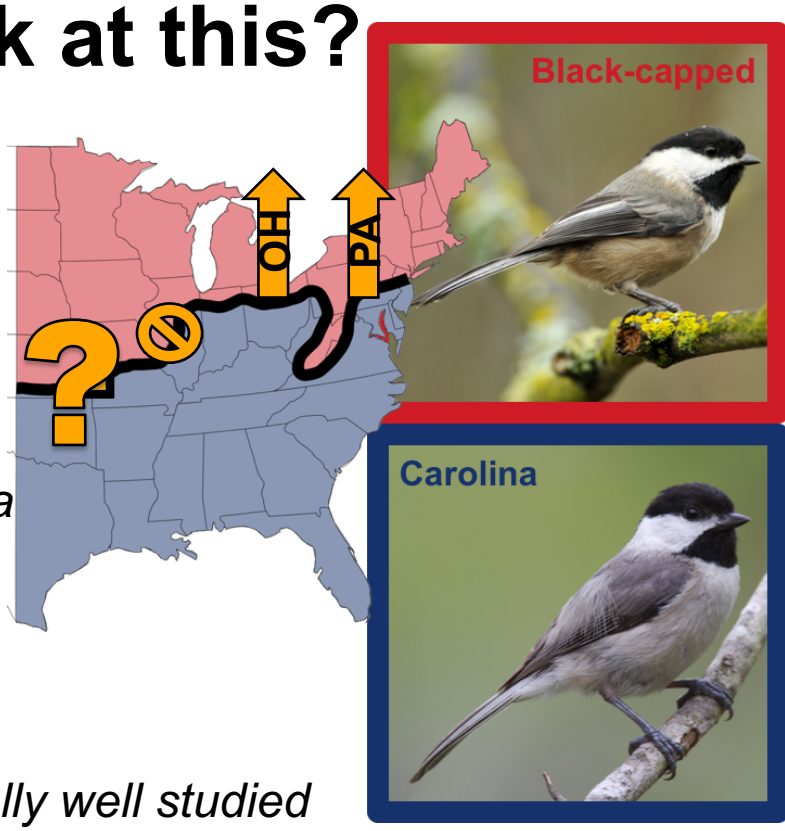
Looking at the change in where black-capped and Carolina chickadees are in Missouri by using genetics

Ko wai au? Who am I?

My name is Alana Alexander and I'm a scientist down in Aotearoa (New Zealand). I am Māori (the Indigenous people of Aotearoa) and Pākehā (the colonising people of New Zealand). I spent three years in Kansas from 2014 to 2017 and had the opportunity to study your taonga (treasures): the black-capped and Carolina chickadees. I have written up this guide to try and give the knowledge I learned back to the traditional guardians of the chickadees. If you have any questions, please shoot me an email:

alana.alexander@otago.ac.nz

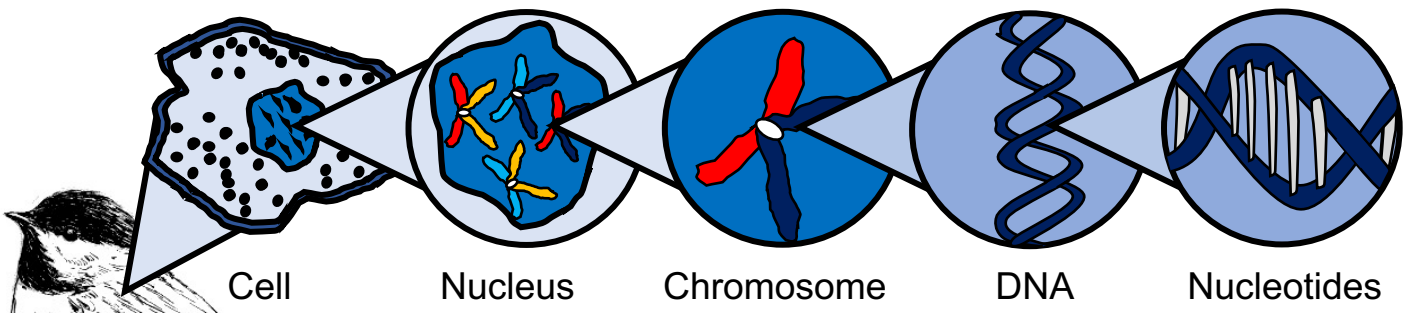
Why did we look at this?

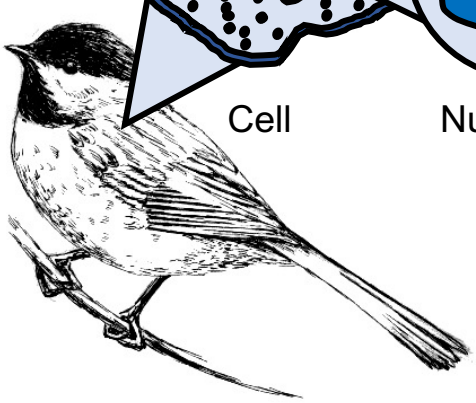


Black-capped and Carolina chickadees have a really long area where they overlap, ranging from New York in the east all the way to Kansas in the west. Where they overlap, sometimes they hybridize i.e. a black-capped and Carolina chickadee pair up to have chicks.

This hybrid zone has been really well studied in the east, particularly in Ohio and Pennsylvania. Studies have shown that the hybrid zone seems to be moving north really quickly – up to 100km over the last century, likely linked to climate change. However little movement was found in Illinois, and not much is known about what is going on in the west in areas like Missouri. Our team was keen to have a look at the hybrid zone in Missouri using genetics.

How did we look at this?

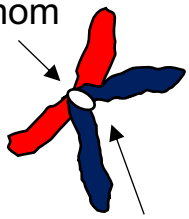




When we zoom in on the chickadees, they are made up of cells. Inside the cells is a compartment called the nucleus. Inside the nucleus are chromosomes.

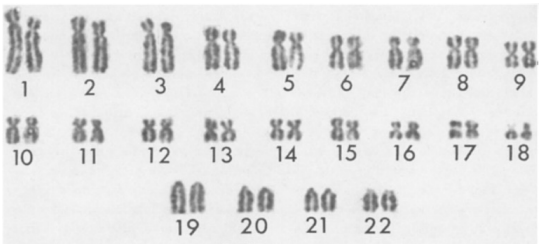
How did we look at this? *Cont…*

Copy of chromosome from the chickadee's mom



Copy of chromosome from the chickadee's dad

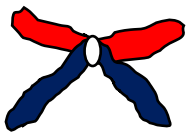
For each chromosome, one copy comes from the chickadee's mom (shown in red on the left) and one comes from the chickadee's dad (shown in blue on the left). In reality, they aren't coloured but look a bit like this:



When we zoom into the chromosomes, these are made up of DNA and the DNA itself is made up of nucleotides. When we run DNA through a DNA sequencing machine, it represents these nucleotides – the letters of the story that is written in us and our ancestors (and the chickadees and their ancestors!) as – A, C, G and Ts e.g.

ACATATGTATATGTATAACTGATTCACTTTGTTATAAAGCATTAACTA

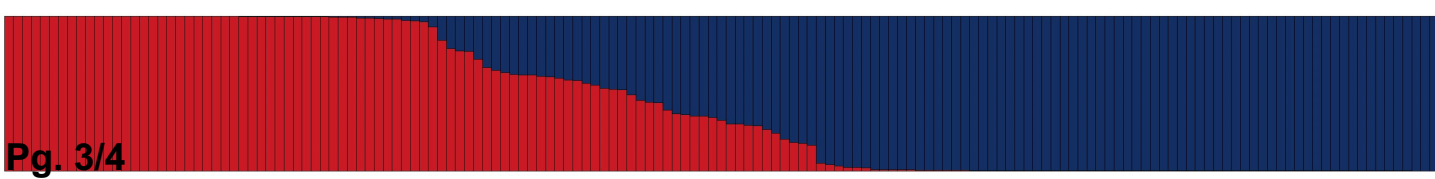
Sometimes the DNA on the chromosome inherited from the chickadee's mom has differences to the DNA on the chromosome inherited from the chickadee's dad:



TGTATAACCGATTCACTTTGTTATAAAGCATTAACTA

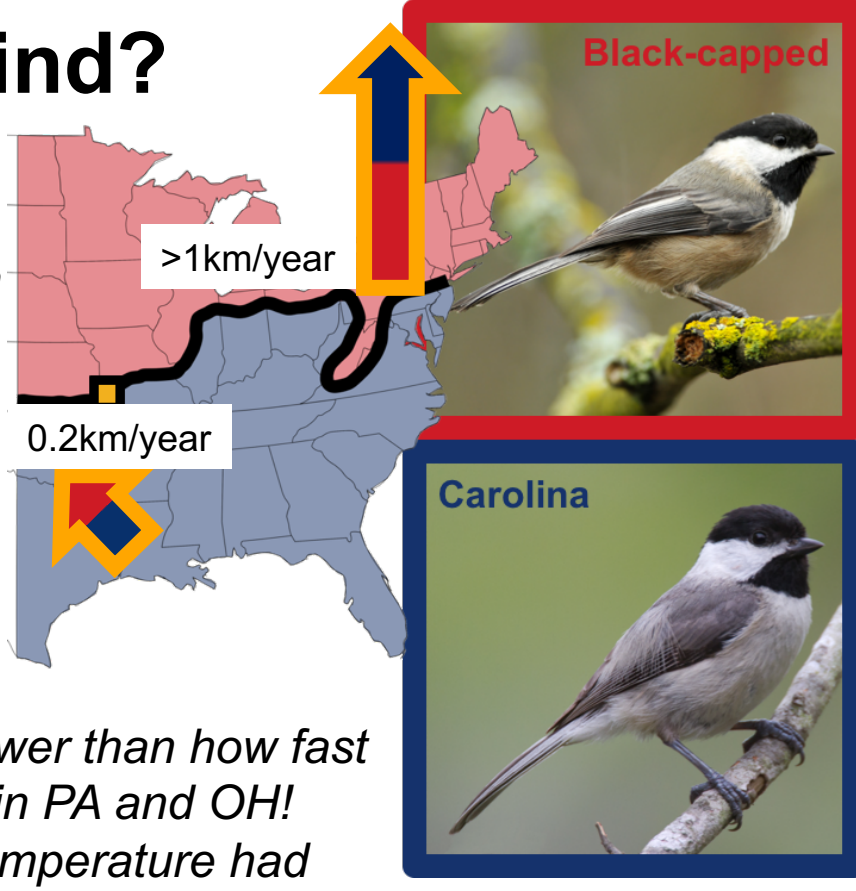
TGTATAACTGATTCACTTTGTTATAAAGCATTGACTA

We refer to these differences as variable sites (sometimes also called heterozygous sites or SNPs). These SNPs can also be handy for telling apart different species, such as the black-capped chickadee vs. the Carolina chickadee. Below, each of the vertical bars represents an individual bird. The birds with more red have more black-capped SNPs, and the birds with more blue have more Carolina SNPs. Those "in the middle" are hybrids.



What did we find?

Using genetic data from birds sampled in 1978-1980 and birds sampled in 2016, we found that the hybrid zone between black-capped and Carolina chickadees in Missouri has moved ~ 5-8km NW over ~40 years.



However, this is a LOT slower than how fast the hybrid zone is moving in PA and OH! When we looked at how temperature had changed in Missouri compared to PA and OH, we found that PA had warmed 50% more than Missouri, so it looks like the slower movement in Missouri is because it has warmed less than other areas. This is important because for species found in many areas, like the chickadees, we need to be prepared for climate change to affect them more in some areas than in others.

We also found some other cool stuff:

- *Morphology (i.e., what the birds look like, and how much they weigh) reflected the patterns we saw with the genes*
- *Song looked pretty different! In some cases, in areas where there were no longer black-capped birds based on genetics, black-capped song was still getting sung*
- *We also found some genes that might explain why hybrids do less well than 'pure' black-capped/Carolina chickadees*

If you would like any more information on this study, or if anything is unclear in the explanations, please email Alana at alana.alexander@otago.ac.nz. Tēnā koutou, tēnā koutou, tēnā rā tātou katoa (acknowledgements to you/us all).