Mercury exposure disrupts the lipid metabolism of migratory birds

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Migratory birds have been called the super-athletes of the animal

kingdom because of the remarkable endurance they display during hours-long, non-stop flights that can span thousands of kilometers. Their endurance is made possible by several unique physiological adaptations that allow birds to fuel long bouts of high-intensity exercise with fat rather than less energy-dense and less storable carbohydrates on which mammals rely. Now, a new study published in *Scientific Reports* is raising concern that a globally ubiquitous pollutant, methylmercury (MeHg), may be hindering the rates at which birds can burn fat during migratory flights and subsequently replenish fat stores during stopovers.

The study's authors, which include researchers from Great Hollow Nature Preserve & Ecological Research Center, UMass-Amherst, Guangxi Normal University, and the University of Western Ontario, examined the lipid metabolism of migratory yellow-rumped warblers (Setophaga coronata) that were found in a previous experiment—published in *Environmental Pollution*—to have weakened flight endurance in a wind tunnel as a result of only short-term exposure to an environmentally relevant concentration of methylmercury.

To investigate mechanisms by which the methylmercury may have caused this reduction in flight endurance, the researchers measured multiple markers of lipid metabolism in the birds' flight muscles, including catabolic enzymes, fatty acid transport proteins, and PPARs. They measured the same markers in the birds' livers to also assess the livers' energy costs and capacity to synthesize and package fat for storage during stopover refueling.

Compared to controls, the researchers found mercury-exposed warblers to have significantly lower muscle aerobic and fatty acid oxidation capacity, elevated hepatic energy costs, lower fatty acid uptake capacity in the liver, and lower liver expression of PPAR-γ (a regulator of key lipogenic enzymes that birds upregulate during migration to facilitate rapid fat storage). The diminished muscle oxidative enzyme capacity of

the mercury-exposed birds likely contributed to their weaker flight endurance in the prior study, while the effects on the liver have potential to inhibit stopover refueling.

"What we have found is that lipid catabolism, synthesis, and storage pathways in birds can be disrupted by only brief and relatively low exposure to this widespread contaminant, which is likely to have significant consequences for migratory performance," said the study's lead author, Chad Seewagen.

"This concerns me that global mercury pollution is making the deadliest event in the life-cycle of migratory birds even more difficult for them to complete alive and on time. What's more, birds in many parts of the world are exposed to much higher levels of mercury and for much longer periods than those in our experiment, so the effects of mercury on migrating birds could actually be even greater in the wild. Considering the influence that migratory performance ultimately has on bird population sizes, we think it should be a priority in bird conservation to better understand and mitigate the impacts of contaminants like mercury on the survivorship of migration."

More information: Chad L. Seewagen et al, Short-term mercury exposure disrupts muscular and hepatic lipid metabolism in a migrant songbird, *Scientific Reports* (2022). DOI: 10.1038/s41598-022-15680-y

Yanju Ma et al, Dietary exposure to methylmercury affects flight endurance in a migratory songbird, *Environmental Pollution* (2017). DOI: 10.1016/j.envpol.2017.12.011

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