SHAPE-SHIFTING Birds responding to heat stress

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Museum collections have always been an essential resource for ornithological research. Going into the third decade of the 21st century, well-maintained and active collections are becoming even more vital for documenting the effects of rapid environmental change. For example, measurements of specimens in collections spanning decades, or even centuries, have revealed that rising temperatures are associated with progressively smaller body size in many birds. Analyses of museum collections are now suggesting another widespread effect of climate change: shifts in the sizes of birds' beaks and legs.

A 2015 paper on five species of Australian parrots revealed that in four of them, beak surface area has increased by four to 10 per cent over the past 140 years. Evidence for avian beaks becoming larger is also turning up in tits, sparrows, waders and Galápagos finches. Similar changes involving appendage size are occurring in mammals too, with wings, ears or legs becoming larger in bats, shrews, mice, rabbits and wild boars. The avian and mammalian species studied to date inhabit latitudes ranging from tropical to polar, emphasising the global nature of this phenomenon.

above *The Red Knot is one of many species in which relative beak size has increased in recent decades.*

The subject of an influential review paper published in 2021, this 'shape-shifting' among birds and mammals is thought to be functionally linked to the role of unfeathered surfaces in heat loss to an animal's surroundings. Avian beaks and legs act as heat radiators during hot weather; by increasing blood flow to these regions, birds accelerate heat dissipation without the need for evaporative cooling and the associated water losses. The larger these appendages, the more effectively heat loss can take place; in large-beaked species like hornbills, ground-hornbills and toucans, heat loss via the beak can be very rapid (see *African Birdlife*, 8(5): 52–53).

The notion that shifts in appendage size across generations occur because of changing needs related to heat balance has its roots in a biogeographic pattern described by Allen's Rule, which posits that animals living in hot climates possess larger appendages than related species in cold environments. In cold environments, small appendages are good for minimising heat loss, whereas large appendages maximise heat dissipation in hot environments. One oft-cited example concerns ear size in foxes: the large ears of desert-dwelling fennec foxes, the medium-sized ears of European red foxes and the tiny ears of Arctic foxes.

The shape and size of beaks is influenced by myriad factors other than heat loss, so demonstrating a direct link between temperature and increasing beak size is often challenging. But evidence for a cause-effect relationship is accumulating, both from museum collections and long-term ringing studies. In the Australian parrot study, increases in beak size among three species were strongly related to average summer temperatures over the five years prior to collection. While much remains to be learnt about the causes and consequences of changes in the dimensions of birds' beaks and legs, shape-shifting is emerging as a widespread avian response to climate change.

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Reference

Ryding S. et al. 2021. 'Shape-shifting: changing animal morphologies as a response to climatic warming.' *Trends in Ecology and Evolution* 36: 1036–1048.