HIGH PCB AND LOW PBDE EXPOSURE IN PELAGIC NORTH PACIFIC ALBATROSSES

Harwani S[1], Park J-S[1], Henry R W[2], Rhee A[1], Patel P[1], Petreas M[1], Hooper K[1]

[1]Environmental Chemistry Laboratory, California Department of Toxic Substances Control, Berkeley, CA 94710, USA; [2]Center for Ocean Health, Long Marine Laboratory, 100 Shaffer Road, University of California – Santa Cruz, CA 95060, USA

Abstract

The long-range transport, fate, and harmful effects of polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs) are well-established. North Pacific Albatrosses are high trophic level consumers and thus subject to increased exposure to persistent organic pollutants (POPs) *via* bioaccumulation. These birds often consume plastic marine debris, and the possibility for a synergetic interaction between: a) lipophilic plastic marine debris that may serve as a substrate for POPs and b) contaminant loading Albatrosses, make it vital to monitor levels of POPs in these top consumers. We collected blood samples (n=59) from Albatrosses nesting on Tern and Guadalupe Islands in North Pacific Ocean during 2005-2006 and present PCB and PBDE contaminant levels from 25 of these Albatross samples using GC-ECD. The 25 Albatross samples were comprised of Black-footed (*Phoebatria nigripes*, n=6) and Laysan (*Phoebastria immutabilis*, n=11) from Tern Island, and Laysan (n=8) from Guadalupe Island. Our preliminary results indicate that North Pacific Albatrosses are still highly exposed to PCBs, which showed both temporal decline and inter-species variation. In contrast, PBDEs were detected at trace levels, indicating these birds in remote North Pacific Ocean have low PBDE exposure relative to PCBs. On-going analyses of the remaining Albatross plasma samples will help to better understand the different levels among different Albatross species, in relation to foraging range, geographical location, and feeding patterns. Upon completion of analyses for all 59 samples we will be able to compare our Albatrosses data with those from previously published reports, and provide additional data on the accumulation of emerging contaminants in pelagic seabirds (*e.g.* PBDEs).

Introduction

The levels, long-range transport, fate, and adverse effects of polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs) are widely studied in human and wildlife[1-7], providing much fuel for the need to monitor these chemicals in remote environments. Due to the decrease in use of PCBs since the late 1970s, it appears that the concentration of PCBs in biota is declining or leveling off[8-10], however, trends in the levels of PBDEs do not show these same declines due to their continued use[11,12].

Monitoring concentrations of these toxic chemicals in and around the North Pacific gyre is important due to oceanographic properties of the gyre that promote entrainment of floating materials, indicating that the North Pacific Gyre could be a natural chemical and material 'landfill'[13,14]. The possible adsorption of these contaminants on plastics, and subsequent uptake of these plastics by predatory birds in the North Pacific gyre makes it vital to monitor levels of these compounds within a predatory species living in and around the North Pacific gyre. Albatrosses are a good sentinel species for biomonitoring persistent organic pollutants (*e.g.* such PCBs and PBDEs) in the pelagic environment because they are top trophic consumers, are known to consume marine debris and integrate massive expanses of the North Pacific Ocean in short temporal scales (thousands of km in days)[15]. Previous similar studies by Auman *et. al.* and Finkelstein *et. al.* reported that the Black-footed and Laysan Albatrosses residing on Sand Island, Midway Atoll were highly exposed to PCBs, ranging from 12 – 450 ng/g wet weight and 25 – 200 ng/mL plasma, respectively[16,17]. However, information on the Albatross exposure to emerging POPs, such as PBDEs, and temporal trends of PCBs, a classic POP, are scarce. Therefore, in this study, we measured both legacy and emerging POPs from North Pacific Albatross plasma samples to investigate the extent of their exposures in relation to temporal and spatial gradients.

Materials and Methods

Blood samples were collected during 2005 and 2006 from 59 Albatross from Guadalupe Island, located off the coast of Baja California, MX and Tern Island, USA in or around the North Pacific gyre. The report here contains results from 25 of the 59 samples. The speciation and location distribution for the 25 samples analyzed are: (1) From Tern Island, Black-footed (n=6) and Laysan Albatross (n=11) and (2) from Guadalupe Island, Laysan Albatross (n=8) (no Black-footed samples from Guadalupe). Plasma was isolated onsite and stored at -20 °C until analyses by the Department of Toxic Substances Control. Samples were extracted using standard extraction and phase-separation techniques[18]. Thirty-two PCBs and three major PBDEs were analyzed using an Agilent 7890 GC-ECD equipped with DB-XLB (J & W Scientific, Folsom, CA; 60 m x 0.25 mm I.D. x 0.25 µm film thickness) and RTX-5MS columns (Restek; 60 m x 0.25 mm I.D. x 0.25 µm film thickness) and quantified using a five-point external calibration curve with $R^2 > 0.99$.

All chemical analyses were performed in the ultra clean laboratory at the Department of Toxic Substances Control, Berkeley, California. Both a standard reference material (SRM1589a, National Institute of Standards and Technology, Gaithersburg, MD) and bovine calf serum (Hyclone; Logan, Utah) spiked with compounds of interest (laboratory control) were used to assure the measurements of PCBs and PBDEs. Concentrations of all compounds in these analyses here are presented as ng/mL wet weight (ng/mL ww).

Results and Discussion

Preliminary results from the analysis of 25 Albatross plasma samples showed PCB-153 levels approximately thirty times higher than PBDE-47 (**Table 1**), indicative of the similar distribution in $\sum_{32}$PCBs and $\sum_{3}$PBDEs since these two congeners were major contributors to their group (**Figure 1a** and **1b**). It was interesting that North Pacific Albatrosses were exposed to PBDEs only in trace levels.

Table 1: PCB-153 and PBDE-47 Concentrations from Initial 25 Albatross Plasma Samples

	# Observations	Mean (ng/mL ww)	Std Dev	Min (ng/mL ww)	Max (ng/mL ww)
PBDE-47	25	0.25	0.11	0.06	0.61
PCB-153	25	8.56	5.37	2.96	24.29

Tern Black-footed Albatrosses showed significantly higher levels (2 – 3 times higher) of PCB-153 than Tern Laysan Albatrosses (**Figure 1a**), which is consistent with other studies[12,13]. These same trends are also noted in the total PCB and PBDE profiles ($\sum_{32}$PCB and $\sum_{3}$PBDE) seen in **Figure 1b**. These differences are likely attributed to differences in diet and foraging ranges between the two species. Generally, Tern Laysan Albatrosses forage in the northern North Pacific while both Black-footed and Guadalupe Laysan Albatrosses spend significant portions of their lives foraging in the Eastern Pacific off western North America. It is also known that Laysan Albatross are known to stay closer to their nesting site[15]. Comparison of only Laysan Albatrosses from colonies located in the central (Tern) and Eastern Pacific (Guadalupe) Islands (**Figure 1c**), indicated no statistical difference in PCB or PBDE contaminant levels (PBDE data not shown in **1c**). This suggests that the difference in diet plays an important role in contaminant concentrations found in North Pacific Albatrosses. To gain a better understanding of PCB and PBDE levels and patterns and to increase statistical power, we are analyzing the remaining 34 samples and will investigate correlations between species, geographical locations, and feeding patterns.

Acknowledgements and Disclaimer

The views expressed herein are those of the authors and do not necessarily reflect those of Department of Toxic Substances Control, California Environmental Protection Agency.

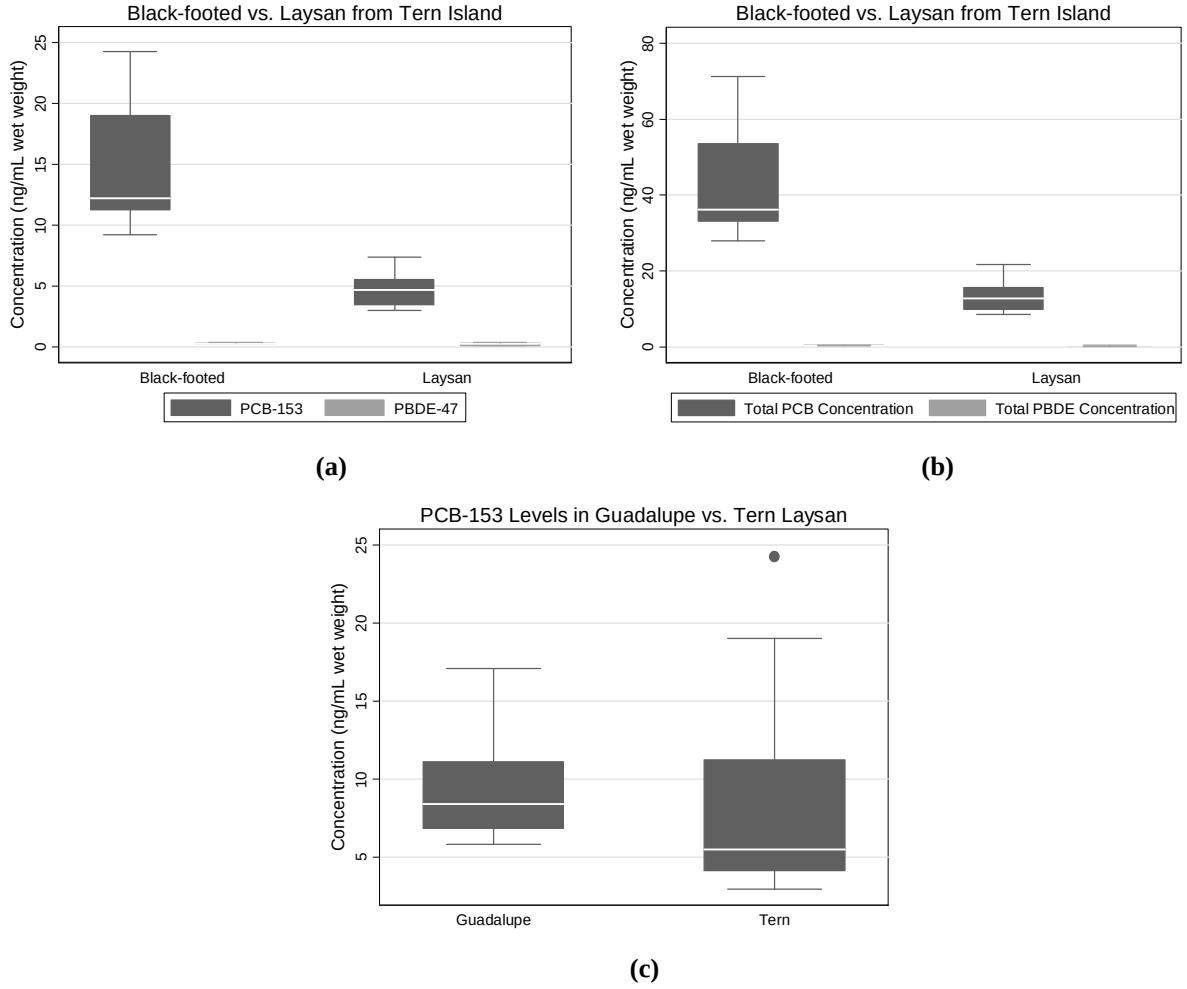

Figure 1 Box plots from the PCB and PBDE analyses of 25 Albatross plasma samples (6 Black-footed from Tern, 11 Laysan from Tern, and 8 Laysan from Guadalupe. **(a)** Comparison of Tern Black-footed *vs.* Laysan Albatrosses **(b)** Comparison of Total PCB Levels of Tern Black-footed *vs.* Laysan Albatrosses **(c)** Comparison of Tern vs. Guadalupe Laysan Albatrosses.

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