# Hollow Hair in Bears: Historic Hybridization and Transfer of an Adaptive Trait

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## Introduction

- **Polar bears** famously have hair that is hollow and air-filled, which is believed to aid in heat retention.
- We discovered this hollow-hair trait in **brown bears** (Fig.1).
- All North American brown bears have some amount of polar bear DNA due to historic gene flow, and the brown bears of the ABC islands of SE Alaska have a high amount of polar bear ancestry ranging from 5-8% per individual (Cahill et al., 2018).
- We are testing two alternative hypothesizes as to how this polar bear trait arose in brown bears (Fig. 2).
- We have worked to characterize this mutant trait and to determine the proportion of SE Alaskan brown bears with the trait.

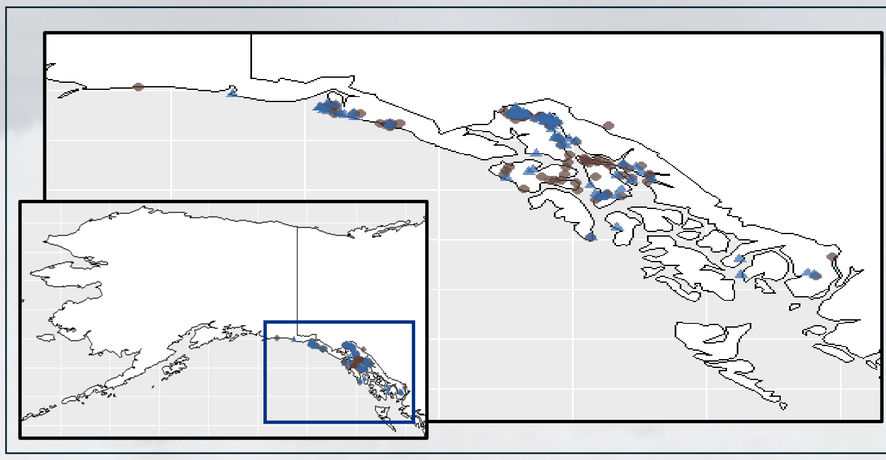

Figure 3: Map of SE Alaska with the brown bear hair sample locations shown. The blue triangles indicate bears with the mutant trait and the brown circles indicate wild type bears.

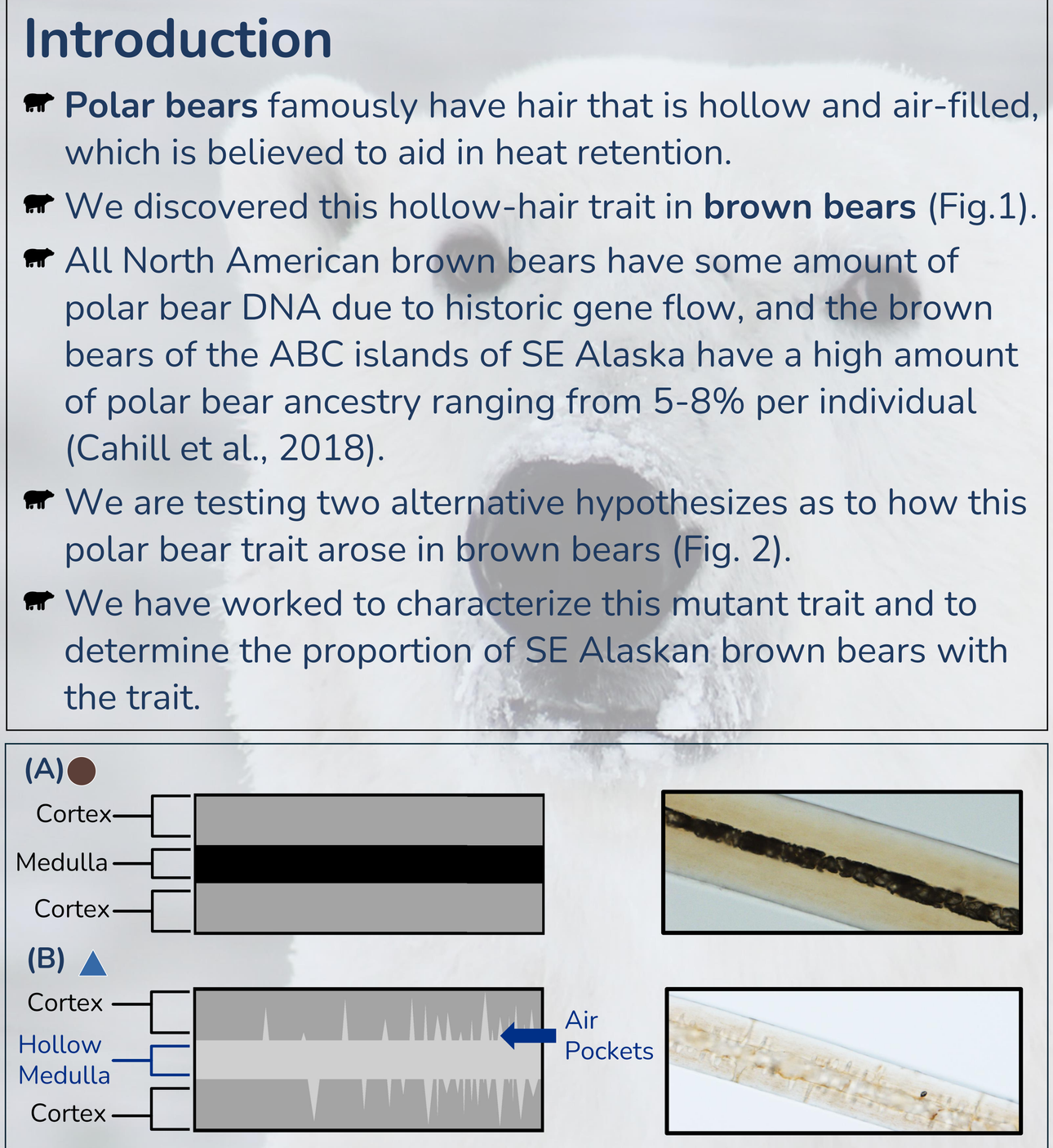


Figure 1: Visual depictions of different brown bear hair phenotypes (physical characteristics). (A) Normal and (B) mutant (hollow) brown bear hairs (left: cartoon; right: photograph of a hair section taken under 40x microscope).

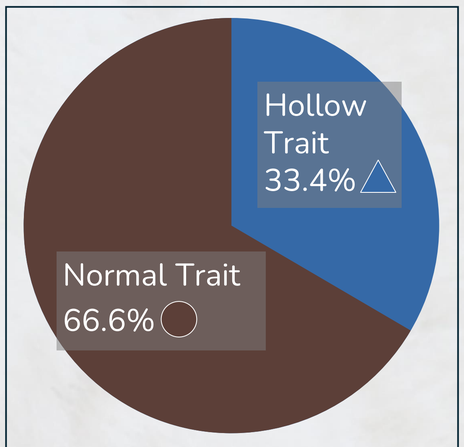


Figure 4: Proportion of SE Alaskan brown bears (n=206) with the wild type (brown; 66.6%) and mutant (blue; 33.4%) traits. This chart also correlates directly to the symbols on Figure 3.

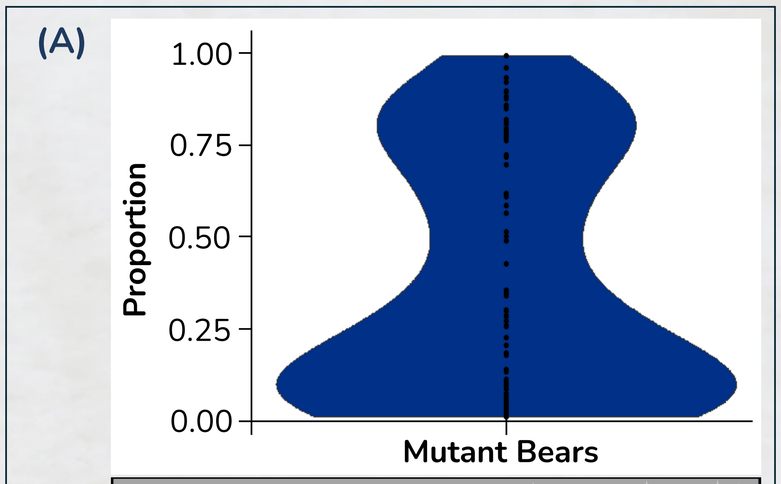


Figure 5: Brown bear hairs with the mutant trait vary in the proportion of the hair expressing the trait. This is shown through (A) a violin plot depicting the average proportion with the mutant phenotype and (B) a cartoon of a brown bear hair with over half of the hair expressing the mutant trait.

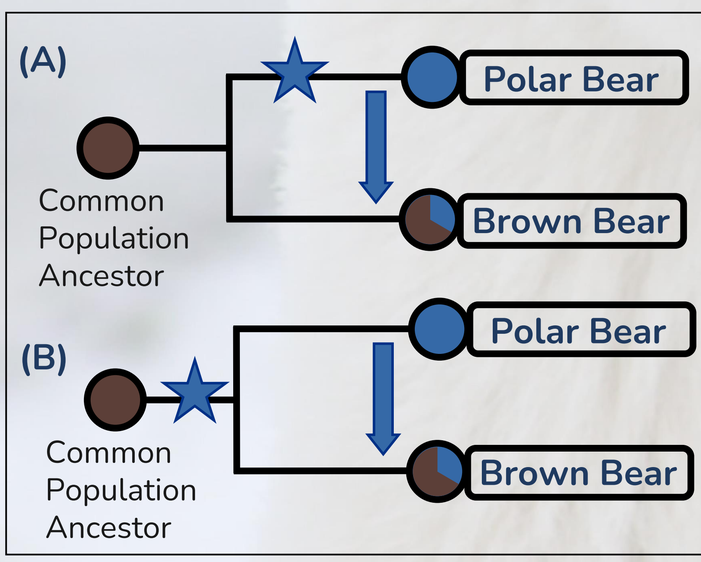


Figure 2: Alternative evolutionary models depicting how the hollow hair trait could have either (A) developed (star) within polar bears and was later introgressed (arrow) into brown bears or (B) the trait originally developed within the common ancestor of the two species and has since fixed within polar bears. Note that in the second model introgression is still present, but it is not the cause of the hollow hair trait being in brown bears.

## Results

- 33.4% of the 206 studied brown bears had the hollow hair trait (Fig. 4).
- The hollow hair trait showed no population specificity (Fig. 3).
- After quantifying the portion of total hair length, a bimodal distribution was found (Fig. 5).

## Future study

- Genetic Architecture
  - We are investigating patterns of gene gain and loss across keratins in polar bears.
  - We will compare differentiation test statistics along chromosomes between three groups (polar bears, normal brown bears, and mutant brown bears) and then run a Genome Wide Association Study.
  - We are collaborating with a proteomics expert to investigate protein differences in hairs of the three groups.
- We will soon receive brown bear hair samples from Sweden that will allow us to assess the evolutionary history of the trait (Fig. 2).

## Methods

- Using a microscope, we measured the total length of 3 hair samples per individual bear and the length of the different traits present in each hair.
- Determined which bears were mutants and which were normal
- Mapped the individual bears and their traits in SE Alaska
- Within the mutant category, we estimated the proportion of the hair with the mutant trait

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## Work Cited

Cahill, J. A. et al. (2018). Genomic Evidence of Widespread Admixture from Polar Bears into Brown Bears during the Last Ice Age. *Molecular Biology and Evolution*, *35*(5), 1120–1129. https://doi.org/10.1093/molbev/msy018