ANIMAL PHYSIOLOGY

They're hot then they're cold—tenrecs take Vegas

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Ever heard of a tenrec? Native to Madagascar and parts of the African mainland, these peculiar mammals belong to a small family of about 35 species that have undergone considerable adaptive radiation. Some are terrestrial, others arboreal or even semi-aquatic. Depending on the particular species, they can resemble hedgehogs or shrews, opossums or otters; they just aren't that closely related to any of those animals. Rather, tenrecs are thought to be one of the most basal of the placental mammals: they have tiny, smooth brains; lack the zygomatic arch around the eye orbit that characterizes other mammals; and, akin to reptiles and birds, have a cloaca rather than separate anal and urogenital tracts.

In Frank van Breukelen's words, "they're the weirdest things ever."

In 2014, after two years of grueling paperwork, van Breukelen's lab at the University of Nevada Las Vegas received a shipment of 40 Malagasy common tenrecs, *Tenrec ecaudatus*, caught and imported from Mauritius. With limited literature on the animals, van Breukelen and his lab weren't sure what they were getting themselves into. "Some people told us that they were going to be 250 grams, and other people told us that they were going to be two kilos," van Breukelen recalls. Their wild animals came in at the lower end but tripled in size in just four months, with no apparent limit; captive-born tenrecs, in litters of up to 19, can grow from 12 grams to over 400 in five weeks. Putting them on diets makes no difference: they just drop their metabolism, van Breukelen says, noting that one kilogram animals will maintain their weight even on diets of just five grams of food per day. "They just don't care," he says.

Caring for them though is time consuming; he estimates that his team spends about six hours a day on husbandry for their current colony of 35 animals. So why go through all the trouble of importing, establishing, and maintaining a lab colony of such strange mammals? To study the strange way they hibernate.

van Breukelen is interested in how animals live in harsh environments. In the past, he has worked with ground squirrels to study hibernation and how the body maintains homeostasis and cell integrity at low temperatures. Interbout arousals—the short periods during which small hibernating mammals shiver and raise their body temperatures—are thought to have something to do with it. "Much of my career was centered on the idea that they use these interbout arousals in order to reset homeostatic processes," he says. So when a colleague showed field data suggesting that tenrecs don't follow suite, he took it as a challenge. In the field in Madagascar, the temperature was around 25 °C while the animals were hibernating; in the lab, he could control the thermostat. He expected to see interbout arousals at lower ambient temperatures.

Down for the count: a torpid tenrec in the van Breukelen lab at the University of Nevada, Las Vegas. Credit: D. Sigler

He did not. "Early on, we realized they weren't ground squirrels," he says. "That sounds funny, but it was actually kind of a profound thing of wow, these are not like any other hibernator." The tenrecs proved themselves to be unpredictable and remarkably plastic: they'll hibernate while hot, be active while cold, and vice versa, regardless of the ambient temperature around them (in the current study, 12, 20, or 28 °C). Oxygen consumption and heart rate also vary greatly in the animals, but without clear correlations to either body or ambient temperatures. They are a bit more sluggish while hibernating, but unlike in other hibernators, tenrec body temperature isn't a strong indicator of the depth of torpor. And at the end of their hibernation, they emerge quite gradually to resume normal activity and their prolific growth.

The results, published in *The Journal of Experimental Biology*, go against some of the accepted notions about hibernation. "We always thought about it as being associated with the cold, but that's probably just a very northern hemisphere-centric view," van Breukelen says. The root "hiber" is Latin for "overwintering," but in tropical animals like tenrecs, it may have evolved instead as a way to disrupt predator-prey dynamics, he says. "If you're not breeding, then why not just go underneath the ground and wait it out?"

Because the tenrecs don't appear to be responding to any kind of internal or external thermal cues (nor in the years so far has the colony adapted to the northern hemisphere to hibernate during boreal rather than austral winter), the animals could help researchers eliminate the temperature variable when studying hibernation. van Breukelen plans to follow up the current whole-organism study with a closer look at organ function and how the transcription and translation of proteins is controlled in hibernating tenrecs, to then compare against previously collected data in ground squirrels. He refers to those animals to 'the Usain Bolts' of hibernation; the tenrecs, meanwhile, are more like Homer Simpson—"they're not good at [hibernating], they screw up a lot, and they're kind of bumbling," he says.

But, both the Bolts and the Simpsons of the animal world are needed to get the complete picture of what it means to be a hibernator, regardless of how much work it is to keep the latter as a lab animal. "There's that value to us in terms of that," says van Breukelen, "but I think everyone in my lab will be very happy if somebody else picked up this project."

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