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INSIDE JEB

Parrots evaporate water to keep cool in sizzling temperatures

A mulga parrot (*Psephotellus varius*; left) and a galah (*Eolophus roseicapilla*; right). Photo credits: Matt Baumann (left) and William Talbot (right).

The title of 'The hottest place on Earth' is keenly debated. Some experts have cast doubt on the reliability of Death Valley's 1913 record (56.7°C), although the second highest temperature of 54°C, recorded there in 2013, is probably more realistic. However, as global temperatures continue rising, it seems likely that other locations could experience similar sizzling temperatures in the not-too-distant future. Recalling the deaths of thousands of budgerigars and zebra finches near Perth during a scorching heat wave of 45°C in 2009, Todd McWhorter, from the University of Adelaide, Australia, wondered how other desert residents, specifically mulga parrots (*Psephotellus varius*) and galahs (*Eolophus roseicapilla*), might cope as temperatures in some regions of Australia are expected to rise by more than 4°C by the end of the century. He says, 'Scientists have studied energy use and water loss in parrots, including Australian species, for a long time, but they've mostly done so at cool or moderate temperatures'.

Gently capturing mulga parrots and galahs at the Gluepot Reserve in South Australia, McWhorther and his team of international colleagues injected a minute thermometer into the body of each bird before placing it in a chamber to measure the amount of water lost by the animal and how much carbon dioxide it exhaled – to calculate its metabolic rate – as the temperature increased from 40°C to 55°C. Impressively, the galahs were able to tolerate air temperatures of 55°C by allowing their body temperature to rise from 40°C to 44.1°C; however, the mulga parrots were less resilient, reaching a dangerously high body temperature of 43.4°C at air temperatures of up to 49°C. And when the team calculated the birds' water loss rates, they increased gradually up to air temperatures of ∼40°C, before soaring and increasing by 1000% in the galahs and 700% in the mulga parrots at their highest body temperatures. In addition, the birds' resting metabolic rates (the amount of energy required to keep the body ticking over) increased significantly above 41°C, when they began panting, and doubled at the highest temperatures that the mulga parrots could tolerate. Meanwhile, the galahs experienced a second hike in their resting metabolic rate at 52°C as they struggled to cope.

McWhorter says, 'The parrots controlled their body temperatures by greatly increasing evaporative cooling at hot temperatures, compared with at cooler temperatures'. However, when the team compared the performance of the more tolerant parrots with the high-temperature coping strategies of doves, pigeons and members of the nightjar family, the parrots were less well prepared, although they coped with the heat as well as members of the songbird family. 'Our results in mulga parrots and galahs, along with some other studies of how parrots cope with high temperatures, indicate that, as a family, parrots may be more vulnerable to extreme weather events, like heat waves, than other groups', says McWhorter.

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McWhorter, T. J., Gerson, A. R., Talbot, W. A., Smith, E. K. McKechnie, A. E. and Wolf, B. O. (2018). Avian thermoregulation in the heat: evaporative cooling capacity and thermal tolerance in two Australian parrots. *J. Exp. Biol.* **221**, doi: 10.1242/jeb.168930.

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