# When butterfly male sex-bias flaps its wings

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In butterflies, sex is determined by chromosome differences between males and females. But unlike in humans with the familiar X and Y, in butterflies, it is the females that determine the sex of offspring.

They do so by either passing along either their Z (male) or W (female) chromosomes. Males are ZZ, while females are ZW. This ZW pattern is also prevalent in birds, some fish, and insects like butterflies. Similar to XY pairs, ZW pairs are different from each other in their shape and gene content: The Z chromosome is larger and has many genes, while the W consists mainly of repetitive DNA.

Sex chromosomes typically evolve from a pair of autosomes. After acquiring sex determining genes, W-chromosomes often degenerate and lose genes (just like the male Y in humans). Beatriz Vicoso and her team are interested in how females compensate for the loss of genetic information, in a broad biological phenomenon called dosage compensation. In this case, either the genes get up-regulated in females (since they have only one Z) or down-regulated in ZZ males.

But to date, prior studies have painted an incomplete picture, with some species having complete compensation of the Z while others seemingly less so.

"Dosage compensation is common and well understood in XY species, but there has been speculation for decades that ZW species may not have it," said Vicoso. "The inconsistent patterns in butterflies and moths had further muddled the picture."

Vicoso's research group at the Institute of Science and Technology in Austria attempts to clear up the confusion with an examination in butterflies and moths.

In a new paper, appearing in the advanced online edition of the journal *Molecular Biology and Evolution*, they examined the gene expression patterns in two butterfly (which last had a common ancestor around 35 million years ago) and two moth species, and looked at these at distinct times of development and in different tissues to better understand dosage compensation.

Their work shows that, contrary to previously inconsistent findings, dosage compensation appears to be common in somatic tissues throughout the clade. In all species studied, they found that the expression of Z-linked genes is consistently equalized between the sexes.

But there are some nuances to the pattern. It's in the gonads—the testis and ovaries —that things get tricky. In this tissue, Z-chromosome expression was not balanced between the sexes. But this is most likely due to a masculinization of the Z chromosome (the accumulation of many genes with strong male bias in expression, which cannot be accounted for by a two-fold difference in gene copy number)—and by the loss of female-biased genes.

When these strongly sex-biased genes are removed, balance is restored between male and female gene expression of the Z chromosome. Finally, the study authors speculate that this bias is found in the accumulation of genes with testis-specific functions.

"Our study shows that these inconsistencies were due to differences in experimental setup, and that dosage compensation is not just possible but widespread in this ZW group," said Vicoso. "It also emphasizes the importance of taking into account genes with sex-specific function, which are unbalanced between the sexes for functional reasons. While there is still a long way to go, these results take us one step closer to understanding what drives some species to balance the expression of their sex chromosome, while other do not."

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