Thick-billed Murre

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

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 (LC_{50}) 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

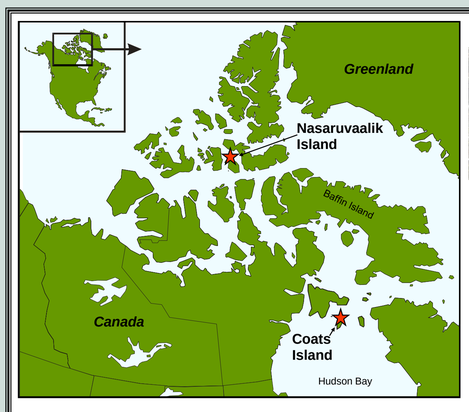
- Mercury (Hg) has increased in marine mammals and seabirds (e.g. thick-billed murres) in some regions of the Canadian Arctic over the past few decades[1].
- Methylmercury (MeHg) is highly embryotoxic making reproduction one of the most sensitive endpoints of Hg toxicity.
- Nearly 100% of Hg transferred to eggs is in the form of MeHg.
- Significant interspecies differences were found among 26 avian species tested for sensitivity to embryotoxic effects of MeHg[2].
- 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]

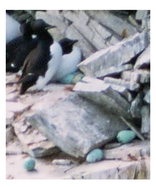
- Followed protocol of Heinz et al.[4].
- 120 fresh, unincubated eggs were collected from each species within 24 h of being laid.
- Eggs were randomly assigned to 8 dose groups (0.05, 0.1, 0.2, 0.4, 0.8, 1.6, 3.2, 6.4 μg g^{-1} MeHg chloride dissolved in safflower oil) plus a vehicle-control group.
- 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 (LC_{50}) and 95% confidence intervals (CI) were calculated using the SAS probit procedure.
- Survival data were corrected for control mortality using Abbott's formula[5].
- LC_{50} 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.



Arctic tern eggs collected from Nasaruvaalik Island in 2010



Thick-billed murre eggs collected from Coats Island in 2009

Murre eggs in pelican cases

Drilling hole through eggshell at air cell

Dosing egg with MeHg dose solution

Contact incubator with murre eggs

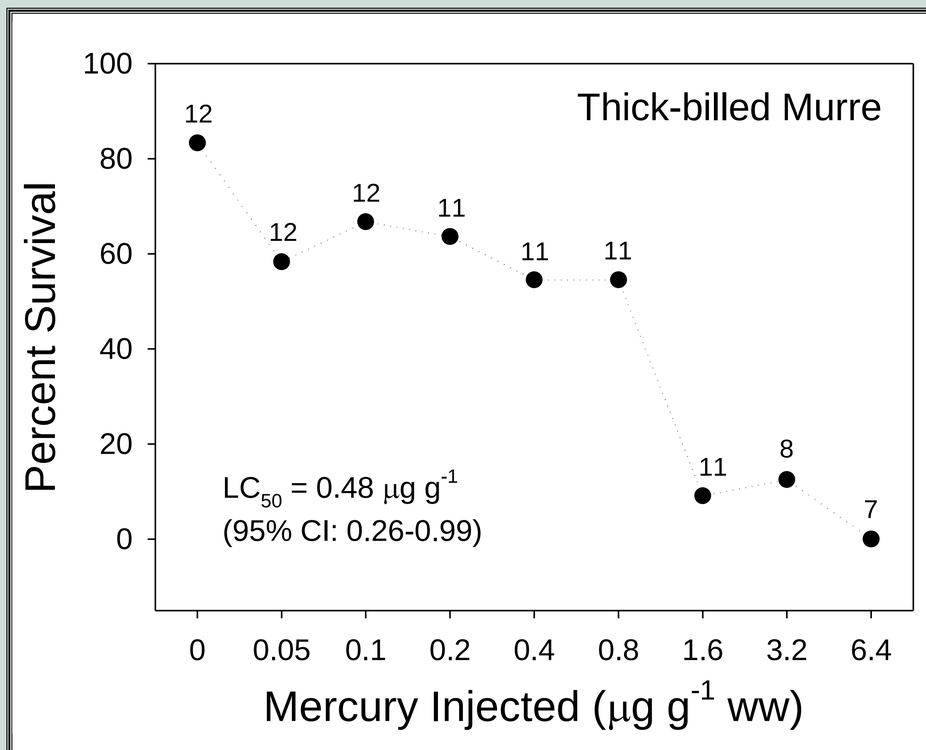


Figure 1. Survival of thick-billed murre embryos through 90% of development when eggs were injected with MeHg. Percent survival plotted by dose group. Sample sizes are given above each point on the graph. The LC_{50} and 95% CI are also shown.

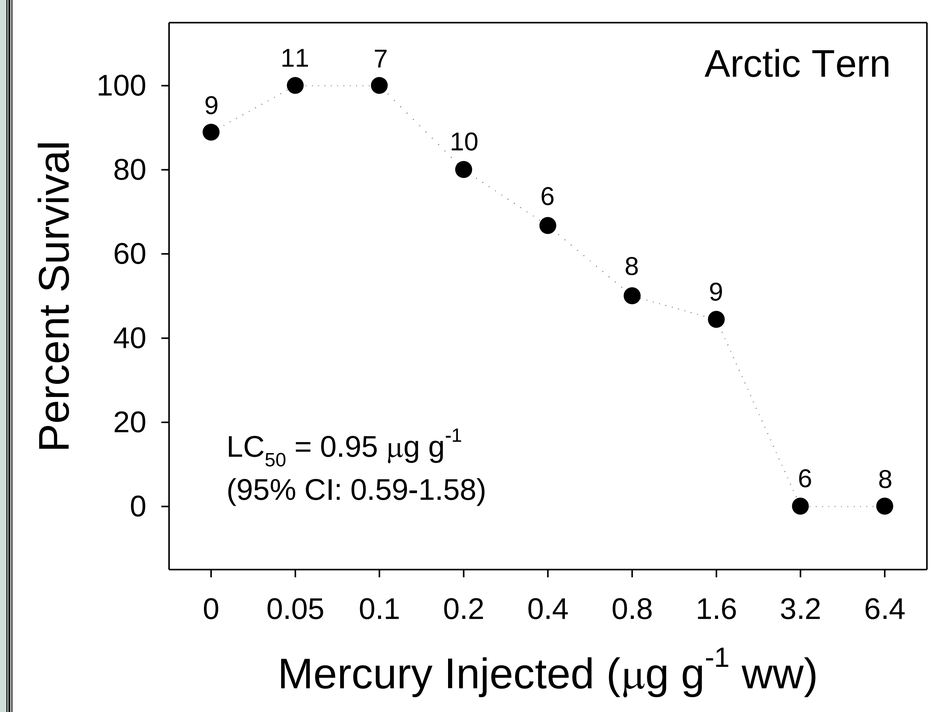


Figure 2. Survival of arctic tern embryos through 90% of development when eggs were injected with MeHg. Percent survival plotted by dose group. Sample sizes are given above each point on the graph. The LC_{50} and 95% CI are also shown.

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Results

- The LC_{50} 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 LC_{50} 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 Nasaruvaalik Island in 2008 averaged 0.49 μg g^{-1} ww[6].
- Compared with LC_{50} values for 26 tested species[2], both thick-billed murres and arctic terns had medium sensitivity to MeHg ($0.25 < LC_{50} < 1$ μg g^{-1} ww) based on injected MeHg.
- Based on measured THg, the sensitivity of arctic tern embryos changed to low sensitivity ($LC_{50} \geq 1$ μg g^{-1} ww).

Conclusions

- Average colony THg concentrations for eggs do not exceed estimated LC_{50} 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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