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INSIDE JEB

Tenrecs deal with poor air quality like reptiles

A group of tenrecs piled up together in an igloo. Photo credit: Claudia Silva Rubio.

Dealing with dangerously high CO_2 levels is a regular part of life for burrowing creatures. 'Most animals that are able to tolerate such environments reduce their metabolic rate to re-balance their energy demands', says Matthew Pamenter from the University of Ottawa, Canada. So, when he heard Frank van Breukelen of the University of Nevada, USA, talk about his burrowing tenrec (*Tenrec ecaudatus*) colony at a conference in 2019, he realised that the animals might also experience dangerous CO_2 concentrations – up to 13.5%, compared with 0.04% in the atmosphere – when hibernating with burrow-mates for 8–9 months. Yet tenrecs are not regular mammals. They can remain active even when their body temperature plummets to 12°C; so how do they cope with the toxic air in their hibernation burrows?

Pamenter contacted van Breukelen to suggest a collaboration, and in March 2020, Maiah Devereaux (University of Ottawa) joined Claudia Silva Rubio and van Breukelen at the University of Nevada to find out how tenrecs deal with excessive CO_2 and low O_2. 'Our tenrecs are handled very frequently and so they are very docile. To be honest, they are kind of lazy!' chuckles van Breukelen, who recalls that the animals were content to hang out in a respirometry chamber while Devereaux and Silva Rubio measured the tenrecs' breath rate and O_2 consumption to calculate their metabolic rate. The duo then modified the air mixture the tenrecs were breathing – first reducing the O_2 content from 21% to 9% and 4%, before boosting the CO_2 levels from 0% to 5% and 10% – at 28°C and 16°C, to find out how the mammals responded. 'Trying to maintain a stable [gas] flow rate required some troubleshooting', says van Breukelen.

Even when the tenrecs were breathing normal air in the cooler conditions, the active animals' metabolisms responded unconventionally. Some barely breathed at all – only consuming 2 ml O_2 min^{-1} kg^{-1} – while others inhaled a colossal amount (23 ml O_2 min^{-1} kg^{-1}) relative to the warmer tenrecs, which only inhaled 12 ml O_2 min^{-1} kg^{-1} at the most. Raising the CO_2 levels in the air didn't affect the range of the cold tenrec's metabolic rates; however, when the team reduced the animals' O_2 supply, the chilly animals no longer had the wide range of metabolic rates they had when breathing normal air.

The air temperature also had a major impact on the way the tenrecs breathed when their air was contaminated with CO_2. The warmer animals began hyperventilating when the CO_2 levels increased, in contrast to the cooler tenrecs, which were more like other burrowing mammals and did not hyperventilate.

In short, the tenrecs' breathing and metabolism were more affected by the environmental temperature than the build-up of toxic CO_2 and quantity of O_2 available. In addition, the animals in the colder conditions allowed their body temperatures to drift, with some cooling to 20°C while others remained at 32°C regardless of the air quality; all of the tenrecs in 28°C air maintained a warm body temperature (~32°C) despite the air conditions. The physiological responses of the tenrecs were more like those of cold-blooded reptiles than those of warm-blooded burrowing mammals, probably because they don't have to maintain a high body temperature to survive. van Breukelen exclaims, 'Many of the things that tenrecs do result in me saying, "How the heck do they do this?"', and he is excited to find out how the animals cope with poor air quality when breathing as little as once every 45 min while hibernating.

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