PERSISTENT ORGANIC POLLUTANTS IN MURRE EGGS FROM THE BERING SEA AND GULF OF ALASKA

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INTRODUCTION

Common (*Uria aalge*) and thick billed murres (*U. lomvia*) are distributed throughout the Arctic and sub Arctic where they form large nesting colonies. Murres are opportunistic piscivores, surface diving to capture forage fish such as pollock, sculpins, capelin and flounder as well as a variety of other prey items [1,2], thus feeding at the same trophic level as some species of marine mammals. Murres may also comprise an important part of the Alaska Native diet. Based on a survey of two villages on St. Lawrence Island in 1995 – 1996, the average household consumes between 60 and 104 murres and eggs per year [3]. Birds in the Alcidae family, such as murres, have been recommended as target species for the Arctic Monitoring and Assessment Programme [4]

As a result of the need to monitor Alaska wildlife for man-made contaminants, a program was initiated in 1999 by the US Fish and Wildlife Service (USFWS), the US Geological Survey (USGS), and the National Institute of Standards and Technology (NIST) to collect, archive and analyze eggs from murre colonies. Currently, the Seabird Tissue Archival Project (STAMP) has collected eggs from five seabird nesting colonies and is expanding the project to include the monitoring of eggs from other colonies in the Bering Sea and Gulf of Alaska. The objective of this work is to generate persistent organic pollutant (POP) data on murre eggs from the five colonies so far sampled and to examine geographical differences in POP levels and patterns.

MATERIALS AND METHODS

A total of 67 murre eggs were collected and processed following published standard protocol [5]. In 1999, common or thick-billed murre eggs from Little Diomede Island (n = 9; N. Bering Sea) and common murre eggs from St. George Island (n = 11; N. Bering Sea), East Amatuli Island (n = 11; Gulf of Alaska) and St. Lazaria Island (n = 10; Gulf of Alaska) were collected. In 2000, thick-billed murre eggs from St. George Island (n = 7) and Bogoslof Island (n = 10; S. Bering Sea) and common murre eggs from Bogoslof Island (n = 9) were collected. Eggs were collected by subsistence harvesters at Little Diomede Island and by USFWS personnel at all other locations. The eggs were individually cryohomogenized and divided into approximately 5-g aliquots and stored in Teflon jars at -150 ^{o}C in liquid N_2 vapor until analysis.

Methods for the analysis of PCBs and organochlorine pesticides have been detailed elsewhere [6], but are summarized here. One gram samples of cryohomogenized blubber were mixed with sodium sulfate and added to pressurized fluid extraction (PFE) cells. A mixed internal standard was added and the samples were extracted with dichloromethane. High-molecular weight compounds were removed by size exclusion chromatography and the cleaned-up extracts were fractionated by LC using an aminopropyl silane column. Samples were analyzed using GC-dual ECD (Agilent 6890, Palo Alto, CA) for approximately 50 PCB congeners and 20 organochlorine pesticides. The compounds were separated on 60 m DB-5 and 60 m DB-XLB columns (J&W Scientific, Folsom, CA) after the injection was split between the two columns. Standard Reference Material 1946 "Lake Superior Fish Tissue" and a blank were analyzed with each batch for quality control. Herring gull egg reference material from the Canadian Wildlife Service was analyzed with the last two batches as additional control material.

RESULTS AND DISCUSSION

The major POPs in Alaskan murre eggs were DDE, ΣPCB, HCB, β-HCH, and ΣCHL (ranging from 387-3687, 293-2963, 196-1057, 59.0-282, and 22.2-322 ng/g lipid mass, respectively (Table 1). PCB congeners 153, 118, 138, 99, and 151 were major contributors to ΣPCBs in murre eggs ranging from 43.1-642, 43.9-289, 18.6-346, 14.9-184, and below detectable limit to199 ng/g lipid mass, respectively. Oxychlordane and heptachlor epoxide comprised an average of 82.5 % of all chlordane compounds ranging from below detectable limit to 197 and 150 ng/g lipid corrected wet mass, respectively. POPs, with the exception of β-HCH, were significantly different among colonies (ANOVA, $p < 0.05$). Numerous between colony differences in POP concentrations in common murre eggs were detected (Table 1).

Common murre eggs from Bogoslof Island and St. George Island collected from 1973-1976 were also analyzed for selected POPs [7]. Concentrations of 4,4'-DDE, oxychlordane, and heptachlor epoxide were significantly lower in the present study than the values presented in [7]. Dieldrin and hexachlorobenzene were not significantly different between the two studies.

Differences in POP concentrations between thick billed murre eggs and common murre eggs were observed at Bogoslof Island and Saint George Island. For instance, 4,4'-DDE was higher in common murres versus thick billed murre eggs at Bogoslof Island, but the reverse was true at Saint George Island. Other species-specific differences in POP levels were detected mainly in Saint George eggs.

Principal components analysis (PCA) performed on the contribution of individual POPs to the total POP levels in eggs revealed colony specific differences (Figure 1). A gradient was observed in the patterns of POPs with the N. Bering Sea samples most different from the Gulf of Alaska samples. Bogoslof Island, which is in the Aleutian Islands, was intermediate. Good separation in POP patterns was also observed between POP patterns in common and thick billed murre eggs collected from Bogoslof Island and Saint George Island (figure not shown).

Results from this study indicate strong geographical differences in POP patterns more as a function of water basin than of latitude. The differences observed in the patterns and

concentrations between thick billed murre and common murre eggs suggest feeding behavior or other ecological factors may be important in governing POP bioaccumulation.

LITERATURE CITED

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Table 1: POPs in common murres from the Gulf of Alaska and the Bering Sea. ANOVA detected among colony differences for all compounds except β-HCH. Colonies sharing the same letter are not significantly different ($p < 0.05$). All concentrations are expressed as ng/g lipid wt.

Compound	East Amatuli	St. Lazaria	Bogoslof Island	St. George Island	LittIe Diomede Island
	G. of Alaska	G. of Alaska	S. Bering	N. Bering	N. Bering
n→	11	10	9	11	9
%lipid	8.97 ± 1.4^{b}	12.3 ± 0.87^{a}	10.9 ± 1.5^{ab}	12.3 ± 1.6^{a}	12.8 ± 2.3^{a}
HCB	476 ± 98^{b}	316 ± 72^{c}	576 ± 170^{ab}	679 ± 68^{a}	685 ± 190^{a}
α-HCH	16.1 ± 7.3^{ab}	9.51 ± 4.0^{b}	22.3 ± 7.2^{a}	11.0 ± 4.5^{b}	10.0 ± 5.5^{b}
β-HCH		143 ± 50		161 ± 64	183 ± 63
γ-HCH	4.66 ± 7.1^{ab}	1.97 ± 1.7^{b}	6.27 ± 1.3^{a}	2.63 ± 2.5^{ab}	2.62 ± 2.9^{ab}
ΣCHL	133 ± 65^{ab}	92.2 ± 73^{b}	113 ± 30^{ab}	121 ± 56^{ab}	158 ± 66^{a}
4,4'-DDE	1560 ± 740^{b}	2440 ± 800^{a}	712 ± 140^{c}	594 ± 150^{c}	572 ± 180^{c}
mirex	20.5 ± 11^{a}	25.2 ± 14^{a}	5.01 ± 3.9^{b}	14.5 ± 6.0^{a}	22.6 ± 14^{a}
dieldrin	21.5 ± 12^{a}	35.7 ± 31^{a}	21.5 ± 6.0^{a}	32.6 ± 26^{a}	$40.2a \pm 17^{a}$
ΣPCBs	1120 ± 380^{b}	1970 ± 800^{a}	700 ± 200^{bc}	694 ± 340^{c}	757 ± 310^{ac}
DDE/PCB	1.38 ± 0.42^{a}	1.33 ± 0.30^{a}	1.08 ± 0.34^{ab}	0.937 ± 0.25^{b}	0.783 ± 0.14^{b}

Figure 1. Principle components analysis showing geographical separation of Alaskan common murre (*Uria aalge*) eggs. Circles = Little Diomede Island (N. Bering Sea), squares = St. George Island (N. Bering Sea), triangles = Bogoslof Island (S. Bering Sea), diamonds = East Amatuli Island (Gulf of Alaska), and upside-down triangles = St. Lazaria Island (Gulf of Alaska).