Patterns of Polychlorinated Biphenyl Uptake in Ringed Seal (*Phoca hispida*) from the Canadian Arctic: 1998-2004

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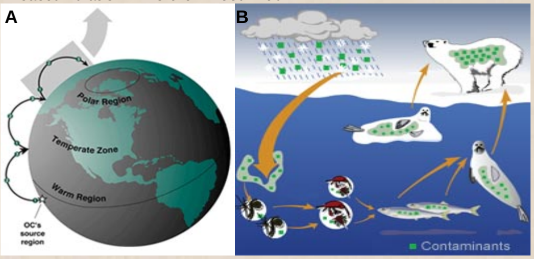
Introduction

- Polychlorinated biphenyls (PCBs) are a family of 209 individual compounds (or congeners), which are lipophilic (adhere to organic matter such as fats) and persistent in the environment. As a result, PCBs have high rates of bioaccumulation, particularly in fish and other aquatic animals.
- It is well documented that PCBs are present in virtually every compartment of the Arctic marine ecosystem and the introduction of these contaminants is generally attributed to long-range atmospheric, oceanic, and riverine processes which transport contaminant releases from distant, industrialized areas (*1*).
- Ringed seal have been identified as an ideal species to monitor PCB levels in the Arctic due to circumpolar distribution and inclusion in traditional northern diets.

Figure 1. Atmospheric Transport of PCBs (Grasshopper Effect) and Bioaccumulation in Northern Food Web.



Source: Inuit Tapirit Kanatami. 2005. Northern Contaminants (www.itk.ca)

Methods

- Ringed seal blubber sample collections were performed by local members of the Hunter and Trappers Association (HTA) during spring substance hunts between 1998 and 2004 at 12 communities across the Canadian Arctic (Figure 2).

Figure 2. Sampling locations.

- Determination of PCBs (104 individual congeners) in blubber was performed using GC-ECD (gas chromatography with electron-capture detection).
- Contaminant data were examined on a lipid-weight (lw) basis to differentiate spatial patterns relating to variability in lipids from those reflecting preferential PCB migration. Data analysis was performed for female animals and log10 transformed, lipid normalized results were normality distributed.
- PCB concentrations were based on the sum of all congeners (ΣPCB). For comparison to previous work, PCB concentrations were also calculated based on the sum of 10 congeners (CB 28, 31, 52, 101, 105, 118, 138, 153, 156, and 180).

Results and Discussion

- PCB concentrations in blubber were significantly higher in female ringed seal from more southern and eastern communities (Figure 3).
- PCB concentrations in female ringed seal were not significantly influenced by age (Figure 4).
- PCB concentrations are decreasing over time (Figure 5).
- PCB congener profiles illustrate the prevalence of lower chlorinated congeners at increasing longitudes and decreasing latitudes. Higher chlorinated congeners were dominant in profiles from southern locations and tend to resemble that of commercial mixture Aroclor 1260 (Figure 6).
- Accumulation of dioxin-like congeners (105, 114, 118, 156, 167 and 189) was generally similar between sites (Figure 6).

Figure 3. Spatial comparison of PCB concentrations (ΣPCB10 and ΣPCB ng/g, lipid weight (lw)) and corresponding ages for female ringed seal samples collected from 12 locations in the Canadian Arctic between 1998 and 2004.

Location	Year	N	Mean Age*	ΣPCB10 Geometric Mean±SD	ΣPCB Geometric Mean±SD
Resolute^{C,D}	2000	8	4.8 (n=6)	159 ± 118	314 ± 187
	2004	9	6.7 (n=7)	145 ± 52.4	284 ± 95.8
Arctic Bay^{C,D}	2000	7	6.8	161 ± 78.0	338 ± 145
	2004	8	7.5	160 ± 71.4	342 ± 120
Holman^{AB,DF}	2001	5	16	151 ± 20.8	400 ± 77.7
Sachs Harbour^{C,DF}	2001	10	4.1 (n=8)	197 ± 87.9	409 ± 161
Kangiqsualujjuaq^{BC,DEF}	1998	5	7.2	230 ± 96.7	466 ± 188
	2002	3	N/A	263 ± 62.8	457 ± 99.4
Arviat^{A,DEF}	1998	11	18	289 ± 236	598 ± 435
	2003	4	N/A	181 ± 121	403 ± 258
Hudson Strait ^{BC,DEF}	2002	9	6.2 (n=4)	224 ± 74.8	390 ± 139
Pangnirtung^{B,DEF}	1999	9	7.3 (n=8)	254 ± 107	512 ± 221
Gjoa Haven^{C,DEF}	2004	6	3.8 (n=5)	308 ± 111	589 ± 182
Grise Fiord^{C,DEF}	2003	6	4.6 (n=5)	387 ± 127	673 ± 232
Nain, Labrador ^{C,DEF}	1998	5	5.4	322 ± 256	718 ± 603
Inukjuak^{ABC,EF}	2002	8	7 (n=1)	454 ± 223	811 ± 377

ANOVA was performed on age and log transformed data (sum of 10 PCB congeners), post hoc pairwise probabilities were adjusted using Tukey method. Superscripted letters relate to comparison probabilities, such that ABC are associated with age based comparisons, while DEF correspond with ΣPCB10. Where comparisons were not significantly different (p>0.05) similar 'codings' are found by location. *n presented in brackets represents number of discrete age values used for statistical analysis if deviated from N (total number of samples). N/A: not available; age determination not yet completed.

Figure 4. Female ringed seal age distribution (years) and corresponding PCB concentrations (ΣPCB10 and ΣPCB ng/g, lw) in adipose tissues (n=85).

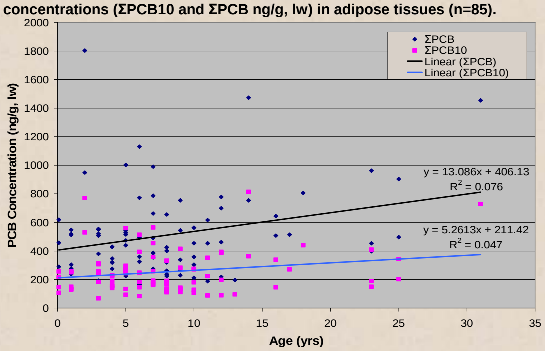


Figure 5: Temporal comparison of PCB concentrations (ΣPCB10, ng/g, lw) and relative contribution of PCB congener 153 (CB153) for female ringed seal blubber samples collected from Arctic Bay from 1975 to 2004. Data presented for years prior to 2000 were previously reported (*2-4*). Error bars represent the upper 95% confidence interval, based on log transformed data.

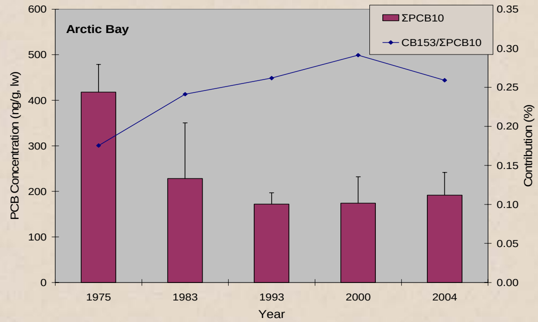
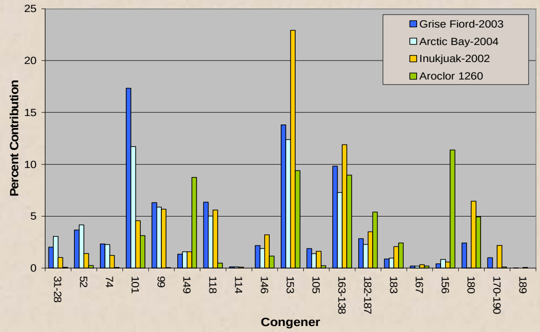


Figure 6: PCB congener profile (contribution of 19 individual congeners to ΣPCB) for female ringed seal blubber collected from Grise Fiord (2003), Arctic Bay (2004) and Inukjuak (2002) compared to PCB commercial mixture Aroclor 1260.



Conclusions

- Spatial trends and PCB congener profile results agree with long-range transport studies.
- Significant temporal ΣPCB declines were observed only over long time period (15 yrs +). An increased dominance of congener 153 over time suggests a shift toward more weathered sources.
- PCB congener profiles suggest diet preference plays significant role in PCB uptake in ringed seal.

Acknowledgements

We thank the Dept. of Indian and Northern Affairs Canada, Environment Canada and ArcticNet for funding. We also wish to extent thanks to: HTA, Alex Gordon, Peter May (NvRC in Kuujjuaq), Allison Puhl, Ed Kaminski and Steve Cagampan of NLET. Appreciation is also extended to Mary Williamson (NLET) and Xiaowa Wang (EC).

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November 2005

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