Polyandrous birds evolve faster than monogamous ones, new study finds

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Female painted snipe (Rostratula benghalensis) mate with several males in each season, leaving fathers to rear the young . Credit: Dr Sin-Syue Li

New research led by the University of Bath's Milner Centre for Evolution shows that shorebird species where females breed with multiple males in each season evolve significantly faster than monogamous species. Their findings suggest that mating systems of birds have a stronger effect on evolution rates than previously thought.

The researchers, publishing their findings in the *Proceedings of the Royal Society B*, tracked genetic changes in the one of the sex chromosomes and investigated the effect of different mating systems on the rate of evolution of species.

All animals have two copies of each chromosome—one inherited from the mother and one from the father, with biological sex being determined by the sex chromosomes. Whereas mammals have XX (female) and XY (male) sex chromosomes, birds have a different system with males having ZZ and females having ZW chromosomes.

It's been previously observed that Z chromosomes tend to evolve faster than other chromosomes (called autosomes) in the genome: this phenomenon is termed "fast Z evolution."

Faster evolution of the Z chromosome

In birds, this is generally thought to be caused by so-called genetic drift, where random chance changes the frequency of an existing genetic variation in a population.

According to natural selection, harmful mutations that happen by chance are removed from a population because it makes the individual less likely to breed and pass on the mutation.

But because there are fewer copies of Z chromosomes being circulated in the total population (females only have one copy), the effect of random chance becomes more influential, and harmful Z chromosome mutations are more likely to be passed on.

Even faster Z evolution in shorebirds

The researchers looked at whether mating systems had an effect on Z chromosome evolution rates and found that in bird species that were polyandrous—where females mated with multiple breeding partners in a season—the fast Z evolution effect was even faster.

Dr. Kees Wanders, joint first author of the paper who did the research at the University of Bath but is now at the University of Copenhagen, said, "Generally in birds, genetic drift has been the most important process driving the fast evolution of the Z chromosome, but it's a different picture in the polyandrous shorebirds.

"In shorebird species where the sex ratios are skewed—so there are more of one sex than the other—instead of pairing up for the breeding season, the rarer sex will mate with multiple partners and leave them to rear the young.

"So for populations where females are outnumbered by males, the females will mate with several males, meaning each individual will have more offspring per breeding season than if they had stayed monogamous."

He added, "Since females are the source of the fast-Z effect (carrying only one Z chromosome), we initially expected to see slower Z chromosome evolution in polyandrous species where fewer females are breeding (compared with the number of breeding males). Instead, we saw faster Z chromosome evolution under polyandry, which we think is due to the very strong sexual selection acting on polyandrous females as they compete for mates.

"Under such strong competition, the females that do manage to breed represent particularly impressive individuals, and any beneficial mutations they carry are spread more quickly through the population.

"The effect is especially strong when it comes to the Z chromosome, because females have only one copy—this means that any useful mutations that appear on the Z chromosome will affect the female's ability to compete, whereas if the mutations appeared on another chromosome, their effects would often be masked by the second chromosome copy.

"It's important to understand the forces driving evolution in different species because it gives us a good picture of how quickly species can adapt to changing ecosystems. It shows how efficiently populations are able to use beneficial mutations and remove the harmful ones from the gene pool. Our research shows that sexual selection and the mating system are important factors in this process."

The researchers tracked how the genomes of 23 shorebird species have diverged since their last common ancestors; of those, four exhibited polyandrous mating systems.

Professor Tamás Székely, from the Milner Centre for Evolution at the University of Bath said, "Shorebirds have been noted already by Charles Darwin for their diverse mating behaviors. The new research in our group suggests that the variation in their mating system influences the rate of their genome evolution."

More information: Kees Wanders et al, Role-reversed polyandry is associated with faster fast-Z in shorebirds, *Proceedings of the Royal Society B: Biological Sciences* (2024). DOI: 10.1098/rspb.2024.0397

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