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Contaminants in the traditional Greenland diet – Supplementary data

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Poul Johansen [1]
Derek Muir [2]
Gert Asmund [1]
Frank Riget [1]

[1] National Environmental Research Institute
[2] Environment Canada, National Water Research Institute

Data sheet

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Abstract: This report adds data to a previous report (NERI Technical Report No.492) regarding contaminant levels in traditional Greenland diet items. Our study has included cadmium, mercury, selenium, polychlorinated biphenyls (PCB), dichlorophenyltrichloroethane (DDT), chlordane, hexachlorocyclohexanes (HCH), chlorobenzenes, dieldrin, brominated diphenyl ethers and toxaphene in tissues from walrus, hooded seal and minke whale.

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Summary

This report adds data to a previous report regarding contaminant levels in traditional Greenland diet items. We present data for muscle, liver, kidney and blubber from walrus (*Odobenus rosmarus*) and hooded seal (*Cystophora cristata*) and blubber and skin from minke whale (*Balaenoptera acutorostrata*). Contaminants covered are heavy metals (cadmium, mercury and selenium) and persistent organic pollutants (PCBs, DDTs, chlordanes, hexachlorcyclohexanes (HCHs), chlorobenzenes, dieldrin, toxaphene and brominated diphenyl ethers).

Cadmium, mercury and selenium levels in the tissues from walrus were similar to those found in seal species (ringed seal, harp seal and hooded seal) in the previous study.

If organochlorine levels in walrus and hooded seal are compared to levels found earlier in ringed and harp seal, no systematic picture is apparent. In some cases levels in walrus and hooded seal generally are higher than in the other seal species (PCBs, DDTs, chlordanes, dieldrin), whereas in other cases they are lower (toxaphene, coplanar PCBs).

In the previous study unexpected high levels of toxaphene were found in skin compared to blubber of minke whale sampled in 1998 and analyzed in 2000. Therefore more samples of minke whale blubber and skin (also collected in 1998) were analyzed in 2005. In this set of samples the highest toxaphene concentrations were found in blubber. In most cases organochlorine levels in minke whale skin and blubber analyzed in 2005 were similar to levels found in samples analyzed in 2000, and although there are differences, these most likely may be explained by individual variation (not the same individuals analyzed in both rounds).

Levels of brominated diphenyl ethers (PBDEs) in walrus and hooded seal blubber were at the same level as found earlier in ringed seal blubber from West Greenland, but lower than in harp seal blubber. The highest PBDE concentrations were found in minke whale blubber.

Dansk resume

I denne rapport præsenteres yderligere data om kontaminantniveauer i traditionel grønlandsk kost. Vi præsenterer data for kød, lever, nyre og spæk fra hvalros (*Odobenus rosmarus*) og klapmyds (*Cystophora cristata*) samt spæk og mattak fra vågehval (*Balaenoptera acutorostrata*). Kontaminanterne omfatter tungmetaller (cadmium, kviksølv og selen) og persistente organiske forbindelser (PCBer, DDT, klordaner, hexaklorcyclohexaner (HCHs), klorbenzener, dieldrin, toxafen and bromerede flammehæmmere).

Niveauet af cadmium, kviksølv og selen i væv fra hvalros svarede til det der tidligere er fundet i sæler (ringsæl, grønlandssæl og klapmyds).

Organoklorin-niveauerne i hvalros og klapmyds er ikke systematisk forskellige fra de niveauer, der tidligere er fundet i ringsæl og grønlandssæl. I nogle tilfælde er niveauerne i hvalros og klapmyds generelt højere end i de to andre sælarter (PCBer, DDT, klordaner, dieldrin), mens de i andre tilfælde er lavere (toxafen, coplanare PCBer).

I den tidligere undersøgelse blev der fundet uventet høje toxafenværdier i mattak sammenlignet med spæk i vågehvaler, som blev indsamlet i 1998 og analyseret i 2000. Derfor blev der i 2005 analyseret et yderligere antal prøver, som også var indsamlet i 1998. I dette prøvesæt fandtes de højeste toxafenværdier i spæk. I de fleste tilfælde var organoklorinværdierne i spæk- og mattakprøver analyseret i 2005 på samme niveau som de prøver, der blev analyseret i 2000. De forskelle, der fandtes, kan sandsynligvis forklares af individuelle forskelle, idet det ikke var de samme individer, som blev analyseret i de to analyserunder.

Koncentrationerne af bromerede flammehæmmere (PBDEer) i hvalros- og klapmydsspæk var på samme niveau som fundet tidligere i ringsælspæk fra Vestgrønland, men var lavere end i spæk fra grønlandssæl. De højeste PBDE koncentrationer blev fundet i vågehvalspæk.

Imaqarniliaq

Nalunaarusiami matumani minguit kalaaliminerniittut pillugit paasissutissat sukumiinerusut saqqummiunneqassapput Aarrit (*Odobenus rosmarus*) kiisalu natsersuit (*Cystophora cristata*) neqaat, tingui orsuilu pillugit paasissutissat kiisalu tikaagulliit (*Balaenoptera acutorostrata*) orsui mattaallu pillugit paasissutissat takutippavut. Minguit pineqartut tassaapput saffiugassat oqimaatsut (cadmium, kviksølv aammalu selen) kiisalu minguit timimiittartut arrortikkuminaatsut (PCBer, DDT, klordaner, hexaklorcyclohexaner (HCHs), klorbenzener, dieldrin, toxafen kiisalu ikuallannaveersaatit).

Cadmiumip, kviksølvip selenillu aarrit timaaniittut puisini (natsiit, aataat, natsersuillu) siusinnerusukkut takuneqarsimasutulli annertutigipput.

Organoklorinit qaffasissusii aaverni natsersuarnilu ittut siusinnerusukkut natserni aataanilu nassaarineqarsimasunit allaanerunngillat. Ilaatigut minguit aaverni natsersuarnilu ittut (PCBer, DDT, klordaner, dieldrin) puisinit taakkunannga marlunnit qaffasinnerusarput, ilaatigulli appasinnerusarlutik (toxafen, coplanare PCB).

Misissuinermi siusinnerusukkut ingerlanneqartumi toxafanit mattammiittut 1998-imi tikaagulliit orsuiniit tigooqqarneqartunut 2000-imilu misissoqqissaarneqartunut sanilliullugit ilisimagisamit qaffasinnerunerujussuat paasineqarpoq. Tamanna pillugu 2005-imi misiligutit 1998-imissaaq katersorneqarsimasut suli amerlanerit misissuiffigineqarput. Misissukkani taakkunani orsumi toxafan annerpaaq nassaarineqarpoq. Amerlanertigut orsuni mattannilu 2005-imi misissorneqartuni organoklorin 2000-imi misissorneqartutullu qaffasissuseqartarpoq. Assigiinngissutaat uumasut ataasiakkaat akornanni assigiinngissutinik nassuiaatissaqarunarput uumasut taakkorpiaasimanngippata misissuinerni assigiinngitsuni misissorneqartut.

Ikuallannaveersaatit (PBDE-it) aarrit natsersuillu orsuini ittut Kitaani natserni siusinnerusukkut uuttukkatulli qaffasissuseqarput, aataaniittuniilli annikinnerullutik. PBDE qaffasinnerpaat tikaagulliit orsuini nassaarineqarput.

1 Introduction

People in Greenland are more exposed to contaminants from their diet than people in Europe and North America. The cause is that marine traditional food items (fish, seabirds, seals and whales) are much more important in Greenland, and that at the same time some of these food items contain high levels of contaminants, i.e. metals like mercury and cadmium and organochlorines like PCBs. Within the Arctic, Greenlanders have the highest concentrations of mercury and most organochlorines (Hansen 1998, Van Oostdam & Trembley 2003), and estimated daily intakes of mercury, cadmium and several organochlorine compounds exceed "acceptable or tolerable daily intakes" for many people in Greenland (Johansen et al. 2000, 2004a).

This was the background to initiate a study of contaminant levels in the traditional Greenland diet in 1999. The study was reported by Johansen et al. (2004b) and included almost all species identified to be important in the diet. However, we did not succeed in getting samples from hooded seal and walrus, and we found unexpectedly high levels of organochlorines, in particular toxaphenes, in skin compared to blubber of minke whale. We therefore suggested that more samples of skin and blubber from minke whale should be analyzed for organochlorines together with samples from hooded seal and walrus, which we succeeded in obtaining in 2004.

In this report we present contaminant data from muscle, liver, kidney and blubber from hooded seal and walrus and blubber and skin from minke whale. All samples were collected in West Greenland. Chemical groups analyzed include cadmium, mercury, selenium, PCB, DDT, chlordanes, toxaphene, HCH, chlorobenzenes, mirex, octachlorostyrene, endosulfan, coplanar PCBs and brominated diphenyl ethers.

2 Methods

Sampling was carried out in 1998 (minke whales from West Greenland), in 2003-04 (hooded seal from Nuuk) and in 2004 (walrus from Sisimiut) by or assisted by the Greenland Institute of Natural Resources in connection with other of their studies. Biological parameters were recorded and tissue samples collected in Greenland. These samples were then sent frozen to the laboratory of NERI, where they were thawed and tissue samples were taken for chemical analysis. These samples were cut out from the inner part of the sample so that possible contamination of the outer exposed part caused by handling and storage was avoided.

Samples for chemical analysis were either stored to be analyzed later (for organic contaminants) or prepared for analyses directly (for metals). Stored samples to be analyzed for organics were kept in glass jars rinsed with hexane and with the lid protected with aluminum foil and shipped frozen from NERI to the National Water Research Institute (NWRI) by airfreight. At NERI or NWRI, all frozen samples were stored at –20° C in freezers equipped with monitored alarm systems.

The Department of Arctic Environment, NERI, analyzed cadmium, mercury and selenium. The National Water Research Institute of Environment Canada in Burlinton analyzed the organic contaminants. The methods used were the same as reported in the previous report of this study (Johansen et al. 2004b) and we refer to that for a description of analytical methods, quality assurance etc.

3 Results and discussion

All contaminant levels are presented on a wet weight basis with arithmetic means and standard deviations shown in Appendices.

For minke whales where a set of samples were analyzed for organochlorines both in 2000 and 2005, we tested if means were significantly different (Welch Two Sample t-test). Data were log transformed before being tested in order to meet the requirement of normality of data. The result of the test is shown in Table 1 (blubber) and Table 2 (skin). The means presented in these tables are geometric means (backtransformed means of logged values) and thus different from the arithmetic means for the same tissues presented in the Appendices.

Table 1. Organochlorine concentration (ng/g wet wt, geometric means) and significance level in blubber from minke whale collected in 1998 and analyzed in 2000 (17 samples) and 2005 (10 samples). A significance level below 5% is marked with *.

Contaminant	Analyzed in 2000	Analyzed in 2005	p (significance level)
sPCB	2,122	1,556	0.23
sPCB10	143	217	0.21
sDDT	614	590	0.89
sCHL	65	170	0.004*
sHCH	233	87	0.05
sHCB	81	87	0.78
Dieldrin	286	275	0.88
Total toxaphene	247	172	0.11
Toxaphene 26,50,62	14	16	0.76

Table 2. Organochlorine concentration (ng/g wet wt, geometric means) and significance level in skin from minke whale collected in 1998 and analyzed in 2000 (5 samples) and 2005 (10 samples). A significance level below 5% is marked with *.

Contaminant	Analyzed in 2000	Analyzed in 2005	p (significance level)
sPCB	658	590	0.60
sPCB10	206	210	0.95
sDDT	437	361	0.52
sCHL	302	279	0.75
sHCH	75	48	0.08
sHCB	85	74	0.65
Dieldrin	198	190	0.90
Total toxaphene	829	189	0.07
Toxaphene 26,50,62	244	45	0.04*
Coplanar 81,77,126,169	172	58	0.10

Cadmium, mercury and selenium

These elements were analyzed only in walrus. The mean cadmium concentration ranges from 0.04 in blubber to 14.1 µg/g wet wt in kidney, the mean mercury concentration ranges from 0.009 in blubber to 3.61 µg/g wet wt in liver, and the mean selenium concentration ranges from 0.067 in blubber to 4.13 µg/g wet wt in kidney (Appendix 1). Levels in the tissues from walrus were similar to those found in seal species earlier

(ringed seal, harp seal and hooded seal). The lowest concentrations are also seen in blubber and muscle and the highest in liver and kidney.

PCBs

PCB levels in hooded seal, walrus and minke whale are presented in Appendix 2 as the sum of 104 congeners (includes co-eluting congeners as single values), as the sum of 10 congeners (s10PCB) and as the sum of 8 homologue groups with 1 to 9 chlorine atoms (termed s-mono, s-di, s-tri, s-tetra, s-penta, s-hexa, s-hepta, s-octa and s-nona in the appendix). The following comparison will be based on the s10PCB results. These 10 congeners are CB 28, 31, 52, 101, 105, 118, 138, 153, 156 and 180. This group represents most of the predominant congeners in fish and marine mammals and is consistently measured by most laboratories.

The mean s10PCB concentration ranges from 17.9 to 986 ng/g wet wt in the species and tissues analyzed (Appendix 2). The level in minke whale skin analyzed in 2005 is similar to what was found in 2000, whereas the PCB concentration in minke whale blubber is less than half of that found earlier, however this difference is not statistically significant. In hooded seal and walrus PCB levels are in the high end of or higher than in ringed and harp seal.

DDTs

DDT levels are presented in Appendix 3 as sDDT (= sum of p,p'-DDE, -DDD, -DDT + o,p'-DDE, -DDD, -DDT) and as p,p´-DDE (major persistent break-down product of DDT).

The mean sDDT concentration ranges from 2.4 to 1,003 ng/g wet wt. The levels in minke whale skin and blubber analyzed in 2000 and 2005 are not different (statistically tested, see Table 1 and 2), and the pattern is similar with the highest concentration in blubber. In walrus DDT levels are similar to those found in ringed and harp seal, whereas levels in hooded seal are higher than in the other seal species; in blubber they are 2-3 times higher.

Chlordanes

Chlordane levels are presented in Appendix 3 as sCHL (= sum of heptachlor, heptachlor epoxide oxychlordane, cis- and trans-Chlordane, cis- and trans-Nonachlor) and as Oxychlordane (the major metabolite of chlordane in mammals). The mean sCHL concentration ranges from 4.7 to 732 ng/g wet wt. The level in minke whale skin analyzed in 2005 is similar to what was found in 2000, whereas in minke whale blubber, the sCHL concentration is 68% higher than earlier. This difference is statistically significant (see Table 1). In hooded seal and walrus chlordane levels are in the high end of or higher than in ringed and harp seal. In blubber of walrus and hooded seal they are 2-3 times higher than in ringed and harp seal.

HCHs

HCH levels are presented in Appendix 3 as sHCH (= sum of α-, β and γ-HCH) and as β-HCH (the most recalcitrant isomer that predominates in mammals). The mean sHCH concentration ranges from 0.3 to 101 ng/g wet wt. The level in minke whale blubber and skin analyzed in 2005 appears to be lower than found in 2000, but the difference is not statistically significant (see Table 1 and 2). sHCH levels in walrus and hooded seal are similar to those found in ringed and harp seal, except in hooded seal blubber, where the concentration is about or less than half of levels in ringed and harp seal.

Chlorobenzene

Chlorobenzene levels are presented in Appendix 3 as sCBz (= sum of 1,2,3,4-tetrachlorobenzene, pentachlorobenzene and hexachlorobenzene). The mean sCBz concentration ranges from 0.1 to 118 ng/g wet wt. The levels in minke whale skin and blubber analyzed in 2000 and 2005 are not different (statistically tested, see Table 1 and 2). sCBz levels in walrus and hooded seal are similar to those found in ringed and harp seal.

Dieldrin

Dieldrin levels are presented in Appendix 3. The mean dieldrin concentration ranges from 0.5 to 360 ng/g wet wt. The levels in minke whale skin and blubber analyzed in 2000 and 2005 are not different (statistically tested, see Table 1 and 2). In most tissues dieldrin levels are higher in walrus and hooded seal than in ringed and harp seal. In blubber this difference is up to a factor of 4.

Toxaphene

Toxaphene levels are presented as "total" toxaphene quantified with a technical toxaphene standard, as the sum of 22 chlorobornane congeners (specified in Appendix 4) and as a sum of Parlar 26, 50, 62 (Appendix 4). The mean total toxaphene concentration ranges from 0.2 to 171 ng/g wet wt. In hooded seal and walrus toxaphene levels are lower than reported earlier in ringed and harp seal, a factor of about 2 to 17 in blubber.

Additional minke whale skin and blubber samples collected in 1998 were analyzed in 2005, because toxaphene concentrations when analyzed in 2000 were higher in skin than in blubber, which was unexpected, as normally the highest organochlorine concentrations in marine mammals are found in blubber. Table 3 compares arithmetic toxaphene concentrations in samples analyzed in 2000 and 2005. It is seen that mean concentrations in skin are much lower in the samples analyzed in 2005 and lower than in blubber. However, this difference is not statistically significant (see Table 1 and 2), because of high standard deviation and large individual variation.

Table 3. Total toxaphene concentration (ng/g wet wt) in blubber and skin from minke whale analyzed in 2000 and 2005. n: number of samples.

	Blubber			Skin		
	N	mean	SD	n	mean	SD
2000	17	369	531	5	1,370	1,240
2005	10	171	78.1	10	96.4	35.6

Coplanar PCBs

A subset of samples was analyzed for coplanar PCBs. Co-planar PCBs are presented as PCB 77, PCB 81, PCB 126 and PCB 169 in Appendix 5. CB77 and CB126 were the predominant non-ortho substituted (or coplanar) PCBs in the samples analyzed, ranging from 3.2 pg/g wet wt in walrus blubber to 38.9 pg/g wet wt in minke whale blubber. The highest concentrations of CB126, the congener with the greatest dioxin toxic equivalent factor (TEF), were found in blubber of minke whale. In hooded seal and walrus coplanar PCB levels are lower than reported earlier in ringed and harp seal, a factor of about 3 to 10 in blubber for CB77 and CB126. For minke whale skin which was analyzed both in 2000 and 2005, the 2005 are lower for three out of four CBs. However, this difference is not statistically significant (see Table 1 and 2).

Brominated diphenyl ethers

The results for PBDEs are presented in Appendix 6 as the concentration of BDE47, BDE99, BDE100, HBCD (Hexabromocyclododecane) and the sum of 15 PBDE congeners. The total PBDE concentration ranges from 5.31 ng/g wet wt in hooded seal blubber to 37.3 ng/g wet wt in minke whale blubber. The tetrabromo-congener BDE 47 predominated in all species. The HBCD concentration generally was lower than the BDE47 concentration ranging from 0.36 ng/g wet wt in walrus blubber to 5.55 ng/g wet wt in hooded seal blubber. PDBE concentrations in walrus and hooded seal blubber are at the same level as found earlier in ringed seal blubber from West Greenland, but lower than in harp seal blubber.

"Dioxin-like" potency of the PCBs

Toxic equivalent concentrations (TEQs) of planar PCBs were calculated by combining the coplanar PCB results with the mono-ortho PCBs, for which TEFs have been promulgated (Van den Berg et al. 1998). Results are presented in Appendix 7. These TEQs give an indication of the "dioxin-like" potency of the PCBs and served to indicate which PCBs contribute to this potential toxicity. Total TEQ values were very low ranging from 1.17 pg/g in hooded seal blubber to 5.32 pg/g in minke whale blubber. These values are lower than reported earlier from other seal and whale species from Greenland. The total TEQ for minke whale skin was calculated both from 2000 and 2005 results, and in 2005 the total TEQ was about 3 times lower than reported for the 2000 results, where CB126 represented the greatest proportion of total TEQs.

Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) were not determined in this study. However, previous studies of fish and ma-

rine mammals in eastern Canadian Arctic found very low concentrations compared to urban industrialized areas of Europe and North America (Nordstrom et al. 1990, reviewed by de March et al. 1998). PCDD/Fs represented less than 10% of total TEQs (calculated with PCDD/Fs, coplanar and mono-orthe PCBs) in walrus, narwhal and beluga. In ringed seals and char PCDD/Fs represented from 30 to 90% of TEQ (de March et al. 1998).

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Appendixes

Appendix 1. Cd, Hg and Se concentrations (µg/g wet wt) in walrus from West Greenland collected in 2004.

Tissue	Cd n	Cd mean	Cd sd	Hg n	Hg mean	Hg sd	Se n	Se mean	Se sd
Muscle	10	0.071	0.062	10	0.037	0.011	10	1.45	0.59
Liver	5	3.06	2.07	5	3.61	2.58	5	2.50	1.00
Kidney	5	14.1	8.54	5	0.281	0.113	5	4.13	0.58
Blubber	5	0.040	0.074	5	0.009	0.003	5	0.067	0.016

Appendix 2. Concentrations of PCBs (ng/g wet weight) in biota from West Greenland. Samples collected between 1998 and 2004. For explanation of CB groups see below the table.

Species	Tissue	N	Stat	% Lipid	sPCB	s10PCB	smono-di	s-tri	s-tetra	s-penta	s-hexa	s-hepta	s-octa	s-nona
Hooded seal	Muscle	9	Mean	2.6	51.5	16.6	1.0	15.5	3.8	8.1	15.8	5.4	1.0	0.2
			SD	1.0	31.9	16.7	0.7	10.0	2.6	6.2	15.6	6.8	1.3	0.2
	Liver	5	Mean	11.8	134.4	66.2	0.1	2.6	11.1	20.6	62.4	29.3	5.0	0.6
			SD	8.1	91.9	49.5	0.1	1.3	5.3	13.3	47.0	24.6	4.7	0.5
	Kidney	5	Mean	2.9	47.1	5.4	0.4	32.8	3.1	4.1	4.6	1.2	0.3	0.0
			SD	0.6	12.1	3.3	0.2	10.1	0.7	1.6	3.0	0.9	0.2	0.0
	Blubber	9	Mean	85.6	1880.1	951.2	3.5	27.4	113.1	341.6	886.5	386.5	77.9	11.4
			SD	1.4	1833.6	985.5	3.0	17.9	76.6	274.4	906.1	431.4	95.4	14.8
Walrus	Muscle	10	Mean	1.0	17.9	7.4	0.3	4.6	1.2	2.8	6.2	1.9	0.4	0.1
			SD	0.4	15.0	9.1	0.2	6.7	0.8	3.3	7.9	2.5	0.5	0.1
	Liver	5	Mean	9.1	130.5	28.8	1.4	65.6	5.0	21.2	25.5	7.3	1.7	0.5
			SD	13.5	139.3	31.6	0.9	68.8	5.1	24.8	28.5	8.2	1.9	0.5
	Kidney	5	Mean	5.1	75.9	22.7	1.0	31.2	5.0	11.8	18.8	5.1	1.0	0.2
			SD	3.7	41.8	16.9	0.3	26.4	1.8	7.5	15.1	4.6	0.9	0.2
	Blubber	10	Mean	81.3	1428.1	790.2	7.8	21.3	81.7	343.5	680.5	203.6	31.1	3.9
			SD	4.2	1749.6	983.0	10.0	22.6	89.8	412.8	853.4	263.7	38.9	4.4
Minke whale	Skin	10	Mean	40.5	601.6	230.2	2.6	12.1	94.0	191.0	195.0	63.7	5.9	0.4
			SD	9.9	243.3	94.5	2.8	4.1	37.3	79.9	82.1	30.5	3.7	0.3
	Blubber	10	Mean	75.1	1493.4	435.6	7.3	52.4	210.6	677.5	353.7	115.5	11.7	0.9
			SD	26.8	963.4	243.2	8.0	98.0	211.3	479.2	141.0	40.2	4.3	0.6

s10PCB = sum of CB 28, 31, 52, 101, 105, 118, 138, 153, 156, 180

s-mono-di = sum of CB 1, 3, 4-10, 7-9, 6, 8-5, 12-13

s-tri = sum of CB 33-20, 18, 15-17, 24-27, 16-32, 54-29, 26, 25, 31-28, 22, 19

s-tetra = sum of CB 55, 56-60 ,66, 63, 74, 45, 46, 52, 43, 49, 47-48, 44, 59, 42, 71-41-64, 40, 53, 51, 50

s-penta = sum of CB 114, 105, 118, 107, 110, 82, 92, 84, 101, 99, 119, 83, 97, 81-87, 85, 95, 91, 70-76-98, 100

s-hexa = sum of CB 136, 151, 135-144, 147, 149, 133, 134-131, 146, 153, 132, 141, 137, 130, 163-138, 158, 129, 128, 156, 157-200

s-hepta = sum of CB 179, 176, 178, 175, 182-187, 183, 167, 185, 174, 177, 202-171, 172, 173, 180, 193, 191, 170-190

s-octa = sum of CB 194, 205, 198, 201, 203-196, 189, 199, 197

s-nona = sum of CB 206, 209, 208-195, 207

Appendix 3. Concentrations of organochlorine pesticides (ng/g wet weight) in biota from West Greenland. Samples collected between 1998 and 2004.

Species	Tissue	N	Stat	% Lipid	sDDT	p,p'-DDE	sCHL	Oxychlor-dane	sHCH	β-HCH	sCBz	HCB	Diel-drin
Hooded seal	Muscle	9	Mean	2.6	19.0	17.1	8.7	2.9	0.3	0.2	0.7	0.6	1.4
			SD	1.0	20.3	18.5	6.3	2.6	0.2	0.1	0.4	0.3	0.6
	Liver	5	Mean	11.8	69.7	60.1	49.7	16.9	2.3	1.4	2.8	2.3	9.3
			SD	8.1	46.9	40.5	40.6	14.5	2.4	1.5	2.5	2.1	7.7
	Kidney	5	Mean	2.9	4.5	4.1	4.7	1.7	0.2	0.2	0.4	0.33	1.4
			SD	0.6	2.5	2.4	3.2	1.6	0.1	0.1	0.2	0.2	0.5
	Blubber	9	Mean	85.6	1003	838	732	247	25.3	14.6	19.7	14.6	100
			SD	1.4	850	750	738	268	9.6	6.2	3.8	3.6	50.7
Walrus	Muscle	10	Mean	1.0	3.3	3.2	4.2	2.9	0.7	0.7	0.1	0	1.4
			SD	0.4	5.1	4.98	5.2	3.6	0.5	0.5	0.1	0	1.1
	Liver	5	Mean	9.1	17.7	16.0	25.9	17.9	2.7	2.7	0.6	0	9.5
			SD	13.5	23.1	21.4	24.4	16.8	1.8	1.8	0.4	0	5.9
	Kidney	5	Mean	5.1	7.1	6.7	16.4	11.3	2.0	2.0	0.5	0	9.0
			SD	3.7	7.9	7.8	10.7	7.4	1.1	1.1	0.2	0	3.5
	Blubber	10	Mean	81.3	417	389	562	368	101	92.9	11.3	0.4	202
			SD	4.2	614	578	626	403	84.5	79.0	9.1	0.4	148
Minke whale	Skin	10	Mean	40.5	372	201	297	36.6	46.7	24.4	77.1	75.6	212
			SD	9.9	188	92.9	142	18.1	32.7	15.5	33.2	32.5	119
	Blubber	10	Mean	75.1	668	325	562	77.8	85.9	38.3	118	114	360
			SD	26.8	319	165	297	37.3	35.2	18.4	41.8	40.7	169

Appendix 4. Concentrations of toxaphene (ng/g wet weight) in biota from West Greenland. Samples collected between 1998 and 2004. Contaminant groups are explained below the Appendix.

Species	Tissue	N	Stat	% Lipid	Total toxaphene	Σ-congeners	Σ-Parlar 26,50,62
Hooded seal	Muscle	9	Mean	2.6	1.6	1.3	0.3
			SD	1.0	0.7	0.5	0.2
	Liver	5	Mean	11.8	9.2	4.9	1.3
			SD	8.1	8.2	5.1	1.7
	Kidney	5	Mean	2.9	0.8	0.8	0.2
			SD	0.6	0.4	0.4	0.1
	Blubber	9	Mean	85.6	106	56.6	17.0
			SD	1.4	62.6	32.2	11.7
Walrus	Muscle	10	Mean	1.0	0.2	0.1	0.1
			SD	0.4	0.1	0.1	0
	Liver	5	Mean	9.1	0.4	0.6	0.4
			SD	13.5	0.3	0.6	0.3
	Kidney	5	Mean	5.1	0.5	0.4	0.2
			SD	3.7	0.5	0.3	0.3
	Blubber	10	Mean	81.3	21.0	12.7	6.3
			SD	4.2	17.2	10.0	5.4
Minke whale	Skin	10	Mean	40.5	96.4	47.3	21.5
			SD	9.9	35.6	20.8	9.8
	Blubber	10	Mean	75.1	171	77.4	31.9
			SD	26.8	78.2	38.9	16.9

"Total toxaphene" is quantified with a technical toxaphene standard.

"Σ-congeners" is the sum of 22 chlorobornane congeners (Parlar 11-12, 15, Hex-sed, 21, Hep-sed, 25, 32, P26, 31, 38, 39, 40-41, 42, 44, 50, 51, 56, 58, 59, 62, 63)

"Σ-Parlar 26, 50, 62" is the sum of Parlar 26, 50, 62.

Appendix 5. Concentrations of co-planar PCBs (pg/g wet weight) in samples from Greenland. Samples collected between 1998 and 2004.

Species	Region	Tissue	N	Stat	PCB 77	PCB 81	PCB 126	PCB 169
Hooded seal	W.Grl.	Blubber	9	Mean	10.3	2.7	7.3	1.5
				SD	6.0	2.7	3.1	1.3
Walrus	W.Grl.	Blubber	10	Mean	7.1	4.0	3.2	0
				SD	3.9	4.7	4.9	
Minke whale	W.Grl.	Blubber	10	Mean	38.3	14.9	38.9	11.5
				SD	47.2	7.4	22.0	5.1
Minke whale	W.Grl.	Skin	10	Mean	12.7	5.1	16.5	4.8
				SD	7.4	5.1	10.5	2.4

Appendix 6. Concentrations of Polybrominated Diphenyl Ethers and Hexabromocyclododecane (ng/g wet weight) in biota from West Greenland. Samples collected between 1998 and 2004. See below the appendix for an explanation of congeners.

Species	Tissue	N	Stat	BDE47	BDE99	BDE100	ΣBr2-Br7	BDE209	HBCD
Hooded seal	Blubber	9	Mean	3.28	0.70	0.27	5.31	0	5.55
			SD	1.99	0.33	0.16	2.68		2.92
Walrus	Blubber	10	Mean	5.71	1.14	0.19	8.30	3.69	0.36
			SD	6.83	2.07	0.43	8.52	2.90	0.56
Minke whale	Blubber	10	Mean	24.19	5.46	2.61	37.32	2.49	2.85
			SD	19.30	4.67	1.90	27.70	5.24	2.33
Minke whale	Skin	10	Mean	7.07	0.34	0.48	13.55	0	1.04
			SD	6.72	0.22	0.44	8.24		0.90

ΣBr2-Br7 is the sum of BDE 17, 28-33, 47, 49, 71, 66, 100, 99, 85, 138, 154, 153, 183 and 190.

HBCD is hexabromocyclododecane

Appendix 7. Concentrations of coplanar (non-ortho) and mono-ortho-PCBs in samples as pg/g wet wt and pg TEQ/g wet wt.

Species	Tissue	n		CB81	CB77	CB126	CB169	CB118	CB114	CB105	CB167	CB156	CB157	CB189	Total TEQ
			TEF	0.0001	0.0001	0.1	0.01	0.0001	0.0005	0.0001	0.00001	0.0005	0.0005	0.0005	
A. Toxic Equivalents (pg TEQs/g)															
Hooded seal	blubber	9	Mean	0.00022	0.00103	0.72888	0.01542	0.14194	0.01112	0.02451	0.00022	0.17079	0.04346	0.03228	1.16986
			SD	0.00027	0.00060	0.30829	0.01289	0.09647	0.00788	0.01520	0.00012	0.15572	0.03638	0.04320	
Walrus	blubber	10	Mean	0.00039	0.00071	0.32396	0.00000	0.75969	0.03662	0.29579	0.00046	0.10592	0.08073	0.00174	1.60602
			SD	0.00047	0.00039	0.48772	0.00000	0.85907	0.04096	0.37999	0.00037	0.11722	0.09304	0.00243	
Minke whale	blubber	10	Mean	0.00149	0.00383	3.88959	0.11466	0.75518	0.07063	0.09875	0.00413	0.27483	0.07764	0.02129	5.31202
			SD	0.00074	0.00472	2.19480	0.05082	0.41394	0.03823	0.06970	0.00228	0.16296	0.04483	0.01073	
Minke whale	skin	10	Mean	0.00051	0.00127	1.64472	0.04754	0.26955	0.02634	0.03819	0.00132	0.09442	0.02619	0.00714	2.15719
			SD	0.00051	0.00073	1.05042	0.02413	0.14826	0.01477	0.02994	0.00068	0.05587	0.01477	0.00373	
B. Concentrations in pg/g wet wt															
Hooded seal	blubber	9	Mean	2.2	10.3	7.3	1.5	1419.4	22.2	245.1	21.7	341.6	86.9	64.6	
			SD	2.7	6.0	3.1	1.3	964.7	15.8	152.0	12.0	311.4	72.8	86.4	
Walrus	blubber	10	Mean	3.9	7.1	3.2	0.0	7596.9	73.2	2957.9	46.1	211.8	161.5	3.5	
			SD	4.7	3.9	4.9	0.0	8590.7	81.9	3799.9	37.2	234.4	186.1	4.9	
Minke whale	blubber	10	Mean	14.9	38.3	38.9	11.5	7551.8	141.3	987.5	413.1	549.7	155.3	42.6	
			SD	7.4	47.2	21.9	5.1	4139.4	76.5	697.0	228.4	325.9	89.7	21.5	
Minke whale	skin	10	Mean	5.1	12.7	16.4	4.8	2695.5	52.7	381.9	131.9	188.8	52.4	14.3	
			SD	5.1	7.3	10.5	2.4	1482.6	29.5	299.4	67.7	111.7	29.5	7.5	

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Frederiksborgvej 399
PO Box 358
DK-4000 Roskilde
Denmark
Tel: +45 4630 1200
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National Environmental Research Institute
Vejlsøvej 25
PO Box 314
DK-8600 Silkeborg
Denmark
Tel: +45 8920 1400
Fax: +45 8920 1414

Monitoring, Advice and Research Secretariat
Department of Marine Ecology
Department of Terrestrial Ecology
Department of Freshwater Ecology

National Environmental Research Institute
Grenåvej 14, Kalø
DK-8410 Rønde
Denmark
Tel: +45 8920 1700
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