

# Elaborate egg shells help prevent forgery

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Duke graduate student Eleanor Caves looks over a collection of African songbird eggs that have been sorted into their original clutches based on tiny numbers written on them by a meticulous collector. Although these eggs are all from the same species, their coloration and patterns differ dramatically. Credit: Eleanor Caves

There's a high-stakes arms race being waged with colors and patterns in the scrublands of southern Zambia. It's a battle that's probably being fought everywhere there are birds practicing what is known as "brood parasitism"—laying eggs in the nests of another bird species.

In a new study appearing online June 17 in the *Proceedings of the Royal Society B*, Duke University graduate student Eleanor Caves has found that African songbirds that are frequently victimized by brood parasitic cuckoos have taken to creating elaborate patterns on their eggs to help them recognize the forgeries.

But of course it doesn't work perfectly, or the war would be over.

During her Master's research at the University of Cambridge, Caves methodically examined how two kinds of songbirds pattern their eggs to try to stay one step ahead of two species of parasitic birds.

"We don't know at what stage of this evolutionary [arms race](#) we're seeing these species," Caves said, but her study has found that birds that are heavily parasitized are able to "sign" their eggs with color and pattern traits in unpredictable combinations.

The hundreds of eggs used in her study had been meticulously collected

and catalogued by a retired British military officer, Major John F.R. Colebrook-Robjent, on his ranch in the Choma district of Southern Zambia over a 35-year period. He painstakingly drilled and blew out each of the tiny eggs, and marked them with a set number to indicate which ones belonged in the same clutch.



A new study of egg patterning is based on a collection created by retired British Maj. John F.R. Colebrook-Robjent on his ranch in the Choma district of Southern Zambia over a 35-year period. He painstakingly drilled and blew out each of the tiny eggs, and marked them with a set number to indicate which ones belonged in the same clutch. Credit: Eleanor Caves

Colebrook-Robjent's egg collection grew to at least 14,000 clutches,

from raptors to waterbirds to the songbirds Caves studied. Upon his death in 2008, the collection was bequeathed to the British Museum, but it's still housed on a game farm in Zambia, which proved lucky for Caves.

"It's a hugely valuable scientific resource," said Caves, who is the first author on the study with colleagues from Britain and South Africa.

After spending a week just sorting and organizing the eggs she found in the collection, Caves characterized each egg according to five measurements of background color and brightness in an outdoor lab that was set up to replicate natural lighting in the area where they were collected.

Taking measurements outdoors on a Zambian game farm came with unique challenges. "Sometimes I had to grab the eggs and run inside because the baboons were coming," Caves said.

Caves and colleagues also analyzed digital photographs of the eggs to quantify their markings and the contrast between patterns and background color. In all, the researchers measured nine pattern variables/traits for each egg. The study includes at least 10 clutches each from 11 warbler species and 11 weaver species.

The parasitic cuckoo finches (*Anomalospiza imberbis*) and diderik cuckoos (*Chrysococcyx caprius*) produce a wide variety of egg patterns in an attempt to mimic the variety of their hosts. But an individual parasitic bird isn't always careful to lay in a nest that closely matches the pattern she's producing, so rejections are common.

As for the songbirds, one female will lay one pattern type with just a little variability her whole career. The colors and patterns are created in the shell gland of the mother bird hours before the egg is laid, but the



specifics of the system are still a mystery.

Variation by itself is not new. What's new is being able to study how host birds arrange combinations of individual traits that add up the overall pattern of the [eggs](#), Caves said. She enlisted the help of Duke statistician Edwin Iversen to help her assess the "differential entropy" of the patterns.

Multi-component visual signatures that are individually distinctive like this are important to other species in the animal world, such as paper wasps, which have individual patterns on their faces and abdomens to help identify nest-mates.

And understanding how to make individually distinctive signals from just a few components might also have security uses, like devising a bank note that's more difficult to forge, Caves said.

**More information:** "Hosts of brood parasites have evolved egg phenotypic signatures with elevated information content," Eleanor Caves, Martin Stevens, Edwin Iversen, Claire Spottiswoode. *Proceedings of the Royal Society B*, Online June 17, 2015. [DOI: 10.1098/rspb.2015.0598](#)

Provided by Duke University

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