Analysis of brominated flame retardants in liver samples of lynx from the Norwegian biota

Espen Mariussen[1], John Atle Kålås[2], Anders Borgen[1], Torgeir Nygaard[2] and Martin Schlabach[1]

[1] *Norwegian Institute for Air Research, P.O.Box 100, N-2027 Kjeller, Norway.*

[2] *Norwegian Institute for Nature Research, Tungasletta 2, N-7485 Trondheim, Norway.*

Introduction

The worldwide use of brominated flame retardants (BFRs) is extensive and there is significant release of these components to the environment. Recent studies have revealed that several BFRs bioaccumulate in the food web. The general view is that the highest concentrations are found in animals at the top of the trophic levels, and which have based their nourishment on food of marine or limnic origin. Relatively little information is available about BFRs accumulated in terrestrial animals. This study present levels of polybrominated diphenyl ethers (PBDEs) in the liver of the top predator lynx and in some animal species representing their potential preys.

Materials and Methods

Sample collection

Samples of livers from five different animal species species were collected from different part in Norway. The animal species collected were lynx (*Lynx lynx*), grouse (*Lagopus* sp.), western roe deer (*Capreolus capreolus*) and moose (*Alces alces*).

Extraction and clean up

Livers were homogenized in Na_2SO_4 to remove water, spiked with internal standards (BDE71 and C13-BDE209) and subjected to cold extraction with cyclohexane and ethylacetate. The crude solvent extract where cleaned by eluting the extract through a column with acid treated silica with 3% ether in hexane. The purified extracts were added recovery standard and subjected to GC-MS analysis.

Analysis of PBDE by GC-MS

Analysis of the PBDEs in the livers were performed by GC/HRMS in EI mode detected by monitoring at *m/z* of the molecular ions with BD-E71 as internal standard, or by GC/LRMS in the NCI mode monitoring at *m/z* 79 and 81 with methane as the chemical ionisation gas. The PBDE were separated by a fused silica capillary column (J&W S, Ultra 2, 25m, 0.2mm id, 0.11µm film thickness or a HP5, 20m, 0.25mm id, 0.10µm film thickness).

Results and Discussion

Table 1a. Mean concentration (pg/g wet weight) of seven PBDE congeners in livers from four different animal species.

PBDE / Animal	BDE-28	-47	-99	-100	-153	-154	-183	SUM
Lynx (1993/1994)	2.1	58.6	29.5	1.1	401	8.2	76	536
Moose (1995)	1.2	13.9	16.1	2.4	4.9	1.7	2.7	39.9
Western roe deer (1995)	3.6	28.6	25.4		24.1	1.5	4.3	72.6
Grouse (1990/1993)	4.6	10.4	10.3		2.8	1.7		24.7

Table 1b. Mean concentration (pg/g lipid weight) of seven PBDE congeners in livers from four different animal species.

PBDE / Animal	BDE-28	-47	-99	-100	-153	-154	-183	SUM
Lynx (1993/1994)	36	1004	447	23	7768	131	1077	9870
Moose (1995)	24	311	358	47	105	27		873
Western roe deer (1995)	110	881	799		383	24		2198
Grouse (1990/1993)	120	271	270		73	44		643

PBDEs were found in all samples, but at relatively low levels.
An interesting observation was the relatively high level of BDE-153 in the lynx samples.

Table 2a. Median concentration (pg/g wet weight) of seven PBDE congeners in livers from lynx caught in 1993/1994 and 2002.

PBDE / Animal	BDE-28	-47	-99	-100	-153	-154	-183	SUM
Lynx (1993/1994)	2.4	29	8.2	1.1	441	3.3	6.8	462
Lynx (2002)	2.6	69	19	4.9	431	8.6	13	582

Table 2b. Median concentration (pg/g lipid weight) of seven PBDE congeners in livers from lynx caught in 1993/1994 and 2002.

PBDE / Animal	BDE-28	47	-99	-100	-153	-154	-183	SUM
Lynx (1993/1994)	42	629	183	23	8391	60	152	8452
Lynx (2002)	58	1498	448	98	9567	154	249	9570

Table 3 shows mean, media and range of SUM PBDEs in lynx liver.

	PBDEs *ng/g wet weight*			PBDEs *ng/g fat weight*		
	Mean	Median	Range	Mean	Median	Range
Lynx, 1993/1994 (n=7)	0.536	0.44	0.22-1.44	9.9	8.5	4.7-19.6
Lynx, 2002 (n=19)	2.57	0.58	0.12-13.3	50	9.6	3.3 313

The variation of the results within sample groups was high. Indications of a historical trend, but not significant.

Table 4a. Mean concentration (pg/g wet weight) of seven PBDE congeners in livers from grouse caught in 1990/1994 and 2000 from two different localities.

PBDE / Animal	BDE-28	-47	-99	-100	-153	-154	-183	SUM
Grouse 1990, Location 1	3.6	11.1			2.7	1.7		19.0
Grouse 2000, Location 1	1.8	9.8	2.9					14.5
Grouse 1993, Location 2	5.6	9.8	10.3		2.9	1.8		30.4
Grouse 2000, Location 2	9.4	20.6	12.5	2.2	2.1	2.9		49.7

Table 4b. Mean concentration (pg/g lipid weight) of seven PBDE congeners in livers from grouse caught in 1993/1994 and 2000 from two different localities.

PBDE / Animal	BDE-28	-47	-99	-100	-153	-154	-183	SUM
Grouse 1990, Location 1	92	285			69	43		488
Grouse 2000, Location 1	53	281	84					419
Grouse 1993, Location 2	148	256	270		77	46		798
Grouse 2000, Location 2	241	527	320	57	55	75		1275

There were indications of a spatial trend, but no clear indications of a historical trend.

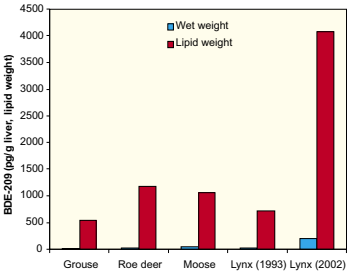

Fig 1. The level of the decabrominated BDE209 in liver samples from different animal species.

BDE 209 was found in most of the samples. Some indications of a historical trend was observed in the lynx samples. In the moose samples BDE209 was mainly found from a certain region in northern parts of Norway (Troms).

Conclusions

- PBDEs, including BDE209, are accumulated in terrestrial animals
- Highest concentrations found in the top predator lynx
- Generally, no clear historical trend the past ten years
- The levels are considerable lower than found in marine organisms