

# Using herbarium specimens to investigate long term phenological trends in Western Greenland

By  
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## Background

Under climate change, phenology in many high latitude systems is advancing. The Arctic region has experienced warming at twice the global rate, but few long-term phenological records for these regions exist. Field observation records and herbarium specimens can provide historical phenology records to estimate plant sensitivity to climate change [1, 2]. Botanical collection in South West Greenland dates to the early 19<sup>th</sup> century, as it was a stopover for many Arctic explorations. Most collected specimens are not digitised and therefore not available for analysis. To investigate plant response in SW Greenland, 3,581 herbarium specimens were digitised at the Royal Botanical Gardens Edinburgh (RBGE) and 2,051 were imaged in the Natural History Museum of Denmark, Copenhagen (CPH).

## Methods

Herbarium sheets were barcoded and digitised. The phenology scoring was adapted from [3]. Analysis was conducted on flowering mature specimens in the most abundant 19 species, all in the CPH dataset, from 1871 to 1993. Slope parameters for DOY of flowering event were estimated using Bayesian hierarchical linear regression in R 3.6.1.



Figure 1. Greenland. Red circled area showing where herbarium specimens originated.

# Greenland herbarium specimens show an overall flowering delay of one day per decade and a contraction of the flowering window over 122 years caused by early flowering species flowering later and late flowering species flowering earlier

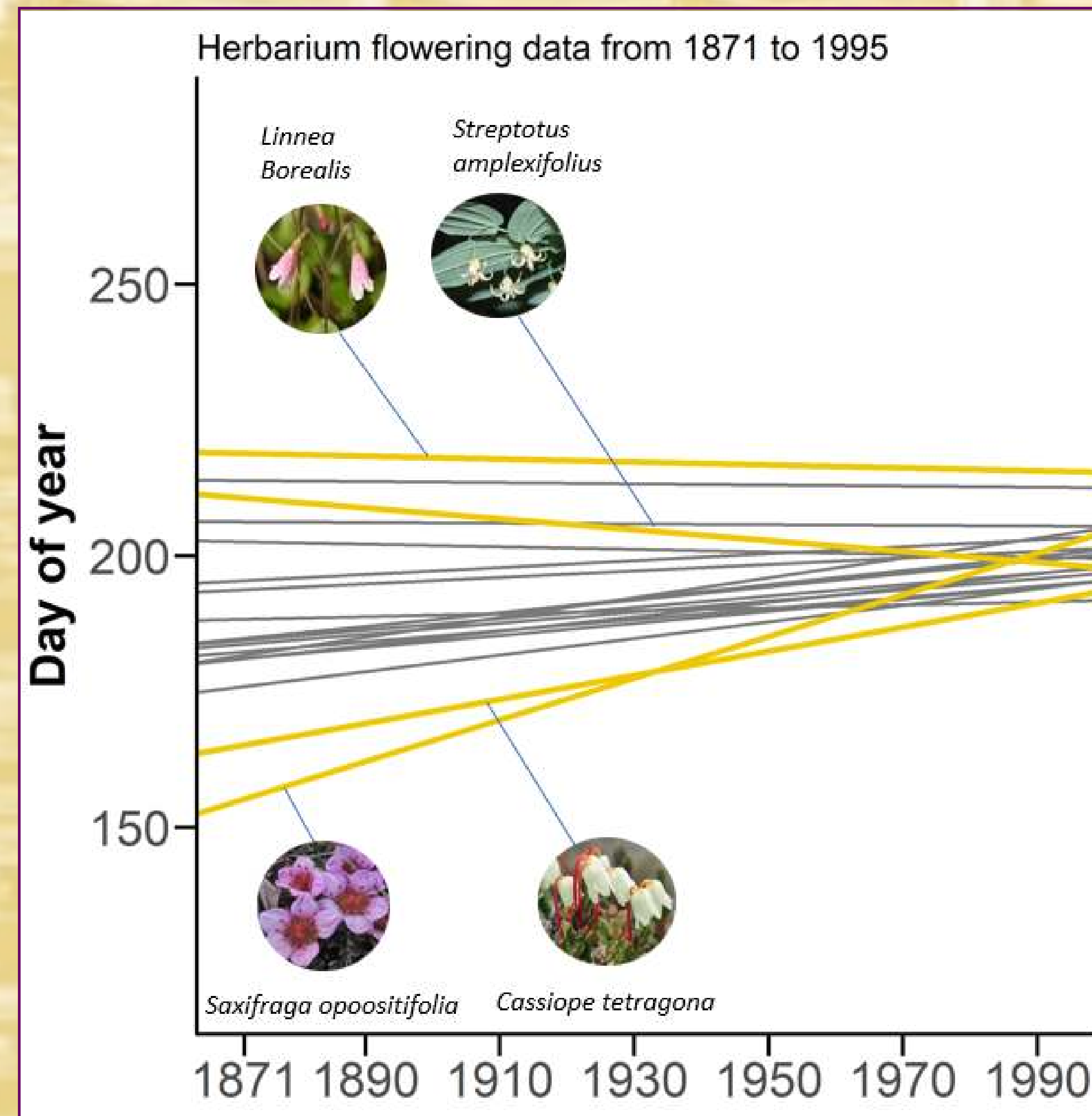


Figure 2. Linear graph representing flowering trends over time for 19 species in the CPH Greenland herbarium. The overall model trend (0.09, CI -0.03 to 0.22) indicates a flowering delay of just under a day per decade with a stronger delay in early flowering species (*S. oppositifolia* and *C. tetragona*) and a slight flowering advancement in late flowering species (*L. borealis* and *S. amplexifolius*).



Figure 3. Typical specimen images from the Copenhagen Museum collection. Clockwise from top left, flowering immature (FL-I), flowering mature (FL-M), fruiting mature (FR-M) and flowering old/fruiting immature (FL-O/FR-I).

## Discussion and Conclusion

This study provides the first phenology analysis using Greenland herbarium records. The herbarium records showed an overall delay in flowering and point to a contraction of the flowering season, a finding echoed in [4]. This study provides important information on Arctic flowering trends in early and late flowering species and reinforces the importance of long time series to understand phenology variation in the rapidly changing Arctic.

## References

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