

Population genomics of Arctic fox in Greenland

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Overview

You will be working on an imputed genome-wide SNP dataset for Arctic fox samples (*Vulpes lagopus*), which were mainly sampled from Greenland. The Arctic fox has occupied a wide range of habitats across the Arctic regions of the Northern Hemisphere. The Arctic foxes have long been known to migrate over great distances across their ranges. A notable instance is a GPS-tracking study in 2019 (Specia, 2019), revealing an Arctic fox's impressive journey of over 3,500km (2,000 miles) from Norway to Canada in a mere 76 days. Genetically, previous studies based on microsatellite data showed very small differences between Arctic foxes in North America, Svalbard, and Siberia (Lai et al., 2017; Norén et al., 2011). However, our knowledge of genetic history and population structure in Greenlandic Arctic foxes is still limited and this project allows you to explore that.

Dataset

The data is a set of ~0.8 million bi-allelic SNPs based on whole genome resequencing of 47 Arctic fox individuals. The samples were mainly collected from four locations in Greenland (Zackenberg, Ittoqqortoormiit (Scoresbysund), Qanisartuut and Kangerlussuaq). For comparison, samples from two locations in Canada and one location in Siberia were also included (see Fig. 1

for sampling locations). You will receive PLINK binary format genotypes. Sequencing reads have been mapped to a recently published genome assembly of the Arctic fox.



Figure 1. Sampling locations of Arctic fox individuals in the study.

Study questions

You are strongly encouraged to explore any aspect of the data and investigate topics of your interest. Some of the questions that may help you get started include:

1) Population structure and differentiation

- Does it look like there is population structure in Greenlandic Arctic foxes?
- What are the levels of genetic differentiation among locations?

2) Effect of colonization?

- Can you see any genetic signal of bottleneck or founder effect in the Greenlandic Arctic foxes?

3) Gene flow?

- Do you find any recent migrants in the Greenlandic Arctic foxes?
- If so, where do you think they came from?

Suggested tools

PLINK is a powerful tool for a variety of analyses. Browse the manual and make yourself acquainted with the most important ones. To avoid having a dataset that could be too large to be practical, you may want to start with thinning the SNPs. The way how you filter the dataset should depend on the analysis you plan to conduct. In addition, you can use many of the analyses (R scripts and programs) that you have used in the course exercises, for example: PCA plots, ADMIXTURE, F_{ST} , etc. Finally, feel free to use your own scripts and relevant software tools available.

Some general advice

You will probably get stuck at some point due to software not working on your files, R code not working etc. This happens all the time even for experienced researchers. Don't panic; try to dissect the problem by running a simpler command (in R, run lines one by one to see exactly where it goes wrong), visualize the input data to check that it looks as you expect or run the same command on an example data set that is almost always supplied with software packages. Googling the error message along with the software name is also a good way to find help. Or use your fellow group members to troubleshoot. Most of the time you will find that the cause of the problem was a tiny detail in the format of the data, a typo in your commands or something similar. If you are unable to resolve the problem after trying all the above, please contact me and I can try to help you. Instead of being frustrated by setbacks keep in mind: this is what real data analysis is like, and you (almost) always learn something from them.

Literature and background reading

Lai, S., Quiles, A., Lambourdière, J., Berteaux, D., & Lalis, A. (2017). Fine-scale population genetic structure of arctic foxes (*Vulpes lagopus*) in the High Arctic. *BMC Research Notes*, 10(1), 663.

Norén, K., Carmichael, L., Dalén, L., Hersteinsson, P., Samelius, G., Fuglei, E., Kapel, C. M. O., Menyushina, I., Strobeck, C., & Angerbjörn, A. (2011). Arctic fox *Vulpes lagopus* population structure: circumpolar patterns and processes. *Oikos*, 120(6), 873–885.

Specia, M. (2019, July 2). An Arctic Fox's Epic Journey: Norway to Canada in 76 Days. *The New York Times*.

<https://www.nytimes.com/2019/07/02/world/europe/arctic-fox-travels-journey.html>