23 FOUR PLANTS, TWO HEMISPHERES, SAME BASELINE?

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1. INTRODUCTION

Changes in plant phenology due to anthropogenic climate change are now well documented – although, the phenological record base for the northern hemisphere is much richer. Currently, the overall picture between the two hemispheres is similar (e.g. earlier occurrence of spring events (Chambers et al. 2013)), however, the rate of change in many cases appears to be faster in the southern hemisphere. So is this in part attributable to climate or species sensitivity or a combination of both? A step to understanding and partitioning this is to examine early records prior to the significant influence of climate on phenology in the middle of the 20th century (Menzel et al. 2008)

2. DATA AND METHODS

Hence we have started to find and compare legacy records from both hemispheres. This necessitates comparison of only native species from one hemisphere with those cultivated in the other, and/or agricultural species. As indicated southern hemisphere records are sparse. However, datasets are available for a few locations (Keatley; Fletcher 2003) of these the records from the Tasmanian Royal Society (Hobart, Australia) covering the period 1864 to 1886 contain primarily northern hemisphere species (Chambers; Keatley 2010, Fig. 1).

The PEP725 (http://www.pep725.eu/) database was examined for matching species, phases and coinciding time periods. Four species (*Aesculus hippocastanum* (Horsechestnut) – first flowering; *Fraxinus excelsior* (Ash) *Robinia pseudoacacia* (Locust) and *Sambucus niger* (Elder) – leafing) overlapped. Each of these is from the Dutch Royal Meteorological Organisation records (1868 to 1898). In all there were seven locations (Table 1) with one location, Oostkapelle, shared between species. We have assumed that the descriptive terms used in Hobart is equivalent to the BBCH code used in PEP725 data (e.g. commencing to flower = BBCH 60). As a first step we compared the seasons the phases occurred in as well as correlations between and among species, and locations.

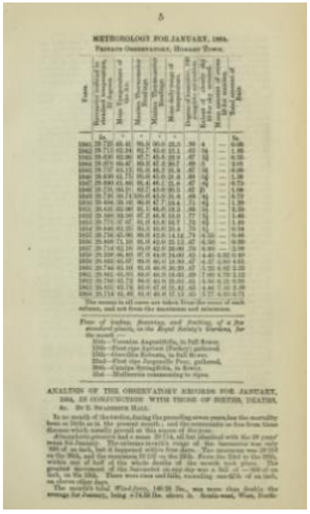

Fig 1: Example of Australian legacy data

3. RESULTS AND DISCUSSION

For *A. hippocastanum* and *F. excelsior* the respective phases occurred in the same season but in early Spring in Hobart and mid to late Spring in the Netherlands. For *S. niger* and *R. pseudoacacia* the phases were not in the same season. In Hobart leafing in these species always occurred earlier: *S. niger* was always coming into leaf by late winter compared to late Spring and early Summer in the Netherlands. *R. pseudoacacia* was in leaf by early Spring in Hobart compared to Summer in the Netherlands (Table 1).

The strongest correlation (R = 0.60) within species was in *F. excelsior* between Oostkapelle and Hobart. Although this was not significant (P = 0.11) and over a very limited period; 1869 and 1876.

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Table 1: Locations, phases and seasons of species

S. niger *Leafing*		*A. hippocastanum* *First flowering*		*F. excelsior* *Leafing*		*R. pseudoacacia* *Leafing*	
Hobart	Winter Aug	*Hobart*	Spring Sept	*Hobart*	Spring Sept	*Hobart*	Spring Sept
Oostkapelle	Spr/Sum May/June	*Oostkapelle*	Spring May	*Oostkapelle*	Spring May	*Oostkapelle*	Summer June/July
Zaandam	Spr/Sum May/June	*Zaandam*	Spr/Sum	*Zaandam*	Spring April/May		
Varsseveld	Spr/Sum May/June	*Aardenburg*	Spring April/May	*Varsseveld*	Spring April/May		
Aardenburg	Spr/Sum May/June	*Bovenkarspel*	Spring May				
Slijk-Ewijk	Spr/Sum May/June						
Utrecht	Spr/Sum May/June						

The largest number of coinciding years between Hobart and The Netherlands, from 1868 to 1883, was in *S. niger* at both Slijk-Ewijk and Zaandam. These correlations were weak (R = 0.13 and -0.16, respectively) and also not significant (P > 0.2). Weak agreement also occurred within species in the Netherlands: for example in *S. niger* between Aardenburg and Varsseveld (R = 0.04) and *A. hippocastanum* between Aardenburg and Bovenkarspel (R = -0.19).

Interestingly, equally as strong or stronger correlations were found between the species. The strongest of these was between *F. excelsior* in Hobart and *R. pseudoacacia* in Oostkapelle (R = 0.92, P = 0.009), however, it was a limited time period (1869 and 1876). This does, however, give rise to the possibly of using surrogate species for current monitoring and/or the development of an index for comparison (Amano et al. 2010; Schwartz et al. 2013). The advantage of an index is that it can overcome the paucity of data in both hemispheres (e.g. Keatley; Fletcher 2003; Keatley; Hudson 2010; Miller-Rushing et al. 2006) possibly account for the variation in phenotypic plasticity and different species. Figure 2 illustrates this with similar anomaly years identified.

4. CONCLUSIONS

This limited examination of phenological phases across the two hemispheres has not provided a clear answer on whether the current differences are attributable to climate or species sensitivity or a combination of both. The reasons for this could be differences in interpretation of phases, the limited number of coinciding years, phenological plasticity or regional adaptive differences. Hence further exploration such as the examination of commonality of growing degree days of these data as well as locating legacy datasets with greater overlapping periods are needed to provide a clear answer. However, the development of phenological indices has also been highlighted as alternative option.

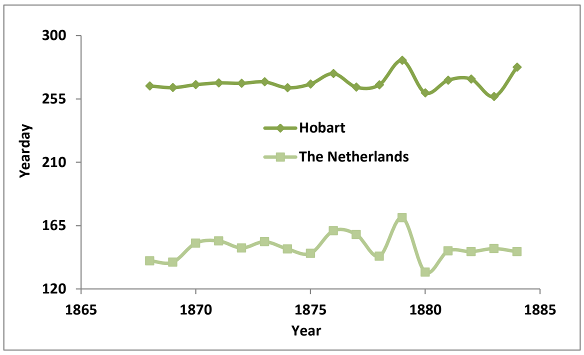

Fig 2: Mean leafing of all Dutch locations and 11 species in Hobart. Note similar anomaly years: 1879, 1880.

5. ACKNOWLEDGEMENTS

This study would not have been possible without the pep725 database.

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