

PCBs and 2,3,7,8- substituted polychlorinated dibenzo-p-dioxins and dibenzofurans in albatross tissues from Midway Island in the central Pacific Ocean.

Paul D Jones¹, Donald J Hannah¹, Simon J Buckland¹, Peter J Day¹, Scott V Leatham¹, Lawrence J Porter¹, John P Giesy², Heidi J Auman², James P Ludwig³, and Cheryl Summer³.

¹ESR:Environmental, Lower Hutt, NEW ZEALAND. ²Department of Fisheries and Wildlife, Michigan State University, E. Lansing MI, USA. ³SERE Group, Victoria BC, CANADA.

Introduction

Planar chlorinated hydrocarbons (PCHs) such as polychlorinated dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDDF) and some polychlorinated biphenyl (PCB) congeners appear to be ubiquitous contaminants in aquatic ecosystems. They have been detected in fresh water and marine organisms at high concentrations in the northern hemisphere. Concentrations in the marine environment in the southern hemisphere are considerably lower^{1,2)} and it is believed that atmospheric transport accounts for the bulk of these materials transported to the southern oceans²⁾. While considerable data is available on contaminants in marine mammals³⁾ similar data is limited for oceanic birds⁴⁾. Studies in fresh water ecosystems have demonstrated that fish eating water birds may be particularly vulnerable to adverse effects from organochlorine contaminants^{5,6)}. As part of a multidisciplinary study to assess human impacts in the remote oceanic environment, we have determined the concentrations of PCDD, PCDF and PCB congeners in albatross tissues collected from Midway Island in the central Pacific Ocean.

Methods

Albatross eggs and tissues were collected from the Midway Atoll group during 1994. Egg samples consisted of pools of 10 eggs, adult fat and liver samples were composites of five individuals collected from the same location. Methods for the analysis of tissues for PCDD and PCDF has been reported previously⁷⁾. After the addition of ¹³C₁₂ standards PCHs were extracted from tissues with 2:1 acetone:hexane by homogenizing in the presence of anhydrous sodium sulphate. Extracts were concentrated and a small portion was used for lipid determination. Extracts were purified by treatment with concentrated sulphuric acid followed by chromatography on a multi-layer column of sulphuric acid silica gel and sodium hydroxide silica gel and chromatography on an alumina column. PCDD and PCDF congeners were removed from the extract using a column of Carboxipack dispersed on Celite. The remaining extract was then subjected to chromatography on Florisil to isolate coplanar PCBs from other PCB congeners. PCDDs, PCDFs and PCBs were determined by HRGC/HRMS on a VG 70 mass spectrometer using

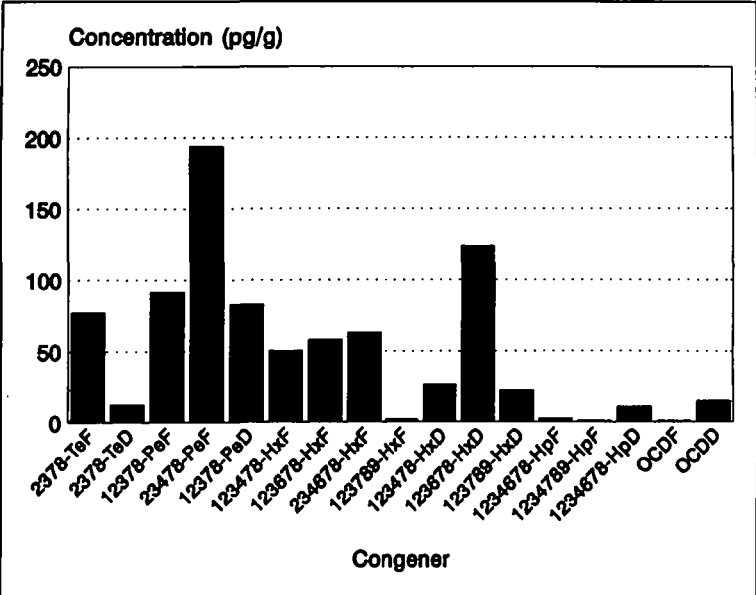


Figure 1 Concentrations of PCDD and PCDF congeners (pg/g wet weight) in Midway Island Laysan albatross fat.

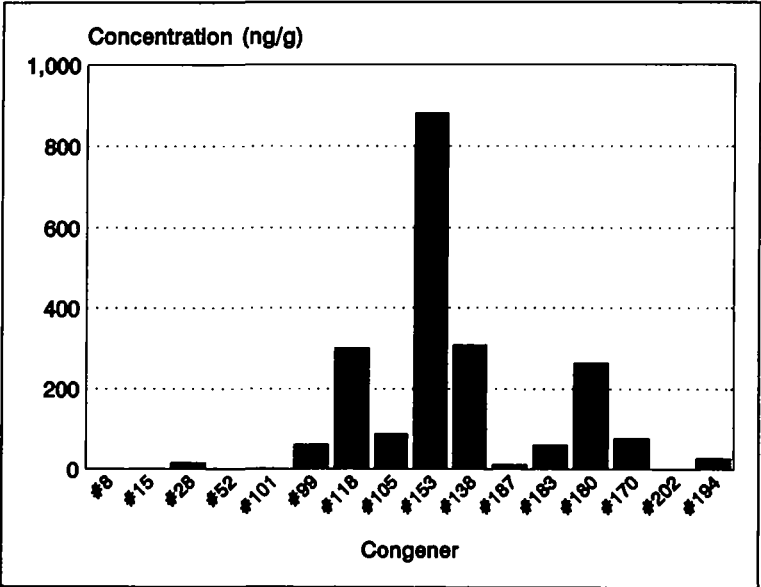


Figure 2 Concentrations of PCB congeners (ng/g wet weight) in Midway Island Laysan albatross fat.

described methods⁷⁾.

Results

2,3,7,8- substituted PCDD and PCDF congeners were detected in all samples analysed. Concentrations were greatest in adult fat, approximately 10 fold less in eggs and still less in adult liver tissue. The five most abundant congeners were 2,3,4,7,8-PeF > 1,2,3,6,7,8-HxD > 1,2,3,7,8-PeF > 1,2,3,7,8-PeD > 2,3,4,6,7,8-HxD (Figure 1). Toxic equivalents (TE) contributed by PCDDs and PCDFs, calculated using NATO Toxic Equivalency Factors⁸⁾, ranged from 300 pg/g in adult fat to between 17 and 37 pg/g in egg composites.

PCB congeners were detected in all samples analysed. The sum of the 19 congeners analysed varied from 2580 ng/g in adult fat to between 200 and 640 ng/g in egg composites. Congener sums were less than 100 ng/g in adult livers. PCB congener profiles were unusual in showing a paucity of lower chlorinated congeners (Figure 2). In addition the ratios of some diagnostic congener pairs were different from those normally observed. Total 2,3,7,8-TCDD toxic equivalents were calculated for PCB mixtures using the Toxic Equivalency Factors of Ahlborg *et al.*⁹⁾. Toxic equivalents derived from PCBs varied from 472 pg/g in adult fat to 30.2-86 pg/g in egg composites (expressed as TCDD equivalents).

Discussion

The PCH congener profiles detected in the Midway Island samples were unusual and indicate that these PCHs may have been accumulated from a combination of local sources and atmospheric deposition. PCBs derived from atmospheric deposition tend to have an abundance of lower chlorinated congeners¹⁾. The high levels of furans present in the Midway Island samples suggest that the major source of the contaminants may be technical PCB mixtures¹⁰⁾. However the high ratio of PCDFs to PCBs would indicate considerable enrichment of the furans compared to the PCBs.

The total concentrations of TE in the egg samples was within the range of concentrations where sensitive avian species show adverse reproductive effects^{5,6)}. This is particularly so for the Black Footed Albatross where egg TE concentrations were 124 pg/g. Of note is that Black Footed Albatross eggs contained considerably greater concentrations of PCDF and PCB congeners than Laysan albatross eggs. This may reflect the different food habits and/or migration patterns of the species.

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