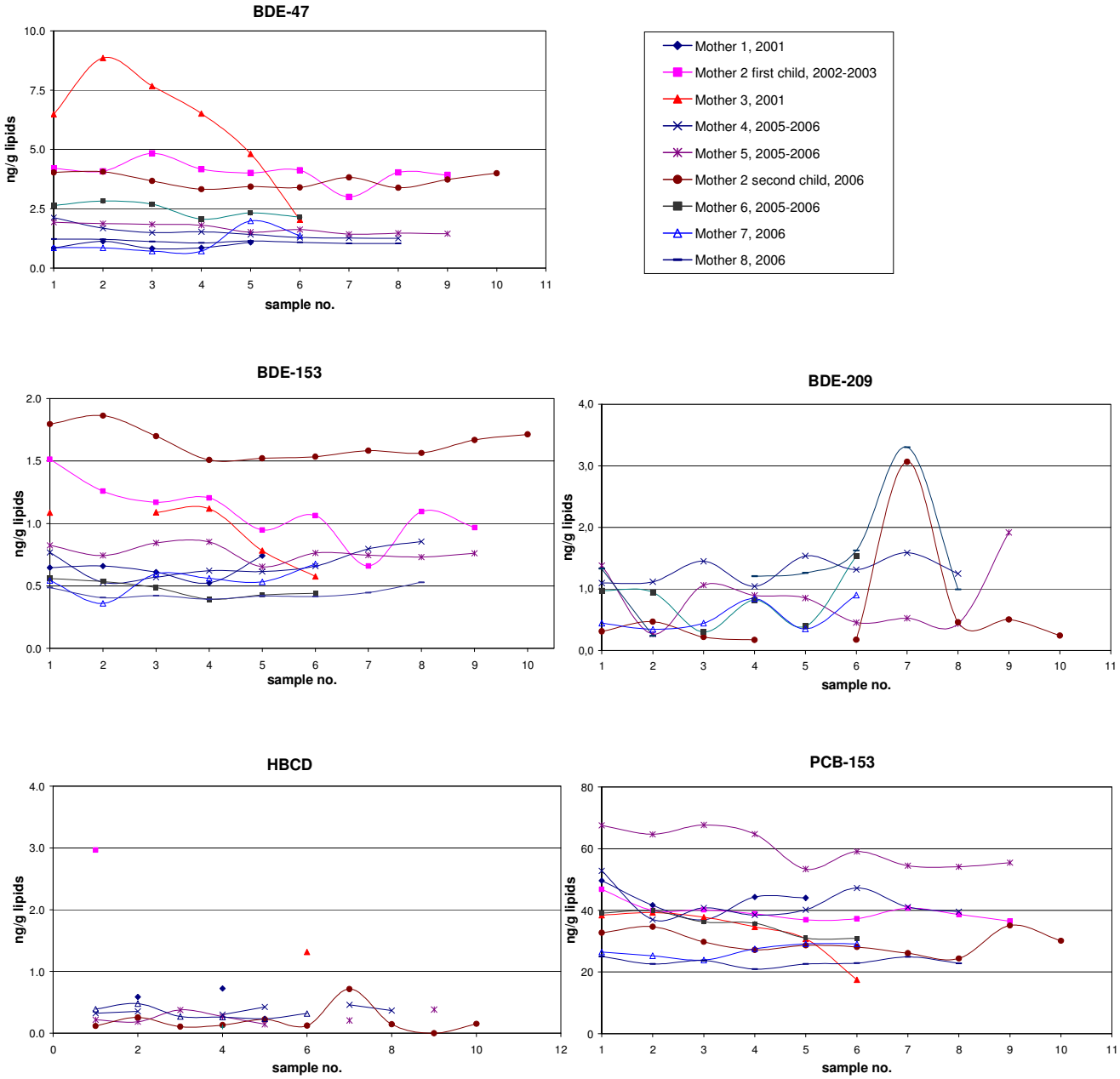

Figure 1. The concentration of BDE-47, BDE-153, BDE-209, HBCD and PCB-153 in breast milk from eight mothers sampled monthly during up to ten months of lactation.

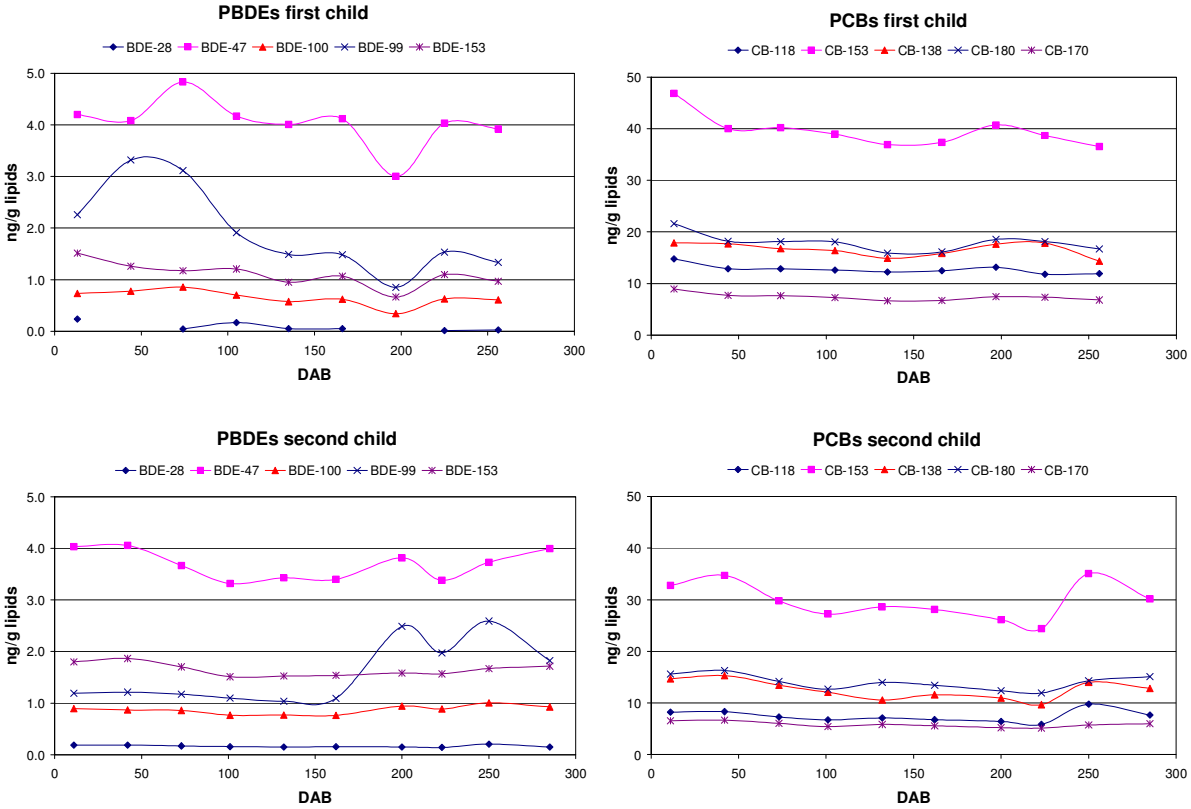

Figure 2. The concentration of the five most abundant PBDEs (except BDE-209) and PCBs in breast milk sampled when mother 2 breast-fed her first and second child. (DAB: days after birth)

Acknowledgements
We greatly acknowledge all the mothers who voluntarily donated breast milk over a long period of time.

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