HOT flushes

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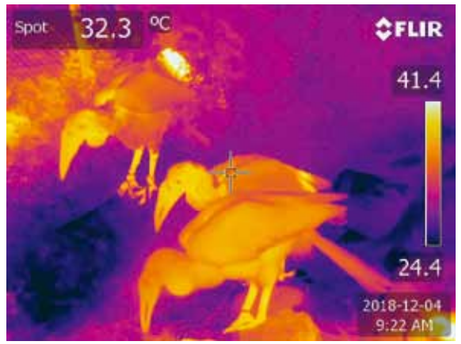
How Southern Ground-Hornbills keep their cool

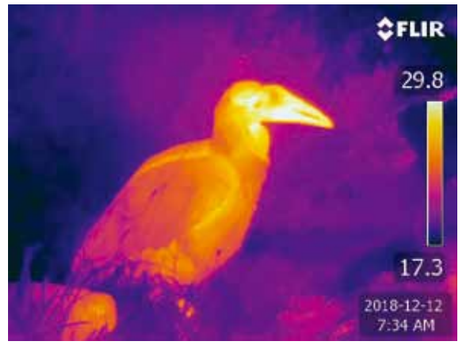
Few sounds are more evocative than the booming duets of Southern Ground-Hornbills, especially when they accompany the last few whoops of hyaenas, distant lions' roars, deep hoots of a Verreaux's Eagle-Owl and the sawing cough of a prowling leopard in the half-darkness just before dawn breaks over the African bush. The number of these stately birds of the savannas and woodlands of southern and East Africa has, however, declined sharply in recent decades because of habitat loss, poisoning and other human impacts. As a result, the species is now red-listed as Vulnerable globally and Endangered in South Africa, Swaziland and Namibia.

Another significant threat looming over the Southern Ground-Hornbill is climate change. In the 1970s Alan and Meg Kemp's pioneering research on the ecology of this species in the Kruger National Park revealed that ground-hornbills are, compared to many other species, relatively heat-intolerant and retreat to shade and begin panting at comparatively mild air temperatures. These observations, together with recent evidence that hot weather negatively impacts the physical condition and breeding success of many birds in subtle but nevertheless consequential ways, provided the stimulus for several recent and ongoing projects aimed at understanding how ground-hornbills are likely to fare under hotter future conditions.

In a new paper in *Journal of Avian Biology*, researchers from the University of Pretoria and the Mabula Ground Hornbill Project (MGHP) teamed up to further investigate the physiology of BirdLife South Africa's Bird of the Year 2020. Over the past decade, research on groups as diverse as toucans, hornbills and Darwin's finches has revealed that the avian beak is a sophisticated, controllable heat radiator. During hot weather, these birds all direct blood to capillary networks in the beak, causing its surface to warm and lose heat to the surroundings. Heat loss via the beak does not require the evaporation of water. For this reason it may be particularly important for desert birds for whom water conservation is vital, as well as for birds that inhabit very humid habitats in which evaporation is impeded. It may also perhaps be significant in non-drinking species like the ground-hornbills.

To establish whether Southern Ground-Hornbills use their beaks as heat radiators, University of Pretoria BSc (Hons) student Andries Janse van Vuuren used a high-end thermal-imaging camera to measure surface temperatures of ground-hornbills at the National Zoological Garden in Pretoria and the MGHP's new Baobab Specialised Conservation Rearing Facility at Loskop Dam Nature Reserve in Mpumalanga. By taking thermal images of the birds over a range of air temperatures from 11 to more than 35 degrees Celsius, Andries was able to visualise how the temperature of the beak surface changes and to quantify the associated heat losses.





The surface of the ground-hornbills' beaks warmed sharply as soon as the air temperature exceeded 20 degrees, confirming that they actively govern blood flow to the beak and use it as a controllable heat radiator. By raising the temperature of the beak to as much as 10 to 12 degrees above that of the surrounding air, the birds used this structure to help dissipate excess body heat. The observation that ground-hornbills begin this process, which is invisible to the naked eye, at such low air temperatures is consistent with the observations of them beginning to pant in the mid-20 degrees, retreating to shade at about 30 degrees and generally showing signs of heat stress during hot weather.

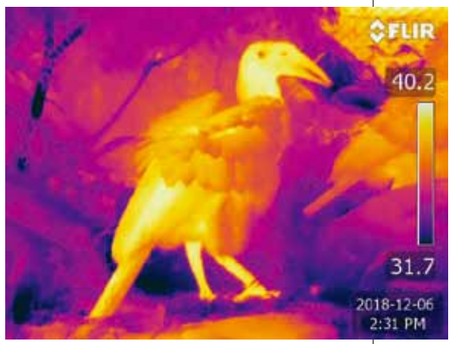
Impressive as the heat loss from the ground-hornbills' beaks may be, this turned out to be only part of the story. Andries also measured the surface temperatures of the bare skin on the birds' face and throat. He found evidence that blood flow to these regions is also regulated in such a way as to aid heat dissipation. By maintaining large, approximately constant differences between skin temperature and air temperature during warm conditions, these areas add significantly to the rate at which heat is dissipated.

The combined capacity of the ground-hornbill's beak and bare skin to radiate heat is impressive, reaching approximately six watts at an air temperature of 26 degrees. This mechanism gives the bird the capacity to dissipate about three-quarters of its resting metabolic heat production simply by adjusting the circulation of blood through capillary beds in the beak and under the skin on its face and throat.

The findings of this study raise the possibility that the heat-loss capacity provided by the beak and bare skin is one of the reasons why the Southern Ground-Hornbill's distribution can include some of the hottest parts of southern Africa.

During the Kemps' research in the Kruger National Park, when air temperatures neared 35 degrees they occasionally observed fluid in the groove in front of each nostril along the length of the birds' beak. Andries also documented this and noticed birds sometimes wiping their beaks on their plumage, apparently to spread the fluid over a larger area. Areas of the beak wet in this manner were evident as prominent cool spots in thermal images, suggesting a function of speeding up heat loss through rapid evaporation. At these high air temperatures there is no longer a large temperature gradient for passive heat loss between the beak and surrounding air, which is probably why the birds keep this behaviour in reserve until it is really hot.

ANDREW McKECHNIE & LUCY KEMP



above *Footage obtained with a thermal-imaging camera provides insights into how ground-hornbills regulate blood flow to unfeathered areas.*

opposite *The beak and unfeathered skin play a hitherto unappreciated role in helping Southern Ground-Hornbills to keep cool.*