Heliconius butterfly mating choices linked to simple neural change, which could speed evolution

March 11 2025

Evolution of mate preference in polymorphic butterflies. These white Heliconius cydno alithea butterflies are mating on a passionflower vine, but the male had a choice between white and yellow-winged females. Nicholas VanKuren, Nathan Buerkle, and their co-authors dive into the genetics and neurobiology of mate choice behavior and find surprising variation in the genome and the eye that correlates with male preference. Credit: Wei Lu (CC-BY 4.0,

A simple neural change alters mating preferences in male butterflies, aiding rapid behavioral evolution, Nicholas VanKuren and Nathan Buerkle at the University of Chicago, US, and colleagues, report in the open-access journal *PLOS Biology*.

Heliconius are a group of tropical butterflies known for their wide variety of wing patterns and colors, which act as a warning to predators. Because wing coloration is crucial for their survival, males have evolved a preference for females with the same wing color. But the sensory and neurological mechanisms behind these preferences are poorly understood.

Researchers investigated the genetic and sensory mechanisms behind mate preferences in two subspecies of Heliconius cydno butterflies that have either yellow or white patches on their wings. They identified four genomic regions linked to both wing color and mate preference, including the "K locus," which has also been associated with these traits in other Heliconius butterflies.

Next, they investigated gene expression patterns in the retina, optic lobe and brain at different stages of development. They found seven genetic variants that were located in genomic regions associated with mate preference, and were also expressed at significantly different levels in yellow and white males, making them strong candidates for influencing mating preferences.

To understand how males perceive different wing colors, they investigated the color sensitivity and activity of photoreceptors in the butterflies' eyes. They found that green-sensitive photoreceptors

inhibited the activity of most UV-sensitive photoreceptors in males, which preferred yellow-winged females, but comparatively few in other butterflies.

This relatively simple modification of the peripheral nervous system could provide a physiological basis for altering the perception and attractiveness of the two wing colors.

The results show that the butterflies' mate preferences result from differences in how sensory information is processed. This suggests that male Heliconius cydno butterflies find females with a matching wing color more attractive, not just easier to see. Inhibitory relationships between photoreceptors are easily evolvable, which may facilitate rapid behavioral evolution, the authors say.

The authors add, "Our work generated a striking picture of how a critical visual behavior—mate choice—is controlled, from variation in the connections between neurons in the eye down to genetic variation across the genome."

More information: Genetic, developmental and neural changes underlying the evolution of butterfly mate preference, *PLOS Biology* (2025). DOI: 10.1371/journal.pbio.3002989

Provided by Public Library of Science