Mobilisation of Persistent Organochlorine Burdens in Migrating Southern Hemisphere Humpback Whales

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1. Introduction

Persistent Organic Pollutants (POPs) were first detected in Antarctic wildlife in the 1960s [1] and continue to be found today [2]. Global fractionation of semi-volatile POPs has been proposed as the primary mechanistic pathway supplying Polar regions with contaminant input [3].

The dependence of polar species on lipid rich diets to sustain the temperature and productivity extremes of high latitude environments, makes them particularly susceptible to bioaccumulation of these often highly lipophilic chemicals. Marine mammals are at the greatest risk of accumulating toxic levels of these chemicals due to their trophic level, longevity and high proportion of body fat.

Southern hemisphere humpback whales (*Megaptera novaeangliae*), feed in the Southern Ocean and overwinter in tropical breeding grounds, seasonally undergoing the longest migration and fasting events known in any mammal. The extreme life history behavior of these populations provide a unique opportunity to study the toxicokinetics of POPs during a period of chronic energy deficit. Previously, medical research has evidenced the toxic effects associated with rapid weight loss and concomitant mobilization of POP burdens [4, 5] Seasonal mobilization of blubber POP fractions during prolonged periods of lipid depletion, may place humpback whales in a higher chemical risk category to that commonly attributed to baleen whales [6].

This study presents a comprehensive overview of the accumulation of POPs in the species, whilst providing insight into the toxicokinetics of POP burdens in wildlife during prolonged periods of fasting and migration.

2. Materials and methods

Sample collection. Biopsy sampling occurred in Moreton Bay Marine Park, North Stradbroke Island, Australia. Fifty-eight skin and blubber biopsies were collected from free-swimming males at two time points on their annual migration as described in detail elsewhere [7].

Chemical analysis. All blubber samples were analyzed for 32 polychlorinated biphenyls (PCBs), and 25 organochlorine pesticides including: chlorobenzenes; the dichlorodiphenyltrichloroethane (DDT) group; hexachlorocyclohexanes (HCHs); chlordanes (Chlordane (cis-, trans-, oxy-), chlordene, Nonachlor (trans- and cis-)) and toxaphenes [12]). Twenty-three of the total fifty-eight, blubber samples were also analysed for the additional cyclodienes: Heptachlor-exo epoxide, Heptachlor-endo epoxide, Dieldrin, Eldrin, Isodrin, Endrin Endosulfan I, Endosulfan II, and Endosulfane-sulfate. Samples were extracted and underwent a series of clean up steps, quantification was carried out via high resolution gas chromatography coupled to a high resolution mass spectrometer, and quality control measures were adhered to. The procedure is described in full elsewhere [7].

Statistical analysis. Concentration Indices (CI) are defined as the ratio between the mean lipid normalised individual compound concentration in late versus early migrating cohorts [18].

3. Results and discussion

Among compound groups, chlorobenzenes (HCB and PeCB) were quantified at the highest average concentrations (combined early and late migration average ng/g l.w.) (160.0) followed by Σ_6DDT (51.0) > Σ_9Cyclodienes (49.0) > Σ_7CHL (23.0) > $\Sigma_8$toxaphenes (19.0) > Σ_{32}PCB (18.0) > Σ_3HCH (11.0).Utilisation of humpback whale blubber lipids across the migration journey was evidenced by an average 23% reduction in blubber lipid between early and late migrating cohorts. This loss was not linear with the observed CI of OC compounds between the two cohorts which, with the exception of three compounds, were consistently greater than 1 (Figure 1). The average CI of compounds detected in ≤50% of both early and late cohort

animals was 5.1. This study did not attempt recapture of individual animals. Similarly, aging cannot yet be performed non-lethally on southern hemisphere individuals. In light of these uncontrolled variables, it is particularly notable that high CIs were a consistent trend.

Figure 1 Concentration Indices (CIs) of individual compounds between late and early migration cohorts

The non-linear relationship between dorsal blubber lipid reduction and the increase in lipid normalised blubber contaminant concentration provides valuable clues regarding lipid dynamics. The uncoupling between the two dependent parameters is indicative of selective energy utilisation and OC mobilisation, from alternate energy depots.

4. Conclusions

The results of this study emphasize the importance of considering prolonged periods of food deprivation when assessing chemical risks posed to wildlife. This is of particular importance for Polar biota adapted to extremes in ecosystem productivity.

5. References

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