A new understanding of reptile coloration

February 3 2023

A small sample of variations in coloring seen in captive-bred ball pythons (Python regius). Credit: McGill University

Snakes and mice don't look alike. But much of what we know about skin coloration and patterning in vertebrates generally, including in snakes, is

based on lab mice. However, there are limits to what mice can tell us about other vertebrates because they don't share all of the same types of color-producing cells, known as chromatophores. For example, snakes have a type of chromatophore called iridophores that can generate iridescent colors by reflecting light.

To gain a better understanding of the genetic basis of coloration in vertebrates, a McGill University-led research team combined a range of techniques (whole gene sequencing, gene-editing, and electron microscopy) to look more closely at color variations and patterning in the skin shed by ball pythons bred in captivity. They were able to identify a particular gene (tfec) that plays a crucial role in reptile pigmentation generally and more specifically in a classic color variant found across vertebrates and distinguished by blotches of white, the piebald.

Crowdsourcing biological data with the help of snake breeders

The sale of captive-bred reptiles is a $1.4 billion industry within the U.S. alone. Over 4.5 million American households keep reptiles, and close to one in five of these are snakes bred in captivity. Due to the spectacular color variations produced through captive breeding, an individual ball python (Python regius—originally found in West and Central Africa) can sell for tens of thousands of dollars.

"Ball pythons show incredible variation in skin coloring and patterning, which is part of their appeal for hobbyists, but also makes them really useful for researchers who want to understand the genetic basis of coloration," says Rowan Barrett, Interim Director of McGill University's Redpath Museum, the Canada Research Chair in Biodiversity Science, and the senior author on the recent paper in Current Biology.

"The pet trade has created a huge pool of color variation that would not have existed otherwise. This provides a catalog for us to figure out the many ways that genes produce the amazing diversity of colors, spots, and stripes we see across different animals."

Gene-editing confirms role of mutation in reptile coloration

To identify the genes that control a particular trait, scientists look for genetic variants that are present in animals that have the trait and absent in animals that don't. Using shed skin collected from snake breeders, Barrett's team found that piebald snakes carried the same mutation in the tfec gene.

But a common problem for scientists is that finding a correlation between a gene and a particular trait, such as the piebaldism, does not imply causation. To make that functional link, the McGill researchers collaborated with Doug Menke's lab at the University of Georgia to modify tfec in a different reptile species, the brown anole lizard, using the gene-editing technology CRISPR. They found that genetically modified lizards do indeed show altered coloration, proving that mutations to tfec cause changes to color-producing cells.

"Our research advances knowledge of the genetics of vertebrate colouration generally and particularly of the development of iridescent cells, which haven't been studied as much as other color pathways" adds Alan Garcia-Elfring, a Ph.D. student in McGill's Biology Department and the first author on the paper.

"It also highlights the potential benefits of working with non-academic communities like ball python breeders to accelerate discoveries in fundamental science. Our job, at this point, is to figure out what other

mutations underlie all this variation seen in captivity, and how these mutations interact. It's an exciting time for both researchers and reptile hobbyists."

The study is published in the journal *Current Biology*.

More information: Alan Garcia-Elfring et al, Piebaldism and chromatophore development in reptiles are linked to the tfec gene, *Current Biology* (2023). DOI: 10.1016/j.cub.2023.01.004

Provided by McGill University