

INSIDE JEB

How gray catbirds time fat storage to fuel migration



A gray catbird in Dry Tortugas, Florida, USA, during the spring migration. Photo credit: Jeremy Cohen.

It takes a lifetime of toil to look like Mr Universe, but migrating songbirds seem to be able to pile on muscle – and fat to power their migrations – with no effort at all. ‘Birds and other migratory animals are unique because they naturally undergo endurance feats yearly, often without any obvious training’, says Kristen DeMoranville from Miami University, USA. ‘It seems to be more like throwing a switch’, says PI Paul Schaeffer, who was curious to find out how migratory birds perform this extraordinary metabolic achievement with minimal exertion. ‘We were interested in trying to pin down the molecular mechanisms that switch this metabolic state on and off’, says DeMoranville. But to do this, Schaeffer, DeMoranville and Keely Corder realised that they would have to track the physiology of one species over the course of an entire year.

‘David Russell helped us choose gray catbirds [*Dumetella carolinensis*],’ says DeMoranville, as the ornithologist knew that the birds overwinter in Belize and are reliable summer visitors to Ohio.

Travelling to the birds’ winter home, DeMoranville, Corder and Schaeffer strung a mist net between poles to capture the animals in flight. ‘We had to... quickly take out any birds that got caught’, recalls Schaeffer. The team then measured the birds’ metabolic rates when the animals were working their hardest to stay warm by popping the animals inside a fridge and providing them with helium-spiked air to breathe – which leaches warmth from their bodies faster than regular air – to make them feel even chillier. However, Schaeffer adds, ‘It was really tough working in Belize’, explaining that the electricity supply in the remote village was intermittent, although DeMoranville says, ‘Our host, Marvelita Murrillos, treated us like family and helped us troubleshoot many of our logistical problems’.

Back in Ohio, the team trapped more catbirds during their spring and autumn migrations (May and September), the breeding season (June) and while preparing for their return south in August, remeasuring their metabolic rates when cold. In addition, the scientists collected

the hearts, leg muscles and pectoral muscles of some of the birds to search for the genes that could be responsible for the birds’ miraculous metamorphosis.

Impressively, the birds were able to ramp up their metabolism most during the early stages of their autumn migration to Belize, with their metabolic rate falling almost 20% during the tropical winter stopover. In addition, the birds’ flight muscles were largest during the autumn migration, while the heart was smallest when the birds overwintered in the tropics. Back in the USA, Angelica Hamilton and Janice Huss at the Beckman Research Institute analysed which genes were turned on in the flight muscles at different times of year. They noticed that the activating genes – which switch on the genes that allow the birds to burn fat – were turned up simultaneously when the birds were preparing to migrate and during the autumn return to Central America; the birds were well prepared to burn fat to fuel their return to the USA. In addition, the genes involved in storing fat were turned on most when the birds were overwintering in the tropics, at the same time that the genes involved in burning fat were turned down; they appeared to be storing fat in preparation for their early spring return north.

As birds rely on fat to fuel their high-endurance migrations – in contrast to mammals, which burn sugars – Schaeffer is impressed that catbirds are using the same genes as us to regulate their metabolism, but switch them on at different times of year. ‘I think of it as having a toolbox, but using the tools in a new way’, he smiles.

10.1242/jeb.209452

DeMoranville, K., Corder, K. R., Hamilton, A., Russell, D. E. Huss, J. M. and Schaeffer, P. J. (2019). PPAR expression, muscle size and metabolic rates across the gray catbird’s annual cycle are greatest in preparation for fall migration. *J. Exp. Biol.* **222**, jeb198028. doi:10.1242/jeb.198028

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