INSIDE JEB

Time tweaks rodents' subterranean hearing

Mashona mole rats (*Fukomys darlingi*). Photo credit: Kai Caspar.

Scampering through the tunnels of an underground rail station, we might feel like scurrying subterranean rodents, but our well-lit and ventilated tunnels bear little resemblance to the complex communal burrows constructed by rodent excavators. Apart from the lack of oxygen in remote burrow corners, sound carries differently through burrow tunnels than in open air. 'Frequencies higher than 1 kHz are notably attenuated, even over distances of just a few meters, while lower frequencies are amplified', says Kai Caspar from the University of Duisburg-Essen, Germany. In addition, the hearing of the rodent species that have descended beneath the surface has altered over time; the question was, had burrowing rodents lost hearing simply through lack of use, or had they actively adapted their hearing to their unique acoustic environment? For example, subterranean rodents could have reduced the sensitivity of their hearing to protect their ears from sounds amplified by tunnels, instead of allowing the sense simply to waste away.

To find out, Caspar and his colleagues Alexandra Heinrich, Lea Mellinghaus, Patricia Gerhardt and Sabine Begall (also from the University of Duisburg-Essen) decided to test the hearing of three subterranean species: naked mole rats (*Heterocephalus glaber*) and Mashona mole rats (*Fukomys darlingi*), which took to burrowing ∼25 million years ago, and the South American coruro (*Spalacopus cyanus*), which only adopted a subterranean lifestyle 3.5 million years ago. The team gently anaesthetised the animals, ranging from youngsters to elderly seniors, playing sounds to the slumbering creatures ranging from a low-pitched 30 Hz buzz up to ultrasonic 36 kHz squeals at volumes of 10–80 dB, recording their brainwaves to determine their hearing thresholds at each pitch.

And when the researchers compared the rodents' hearing, it was clear that the hearing of the recent coruro burrowers was far more sensitive than the hearing of the long-term mole-rat excavators. The coruros could still hear ultrasonic sounds up to ∼32 kHz, while the Mashona mole-rats' hearing tapered out around 4 kHz and the naked mole-rats could barely hear above 6 kHz. Both mole-rat species had lost hearing over the 25 million years since their subterranean shift. Yet, the hearing of all three species was most sensitive to sounds pitched around 1 kHz, which carry most strongly through underground passages. And, when the team recorded conversations between pairs of coruros, Mashona mole-rat duos and a trio of chirping naked mole-rats, the coruros spoke most softly (∼52.6 dB), while the naked mole-rats had the loudest voices ∼58.3 dB, probably to compensate for their poor hearing.

So, it seems that rodents don't necessarily lose hearing sensitivity rapidly when they switch to burrowing for a living; coruros haven't done away with their ultrasonic hearing, even though high pitched squeaks barely carry beneath the ground. However, Caspar says, 'life underground appears to quickly promote a shift of the region of best hearing to low frequencies around 1 kHz'. And, although some aspects of the rodents' hearing could have dwindled through lack of use, the rodents seem to have tuned their hearing to be most sensitive to a specific range, '[possibly] to make the most of the unusual acoustic features of their subterranean homes', says Caspar.

Either way, mole-rat hearing is better than some had thought, in keeping with the creatures' sociable lifestyle nattering in nest chambers, despite the toll taken over time by their subterranean existence on their appreciation of the squeakier end of the rodent range.

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