Rosy finches are Colorado's high-alpine specialists, and researchers want to know why

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Erik Funk with a rosy-finch. Credit: University of Colorado at Boulder

Mountaineers who venture high into the Colorado Rockies have likely spotted medium-sized, brown-and-pink birds rummaging around on snow patches for insects and seeds. These high-elevation specialists are rosy finches, a type of bird that's evolved to survive in some of the most

rugged places in North America.

Researchers are now beginning to unravel some of the mysteries surrounding these unique birds, including the genetic underpinnings that allow them to survive at elevations of up to 14,000 feet and help determine the colors of their feathers.

Their findings suggest that the three recognized North American species of rosy finches—the gray-crowned rosy finch, the black rosy finch and the brown-capped rosy finch—may have evolved within the last 250,000 years, which is a relatively short period in evolutionary terms.

Scientists shared more details from their work in a new paper recently published in the journal *Evolution*.

"These results are adding to the way we think about population divergence and speciation," said lead author Erik Funk, who recently earned his doctorate in evolutionary biology from the University of Colorado Boulder and now works as a National Science Foundation postdoctoral fellow at the San Diego Zoo Wildlife Alliance.

Understanding biodiversity

Even before Charles Darwin published his theory of evolution by natural selection in 1859, scientists had long pondered the Earth's rich biodiversity. How and why are there so many different types of life on the planet? It's a question they still haven't fully answered but, thanks to recent advancements in genetic sequencing, researchers now have new tools for probing deeper.

As a backpacker and climber, Funk has spent a lot of time in the mountains of Colorado and California, where he often observed rosy finches flitting around. But although they often inhabit and breed in high-

elevation regions in the Rockies and the Sierra Nevada, they also breed at sea level, such as along the Alaskan coast and among the Aleutian and Pribilof islands.

Painting of rosy finches. Credit: Liz Clayton Fuller

In addition to these breeding habit differences, the birds have varying feather colors and patterns. Some have brown body feathers, while others have black. Some have a gray patch on the crowns of their heads or on their cheeks, while others do not.

Funk wondered if analyzing the birds' genomes could help explain some of these differences.

"We wanted to understand: Can we identify genetic regions that are responsible for generating the plumage color differences that exist in rosy finches?" he said. "And there's also this question about the elevational differences. Do the birds that live in Colorado possess some unique genetic differences that allow them to live at high elevations that the birds that live at sea level don't have?"

Using blood and tissue samples from the University of Alaska Museum of the North, the Denver Museum of Nature and Science and a 2018 field study, Funk created a whole genome dataset that encompassed the full geographic range and all the varying observable characteristics of North American rosy finches. After analyzing the data, he identified unique genomic regions—and, possibly, specific genes—that are probably playing a role in the birds' trait differences.

For instance, he found genetic differences between birds with and without gray cheek patches in a region of the genome that influences melanin pigments, which give color to feathers, hair, skin and eyes. Comparing birds that breed at high elevations with those that breed at low elevations, he found genetic differences in a region that contains genes that play a role in a cell's ability to operate at different oxygen levels.

The genes he linked with traits are all located in distinct regions of the birds' genome, which means that, over time, they can be reshuffled to form new trait combinations. This supports the theory that different rosy finch populations likely evolved over a relatively short period of time.

"Generally, we think of speciation as taking a long time—on the order of millions of years," Funk said. "But if all of this variation exists within

rosy finches already, and the genome is able to recombine these different genes to produce new trait combinations, it could potentially happen a lot faster. It's a cool way to think about how different traits or trait combinations might be able to evolve and could have implications on the rate at which populations diverge and new species are generated."

More knowledge, more effective conservation efforts

Overall, the findings add to scientists' understanding of biodiversity. But beyond that, they may also help inform conservation decisions in the face of human-caused climate change.

Brown-capped rosy finches, which live primarily in Colorado, are experiencing population declines and, as such, Colorado Parks and Wildlife has identified them as a species of greatest conservation need.

To help stabilize or grow the birds' numbers, scientists and conservationists want to know as much about them as possible—and even genetic knowledge could be helpful.

"Understanding what led to the rapid generation of these different phenotypes, how they are related and the genetic variations that underlie them, allows us to better understand how rapidly evolution can generate differences," said study co-author Scott Taylor, a CU Boulder associate professor of ecology and evolutionary biology and the director of the Mountain Research Station.

"And maybe understanding that will help us better understand how these populations might respond to population collapses or changing environments into the future."

More information: Erik Funk et al, The genetic basis of plumage coloration and elevation adaptation in a clade of recently diverged alpine

and arctic songbirds, *Evolution* (2023). DOI: 10.1093/evolut/qpac064