Birds’ beaks come in a dazzling variety of forms, but few are as bizarre-looking as the giant beaks of hornbills and toucans. These two groups of birds are not particularly closely related, but both boast beaks that in extreme cases, such as the toco toucan, can be as large as their bodies. The birds are able to hold up these immense beaks without damaging their necks because they generally have a lightweight core of spongy bone, a bit like foam rubber. The outer beak covering is made of keratin, the same material our fingernails are made from, and is often brightly coloured and patterned, especially in toucans.

COOL BANANAS!

Hornbills use their giant beaks as air-conditioning units. When the going gets hot, hornbill beaks release heat to the environment and cool down the birds. By Susan Cunningham and Tanja van de Ven

Birds’ beaks are living structures with their own blood supply.

Toucans live in the rainforests of South and Central America, while hornbills are found across Africa and Asia. Hornbills and toucans are often referred to as ‘ecological equivalents’ because of their giant beaks, but until relatively recently no-one really knew what these beaks were for. There was plenty of speculation that their huge size might have something to do with reaching berries at the ends of thin branches, or showing off to mates, but hard evidence was patchy. In 2009, a team of scientists, led by Glenn Tattersall from Canada and his colleagues in Brazil, showed that toucans use their beak as an air-conditioning unit.
Birds’ beaks are living structures, with a blood supply. Unlike the rest of a bird’s body, excluding the legs and feet, beaks don’t have a thick covering of feathers. Glenn’s team realised this meant birds’ beaks should make excellent ‘thermal windows’, areas of an animal’s body with little insulation and a rich blood supply near the surface that can be used for heat exchange. A well-known example is the ears of elephants. On hot days elephants flap their huge ears to cool the blood in the network of veins within them. This cooled blood then returns to the elephant’s body and cools it down.

Glenn’s team showed toucans were using their beaks in the same way. They filmed toucans with a thermal-imaging camera, which showed the beaks of the birds glowing brightly when air temperatures were high, a sure sign the birds were dumping heat into the environment through the surface of the beak. Amazingly, it turns out toucans can turn this on and off as required, stopping themselves from getting too cold by shutting down the flow of blood into the beak when the air temperature is cool.

What about African hornbills? If they are truly ecological equivalents to toucans, are they also flying around with an aircon unit stuck to their face?

One of the most familiar of southern Africa’s hornbills is the southern yellow-billed hornbill, often seen in the Kgalagadi Transfrontier Park and Kruger National Park. Hornbills breed in summer, when it’s hot but also when it rains and when prey items become more abundant. Breeding females wall themselves up in tree hollows during incubation and chick-rearing to keep safe from predators, which leaves them unable to escape high temperatures in the nest and leaves the males to do all the provisioning work. This breeding system puts both parents under lots of strain at the hottest time of year. A beak functioning as an aircon, similar to toucan beaks, could be highly advantageous to breeding hornbills.

In 2013, we headed to the Kalahari armed with a thermal-imaging camera. We discovered that, like toucans, yellow-billed hornbills can control blood flow to the beak. When the going gets hot, hornbill beaks release heat to the environment and cool down the birds.

However, hornbills have to make a compromise. Running at maximum efficiency, a toucan’s beak can offload 60 per cent of the body heat the bird produces. Hornbills seem to be able to manage 20 per cent at a push. Why might this be? One possibility is that hornbills have a tougher diet than toucans. Instead of eating soft fruit, they prise up bark and dig in sand for scorpions and insects and other such prey. This requires a stouter, tougher beak than the lightweight monstrosity sported by a toucan. So it seems the hornbill beak is less efficient at cooling. It’s the rugged version, like a gnarly old Land Cruiser bakkie versus a modern Fortune, with a bit of comfort sacrificed for solid durability and functionality.

Why would hornbills and toucans have evolved such amazing beaks when other birds have not? We think this has
Having a radiator for a beak is useful in hot climates, whether dry or humid.
Allen’s Rule is a biological rule stating that appendages of animals living in cold places will generally be smaller than those of animals living in warmer places. This is because the rate of heat transfer between an animal and its environment is partly determined by the surface area to volume ratio of the animal. Having long limbs, or a large beak, increases the surface area of an animal relative to its volume, allowing heat to be transferred more quickly. The large beaks of toucans and hornbills could be an example of Allen’s Rule in action.