CONCENTRATIONS OF ORGANOCHLORINES and METALS IN JUVENILE RINGED SEALS *(PUSA HISPIDA BOTNICA)* FROM THE BALTIC SEA 1978-2015

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Introduction

The population of ringed seals in the Baltic was estimated at around 190 000-220 000 individuals in 1900 but decreased dramatically in numbers since then. In the late 1970s the population was estimated to be approximately 5000[1]. The decrease was instigated by intense hunting but also, after the 1970s, by problems with reproduction. A disease complex among seals in the Baltic was identified, including sterility among females. Elevated concentrations of organochlorines, specially PCBs and DDTs were believed to be the cause for reproductive impairment among marine mammals.[2,3]. Now the population of ringed seals is slowly recovering. Surveys on ringed seals starting in 1988 indicate a 4.5% yearly increase, which is half the increasing rate that would be expected from a healthy population[4]. Occluded uteri are still found among ringed seals.

Little is known about contaminants in Baltic ringed seals, and the purpose of this study was to evaluate time trends of a variety of contaminants in juvenile seals.

Materials and methods

Blubber tissue samples from a total of 40 juvenile ringed seals from the Baltic Sea were collected between 1978 and 2014 and analyzed for ”dioxins”; polychlorinated dibenzo-*p*-dioxins, dibenzofurans (PCDD/PCDF) and dioxin-like PCBs (dl-PCB) at Umeå University. In addition, these blubber samples + an additional 22 pooled samples comprising 69 juvenile ringed seals were analyzed for PCB and DDT and other pesticides at Örebro University (i.e. 62 samples, from 1974-2015). Finally, 22 pooled samples of liver from 69 juvenile ringed seals were analyzed for metals 10 metals and selenium at ALS Analytica in Luleå.

The seals were either bycaught in fishing geer or shot within the domestic hunt and not specifically for the purpose of this study.

Results and discussion:

Concentrations of PCDDs, PCDFs and dl-PCBs decreased over the study period in ringed seals with a few exceptions. The decrease was primarily seen up to the year 2000 while the concentrations have been stable the last 15 years. Similar pattern was seen for herring from Baltic Proper with no or very small annual decreasing rates the last 15 years[4]. However, we observed increasing concentrations for two dioxins (1,2,3,4,6,7,8-HpCDD and OCDD) and one furan (1,2,3,7,8-PeCDF) in the last 15 year of the study period and one furan decreased in concentrations (1,2,3,7,8,9-HxCDF). The highest increasing rate, 15 % annually, was seen for OCDD the last 15 years (Table 1). Mean fat content in blubber was 94%.

Concerning the dioxin-like PCBs, the four non-ortho, dl-PCBs show no temporal trends during the last 15 years. Four of the mono-ortho dl-PCBs continued to decrease while the other four mono-ortho congeners showed no statistically significant trends in the last 15 years (Table 1).

	min (pg/g w)	max (pg/g w)	median (pg/g w)	SD	Yearly change (%)	p-value	Yearly change last 15 years	p-value
2378-TeCDD	3,8	45	11	12	-5,6	p<0,001	No change	
12378-PeCDD	14	129	30	27	-4	p<0,001	No change	
123478-HxCDD	1,5	7	2,9	1,7	-3,1	p<0,001	No change	
123678-HxCDD	10	125	30	31	-4,1	p<0,001	No change	
123789-HxCDD	0,5	6,4	1,3	1,4	-4,5	p<0,001	No change	
1234678-HpCDD	0,3	2,2	0,7	0,4		ns	9,2	p<0,001
OCDD	0,3	8,9	0,8	1,5	3,1	p<0,01	15	p<0,001
2378-TeCDF	9,1	58	21	9,5	-1,3	p<0,01	No change	
12378-PeCDF	1,4	13	3,6	2,3	-2,2	p<0,001	3,1	p<0,05
23478-PeCDF	19	119	46	25	-2,7	p<0,001	No change	
123478-HxCDF	0,3	2,9	1,3	0,7	-2,5	p<0,001	No change	
123678-HxCDF	0,5	3,4	1,3	0,7	-2,6	p<0,001	No change	
234678-HxCDF	0,3	2	0,9	0,4	-2,3	p<0,01	(+2,7)	p<0,08
123789-HxCDF	0,3	4,5	1	1,1	-3,1	p<0,01	-11	p<0,001
1234678-HpCDF	0,2	1	0,4	0,2	-1,5	p<0,01	No change	
1234789-HpCDF	<0,3	0,23	<0,3				No change	
OCDF	0,1	4	0,4	0,7	*(-1,6)*	p<0,051	No change	

Table 1. Min, max, median concentrations of PCDDs, PCDFs in blubber from juvenile ringed seals (n=40) as well as standard deviation (SD), yearly change (full period) and yearly change (last 15 years) with significance values.

The sum of sPCB decreased over the study period with ca 2.4% annually (p<0.001), which is slower than what is seen in herring from Bothnian Bay (-6,4% p<0.001, n=503)[5]. Forty-four percent of the seal samples had concentrations of 9 mg/kg sPCB ww or more, which is similar to a threshold observed for onset of physiological effects in experimental marine mammal studies[6] (Figure 1). The majority of the seal samples were below 9 mg/kg ww in recent years.

sDDT decreased at a higher rate than PCB (-6.2%, p<0.001) which is similar to time trends of herring from Bothian Bay (-6,8%, p<0.001)[5].

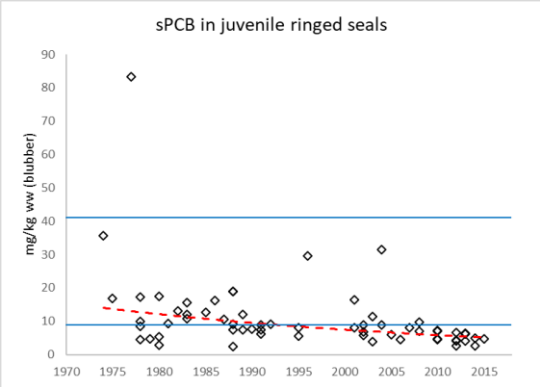

Figure 1. Concentrations of sPCB ww (21 congeners, mg/kg ww) in blubber from juvenile ringed seals from the Bothnian Sea and Bothnian Bay during 1974-2015. The red log-linear regression line was statistically significant (p<0.001). The lower line is the equivalent sPCBs concentrations threshold (9.0 mg/kg lw) for onset of physiological effects in experimental marine mammal studies and the upper line is the equivalent sPCB concentrations threshold for the highest PCB toxicity threshold for marine mammals based on marked reproductive impairment in ringed seals in the Baltic Sea[6].

Ten metals and selenium were analyzed. Seven of these showed no trend over time (As, Co, Cr, Cu, Mn, Ni and Zn). Cadmium, mercury and selenium decreased with ca 2-3% annually ($p<0.04$) and very low concentrations of Pb was seen, the last nine years of the study period concentrations were below level of detection (<0.02-0.03) and before that concentrations were just above detection limit. The concentrations of Hg were between 0.48-10,1 plus one outlyer at 30.2 mg/kg ww. The relationship Hg vs Se on a molar basis showed no trend over time. Generally, the ratio was slightly below 1, but in five samples it did exceeded 1 (mean ratio was 0.9) see Figure 2.

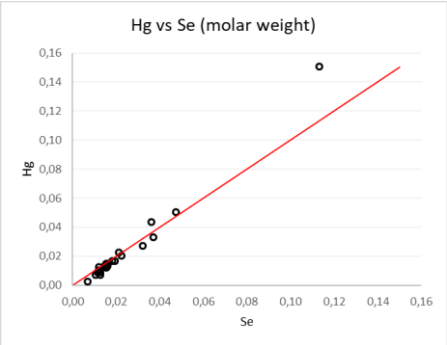

Figure 2. Hg vs Se on molar weight basis. The red line indicate a 1:1 ratio.

Conclusions

Concentrations of most dioxins and PCBs have decreased during the study period, however a few increased: two dioxins (1,2,3,4,6,7,8-HpCDD and OCDD) and one furan (1,2,3,7,8-PeCDF) in the last 15 year of the study period. The highest increasing rate, 15 % annually, was seen for OCDD the last 15 years. Most seals had a ratio Hg:Se just below 1:1 on a molar weight basis and concentrations of Hg, Pb and Cd in liver were generally considered low. Concentrations of sPCB decreased at a slower rate in ringed seals compared to herring from the same area, wheras concentrations of sDDT decreased at similar rates in both seals and herring. The majority of the seal samples were below 9 mg/kg sPCB ww in recent years, however one has to keep in mind that these are very young, juvenile seals. It would be interesting to know the concentrations of sPCB in adults since reproductive impairment is still occuring among ringed seal females and also study the relationship Hg vs Se in adults.

Acknowledgements:

This study was supported by funds from the Swedish Environmental Protection Agency, Agreement nr 2213-15-022.

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