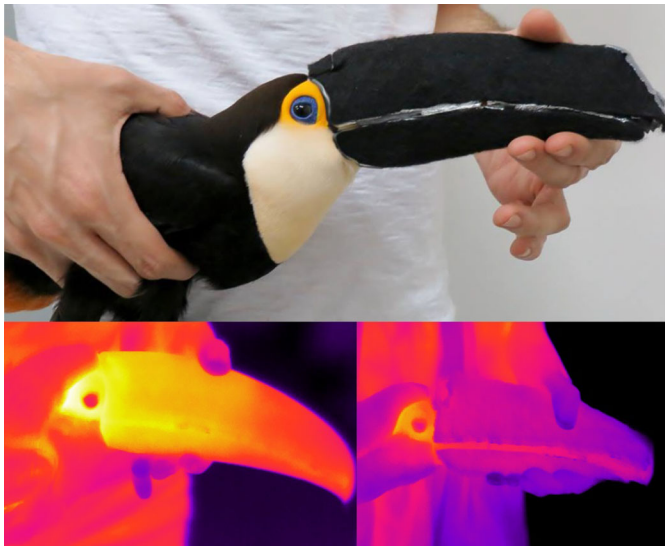


INSIDE JEB

Toucans' ostentatious beaks do not expand their thermoneutral zone



Thermal image of a toco toucan (*Ramphastos toco*) showing its hot beak (bottom left) and a corresponding image of the insulated beak (bottom right) after covering it with felt (top).

Some birds are just instantly recognisable. From elegant flamingos with graceful necks to toco toucans (*Ramphastos toco*) with their jet-black plumage and distinctive beaks, some birds just stand out from the dowdy crowd. And the toucan's outsized beak comes in handy for retrieving fruit and cracking nuts. But Glenn Tattersall from Brock University, Canada, explains that the toucan's outrageous bill also doubles as a radiator; he recalls how, in the 2000s, Augusto Abe (Sao Paulo State University, Brazil) put him on to the possibility that the birds may use their beaks to regulate their body temperature. However, warm-blooded creatures mainly prefer living at temperatures where they expend little energy to remain warm or keep cool, known as their thermoneutral zone. Denis Andrade, Jussara Chaves (both from Sao Paulo State University) and Tattersall wondered whether the toucans' ostentatious beaks could expand the range of temperatures over which the birds live

at relatively little cost to maintain their body temperature.

Collecting six toucans, Chaves settled the birds in Andrade's lab at the Universidade Estadual Paulista, Brazil. Then each night, she placed individual birds into a temperature-controlled chamber – set at temperatures from 0 to 35°C, spanning the 10–25°C temperature range where they expend little energy to remain warm – and measured their oxygen consumption to find out how much energy they used to regulate their temperature when hot and chilly. Then, Chaves repeated the oxygen consumption measurements, but this time she prevented the birds from using their beaks like a radiator by placing a snugly fitting felt jacket over each beak, which allowed the birds to open their beaks if they got warm and needed to pant, while preventing their beaks from absorbing or losing heat to regulate their temperature. If the beaks were allowing the birds to expand the range of temperatures over

which they could live a relatively low-cost life, then the felt beak-jacket would alter the temperatures at which the birds began using more energy to keep warm or cool.

But the beak-jacket didn't extend or reduce the temperature range over which the birds live comfortably. Their thermoneutral zone is not extended by their radiator beaks.

The team also reviewed how the birds slept in cold conditions and realised that the chilliest birds with unjacketed beaks tucked their beaks beneath their wing feathers, in addition to shutting off the blood supply to the beak, to keep warm. However, as the temperatures rose above 30°C, the birds' naked beaks came into their own. The toucans with felt jacketed beaks used 20% more energy than those without beak-jackets, probably because they were panting to keep cool. 'Our estimate is that the beneficial consequence of being able to access the normal heat exchange through the bill at 35°C corresponds to ~32% of basal metabolic rate', Tattersall explains.

So, the toucan's beak can work both ways. 'It promotes heat dissipation quite efficiently, but under conditions of high solar radiation it may also be a window to undesired heat gain', says Andrade. And the team suspects that the toucans' ability to absorb heat through their impressive beaks as they go about their daily business could limit how long they spend foraging for food, forcing them to seek shade at the peak of the day to avoid overheating.

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Chaves, J. N., Tattersall, G. J. and Andrade, D. V. (2023). Energetic costs of bill heat exchange demonstrate contributions to thermoregulation at high temperatures in toco toucans (*Ramphastos toco*). *J. Exp. Biol.* **226**, jeb245268. doi:10.1242/jeb.245268

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