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hot or not?

Physiological variation in White-browed Sparrow-weavers

Models predicting the impacts of climate change often involve the tacit assumption that birds will not be able to adapt to higher temperatures. They predict, therefore, that birds' ranges will shift towards cooler areas as the Earth becomes progressively warmer. This is the basis, for instance, of the expectation that high-altitude endemics are at very high risk of extinction; as global warming advances, their restricted ranges will simply shift up mountainsides until they have nowhere left to go and disappear into oblivion.

There is no doubt that natural selection operates at time scales far too slow for birds to adapt, in a Darwinian evolutionary sense, to the rapid warming that is currently taking place. Nevertheless, there are compelling reasons to be wary of the assumption that birds will be incapable of occupying habitats warmer than those they do at present. One of these reasons concerns the burgeoning evidence that many avian physiological traits are highly flexible and can accommodate substantial climatic fluctuations. Some birds that winter in cold, north-temperate regions, for example, are capable of increasing their capacity for internal metabolic heat production by over 50 per cent during winter compared to summer.

The question of whether birds have the physiological potential to cope with warmer temperatures is one of the focal points of the Hot Birds programme, which involves researchers from the FitzPatrick Institute, the University of Pretoria, and several overseas institutions.

Unsurprisingly, this is not a trivial question to answer. Our starting point has been to ask just how much physiological variation there is within bird species that occupy a wide range of habitats and climates. The species we have focused our attention on is one that will be very familiar to anyone who has spent time in the western parts of southern Africa: the White-browed Sparrow-weaver *Plocepasser mahali*. Besides being abundant in habitats ranging from the hot, arid Kalahari Desert to mesic savannas and woodlands, the sparrow-weaver's habit of roosting communally in distinctive and conspicuous nests makes it a highly tractable study subject.

In order to quantify the physiological variation that exists among various sparrow-weaver populations, we worked at three sites that differ considerably in seasonal temperature extremes. Our site with the harshest climate was in the Kalahari Desert, near the town of Askham, where summer maximum temperatures frequently exceed 40 degrees Celsius. The other two sites were Frankfort, a small town on the Wilge River in the grasslands of the northern Free State, and Polokwane in Limpopo Province. Both these sites have comparatively mild summer maximum temperatures, averaging around 10 degrees cooler than those at Askham.

We caught sparrow-weavers at each of these sites in both summer and winter and investigated their capacity to handle high temperatures. Birds lack sweat glands, and so rely on other avenues to offload heat under very hot conditions. In many birds, including passerines, this is achieved primarily by panting, a behaviour that accelerates the evaporation of water (and hence heat loss) from moist respiratory surfaces. To quantify variation in heat tolerance and evaporative cooling capacity among sparrow-weaver populations, we exposed birds from the three sites to progressively higher air temperatures while measuring body temperature and the rates at which they dissipated heat via evaporation. By continuously monitoring the birds during these measurements, we were able to push them very close to their physiological limits without exposing them to potentially dangerous levels of heat stress.

We found that, in summer, Kalahari sparrow-weavers can handle temperatures up to four degrees higher than the birds in either the Frankfort or Polokwane populations can. Intriguingly, this difference disappears in winter and, as far as we can tell, this is one of the first studies to show that birds can significantly enhance their capacity to handle sweltering conditions during summer. The improved heat tolerance of desert sparrow-weavers appears to result from an increase in the efficiency of evaporative cooling, through an as-yet-unidentified physiological mechanism. More efficient evaporative cooling has obvious advantages for desert birds experiencing harsh summer temperature maximums coupled with a scarcity of water.

Now that we know these sparrow-weaver populations vary in their capacity to tolerate heat, we need to establish whether or not the variation is due to hard-wired genetic differences. In other words, have desert sparrow-weavers evolved through natural selection over many generations to cope with hotter conditions? Or do the differences among populations simply reflect acclimatisation of individuals, in much the same way that exercise or time spent at high altitude triggers consequential physiological changes within individual humans? This distinction between genetic adaptation and phenotypic plasticity has important implications for predicting whether birds will be able to cope with rising temperatures.

Another, closely allied question we need to tackle is whether sparrow-weavers can handle temperatures higher than those they currently experience. To provide a convincing answer, we will take two approaches. One will involve aviary translocation experiments to determine whether birds can successfully acclimatise to hotter conditions than those that currently occur at their native site. The second approach will make use of the new Small Animal Physiological Research Facility currently being built at the University of Pretoria. We will catch sparrow-weavers at various study sites and temporarily house them under different air temperature cycles in this state-of-the-art facility; their physiological responses will provide important information about their capacity to deal with rising temperatures.

The increasing evidence for physiological variation within species such as the White-browed Sparrow-weaver has important implications for understanding avian ecology and evolution. Our work on this widespread species, so common in the more arid parts of southern and East Africa, is providing new insights into how birds' physiologies are shaped by their environments, and how they are likely to respond to a warming world.

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GRANT ATKINSON

The nests in which White-browed Sparrow-weavers roost are conspicuous in dry landscapes in South Africa.

SAVE THE DATE

PAOC 14

Dakar, Senegal, 17–21 October 2016

The Pan-African Ornithological Congress (PAOC) is a regular conference on African ornithology, usually held every four years at an African venue. Its geographic scope is the entire continent from North Africa to the Cape of Good Hope, and east to the Suez Canal and Red Sea, as well as its offshore islands. All continental shelf islands are considered areas of interest, as are areas of provenance and intervening routes of migratory birds that visit Africa.

The aims and purposes of the congress are, with regard to African birds, to further their study, promote their preservation as an integral part of African heritage, foster their appreciation and discussion in relation to man, and disseminate information about them through international meetings and publications.

The constitution states: 'Of vital importance to this scientific and educational organisation is the opportunity for free and open discussion of African avian biology, birds and their relations to man, and man's effects on bird populations.'

The scientific committee of the PAOC invites proposals for symposia at the 14th congress, to be held in Senegal in 2016. Symposia provide the organisational structure for the PAOC and highlight topical and important themes within the overarching theme of African ornithology. They should provide forums for a wide representation of ornithologists to discuss and synthesise the latest developments in the field.

If you would like to propose a symposium at the PAOC 14, submit details via Google Forms: *https://docs.google.com/forms/d/19osaGq1MIa6pyTuYab4RzRw4hHU-zn2MyHGonpo5dzM/viewform?usp=send_form*