Evolution of sex chromosomes in birds

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Most sexual species have two sexes. The sex chromosomes determine if an organism is a male or a female as they "carry" specific genes that determine sexual characteristics. For example, humans and other mammals have X and Y sex chromosomes. In this case, females have two X chromosomes, while males have one Y and one X. In contrast, birds, butterflies and some other animals have Z and W, where females have one Z and one W chromosomes and males have two Z. The sex chromosomes not only carry sex-specific information but also as there is one sex with unpaired chromosomes (XY and ZW) these chromosomes are affected differently by evolutionary mechanism such as natural selection. As a consequence, sex chromosomes have unique morphologic and functional properties, which have fascinated evolutionary biologists for decades.

The recent explosion in techniques to determine and analyse DNA sequences allows us to address several question that were previously impossible to answer. Nowadays, we can sequence and explore the whole genome of an organism and compare differences in each region or even between species. In this project I analysed whole genome sequence data of three birds; the collared flycatcher, the chicken and zebra finch. I compared how DNA sequences have change or evolved in the Z and the rest of the chromosomes, as a consequence of being unpaired in one sex. To do this I examined the number and rate of changes, called mutations, that occurred in the DNA sequences over millions of years in all the genes present in the Z and all the genes present in other chromosomes. I mainly analysed what is the proportion of these mutations that actually cause a functional change and the proportion of mutations that does not.

I found that the chicken and zebra finch Z chromosomes appear to evolve faster than the rest of the chromosomes. However, this is not the case in the flycatcher were data suggest that all chromosomes evolve in a similar rate. These results are very interesting as we could see that there is not a general pattern in all birds. This may imply there are many interacting factors that could affect the evolution of sex chromosomes in each species.

This kind of comparative studies of DNA sequence evolution in sex chromosomes may contribute to the fascinating question of how sex came to be and how sex chromosomes have evolved multiple times and in dissimilar rates in diverse organisms.

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