

# Cardinals living in adjacent deserts are sharply distinct in genetics and song

December 12 2018

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New research suggests that populations of the Northern Cardinal—one of the most ubiquitous backyard birds in the United States—are undergoing speciation in two adjacent deserts. This study, which analyzed genetics and vocal behavior, gives clues about the early steps in bird speciation. The study is published in the journal *Ecology and Evolution*.

"In general, songs are really important for describing and identifying [birds](#)," said lead author Kaiya Provost, a comparative biology Ph.D. Candidate in the American Museum of Natural History's Richard Gilder Graduate School. "Most studies assume that differences in [song](#) are important in the process that gives rise to new bird species. But looking at speciation using both genetics and behavior in [wild birds](#) can be really difficult. We went out to test both of these spheres of biology on wild [desert](#) birds to look at the full story."

The researchers focused on Northern Cardinal populations in two deserts: the Sonoran Desert, which covers parts of Arizona, California, and Mexico; and the Chihuahuan Desert, which covers parts of Texas, New Mexico, Arizona, and Mexico. The deserts are separated by about 120 miles of high-elevation plains. Analysis on the DNA of the birds in these areas shows that the two populations have been separated for at least 500,000 years and possibly for as long as 1 million years, which "might be old enough for the speciation process to finish," Provost said.

In parallel, the researchers examined the song-related behavior of these

populations. Songs play a crucial role in a bird's ability to attract and impress a potential mate. If two birds can't communicate with each other, for instance, by singing different types of songs, they are less likely to breed. Over time, populations that don't reproduce with each other will accumulate more and more genetic differences. As time goes on, these two processes can feed back into each other and lead the populations down the path of speciation.

To investigate, Provost and her collaborators—Brian Smith, an assistant curator in the Museum's Department of Ornithology, and William Mauck III, a researcher at the New York Genome Center—created a bird song experiment that they played in each desert. Each audio series contained four recordings of male birds: neighboring cardinals, cardinals from the same desert but a distance away, cardinals from the adjacent desert, and a control recording of a Cactus Wren.

In the Sonoran Desert, male cardinals reacted to the recorded songs from neighboring birds with aggression—flying around looking for the "intruder" and singing loudly. Songs from birds living further away, both from within the same desert and from the adjacent one, were ignored.

"We saw that the birds are really aggressive to songs by their next-door neighbors, as you would expect, but once there is enough distance between them, they don't understand the songs anymore," Provost said. "It's like if you speak Portuguese in Portugal, you can probably understand Spanish, and you might understand French, but if you keep going further and further away, eventually you'll hit German or Arabic—languages that are unfamiliar, that you can't parse."

In the Chihuahuan Desert, the cardinals also acted aggressively to songs from close neighbors. And, just like the Sonoran birds, they ignored songs from birds across the plains. But, in contrast to Sonoran cardinals, they were aggressive to songs from distant neighbors in the same desert.

"We're not sure why there's a difference, but you can think of it as these Chihuahuan birds singing in Portuguese and hearing songs in Spanish. It's a little different but they still understand it, and they still think it's an intruder," Provost said. "There's something that's keeping those two groups of songs linked together."

One of the major challenges taxonomists face is how to identify young species, or draw the line between species and populations. In the case of the Northern Cardinal, the authors say there is mounting evidence that there are multiple species in the United States. "By combining behavioral experiments with genetic estimates of [population](#) history, we found corroborating evidence that the speciation process is well advanced," Smith said. "It is getting harder to argue that they are a single species."

**More information:** Kaiya L. Provost et al, Genomic divergence in allopatric Northern Cardinals of the North American warm deserts is linked to behavioral differentiation, *Ecology and Evolution* (2018). [DOI: 10.1002/ece3.4596](#)

Provided by American Museum of Natural History

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