Female color perception affects evolution of male plumage in birds

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Male black-throated blue warblers (left) differ greatly in coloration from females (right). The opsin Sws2 appears to play a role in the evolution of these differences. Credit: Mdf, DickDaniels, Wikimedia Commons

The expression of a gene involved in female birds' color vision is linked to the evolution of colorful plumage in males, reports a new study from the University of Chicago. The findings, published Nov. 26 in the *Proceedings of the Royal Society B*, confirm the essential role of female color perception in mate selection and sexual dimorphism.

"This is the first time an aspect of the visual system in birds has been directly associated with plumage evolution," said Natasha Bloch, PhD, who authored the study while a graduate student in ecology & evolution at the University of Chicago. "It tells us color perception plays an important role in the evolution of the spectacular diversity of colors we

see in nature."

Striking differences in coloration between males and females are found across bird species, but the evolutionary causes of this variation are poorly understood. Female color vision and perception are thought to play a role, but measuring this behavior in the laboratory has proven difficult.

To study the link, Bloch focused on opsins - specialized proteins in the retina that are responsible for detecting light. In birds, four types of opsins contribute to color vision, each with different sensitivity ranges for certain wavelengths of light.

Bloch measured gene expression levels of these opsins in males and females from 16 species of New World warblers, a family of songbirds common across the Americas. She found that opsin expression varied greatly between species. As this is a measure of opsin abundance and density, her results suggest the species vary in their sensitivity to and ability to perceive color.

A discriminating eye

When gene expression levels were measured against differences in plumage coloration between males and females, one trend stood out. In warbler species where females had high expression of the opsin Sws2, males were much more colorful. Species where Sws2 expression was low showed the reverse trend, with smaller coloration differences between sexes.

"The strong relationship seen between Sws2 expression and plumage coloration suggests the expression of this opsin changes female perception and thus female preference for color, which in turn drives the evolution of male plumage," Bloch said.

Sws2 is sensitive to wavelengths around the blue region of light, which sits in the middle of the visible spectrum. Color discrimination - the ability to tell different colors apart - is known to require multiple opsins to work in tandem.

"Because sexual selection puts a premium on choosing the sexiest and best quality mate, which requires good color discrimination, it makes sense that it is an opsin in the middle of the spectrum that evolves in response to these pressures," Bloch said.

Bloch also examined the role of the other three opsins. The expression of two of the other opsins varied with the light conditions of the habitats the birds occupied, suggesting they evolve in response to environmental pressures. The remaining opsin showed a weak correlation to sexual selection, but was not significant.

The relationship between vision and sexual selection is complex, Bloch cautions, but these results lay an important foundation for future studies.

"Opsin expression is only one aspect of color vision," she said. "We still need to learn a lot about how the visual system varies across different species to understand how the beautiful colors of animals have evolved and why different species have evolved different colors."

More information: Evolution of opsin expression in birds driven by sexual selection and habitat, *Proceedings of the Royal Society B*, rspb.royalsocietypublishing.or … .1098/rspb.2014.2321

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