

DETERMINING HOW AVIAN EMBRYOS DIFFER IN THEIR SENSITIVITY TO METHYLMERCURY

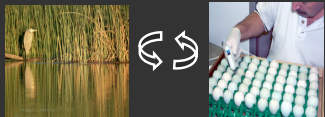
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Introduction

Embryos are the most sensitive life stage in birds (Wiener et al., 2003). However, the thresholds of mercury in the eggs of wild birds that cause embryo mortality are not known, and at present, laboratory-derived values from game farm species are used as default guidelines for wild birds. Data for the wild birds themselves are needed.

Which species of birds are most sensitive to methylmercury?



The answer will come from an integrated combination of field and laboratory studies.

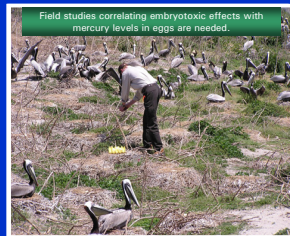
Abstract

More field research is needed to study differences in embryo sensitivity under realistic natural conditions, although these studies are complicated by the presence of other environmental stressors. Laboratory breeding studies can control for other stressors, but the great cost and time required to conduct captive breeding studies with wild birds is going to severely limit the number of these studies undertaken. Most of what is known from the lab about toxic levels of methylmercury in bird eggs came from game farm species such as mallards (*Anas platyrhynchos*), ring-necked pheasants (*Phasianus colchicus*), and chickens (*Gallus gallus*). How the sensitivity of the embryos of the game farm species compares to the sensitivities of the embryos of wild birds is unknown. Using mercury injections into the eggs of wild bird eggs complements data from field and controlled feeding studies. In the future, combinations of field, controlled laboratory feeding, and hybrid field-lab studies (such as egg injection studies) will be required to gain a good idea of how the embryos of various birds respond to methylmercury exposure.

Methods

Data from field and laboratory studies are reviewed. We also used an egg injection technique to compare the toxicity of methylmercury to the embryos of different species of wild birds. With egg injections, wild bird eggs were collected from the field and randomized in the lab to one of several treatment levels of methylmercury.

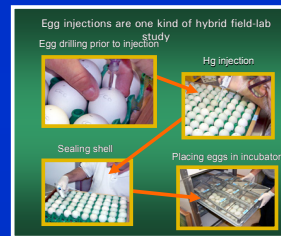
The common loon has been studied in the field.



Field studies correlating embryotoxic effects with mercury levels in eggs are needed.



Captive breeding colonies of mallards have been used to determine the toxic threshold of mercury in eggs.



Egg injections are one kind of hybrid field-lab study

SOME RESULTS FROM FIELD STUDIES

Results from field studies suggest that reproductive success varies from one species to another:

- Common loons: ~2-3 ppm mercury (wet-weight) in eggs was associated with reduced reproductive success (Barr, 1986)
- Common terns (*Sterna hirundo*): ~3.65 ppm mercury in eggs resulted in poor hatching success (Fimreite, 1974)
- Herring gulls (*Larus argentatus*): 16 of 18 eggs that contained 2.3-15.8 ppm mercury hatched (Vermeer et al., 1973)

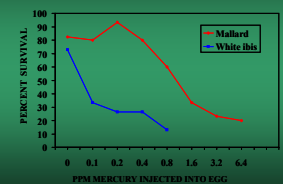
SOME RESULTS FROM CONTROLLED LAB STUDIES

Results from controlled studies also suggest differences in embryo sensitivity among different species of birds:

- Mallards: ~0.8 ppm mercury in eggs is considered a threshold for impaired reproduction (Heinz, 1979)
- Ring-necked pheasants: ~0.5-1.5 ppm mercury is considered a threshold for impaired reproduction (Fimreite, 1971)
- Chickens: ~10 ppm mercury in eggs was associated with a 16.9% hatch of eggs compared to 60.5% for controls (Tejning, 1967)

A SAMPLE OF RESULTS FROM HYBRID FIELD-LAB STUDIES

When eggs of 23 different species of birds were injected with methylmercury, many differences in sensitivity were noted. White ibis embryos (*Eudocinus albus*) are seen to be much more sensitive to mercury than were mallard embryos.



References

- Barr, J.F. 1986. Population dynamics of the common loon (*Gavia immer*) associated with mercury-contaminated waters in northwestern Ontario. Canadian Wildlife Service Occasional Paper 56, 23 pp.
- Fimreite .N. 1971. Effects of dietary methylmercury on ring-necked pheasants. Occasional Paper Number 9, Canadian Wildlife Service, Ottawa, Canada, 39 pp.
- Fimreite, N. 1974. Mercury contamination of aquatic birds from northwestern Ontario. Journal of Wildlife Management 38:120-131.
- Heinz, G.H. 1979. Methylmercury: Reproductive and behavioral effects on three generations of mallards. Journal of Wildlife Management 43:394-401.
- Tejning, S. 1967. Biological effects of methyl mercury dicyandiamide-treated grain in the domestic fowl *Gallus gallus* L. Oikos Supplement 8, 116 pp.
- Vermeer, K., Armstrong, F.A.J., and Hatch, D.R.M. 1973. Mercury in aquatic birds at Clay Lake, western Ontario. Journal of Wildlife Management 37:58-61.
- Wiener, J.G., Krabbenhoft, D.P., Heinz, G.H., and Scheuhammer, A.M. 2003. Ecotoxicology of mercury. In Hoffman, D.J., Rattner, B.A., Burton, G.A. Jr., and Cairns, J. Jr. (eds.). Handbook of Toxicology, 2nd edition. Lewis, Boca Raton, FL, USA.

