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Non-invasive physiological measurements in wild animals

By Amanda Bourne and Susan Cunningham

Just like us, when animals experience stress, they show a physiological response in the body. This response can take many forms – an elevated heart rate, higher metabolic rate, an increase in circulating stress hormones (called cortisol in most mammals, including humans, and corticosterone in reptiles and birds) or, when heat stressed, a heightened risk of dehydration. Studying these responses in animals can tell us a lot about how much environmental stress animals can tolerate, helping to improve our understanding of animal biology and inform conservation management actions.

Traditional methods for measuring physiological responses to environmental stress can cause considerable disturbance, particularly when they involve repeated capture of individuals, along with taking samples of blood or tissue. For example, a common way to estimate energy expenditure and water use is by measuring the turnover of hydrogen and oxygen atoms in an animal's body as they are used during respiration and evaporative cooling. Typically, this involves capturing the animal, injecting it with heavy isotopes of hydrogen and oxygen (non-toxic 'doubly labelled water'), keeping it captive for a brief period, then releasing and later recapturing it. During this period, three blood samples are taken, and levels of heavy isotopes in the blood are measured over time. Likewise, estimates of stress, measured as concentrations of stress hormones (glucocorticoids) circulating in the body, are often measured using blood plasma. Again, this involves capturing and handling study animals. It is possible that handling stress may obscure signatures of environmental stress, and finding less invasive ways to measure physiology in wild animals is therefore an important research priority.

Recently, the FitzPatrick Institute of African Ornithology's Hot Birds Research Project team, led by Dr Susan Cunningham of the University of Cape Town (UCT) and Professor Andrew McKechnie of the University of Pretoria (UP), took up this challenge. PhD student Amanda Bourne (UCT) and Honours student Emma Jepsen (UP) have been developing and testing non-invasive methods for measuring physiological responses in wild birds.

Amanda's research focuses on measuring metabolic rates and water use, and Emma's focuses on measuring stress. The research takes advantage of a habituated population of southern pied babblers, *Turdoides bicolor,* at Kuruman River Reserve in the Northern Cape, in collaboration with Associate Prof. Amanda Ridley, also affiliated with the 'Fitz'. The babblers are trained to weigh themselves on a portable scale in return for a small food reward, and they can be approached and observed by people consistently within 2–5 m without disturbance. Instead of injecting

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Amanda Bourne

Amanda's research relied on a habituated population of southern pied babblers. Instead of injecting the birds with doubly labelled water, she fed them beetle larvae injected with the isotope solution.

the birds with doubly labelled water, Amanda dosed her study birds by feeding them beetle larvae injected with the isotope solution. Instead of capturing the birds and taking blood samples, both Amanda and Emma collected faeces from the ground after the birds had excreted them naturally. These methods remove the need to touch the birds entirely.

In both studies, faeces provided an adequate substitute for blood as a source of body water (for the labelled water study) and stress hormone concentrations (faecal glucocorticoid metabolites used in the stress study). Derived measurements were sufficiently sensitive to detect meaningful biological patterns. And both non-invasive dosing and non-invasive sampling proved feasible in practice.

The two methods were recently published, in *Functional Ecology* (Bourne et al. 2019, 33: 162-174) and *General and Comparative Endocrinology* (Jepsen et al. 2019, 276: 60-68). Together, these studies demonstrate that valuable information on the physiology of wild birds can be collected without imposing capture or handling stress – a step in the right direction for both improving animal welfare in science, and maximising the validity of measurements of responses to environmental stress under natural conditions.

Amanda Bourne is a PhD candidate and Dr Susan Cunningham is her supervisor, a researcher and lecturer at the Fitzpatrick Institute for African Ornithology at the University of Cape Town. This article originally appeared in the July 2019 edition of UCT's Science Faculty Newsletter, Science Matters. http://www.science.uct.ac.za/newsletters-1

Yitzchak Ben Mocha

Amanda Bourne takes notes as the babblers weigh themselves on a portable scale in return for a small food reward.

The Hot Birds Research Project studies the behaviour and physiology of desert birds to understand and predict their responses to climate change. The researchers assess how birds cope physiologically as temperatures rise, the changes they make in their behaviour to mitigate exposure to heat, and the consequences of these behavioural and physiological changes for the birds' survival and reproduction. This information is used to infer which species in desert bird communities are most vulnerable to climate change, and why.

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A. Academy of Science of South Africa (ASSAf) Publications D. Quest: Science for South Africa

2019

Quest Volume 15 Number 4 2019

Academy of Science of South Africa (ASSAf)

Academy of Science of South Africa (ASSAf)

Academy of Science of South Africa (ASSAf), (2019). Quest: Science for South Africa, 15(4).
[Online] Available at: http://hdl.handle.net/20.500.11911/133
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