CBS LEVELS IN DEER TISSUE SAMPLES FOLLOWING AN ACCIDENTAL RELEASE FROM A SPECIAL WASTE TREATMENT CENTER: 2001 RESULTS

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Introduction

In early 1997, high levels of PCDDs/Fs and CBs were detected in deer and moose tissues from the Swan Hills area, Alberta, Canada, following an accidental release of these contaminants from a Special Waste Treatment Center in October 1996.[1] Follow-up wild game sampling was conducted in 2000/01 to examine changes in CBs concentrations in tissues of whitetail deer (*Odocoileus virginianus*) and mule deer (*Odocoileus hemionus*) collected in the same geographic location as in 1997 and 1998/99.[2]

Materials and Methods

Sampling

Field collection was carried out in December 2000 and January 2001. Six whitetail deer and mule deer were collected at distances of 1 - 30 km to the east and west of the Special Waste Treatment Center. Representative muscle, liver and fat samples were taken from each deer. All samples were kept frozen at - 20 °C prior to analysis.

Contaminants Analysis

PCDDs/Fs and CBs determinations for all samples were performed by the Fisheries and Oceans Regional Dioxin Laboratory at the Institute of Ocean Sciences in Sidney, British Columbia, Canada. The methodologies used to process the samples, the criteria used for identification and quantification and the quality assurance quality control protocols were described in detail elsewhere.[3] Briefly, from each sample four aliquots were collected by carbon-fibre fractionation, the last part of the sample clean-up process. Fraction-I contained the *di-ortho* CBs, fraction-II the *mono-ortho* CBs, and fraction-III the *non-ortho* CBs. In fractions I to III all possible 209 CB congeners were measured with minimum isomeric interference.[3] Analysis of all fractions was conducted by high-resolution gas chromatograph/high-resolution mass spectrometry (HRGC/HRMS).[3] For all analyses the MS was operated at 10 000 resolution under positive EI conditions and data were acquired in the Single Ion Monitoring Mode (SIM). The concentrations of identified compounds and their minimum detection limits (MDLs) were calculated by the internal standard method using mean relative response factors determined from calibration standard runs, made before and after each batch of samples was run. Detection limits ranged from 0.04 to 0.08 pg/g for *non-ortho* CBs, 0.1 pg/g for *mono-ortho* CBs and 0.1 to 0.2 pg/g for *di-ortho* CBs.

Results and Discussion

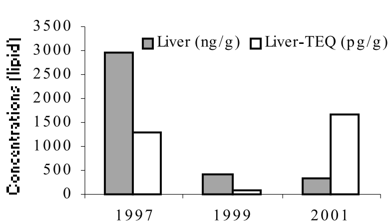
The mean values of ΣCBs and their homologues are summarized in Table 1, 2 and 3. A total of 209 CB congeners were analyzed (see note in Table 1). In the 2001 study, 49 of 209 CB congeners were not detected in the muscle samples, 45 congeners were not detected in the liver and 35 congeners were not detected in the fat. The mean level of CB homologues in the 2001 study was 291 ng/g, lipid basis in the muscle, 317 ng/g in the liver and 506 ng/g in the fat. *Di-ortho* CBs constituted 82 % to 92 % of SCBs for the samples from the 2001 study area as compared to 55 % to 58 % in the control areas. *Non-ortho* CBs constituted very small proportion of ΣCBs.

The concentration of ΣCBs was significantly higher in the muscle and liver in 2001 than those in 1999. Particularly, the levels of penta-CBs and hexa-CBs in *mono-ortho* group and hexa-CBs and hepta-CBs in *di-ortho* group were largely increased. CB-153, CB-138 and CB-180 were the major contributing congeners to these increased levels. CB-153 accounted for 22% to 28% of ΣCBs in all types of samples in the 2001 study, 11 % to 15 % for CB-138 and 13 % to 17 % for CB180. For samples from the 1999 control area, CB-8, CB-28, CB-138, CB-153 and CB-180 accounted for 11 %, 6 %, 4 %, 6 % and 2 % of ΣCBs, respectively. The major contributors in deer from the control site were the lower-chlorinated congeners. Lower chlorinated congeners are likely to persist in vegetation. Thus, they are more frequently detected in herbivores. High proportion of some higher chlorinated congeners observed in deer from the study area suggests different exposure sources for deer in this area.

The highest ΣCBs concentrations were observed in the tissues of one deer collected at a distance of 0.5 km from the facility in 2001 and 1.0 km from the facility in 1999. Similarity to the 1997 results,[4] the PCBs concentrations in all the samples have decreased with distance from the facility. The mobility of white-tail and mule deer is restricted to a radius of 4 to 5 km in winter. This finding suggests that contamination has occurred in the ecosystem in vicinity of the facility and that PCBs have accumulated in deer.

The mean values of ΣCBs-TEQ are also summarized in Table 4. Very high levels of CB-126 (166 ng/g, lipid basis) and CB-126-TEQ (1660 pg/g, lipid basis) were observed in the livers in the 2001 study area. CB-126 TEQ accounted for 99 % of ΣCBs-TEQ and 12 % of STEQ in the liver, 56 % of ΣCBs-TEQ and 21% of STEQ in the muscle and 64 % of ΣCBs-TEQ and 30 % of ΣTEQ in the fat. CB-126 may be a marker congener present in the emissions of the special waste treatment facility as it has been observed to be a major congener in soil, vegetation, sediment, fish and voles collected near the facility since 1996.

In summary, overall levels of ΣCBs in the liver and muscle in 2001and 1999 declined as compared to the 1997 levels (Figure A and Figure B). The levels of ΣCBs TEQ increased in the liver in 2001 as compared to those in the 1997 and 1999 studies (Figure A). Overall levels of ΣCBs TEQ in the muscle in 2001and 1999 declined as compared to the 1997 levels (Figure B).



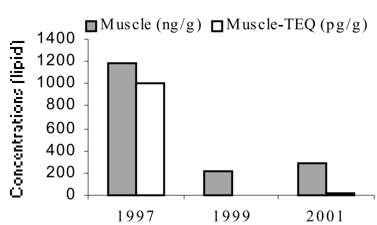


Table 1. Mean of ΣBs Homologues in Deer Muscle (ng/g, lipid basis)

Group	2001 Study Area	1999 Study Area	1999 Control Area	Group	2001 Study Area	1999 Study Area	1999 Control Area
	(N=6)	(N=9)	(N=10)	(N=6)	(N=9)	(N=10)	

*Non-ortho**				Di-ortho***			
Di-CBs	0.67	0.40	0.23	*di-CBs*	0.23	0.04	0.06
Tri-CBs	1.17	0.24	0.08	*tri-CBs*	1.58	0.34	0.31
tetra-CBs	0.51	0.09	0.06	*tetra-CBs*	5.72	0.75	0.49
penta-CBs	0.13	0.07	0.01	*penta-CBs*	22.03	1.25	0.53
hexa-CBs	0.04	0.004	0.002	*hexa-CBs*	115.67	7.58	1.00
Total *non-ortho*	**2.52**	**0.80**	**0.38**	*hepta-CBs*	79.49	4.74	0.46
				octa-CBs	28.19	1.83	0.16
*Mono-ortho***				*nona-CBs*	2.34	0.24	0.04
di-CBs	0.00	0.32	0.72	*deca-CBs*	0.37	0.08	0.07
tri-CBs	3.46	0.92	0.68	**Total *di-ortho***	**256**	**16.86**	**3.11**
tetra-CBs	7.74	0.39	0.20				
penta-CBs	13.75	1.32	0.21	**Total CBs**	**291**	**21**	**5.3**
hexa-CBs	7.05	0.51	0.06	% of *non-ortho*	1.0	4.0	7.0
hepta-CBs	0.60	0.06	0.002	% of *mono-ortho*	11	17	35
Total *mono-ortho*	**32.6**	**3.52**	**1.87**	% of *di-ortho*	88	79	58

* Non-ortho CBs: di- (no.11-14), tri- (no. 35-39), tetra- (no. 77-81), penta- (no. 126, 127) and hexa- (no. 169). ** *Mono-ortho* CBs: di- (no.5-9), tri- (no. 20-23, 25-26, 28-29, 31, 33-34), tetra- (no. 55-58, 60-61, 63, 66-67, 68, 70, 72, 74, 76), penta- (no. 105, 107, 108, 111,114, 118, 120, 122-124), hexa- (no. 156, 157, 159, 162, 167) and hepta- (no.189). *** *Di-ortho* CBs: di- (no.4, 10), tri- (no. 16-19, 24, 27, 30, 32), tetra- (no. 40-54, 59, 62, 64, 69, 71, 73, 75), penta- (no. 82-104, 109-110, 112-113, 115-117, 119, 121, 125), hexa- (no. 128-155, 158, 160, 161, 163-166, 168), hepta- (no. 170-188, 190-193), octa- (no. 194-205), nona- (no.206-208) and deca- (no. 209).

Table 2. Mean of CBs Homologues in Deer Liver (ng/g, lipid basis)

Group	2001 Study Area (N=6)	1999 Study Area (N=9)	1999 Control Area (N=10)	Group (N=6)	2001 Study Area (N=9)	1999 Study Area (N=10)	1999 Control Area
Non-ortho				Di-ortho			
di-CBs	0.20	0.84	0.53	*di-CBs*	0.09	0.18	0.04
tri-CBs	0.27	0.28	0.10	*tri-CBs*	0.67	1.01	0.21
tetra-CBs	0.28	0.18	0.04	*tetra-CBs*	1.34	2.19	0.41
penta-CBs	16.60	0.96	0.02	*penta-CBs*	6.96	3.26	0.37
hexa-CBs	0.72	0.03	0.002	*hexa-CBs*	138.92	8.43	0.40
Total *Non-ortho*	**18.08**	**2.28**	**0.70**	*hepta-CBs*	79.22	12.07	0.75
				octa-CBs	29.30	11.69	0.52
Mono-ortho				*nona-CBs*	1.55	0.41	0.03
di-CBs	0.18	0.35	0.34	*deca-CBs*	0.21	0.18	0.04
tri-CBs	2.25	1.16	0.89	**Total *di-ortho***	**258.2**	**39.42**	**2.77**
tetra-CBs	3.63	0.92	0.15				
penta-CBs	17.78	1.90	0.12	**Total CBs**	**317**	**47**	**5**
hexa-CBs	15.63	0.93	0.04	% of *non-ortho*	5.0	5.0	14
hepta-CBs	0.98	0.09	0.002	% of *mono-ortho*	13	11	31
Total *mono-ortho*	**40.43**	**5.35**	**1.54**	% of *di-ortho*	82	84	55

Table 3. Mean of CBs Homologues in Deer Fat in Study Area 2001 (ng/g, lipid basis)

Non-ortho	*Mono-ortho*	Di-ortho	*nona-CBs*	3.58

di-CBs	0.04	*di-CBs*	0.19	*di-CBs*	0.01	*deca-CBs*	0.27
tri-CBs	0.02	*tri-CBs*	0.54	*tri-CBs*	0.08	**Total** *Di-ortho*	**466.7**
tetra-CBs	0.05	*tetra-CBs*	1.89	*tetra-CBs*	0.33		
penta-CBs	0.24	*penta-CBs*	22.53	*penta-CBs*	19.95	**Total CBs**	**506**
hexa-CBs	0.06	*hexa-CBs*	12.54	*hexa-CBs*	244.0	% of *non-ortho*	0.08
Total	**0.41**	*hepta-CBs*	0.85	*hepta-CBs*	157.1	% of *mono-ortho*	7.62
Non-ortho		**Total** *Mono-ortho*	**38.5**	*octa-CBs*	41.37	% of *di-ortho*	92.3

Table 4. Mean of CBs TEQ in Deer Tissues in Study Area 2001 (pg/g, lipid basis)

CBs	Muscle	%	Liver	%	Fat	%
CB-77	0.14	0.79	0.03	0.00	0.02	0.04
CB-105	0.37	2.15	0.40	0.02	0.60	1.61
CB-114	0.20	1.13	0.25	0.01	0.36	0.97
CB-118	0.92	5.33	1.29	0.08	1.56	4.19
CB-123	0.01	0.06	0.01	0.00	0.01	0.03
CB-126	9.70	56.4	1660	98.9	23.89	64.2
CB-156	2.73	15.9	5.69	0.34	4.96	13.3
CB-157	0.56	3.25	1.26	0.08	0.88	2.36
CB-167	0.00	0.03	0.02	0.00	0.01	0.02
CB-169	0.43	2.49	7.22	0.43	0.59	1.60
CB-170	1.70	9.87	1.72	0.10	3.60	9.67
CB-180	0.40	2.33	0.39	0.02	0.65	1.75
CB-189	0.06	0.35	0.10	0.01	0.08	0.23
ΣCBs TEQ	17		1678		37	
ΣPCDDs/Fs TEQ	29		12589		42	
Σ TEQ	46		14267		79	
% of CB-126 in Σ TEQ	21		12		30	

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