



## **Applicability of flowering onset time series for a proxy of temperatures based on long-term Transylvanian phenological observations in the 19th century**

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Eco-climatological studies often refer that plant phenophases are strongly influenced by temperature thus these variables might be used as proxy in climate reconstructions. In the present study, we have investigated the first flowering response of numerous plant species given to the interannual fluctuation of seasonal temperatures (i.e. heat sensitivity of the phenophase), also the degree of these species-specific sensitivities in order to test their applicability as proxy.

The analyses were accomplished using flowering onset data recorded in the 19th century to get a reference time series without any influence of recent anthropogenic warming on local climate conditions. From the few available data sources in the Carpathian Basin during the 19th century, relatively long (period: 1851-1891) first flowering data sets of 16 wild plants and time series of ambient temperatures recorded in a locality (site: Hermannstadt) were selected for the analyses. From the 20th century, average regional flowering time series (1961-1997) were used for comparison of characteristics in case of the same plant species.

The aim of the present study is to address the following issues using different statistical methods (e.g., trend analysis, cross-correlation function, regression analysis): (i) the effect of mean monthly, bi-monthly, tri-monthly temperatures on first flowerings using a 'moving-window' technique (Teff) was estimated; (ii) the temporal shifts of first flowering as a response to a unit change of Teff were calculated. Furthermore (iii) the species ranking on the basis of the temperature sensitivity of flowering onsets; (iv) the accuracy of proxy estimations were determined.

Heat sensitivities of observed plants to the effective temperatures were different. To mean temperatures of all investigated time periods 7 plant species as 'thermal indicators' expressed the strongest response: *Tussilago farfara*, *Salix fragilis*, *Syringa vulgaris*, *Robinia pseudoacacia*, *Scilla bifolia*, *Euonymus europaeus*, and *Vitis vinifera*. On the base of these characteristics the selected plant species were ranked to use for proxy test. Using the first flowering data as proxy for different effective temperatures the accuracy of estimation was between 1.0 °C and 1.5 °C. Furthermore, significant differences were found between effective temperatures of the same plant species for the 19th and the 20th century.