ROLE OF ADIPOSE TISSUE RESPONSIBLE FOR ECHOLOCATION IN THE BIOACCUMULATION PROCESS OF LIPOPHILIC COMPOUNDS IN HARBOUR PORPOISES

Iris Schaap[1,2], Lutz Gross[3], Adrian Covaci[4], Thibaut Bouveroux[5], Fabien Demaret[6], Ronny Blust[7], Martin van den Berg[2], Liesbeth Weijs[1,8*]

1 – Queensland Alliance for Environmental Health Sciences (QAEHS), The University of Queensland, 39 Kessels Road, Coopers Plains, Queensland 4108, Australia
2 – University of Utrecht, Domplein 29, 3512 JE Utrecht, The Netherlands
3 – School of Earth and Environmental Sciences, The University of Queensland, Brisbane St Lucia, Queensland 4072, Australia
4 – Toxicological Centre, University of Antwerp, Universiteitsplein 1, 2610 Wilrijk, Belgium
5 – OCEAMM, 5 Place de la Gare, 59123 Zuydcoote, France
6 – Observatoire Pelagis, Université de La Rochelle / CNRS, 5 Allées de l'Océan, 17000 La Rochelle, France
7 – Department of Biology, University of Antwerp, Groenenborgerlaan 171, 2020 Antwerp, Belgium
8 – Australian Rivers Institute (ARI), Griffith University, Gold Coast Campus, Southport, QLD 4125, Australia

Introduction

Previous studies have suggested that persistent organic pollutants (POP) can lead to adverse effects in marine mammals, including harbour porpoises (*phocoena phocoena*), thereby causing illnesses. Traditionally, blubber is an ideal matrix to assess POP bioaccumulation in marine mammals. However, during times of energy deficits, blubber tissue is broken down in which POPs are redistributed in the body. Echolocating tissues melon and mandibular fat are inert lipid bodies in odontocetes and, in contrast with blubber, are less prone to release POPs, which makes them ultimate sinks for POP lifetime bioaccumulation.
This study aimed to assess the lifetime bioaccumulation of POPs in harbour porpoises through 1) analysis of POPs in various tissues and/or organs of harbour porpoises, including lipid rich bodies as blubber, melon and mandibular fat, and 2) Physiologically based toxico-kinetic (PBTK) modelling of PCB 153 and PBDE 153 to compare bioaccumulation of lipophilic compounds in lipid-rich tissues with different lipid composition and purpose (echolocation versus insulation) over the whole lifespan of male harbour porpoises.

Material and methods

All harbour porpoises (n=9 male and n=2 female) were found stranded on the Belgian and French North Sea coastline between January and April 2012. POP analysis consisted, of sample preparation, gravimetrical lipid content determination and quantification with gas chromatography–mass spectrometry (GC-MS). Blubber, melon, mandibular fat, kidney, liver and muscle tissue samples were screened on 32 PCB congeners (IUPAC numbers: CB 18, 28, 49, 52, 66, 74, 95, 99, 101, 105, 110, 118, 128, 138, 146, 149, 151, 153, 156, 167, 171, 174, 177, 180, 183, 187, 194, 196/203, 199, 206, 209), 7 PBDEs (IUPAC numbers: BDE 28, 47, 49, 99, 100, 153, 154), 6 DDX pesticides (o,p-DDE, p',p-DDE, o,p-DDD, p',p-DDD, o,p-DDT, p',p-DDT), 3 chlordanes (oxychlordane (OxC), trans-nonachlor (TN), cis-nonachlor (CN)), the fungicide hexachlorobenzene (HCB), and 2 naturally produced methoxylated PBDEs (2-MeO-BDE 68 and 6-MeO-BDE 47). The numerical models were programmed and developed in Berkeley Madonna software as well as in Python and will be validated by using POP analysis results analysed by GC-MS in tissue samples of harbour porpoises originating from the southern North Sea. Physiological and

biochemical parameters were obtained from the literature. In the model, the predominant intake of lipophilic pollutants was via milk in the first eight months after birth and after weaning, a fish diet was set as the main food source.

Results and discussion

1. POP analysis

In general, PCB congeners were the most abundant group of pollutants found in any organ and/or tissue sample, followed by DDXs, chlordanes, PBDEs and MeO-PBDEs. Nevertheless, concentration profiles depended on type of tissue and chemical (figure 1), in which for example patterns of PCB congener groups and PBDEs in blubber, mandibular fat and melon are almost identical, but differ from the patterns in liver and kidney. Overall, concentrations of POPs decreased from mandibular fat to > melon, > blubber, > liver, > muscle, > and kidney. Based on POP analysis, mandibular fat is a sink for POPs and therefore a better proxy for lifetime exposure than blubber, which can be both a sink and source of POPs. Knowledge of adverse health effects on the echolocation system of marine wildlife has been poorly studied. Interestingly, PCBs have been linked with hearing loss in Inuit people, which consume, similar to harbour porpoises, predominantly a fish rich diet (Dallaire et al., 2006; Boucher et al., 2010; Dallaire et al., 2004).

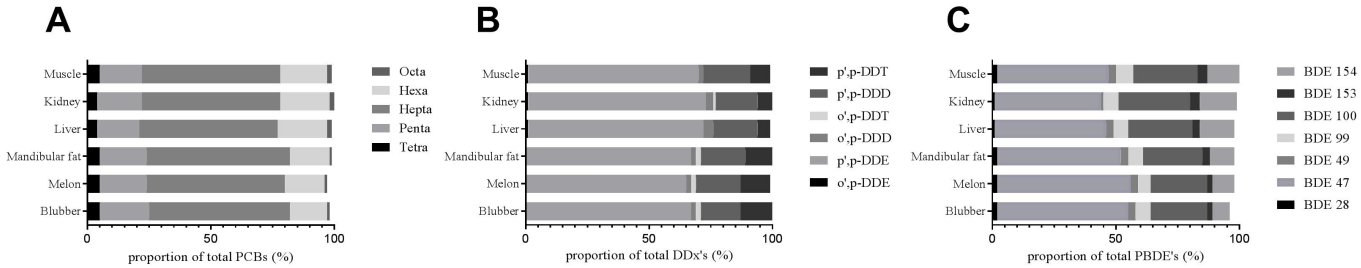

Fig. 1 Concentration profiles of specific POP classes (A: PCBs; B: DDXs, and C: PBDEs in blubber, melon, mandibular fat, liver, kidney and muscle.)

2. PBTK Modelling

PBTK modelling showed that mandibular fat was a better proxy to assess the lifetime bioaccumulation of PCB 153 in harbour porpoises. In contrast, BDE 153 bioaccumulation model revealed that echolocating bodies were not a good substitute for whole lifetime bioaccumulation of PBDEs. Even though an in-depth understanding of the mechanisms behind bioaccumulation of POPs into these types of tissues is lacking, this PBTK model has shown to predict the partitioning trend in this tissues, which, in turn, makes these computer based simulations a valuable tool in the risk assessment of chemicals.

References

Boucher, O., Bastien, C. H., Saint-Amour, D., Dewailly, E., Ayotte, P., Jacobson, J. L., ... & Muckle, G. (2010). Prenatal exposure to methylmercury and PCBs affects distinct stages of information processing: an event-related potential study with Inuit children. Neurotoxicology, 31(4), 373-384.

Dallaire, F., Dewailly, É., Muckle, G., Vézina, C., Jacobson, S. W., Jacobson, J. L., & Ayotte, P. (2004). Acute infections and environmental exposure to organochlorines in Inuit infants from Nunavik. Environmental health perspectives, 1359-1364.

Dallaire, F., Dewailly, É., Vézina, C., Muckle, G., Weber, J. P., Bruneau, S., & Ayotte, P. (2006). Effect of prenatal exposure to polychlorinated biphenyls on incidence of acute respiratory infections in preschool Inuit children. Environmental health perspectives, 1301-1305.