

Sensitivity of Developing Embryos of Two Arctic-breeding Seabirds to Methylmercury Exposure



Thick-billed Murre



Arctic Tern

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Abstract

To determine species sensitivity to mercury exposure and evaluate potential reproductive consequences, eggs of thick-billed murres (*Uria lomvia*) and arctic terns (*Sterna paradisaea*) were dosed with graded concentrations of methylmercury and artificially incubated to pipping. Median lethal concentrations (LC₅₀) were 0.48 μg g⁻¹ wet weight (ww) for thick-billed murre embryos and 0.95 μg g⁻¹ ww for arctic tern embryos. Compared with other avian species, the murres and terns had a medium sensitivity to methylmercury exposure.

Introduction

- Mercury (Hg) has increased in marine mammals and seabirds (e.g. thick-billed murres) in some regions of the Canadian Arctic over the past few decades¹.
- Methylmercury (MeHg) is highly embryotoxic making reproduction one of the most sensitive endpoints of Hg toxicity.
- Nearly 100% of Hg transferred to eggs is in the form of MeHg.
- Significant interspecies differences were found among 26 avian species tested for sensitivity to embryotoxic effects of MeHg².
- Given that Hg is increasing in some Canadian Arctic seabirds, our objective was to determine the relative sensitivities of two Arctic-breeding seabirds, the thick-billed murre and arctic tern, to MeHg exposure.

Methods [see Braune et al.³ for details]

- Followed protocol of Heinz et al.⁴.
- 120 fresh, unincubated eggs were collected from each species within 24 h of being laid.
- Eggs were randomly assigned to 8 dose groups (0.05, 0.1, 0.2, 0.4, 0.8, 1.6, 3.2, 6.4 μg g⁻¹ MeHg chloride dissolved in safflower oil) plus a vehicle-control group.
- MeHg dose was injected into the air cell and eggs then artificially incubated to pipping (start of hatch).
- 90% development was the endpoint.
- Embryos and egg contents were homogenized, freeze-dried and analyzed for total Hg (THg) by direct mercury analyzer (AMA-254).

Data Treatment

- Median lethal concentrations (LC₅₀) and 95% confidence intervals (CI) were calculated using the SAS probit procedure.
- Survival data were corrected for control mortality using Abbott's formula⁵.
- LC₅₀ values were calculated in two ways: (1) based on injected MeHg doses, and (2) based on measured THg concentrations; i.e. maternally-deposited THg plus the injected MeHg dose.

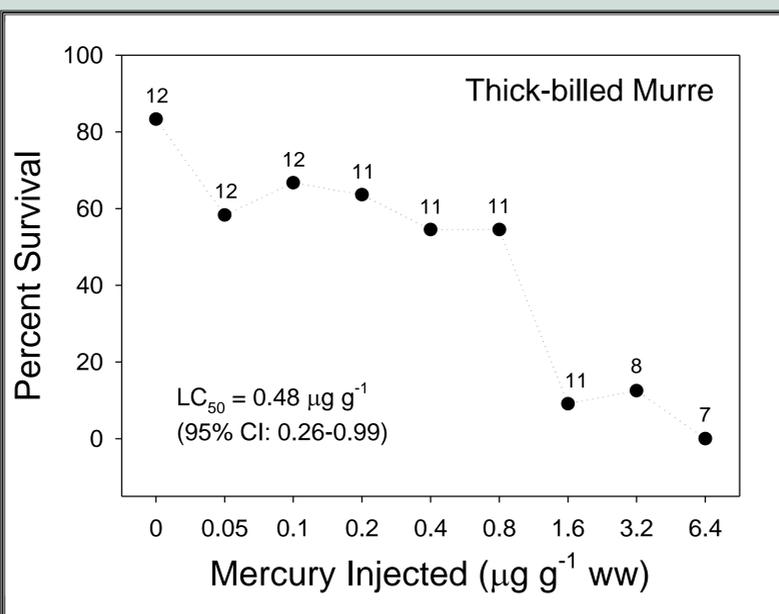
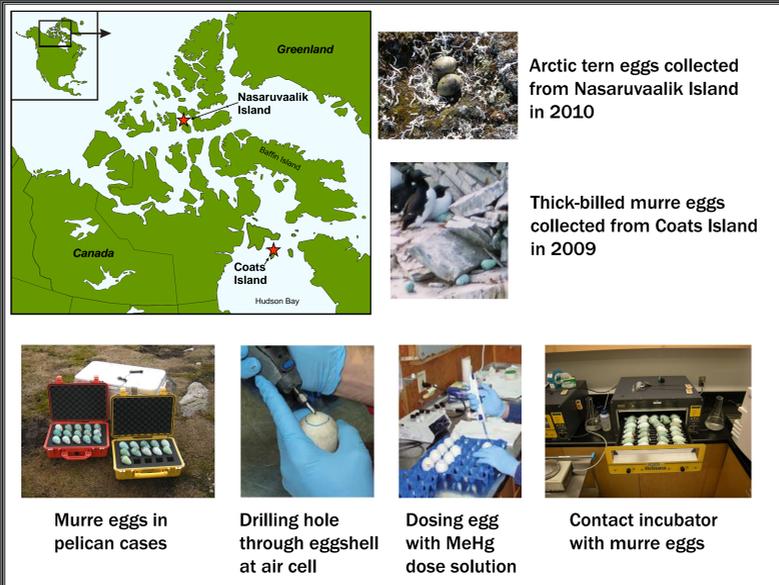


Figure 1. Survival of thick-billed murre embryos through 90% of development when eggs were injected with MeHg. Percent survival plotted by dose group. Sample sizes are given above each point on the graph. The LC₅₀ and 95% CI are also shown.

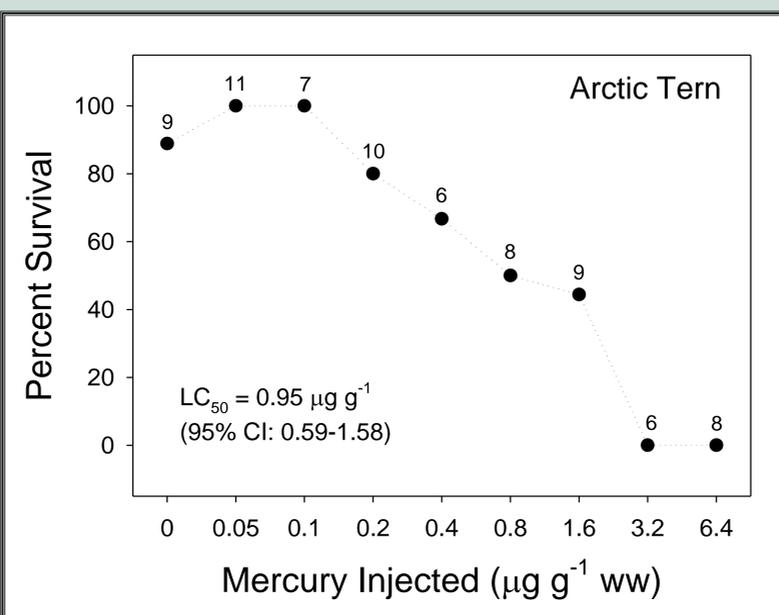


Figure 2. Survival of arctic tern embryos through 90% of development when eggs were injected with MeHg. Percent survival plotted by dose group. Sample sizes are given above each point on the graph. The LC₅₀ and 95% CI are also shown.

Results

- The LC₅₀ for murre embryos was 0.48 μg g⁻¹ ww based on MeHg injected into eggs uncorrected for maternally-deposited THg (Fig. 1), and 0.56 μg g⁻¹ ww based on THg measured in the embryos (i.e. maternally-deposited THg plus injected MeHg dose).
- The LC₅₀ for tern embryos was 0.95 μg g⁻¹ ww based on MeHg injected into eggs uncorrected for maternally-deposited THg (Fig. 2), and 1.10 μg g⁻¹ ww based on THg measured in the embryos.
- THg in murre eggs from Coats Island in 2009 averaged 0.16 μg g⁻¹ ww, and for Prince Leopold Island in the high Arctic, 0.40 μg g⁻¹ ww.
- THg in arctic tern eggs from Nasaruaalik Island in 2008 averaged 0.49 μg g⁻¹ ww⁶.
- Compared with LC₅₀ values for 26 tested species², both thick-billed murres and arctic terns had medium sensitivity to MeHg (0.25 < LC₅₀ < 1 μg g⁻¹ ww) based on injected MeHg.
- Based on measured THg, the sensitivity of arctic tern embryos changed to low sensitivity (LC₅₀ ≥ 1 μg g⁻¹ ww).

Conclusions

- Average colony THg concentrations for eggs do not exceed estimated LC₅₀ values for either species, but they are within the same order of magnitude.
- Given that Hg has been increasing in some Canadian Arctic biota, continued monitoring of these seabird colonies is warranted.

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