ACCUMULATION PATTERN OF ORGANOCHLORINES IN JUVENILES OF *ARCTOCEPHALUS AUSTRALIS* FOUND STRANDED ALONG THE COAST OF SOUTHERN BRAZIL

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Introduction

Among synthetic organic chemicals, organochlorines (OCs) such as PCBs (polychlorinated biphenyls), DDTs, CHLs (chlordanes) and HCB (hexachlorobenzene) continue to cause concern due to their lipophilic and highly bioaccumulative nature and toxic effects [1]. PCBs and DDTs have been shown to have endocrine disrupting properties [2]. A number of studies have been conducted regarding contamination in developed nations, which have shown high concentrations of OCs in aquatic mammals, the top predators of ecosystems. Few studies, however, have documented the status of OC contamination in the Southern Hemisphere. Even less information has been reported on OC distributions among different tissues of marine mammals, despite their association with reproductive, endocrinological and morphological disorders in marine mammals [3].

The present study was conducted to elucidate the specific distribution of organochlorine (OC) compounds in various tissues and organs of the South American fur seal (*Arctocephalus australis*) from Southern Brazil.

Methods

Concentrations of PCBs (sum of 55 congeners), DDTs (sum of *p,p'*-DDE, *o,p'*-DDE, *p,p'*-DDD, *o,p'*-DDD, *p,p'*-DDT and *o,p'*-DDT), HCHs (sum of α-, ß-, γ-, δ-isomers), CHLs (sum of *trans*-chlordane, *cis*-chlordane, *trans*-nonachlor, *cis*-nonachlor) and HCB (hexachlorobenzene) were measured in the liver, kidney, muscle, blubber, bladder, heart, adrenal gland and skin/fur from eight juveniles of South American fur seals (*A. australis*) which had died through becoming stranded along the coast of Rio Grande do Sul state (Southern Brazil) during 1999.

OCs were analysed using a sample preparation method modified from Kannan *et al*. [4] and Nakata *et al*. [5]. Briefly, tissue samples (~1 g) were Soxhlet extracted into hexane/dichloromethane. The extract was transferred to a column packed with Florisil® (untreated) for lipid removal, and then eluted with acetonitrile/water. The eluant was collected in a separating funnel containing hexane and water. After shaking and phase separation, the hexane layer was concentrated. Samples were treated with concentrated sulphuric acid and then cleaned-up and fractionated using activated Florisil® Quantification of PCBs was performed using GC (Hewlett Packard 6890 series) equipped with an ECD.

Results and Discussion

Concentrations of PCBs, DDTs, HCHs, CHLs and HCB in the different tissues are presented in Figure 1. The OC residue concentrations were in the order: PCBs > DDTs > CHLs > HCHs > HCB. A

similar trend has previously been found in grey seal (*Halichoerus grypus*) samples from the St. Lawrence Estuary, Canada [6]. The levels of OCs, except for HCB, were positively correlated with lipid content, accumulating at higher concentrations in lipid rich blubber than in other tissues (on wet weight basis). No trend was recorded relating to the sex of the individuals, probably because the animals analysed were juveniles. Lower concentrations of OCs in mature females have previously been reported and explained by the lactational transfer of these compounds to their calves [1]. Results expressed on a lipid weight basis show a more homogenous distribution among the tissues (Figure 2). The poor nutritional status of these animals had probably allowed remobilization of some organochlorines stored in lipids to the other body tissues. The remobilization of lipids during periods of inanition may increase OC concentrations in the blood stream, potentially intensifying effects such as reproductive, hormonal or morphological disorders.

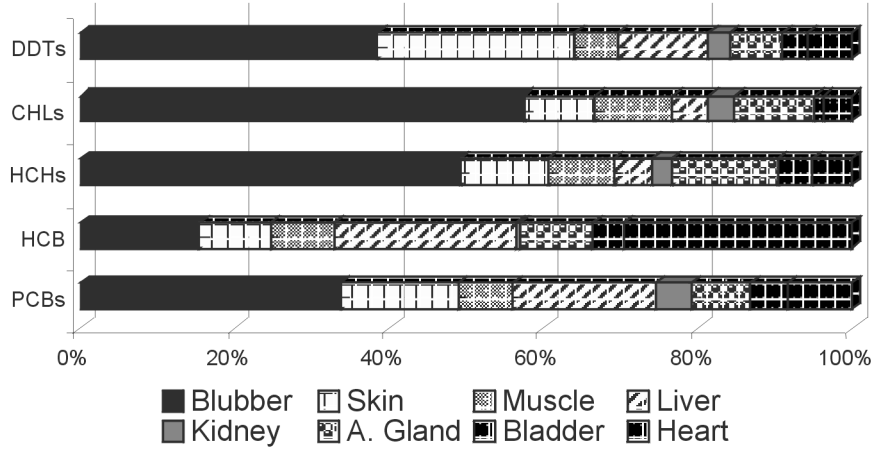

Figure 1. Composition of organochlorines (on a wet weight basis) in different tissues of juveniles of *A. australis* from Southern Brazil.

The residue levels of PCBs ranged from 0.01 – 3.7 mg g^{-1} (on a wet weight basis) and 1.5 - 11 mg g^{-1} (on a lipid weight basis). Mean values of PCBs in South American fur seal were comparable or lower than other pinnipeds throughout the world (Table 1). PCB 138 was the most abundant congener, followed by PCB 180, PCB 170, PCB 153, PCB 128, PCB 118, and PCB 183. These predominant congeners account for more than 90 % of the total PCB concentrations. These are most likely to have been originated from PCB usage as a dielectric fluid for the manufacture of capacitors and transformers in Brazil, Argentina and Uruguay.

DDTs were the second most prevalent group of contaminants and were detected in all tissues. The range of DDTs was 0.1 - 0.7 mg g^{-1} (wet wt) and 1.1 – 4.8 mg g^{-1} (lipid wt). DDT levels observed in the present study are comparable to concentrations reported for other species from different parts of the world (Table 1). Mean concentrations were lower than those in pinnipeds from the Baltic Sea and comparable to those from Japan and Arctic. *p,p'*- DDE, which is the major breakdown/metabolic product of DDT, accounted for >65 % of the total DDT concentration.

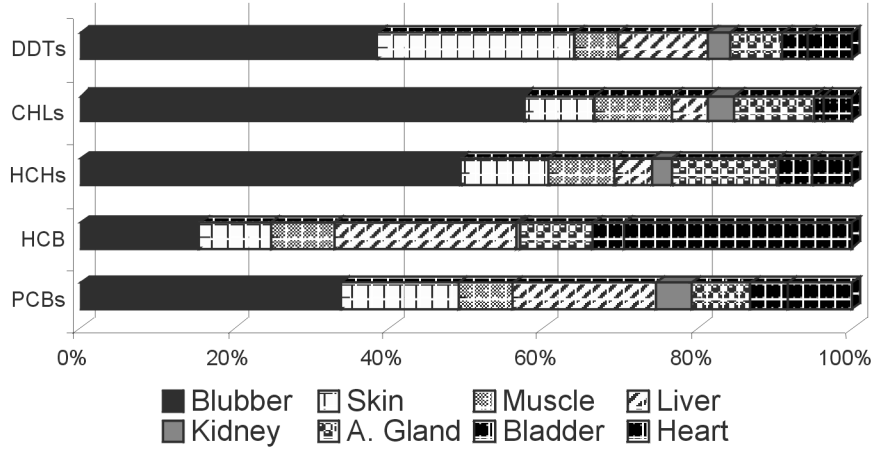

Figure 2. Composition of organochlorines (on a lipid weight basis) in different tissues of juveniles of *A. australis* from Southern Brazil.

Table 1. Comparison of mean organochlorine residue levels (mg g^{-1} lipid wt) in blubber of *A. australis* and other pinnipeds from different parts of the world.

Species	Location	Year	Maturity	PCBs	DDTs	CHLs	HCHs	Reference
A. australis	South Brazil	1999	juvenile	7.8	2.1	1.3	0.01	this study
Phoca vitulina	St. Lawrence Estuary	1996	juvenile	14.8	4.8	1.3	0.1	[6]
E. jubatus	Hokkaido, Japan	1994	mature	2.5	2.9	0.5	0.2	[7]
Phoca sibirica	Lake Baikal, Russia	1992	mature	31	64	1.0	0.09	[5]
Phoca sibirica	Lake Baikal, Russia	1992	mature	13	22	0.47	0.06	[5]
Phoca hispida	Baltic Sea	1986	mature	320	340	N.A.	N.A.	[8-9]
Phoca hispida	Barrow Strait, Arctic	1984	mature	0.63	0.79	0.51	0.30	[10]
Phoca hispida	Barrow Strait, Arctic	1984	mature	0.42	0.53	0.40	0.34	[10]

* N.A. – no data available

Concentrations of CHLs were in the range of 0.01 – 0.2 mg g^{-1} (wet wt) and 0.07 – 3.4 mg g^{-1} (lipid wt), comparable to the concentrations reported for seals in other regions (Table 1). *Cis*-chlordane accounted for the highest proportion in blubber, while *trans*-nonachlor predominated in the other tissues.

Low concentrations of HCHs were detected in *A. australis*, ranging from 0.1 - 2.1 ng g^{-1} (wet wt) and 11 - 34 ng g^{-1} (lipid wt). The mean values are lower than those reported in other areas (Table 1). With regard to the composition of the HCH isomers, the ratio between a- and g-isomers ranged from 0.2 (heart) to 4.2 (bladder), suggesting that HCH contamination arises through the use of both HCH formulations. Elevated percentages of the g-isomer indicate the use of lindane as a pesticide in the region, while technical HCH (which is also used as a pesticide) has been reported as a mixture of b (c. 9

%), g (c. 14 %) and a (c. 70 %) isomers [11]. The use of lindane has been recorded in Brazil, Uruguay and Argentina [12].

HCB was also found in all tissues from *A. australis*. The HCB levels were much lower than other compounds, ranging from 0.03 – 2.1 ng g^{-1} (wet wt) and 5 – 101 ng g^{-1} mg g^{-1} (lipid wt). The mean values are lower than those found in *Phocoena phocoena* from the Baltic Sea [13].

From a toxicological perspective, the estimated 2,3,7,8-TCDD equivalents (TEQs) of mono- and di-*ortho* coplanar PCB congeners [14]. range from 40 pg g^{-1} (wet wt) in adrenal gland to 132 pg g^{-1} (wet wt) in blubber, which are lower than those reported for Baikal seals [5].

Conclusions

The concentration pattern of OCs in *A. australis* are in the order: PCBs > DDTs > CHLs > HCHs > HCB. The composition of DDTs, HCHs and CHLs are not compatible with recent inputs of these compounds in the area. No gender difference in organochlorine concentrations was detected, probably because the animals analysed were juveniles.

In general, accumulation of DDTs, PCBs, CHLs and HCHs was greater in tissues/organs with high lipid contents (e.g. blubber and liver). However, results expressed on a lipid weight basis demonstrate a more homogenous distribution of the compounds among tissues. The poor nutritional status of these animals probably allowed remobilization of organochlorines stored in lipids to other tissues throughout the bodies.

Results of this study suggest that South American fur seals accumulate OCs and may be vulnerable to toxic effects. Especially because their reduced capacity to metabolise contaminants.

Acknowledgements

G. Fillmann was sponsored by CAPES (BEX1536/96-6).

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