

# Is Flowering in South West Greenland Advancing? Using Historical Records to Investigate Phenology in a Warming Arctic

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Temperature is important for flowering and fruiting timing, and scientists have recorded earlier flowering with rising temperatures in several countries where abundant records stretching back for decades have allowed analysis. But what about the Arctic flora, where temperatures are rising at twice the global rate? The Arctic is vast, and compared to other countries such as the UK, relatively under sampled. A 2016 study by Panchen and Gorelick used herbarium and historical records to investigate the advancement of flowering and seed dispersal time in Arctic Canada and the sensitivity of certain species to warming. However, this is the only study to date from the Arctic region exploring the use of historical records to investigate phenology. Here, we used previously undigitised herbarium specimens from South West Greenland to investigate the flowering trend of 19 species over 122 years. We digitised over 5,600 herbarium plant specimens from the Royal Botanic Gardens in Edinburgh and the Museum of Natural History of the University of Copenhagen and scored the phenology of over 2,100 specimens using an adaptation of the protocol by Yost et al. (2018). We conducted a linear Bayesian hierarchical analysis to determine if flowering advanced in those 19 species over 122 years. Records indicated that flowering did not advance over that period (effect size coefficient 0.03, 95% credibility interval -0.2 to 0.3). Instead, we found that early flowering species were flowering later and late flowering species flowering earlier leading to a contraction of the flowering season. Shorter flowering seasons with warming have also been reported by Prevey et al. (2019) in a data synthesis of phenology data from Arctic and alpine ecosystems and has potential effects for both pollinators and plant populations. Vast numbers of herbarium samples with phenological information remain locked in undigitised specimens that could provide insight into phenological trends for remote ecosystems such as the Arctic. Using a standardised phenology scoring protocol in herbaria would further enable urgently needed large synthesis of biological records to investigate the disruption of biotic interactions of shifting phenological trends with warming and any resulting disruption to biotic interactions.

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