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Natural radiator

The toucan's beak, nearly the size of its entire body, is an efficient heat sink

Francisco Bicudo

When the heat is intense, we rush to open the windows to get relief from the breeze. At the other extreme, when temperatures are low, we run to close the windows to quickly help warm up the room. This is exactly how the toucan's beak works, like an "efficient thermal window, nearly the size of the area to be regulated," according to biologist Augusto Abe at the São Paulo State University (Unesp) at Rio Claro, who compares the toucan's beak to "*a powerful car radiator*." Their capacity to regulate temperatures was announced in July 2009 in a study conducted by the team led by Abe in partnership with Canadian Glenn Tattersall from Brock University, published in *Science* magazine. In order to reach this conclusion, however, the team had to travel a circuitous, and inquisitive, route.

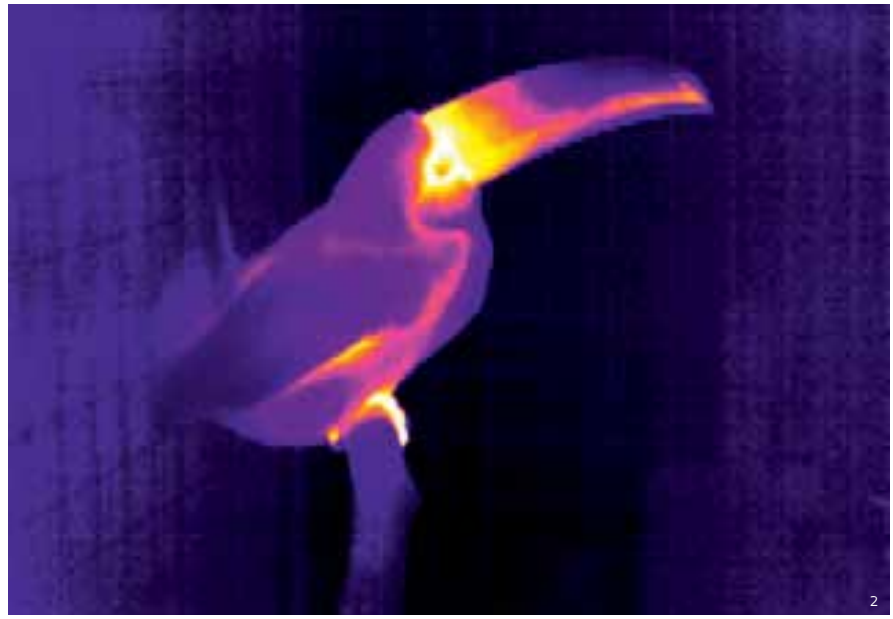
The story began in 1985 when Abe received a toucan as a gift. Although the bird had no official name, the biologist's closest friends called it 'Amadeus'. As it settled down for the night, Amadeus would turn its head around and tuck its beak

under its tail, using its wings as blankets. The scene attracted the attention of the biologist who, when touching the beak, found that it was warm. He therefore thought that all the trouble the toucan went through was a trick that allowed it to keep its body warm. At that time, however, Abe did not have the appropriate equipment needed to measure the beak's temperature and study it in more detail. But the sight of the bird covering and protecting itself for sleeping stuck in the biologist's mind.

In 2003, the Unesp team received a visit from Tattersall, with whom Abe had already been in partnership on several projects. In his suitcase, the Canadian carried an infrared camera, which on that occasion was to be used to evaluate heat production in snakes after feeding. An idea suddenly occurred to Abe who, without wasting another minute, took his Canadian colleague to the zoo in Americana, a city in the interior of São Paulo state (Campinas region) that housed a toucan vivarium. They took several pictures of the bird with the special camera. "The outcome was frustrating because nothing happened," Abe recalls. But as they were on their way out, they decided to take one last picture just to set their minds at ease. "That's when we noticed that the beak was quick to warm up and cool down," the Brazilian says. So they agreed to study toucan beaks together.

In 2005, they began to conduct studies in a climate-controlled enclosure in the laboratory, at temperatures between 10 and 25°C. There, a thermographic camera was installed to photograph toucans of the species *Ramphastos toco*, native to the Brazilian *cerrado*. The camera was responsible for producing images along the color spectrum, ranging from yellow (hotter) to blue (colder). The temperature was slowly increased or decreased over a 12-hour period each day.

The pictures showed in great detail that when the ambient temperature was cold, the toucan cut off the flow of heat to the beak, which then cooled down to retain warmth in its body. Inversely, when the heat in the laboratory vivarium was intense, the toucan increased blood flow to the beak, which was responsible for dispersing the excess heat into the environment. Depending on the situation, the beak was able to disperse 25-400% of all the heat produced by the bird at rest. "We adjusted our previous thinking that the beak served only for feeding, peeling fruit or attacking other nests and we discovered that the organ has other relevant functions," says biologist Denis Andrade, co-author of the paper and researcher at Unesp Rio Claro. He believes this capability still needs to be studied more closely in order to obtain a more comprehensive understanding of the toucan's anatomy, ecology and evolution.



1. From up close you can see the vessels that supply the beak

2. Thermal image shows where the heat is concentrated (in yellow)

PHOTOS THIAGO FILADELPHO

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In expanding upon the original project, the Rio Claro team was able to show that the toucan's ability to adapt to temperature changes is very quick– it takes about ten minutes for the birds to adjust and respond to ambient temperatures that drop sharply from 25 to 10°C. "This confirms that the beak is actually a very good thermal regulator," adds Andrade. By the end of the year the group hopes to publish promising new information about thermoregulation in wasps and flies. ■

PROJECT

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GRANT MECHANISM
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SCIENTIFIC ARTICLE

TATTERSALL, G. J. *et al.* Heat Exchange from the Toucan Bill Reveals a Controllable Vascular Thermal Radiator, **Science**. v. 325, n. 5939, p. 468-70, 2009.

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