ALBERT FRONEMAN

WORLD ON *the boil*

HEATWAVES TAKE THEIR TOLL ON BIRDS

In January 2009 an intense heatwave, during which air temperatures topped 45 degrees Celsius for several consecutive days, struck a remote area some 500 kilometres north of Perth, Western Australia. The result was an avian catastrophe, with the extreme temperatures killing tens of thousands of Budgerigars, Zebra Finches and other birds. Photographs show bushes festooned with hundreds of dead and dying Budgerigars and patches of ground literally carpeted with their carcasses. Although it was initially considered that the birds had been poisoned, subsequent investigation confirmed heat stress and dehydration as the causes of death.

A similar event took place a year later, again in Western Australia. This time, several hundred birds perished in the Hopetoun area when temperatures soared into the upper 40s and lower 50s. Although the fatality count was considerably lower than during the 2009 episode, the Hopetoun victims included 150 Carnaby's Black Cockatoos, a species red-listed as Endangered. These deaths represent a devastating blow to this threatened species; at one breeding site, 50 per cent of the local population perished in a single day. Ornithologists who were monitoring the cockatoos tell of finding adults in tree hollows where they died from heat stress while incubating eggs.

Are these catastrophes the work of climate change? Mass mortality events are not a new occurrence – in 1932, millions of birds perished during a severe heatwave in central Australia (see *Africa – Birds & Birding* 10(2): 12). However, the increased frequency of episodes in recent years suggests a pattern symptomatic of a warming world: two bird die-offs in Western Australia within a year, reports of similar occurrences in India, the deaths of 2 000 Common Ostriches during a heatwave in the Little Karoo of South Africa, and an estimated 30 000 flying foxes dying between 1994 and 2007 during heatwaves in south-eastern Australia. Records reinforce this impression, with periods of extremely hot weather being far more frequent now than two decades ago.

Such mass die-offs during heatwaves in Australia may well be a harbinger of similar events in hot parts of Africa. The Sahara, in particular, is one of the world's truly hot deserts, making it a prime location for heatwaves severe enough to overwhelm birds' physiological tolerances. It is more difficult to predict what will happen in the southern African deserts. The Kalahari, Karoo and Namib are certainly sweltering places in midsummer, but in terms of maximum temperatures they are not in quite the same league as the deserts of Australia, the south-western USA or the Middle East. Climate change could affect birds of the southern African deserts in ways that are more subtle, but no less significant to their populations.

Above *Higher air temperatures will potentially have profound consequences for many water-dependent birds, such as these Namaqua Sandgrouse, as they will need to visit water far more frequently.*

Opposite *The heatwave that struck Western Australia in 2009 resulted in the deaths of many thousands of birds. The ground was littered with dead and dying Budgerigars.*

Understanding desert birds' responses to climate change is one of the most important challenges currently facing ornithologists in Africa and elsewhere. A team led by Phil Hockey (Percy FitzPatrick Institute) and Andrew McKechnie (University of Pretoria) is tackling this issue through a multifaceted research programme focused on the bird communities of the southern Kalahari Desert. Based at Tswalu Kalahari Private Game Reserve, the 'Hot Birds' team is examining the relationships between high air temperatures and several key aspects of avian behaviour and physiology. Understanding the stresses placed on birds by periods of very hot weather will provide the foundation for predicting avian responses to a warmer climate, as well as when these impacts are likely to occur.

One key issue the team is investigating concerns the implications of higher temperatures for how birds spend their time. A hotter climate will mean that they have to spend a greater proportion of each day inactive in deep shade or engaged in heat-dissipation behaviours such as wing-drooping. These changes in behaviour patterns may result in reduced time available for foraging and in birds not being able to meet their energy demands during key periods, such as when feeding hungry chicks. Higher temperatures will also have profound consequences for the extent to which birds depend on drinking water, and many water-dependent groups such as sandgrouse, waxbills and finches will probably have to visit water much more frequently.

Species such as mousebirds can get by without access to standing water at moderate temperatures, but under hotter conditions they must drink in order to balance water losses. Warmer climates in desert regions may thus cause significant species declines in areas where no natural or artificial waterholes exist.

An aspect being addressed by the team's Rowan Martin and Susie Cunningham is the availability of localised spots of relatively cool temperatures ('microsites') within a landscape. Climate change will mean that birds become increasingly dependent on trees and bushes that provide deep shade, sites where the birds can take refuge from the sun's intense heat. Although these microsites will not shield birds from increases in air temperature (i.e. temperature measured in the shade), they will at least allow them to avoid the blistering temperatures associated with exposed areas of low shrubs, grass and bare ground. The presence of trees such as camelthorns *Acacia erioloba* and shepherd's trees *Boscia albitrunca* may be critical in determining whether particular bird species remain in an area under climatic conditions hotter than those that prevailed in the past.

During extremely hot weather, birds face a physiological catch-22: they must evaporate large amounts of water to offload heat, but in doing so are exposed to the risk of fatal dehydration

The research of another team member, Ben Smit, is providing crucial links between behaviour patterns and underlying physiological processes. Even small increases in body temperature can be fatal for birds, and the behaviours they exhibit during very hot weather reflect this requirement to avoid hyperthermia (over-heating). During extremely hot weather, birds face a physiological catch-22: they must evaporate large amounts of water to offload heat, but in doing so are exposed to the risk of fatal dehydration, when their bodies shut down from excessive water loss. Smit is examining how water requirements increase with rising temperatures and how this affects birds' behaviour and daily movements.

Deserts are challenging environments for birds at the best of times, and recent events underscore the vulnerability of arid-zone species to increases in heatwave intensity and frequency. Because even small increases in temperature have major consequences for many aspects of avian behaviour and physiology, in coming decades desert birds will find themselves living in environments even less hospitable than at present.

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