Western Ecological Research Center

Publication Brief for Resource Managers

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Malpositioned Embryos and Hatching Failure in Tern Eggs Linked to Mercury Contamination

Methylmercury is well known for its ability to reduce hatching success of avian eggs, although the exact mechanism that causes hatching failure is poorly understood. One potential mechanism for mercury to exert its toxicity is through malpositioned embryos. Embryo malpositions occur when chicks cannot orient themselves into the correct hatching position, preventing chicks from being able to break-out of their eggshell and killing them.

In a study published in *Environmental Toxicology and Chemistry* in 2010, University of California-Davis postdoctoral research scholar Dr. Garth Herring and USGS scientists Dr. Josh Ackerman and Dr. Collin Eagles-Smith examined the prevalence of embryo malpositions in relation to mercury and selenium concentrations in eggs of American avocets (*Recurvirostra americana*), black-necked stilts (*Himantopus mexicanus*), and Forster's terns (*Sterna forsteri*) breeding in San Francisco Bay, California. They also examined the prevalence of embryo structural deformities in the eggs of all three species, including traits such as exposed organs, extra mandibles and lack of feet.

In the eggs examined in all three species, 11 percent of embryos were malpositioned in eggs at or older than 18 days of age, and 2 percent of embryos were structurally deformed in eggs at or older than 13 days of age.

Considering only those eggs that failed to hatch, embryo malpositions occurred in 24 percent of eggs at or older than 18 days of age, and embryo structural deformities occurred in 7 percent of eggs at or older than 13 days of age. (*Continue to page 2*)

Management Implications:

- Results of their study indicated that embryo malpositions were prevalent in waterbird eggs that failed to hatch and the likelihood of an embryo being malpositioned increased with egg mercury concentrations in Forster's terns.
- Malpositioning of avian embryos may be one reason for mercury-related hatching failure that occurs late in incubation, but further research is needed to elucidate this potential mechanism.
- Impaired adult nesting behavior that results in infrequent turning of eggs and associated variability in egg temperatures, and mercury-induced neurological damage in embryos, may impair chicks ability to successfully hatch from their egg.

A Forster's tern chick successfuly hatching from an egg. A bird embryo must be properly positioned within its egg in order to hatch successfully, much like a human fetus before delivery. Photo: Courtesy of Michael Kern.

Overall, the probability of an embryo being malpositioned increased with egg mercury concentrations in Forster's terns, but not in avocets or stilts. The probability of embryo structural deformity was not related to egg mercury concentrations in any species. Using a reduced dataset with both selenium and mercury concentrations measured in eggs, the authors found no interaction between selenium and mercury on the probability of an embryo being malpositioned or structurally deformed.

Avian reproduction is among the most sensitive endpoints for toxicity to contaminants, especially for persistent and bioaccumulative chemicals like methylmercury. This finding provides an important step towards our understanding of environmental mercury impacts on key biological processes.

Herring, G., J. T. Ackerman, and C. A. Eagles-Smith. 2010. Embryo malposition in avian eggs: a potential mechanism for mercury-induced hatching failure. Environmental Toxicology and Chemistry 29:1788-1794. http://dx.doi.org/10.1002/etc.208

Project Website:
http://www.werc.usgs.gov/Project.aspx?ProjectID=70