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INSIDE JEB

Well-fed African striped mice are prepped for cold spells

African striped mice (*Rhabdomys pumilio*) eating wild fruit. Photo credit: Bernard Dupont (France), CC BY-SA 2.0, via Wikimedia Commons.

Being too cold or getting overheated is a strain for creatures that maintain a stable body temperature; some just go with the flow, allowing their body temperature to fluctuate to conserve energy. In contrast, creatures that maintain a constant body temperature must continually fuel their furnaces to remain warm during cold spells, and small rodents are particularly vulnerable as their tiny frames haemorrhage heat. So how do they manage to remain warm during colder times of year? Shaun Welman and Nomakwezi Mzilikazi from Nelson Mandela University, South Africa, teamed up with Martin Jastroch from Stockholm University, Sweden, to find out how tiny African striped mice (*Rhabdomys pumilio*) keep warm through the seasons.

Heading out to collect the mini rodents near Gqeberha (formerly Port Elizabeth), South Africa, during winter, summer, autumn and spring, Welman and Mzilikazi measured the rodents' metabolic rates as they rested overnight by recording how much oxygen the animals consumed. The pair then kickstarted the animals' internal heaters by injecting them with noradrenaline, and remeasured their oxygen consumption to find out how much energy they were putting into generating warmth. A day later, the researchers chilled the mice by replacing the air in their surroundings with heliox (79% helium and 21% oxygen), which carries heat away from the animals' bodies to cool them rapidly, while recording their oxygen consumption to find out how much energy they were using to try to remain warm when conditions were really cold. So how did the animals from different seasons fare?

Surprisingly, all of the animals maintained a stable body mass of ∼48 g, even though African striped mice from another region of South Africa – where the climate is predictable, but food is unreliable – gained mass to survive winter. In addition, the Gqeberha animals' metabolic rates doubled when resting in winter. The mice also turned up their brown fat heaters – which produce warmth without shivering – in autumn, consuming more oxygen than they had in the summer. And, when Welman and Mzilikazi chilled the mice with heliox, the summer mice had the lowest metabolic rate when they became hypothermic, while the winter, spring and autumn mice had metabolic rates that were about 50% higher. In short, the winter Gqeberha mice were consuming more energy than they did in summer.

So, which of the mice's tissues were using the most energy to maintain their body temperature? Welman and Jastroch checked the animals' brown fat, but found that even though the winter mice carried more of the tissue, the key proteins responsible for brown fat heat production fell by 25%. Brown fat could not be responsible for the winter metabolic rise. Instead, the mice were building up other organs, including the liver and intestines, to increase their metabolic rate to keep warm during the cold season.

But why have the Gqeberha African striped mice opted for a profligate lifestyle during winter when other rodents conserve energy? Welman suspects that the temperate region's bountiful food supply allows the mice to maintain their high-octane way of life across the seasons. But why they do so is more baffling.

Mzilikazi thinks it has something to do with the unpredictable cold snaps that strike Gqeberha. 'We argue that sporadic cold spells at the study site pressurised African striped mice to maintain a high level of heat production throughout the year', she says. So, the mice keep their brown fat on standby, in case of sudden cold periods between autumn and spring. But keeping their heaters prepared for spontaneous action could place them at risk if their plentiful food supply dries up thanks to climate change.

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Welman, S., Jastroch, M. and Mzilikazi, N. (2022). Obligatory homeothermy of mesic habitat-adapted African striped mice, *Rhabdomys pumilio*, is governed by seasonal basal metabolism and year-round 'thermogenic readiness' of brown adipose tissue. *J. Exp. Biol.* **225**, jeb243860. doi:10.1242/jeb.243860.

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