



it's a no-brainer

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Migrants mobilise mercury during flight

Ever since Rachel Carson wrote *Silent Spring* in 1962, chemical pollution has come to symbolise the impacts of humans on nature. One of the most notorious industrial pollutants affecting birds and other animals is mercury, which is often present in ecosystems in the highly toxic form of methylmercury. This extremely dangerous molecule is perhaps most infamous for causing nearly 2000 human deaths in the city of Minamata in Japan over a 36-year period in the mid-20th century.

Recent research has revealed a new dimension to the threat posed by methylmercury to migrating birds. As a bird flies, fat stores in its body are mobilised and used to power muscle activity. But at the same time, some of the protein that makes up organs such as the liver, kidneys and muscles is broken down and also used for metabolic fuel; when a migrant eventually arrives at its destination these tissues may have shrunk to half the size they were at the start of the journey.

One of the trademarks of methylmercury is that, unlike most other pollutants such as the organochlorine pesticides, it

accumulates in lean mass (that is, muscles and organs) instead of fatty tissue. This property of methylmercury means that the breakdown of protein during migratory flights may cause it to be released into the bloodstream, a possibility that three US-based researchers set out to evaluate.

Because of the practical difficulties of working with long-distance migrants, the team instead used Zebra Finches *Taeniopygia guttata*, a tractable study species whose physiology is well characterised. Although Zebra Finches do not migrate, the breakdown of body protein characteristic of long-distance flight can readily be simulated in the finches by fasting them. The finches involved in this study lost an average of just 12 per cent of body mass, much less than the mass loss typically experienced by long-distance migrants but sufficient to evaluate the consequences for methylmercury mobilisation.

As the researchers predicted, fasting the Zebra Finches caused the levels of methylmercury circulating in their bloodstream to increase substantially. Fasted finches had blood mercury concentrations about 10 per

cent higher compared to before fasting. This finding is concerning because it implies that long-distance migrants exposed to methylmercury on their breeding and/or wintering grounds, where it is incorporated into their tissue, probably experience a sharp rise in the concentration of this toxin in their blood during migratory flights.

One of the organs affected by methylmercury is the brain and some of its most serious consequences arise from the effect it has on the nervous system. In humans, symptoms of methylmercury poisoning include muscle weakness, loss of peripheral vision and hearing and speech problems. In migrating birds, there is a real possibility that methylmercury could affect navigation and stopover behaviours related to refuelling.

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Reference

Seewagen, C.L., Cristol, D.A. and Gerson, A.R. 2016. 'Mobilization of mercury from lean tissues during simulated migratory fasting in a model songbird.' *Scientific Reports* 6:25762, DOI: 10.1038/srep25762.



RED KNOTS

Climate change is affecting natural systems in a multitude of ways. Some are dramatic and headline-grabbing, like catastrophic die-offs of birds and flying foxes during extreme heatwaves in Australia. Other manifestations of global warming are far more subtle and difficult to discern and may become apparent only after careful analysis of data collected over decades. A new paper in *Science* provides novel insights into how rising temperatures can literally have far-reaching effects.

Jan van Gils and his colleagues examined Red Knots of the nominate subspecies *Calidris c. canutus*, which breed in the remote Taimyr Peninsula of the Russian Arctic and migrate to wintering grounds in West Africa. Global warming is proceeding far more rapidly in the Arctic compared to lower latitudes. Weather records from the knots' breeding areas reveal that snowmelt has advanced substantially, with snow now disappearing two weeks earlier than it did during the mid-1980s.

The timing of snowmelt, it turns out, is strongly correlated with the size of young knots. When Van Gils and his colleagues

analysed the body mass of nearly 2000 juvenile knots caught along their migration route at Gdansk in Poland over the past 30 years, they found that body mass was significantly lower in years with earlier snowmelt. In other words, young knots making their first southward migration were smaller in warmer years.

The consequences of this link between the timing of snowmelt and the knots' body mass only become apparent on their West African wintering grounds. Smaller knots have shorter bills: a very small individual might have a bill 30 millimetres long, whereas a very large individual's is closer to 40 millimetres. Bill length has a strong influence on the food items a foraging knot can access while probing the surface of intertidal mudflats. At Banc d'Arguin on the Mauritanian coast, where many of the knots spend winter, the most abundant and nutritionally important molluscs are typically buried about 35 millimetres below the surface.

Large individuals with long bills can readily access high-quality food items, but smaller individuals with shorter bills cannot and so are restricted to feeding on less nutritious, more shallowly buried

food resources. This seems to have important consequences, as a long-term colour-ringing study has revealed that survival rates are correlated with bill length and hence body mass. Almost 70 per cent of juvenile knots with 40-millimetre bills survive to the following year, compared to less than 40 per cent of juveniles with 30-millimetre bills.

Van Gils and his colleagues have lifted the lid on a complex cause-and-effect chain that links the date of snowmelt in Russia's remote north to the foraging success of knots on West African mudflats. Their study reveals that the effects of climate change on migratory birds sometimes become evident only on the opposite side of the planet and that rapid warming in polar regions can have important consequences in tropical areas where climate change is proceeding more slowly.

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Reference

Van Gils, J.A. et al. 2016. 'Body shrinkage due to Arctic warming reduces red knot fitness in tropical wintering range.' *Science* 352: 819-821.