24 and me: Discovery of gene of extra chromosome boosts zebra finch biology

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A pair of Zebra finches at Bird Kingdom, Niagara Falls, Ontario, Canada. Credit: Wikipedia

In the zebra finch, an extra chromosome exists in the reproductive, or germline, cells. (Songbirds have 40 chromosomes and 41 with the extra chromosome.) Known as the germline-restricted chromosome, its sequence is largely unknown and none of its genes have been identified, until now. Using sophisticated genome-sequencing techniques, American

University researchers have identified the first gene of the GRC. This finding could pave the way for further research into what makes a bird male or female.

"We don't know the function of this gene, and we don't know how many other organisms have genes like this," said John Bracht, assistant professor of biology at American University.

Bracht led the team of students on the genomics project. The idea originated when he started his lab at AU in 2014 and got to talking about the unusual genomics of zebra finch with Colin Saldanha, a co-author and collaborator on the study. Saldanha is an AU neurobiologist who studies how estrogen protects the brains of zebra finches from dangerous inflammation after traumatic injury. Both scientists agreed it would be worthwhile to try to sequence the mysterious extra chromosome in the germline of songbirds.

The work began three years ago, and since then, Bracht and his students have used computational biology to sequence, sort and filter genetic data obtained from Saldanha's finches. They decided to sequence RNA because much DNA can be highly repetitive and much of it is not used for the protein coding necessary for gene functions. The RNA represented a smaller target in which to find an unknown gene of an unknown chromosome, Bracht said.

Bracht and his students began the assembly process with 167,929 strands of RNA, eventually winnowing down that number through the computational process and verification work in the laboratory to eight proteins, one of which they confirmed as the first gene on the germline-restricted chromosome that they named 'GRC α-SNAP.' This is an exciting find because GRC α-SNAP is part of the SNAP family, genes crucial to membrane fusion in neuroscience and beyond. The fact that this new SNAP gene is found only in the germline immediately suggests

several potential functions and directions for follow-up experiments.

Other findings from the filtering process are useful in filling in the gaps of finch biology. When the zebra finch genome was sequenced in 2010, some genes were missed. The AU team identified 936 of these missing proteins including another SNAP gene beyond the GRC α-SNAP. This makes the zebra finch the first known organism to display a gene duplication for this SNAP family of genes.

Furthermore, an evolutionary analysis showed GRC α-SNAP evolved for positive selection—evolution for changes to its protein sequence, rather than selection to maintain the status quo. This is suggestive of evolution toward a function, but much more research will be needed to determine what that function is and why it exists. For now the team can speculate: for example, a clear genetic determinant of sex is missing in birds. Could the gene play a role in sex determination?

"The discovery of GRC α-SNAP raises questions about sex determination in the zebra finch and the possibility that it is part of what makes a female bird a female, possibly downstream through the genetic expression in the ovaries," Bracht said. Next steps include sequencing the DNA and exploring functionality studies in the zebra finch.

Contributing authors to the paper are Michelle Biederman, Megan Nelson, Kathryn C. Asalone, Alyssa Pederson and Colin Saldanha. The paper is online today in *Current Biology*.

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