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Western Ecological Research Center

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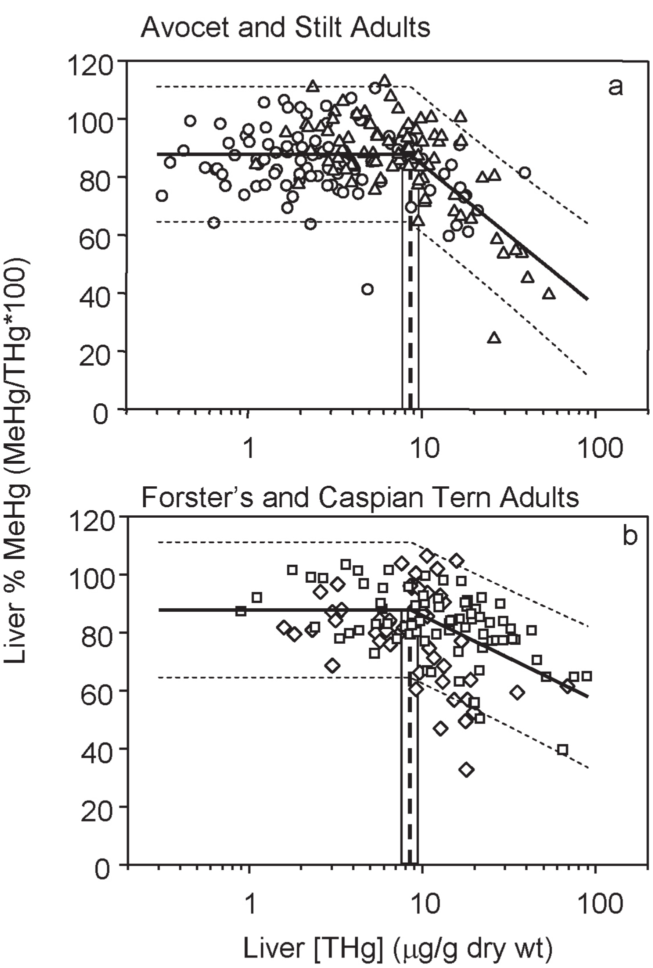
Methylmercury Detoxification in Waterbird Livers: Evidence for Demethylation

Methylmercury contamination of wetlands and waterbodies worldwide is a cause for concern because it is a highly potent neurotoxin that bioaccumulates to potentially toxic levels in wildlife such as waterbirds.



Comparative demethylation responses in (a) American avocet and black-necked stilt and (b) Caspian and Forester's tern adults. Vertical dashed line and solid lines indicate estimated mean (± standard error) demethylation threshold value. Credit: USGS and USFWS.

Management Implications:

- These results provide a benchmark concentration for waterbird mercury studies to evaluate the potential effects of mercury exposure.
- Taxonomic differences in demethylation ability may be an important factor in evaluating species-specific risk to methylmercury exposure.
- Selenium may reduce mercury toxicity in waterbirds through decreasing secondary toxicity.

However, a recent study by USGS scientists Dr. Collin Eagles-Smith, Dr. Josh Ackerman, and Dr. Julie Yee and USFWS scientist Terry Adelsbach investigated the detoxification of methylmercury in waterbird livers, showing that avian species may be able to convert methlymercury in their livers to less-toxic inorganic mercury. They reported their results in a recent issue of *Environmental Toxicology and Chemistry*.

The authors analyzed total mercury, methylmercury, and selenium levels in livers of four waterbird species (American avocet, black-necked stilt, Caspian tern, and Forster's tern) that nest in the mercury contaminated San Francisco Bay. They found that at low to moderate levels of contamination most of the mercury (90–95%) in the waterbird livers was methylmercury, but as contamination became elevated, the proportion of liver mercury that was comprised of methylmercury declined substantially. Their work suggests that there is a threshold mercury concentration above which physiological processes actively detoxify methylmercury. They also found taxonomic differences in the demethylation responses. Avocets and stilts showed a higher demethylation rate than terns when concentrations exceeded the threshold, whereas terns had a lower demethylation threshold (7.48 ± 1.48 μg/g dry wt) than that of avocets and stilts (9.91 ± 1.29 μg/g dry wt).

Finally, they assessed the role of selenium in the demethylation process. Selenium concentrations were positively correlated with inorganic mercury in livers of birds above the demethylation threshold but not below. This suggests that selenium may act as a binding site for demethylated mercury and may reduce the potential for secondary toxicity. These findings indicate that waterbirds demethylate mercury in their livers if exposure exceeds a threshold value and suggest that taxonomic differences in demethylation ability may be an important factor in evaluating species-specific risk to methylmercury exposure.

Eagles-Smith, C. A., J. T. Ackerman, J. Yee, T. L. Adelsbach. 2009. Mercury demethylation in waterbird livers: dose-response thresholds and differences among species. Environmental Toxicology and Chemistry 28:568–577.