The surprising science behind long-distance bird migration

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The blackpoll warbler can fly for thousands of miles without taking a break. Credit: Sherri and Brock Fenton (Western University, London, Ontario).

A team of scientists led by researchers at the University of Massachusetts Amherst has recently made a surprising discovery, with

the help of a wind tunnel and a flock of birds. Songbirds, many of which make twice-yearly, non-stop flights of more than 1,000 miles to get from breeding range to wintering range, fuel themselves by burning lots of fat and a surprising amount of the protein making up lean body mass, including muscle, early in the flight.

This flips the conventional wisdom on its head, which had assumed that migrating birds only ramped up protein consumption at the very end of their journeys, because they would need to use every ounce of muscle for wing-flapping, not fuel. The results appeared recently in the *Proceedings of the National Academy of Sciences.*

"Birds are amazing animals," says Cory Elowe, the paper's lead author and a postdoctoral researcher in biology at UMass Amherst, where he received his Ph.D. "They are extreme endurance athletes; a bird that weighs half an ounce can fly, non-stop, flapping for 100 hours at a time, from Canada to South America. How is this possible? How do they fuel their flight?"

For a very long time, biologists assumed that birds fueled such feats of endurance by burning fat reserves. And indeed, fat is an important part of migratory birds' secret mix. "The birds in our tests burned fat at a consistent rate throughout their flights," says Elowe. "But we also found that they burn protein at an extremely high rate very early in their flights, and that the rate at which they burn protein tapers off as the duration of the flight increases."

"This is a new insight," says Alexander Gerson, associate professor of biology at UMass Amherst and the paper's senior author. "No one has been able to measure protein burn to this extent in birds before."

"We knew that birds burned protein, but not at this rate, and not so early in their flights," continues Gerson. "What's more, these small songbirds

can burn 20% of their muscle mass and then build it all back in a matter of days."

To make this breakthrough, Elowe had help from the bird banding operators at Long Point Bird Observatory, in Ontario, along the northern shore of Lake Erie. Every fall, millions of birds gather near the observatory on their journey to their wintering grounds—including the blackpoll warbler, a small songbird that travels thousands of miles during its migration. After capturing 20 blackpolls and 44 yellow-rumped warblers—a shorter distance migrant—using mist nets, Elowe and his colleagues then transported the birds to the Advanced Facility for Avian Research at Western University, which has a specialized wind tunnel built specifically for observing birds in flight.

Elowe measured the birds' fat and lean body mass pre-flight, then, when the sun set, let the birds free in the wind tunnel. Because the birds naturally migrate at night, Elowe and his colleagues would then stay awake—at one point, for 28 hours—watching for when a bird would decide to rest. At that point, the researchers would collect the bird and again measure its fat and lean body mass content, comparing them with the pre-flight measurements.

"One of the biggest surprises was that every bird still had plenty of fat left when it chose to end its flight," says Elowe. "But their muscles were emaciated. Protein, not fat, seems to be a limiting factor in determining how far birds can fly."

The researchers still don't quite know why the birds are burning such vast stores of protein so early in their journeys, but the possible answers open up a wide range of future research avenues.

"How exactly is it possible to burn up your muscles and internal organs, and then rebuild them as quickly as these birds do," wonders Gerson.

"What insights into the evolution of metabolism might these birds yield?"

Elowe is curious about shivering—nonmigratory birds that overwinter in cold areas keep themselves warm by shivering. "This is also a feat of endurance," says Elowe. "Do birds fuel their winter shivering spells the same way? And as the world warms, which method of coping with the cold—shivering or migrating—might be the better option for survival?"

More information: Elowe, Cory R., Long-duration wind tunnel flights reveal exponential declines in protein catabolism over time in short- and long-distance migratory warblers, *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2216016120

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