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Research paper

# The minimum temperature for budburst in *Betula* depends on the state of dormancy

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Vegis has put forward the theory that the range of growth-promoting temperatures changes during the induction and the release of dormancy. We have tested the response of buds of *Betula pubescens* Ehrh. and *B. pendula* Roth. on temperature during the induction and release of dormancy. *Betula* seedlings were exposed to dormancy-inducing high-temperature and short-day conditions and subsequently to dormancy-releasing chilling conditions in darkness. To monitor the dormancy status of the seedlings, subsets of them were transferred to five forcing temperatures and their budburst was observed. The results show that the expression of dormancy was temperature dependent, so that the minimum temperature for 100% budburst rose during the induction and dropped during the release of dormancy. These responses may explain previous contradictions between experimental and modelling studies, but that needs to be verified with more extensive experiments, some of which are identified in this study. The results provide further evidence for the concept of gradual change in bud dormancy. They also suggest that global change studies modelling budburst phenology should address the changing expression of bud dormancy.

***Keywords***: *Betula pendula*, *Betula pubescens*, bud dormancy, chilling, phenology modelling.

## Introduction

In boreal and temperate tree species, the regulation of the annual cycle of growth and dormancy is of great significance for growth and survival under the northern climatic conditions (Perry 1971, Fuchigami et al. 1982). The main environmental cues for this regulation are photoperiod and air temperature (Hänninen and Tanino 2011). In species with a free growth pattern, the cessation of growth and induction of dormancy are caused by short photoperiods (SD) in the autumn (Dormling et al. 1968, Håbjørg 1972, Heide 1974, Junttila 1976). In seedlings of *Betula*, both the induction rate of bud dormancy and the depth of the dormancy are enhanced by high as opposed to low temperatures during the SD period (Junttila et al. 2003, Heide 2003). Similar results have been reported for other species as well (Dormling et al. 1968, Jonkers 1979, Westergaard and Nymann Eriksen 1997, Søgaard et al. 2008, Granhus et al. 2009). Recent studies with *Populus* have shown that day and night temperatures may have different functions, i.e., the day temperature influences the induction rate of dormancy while the night temperature affects the cessation of growth and the depth of dormancy (Kalcsits et al. 2009, Tanino et al. 2010). Further, temperature modifies the sensitivity to day-length signals at growth cessation and influences the duration of bud formation in poplar (Rohde et al. 2011).

Bud dormancy is released by an exposure to chilling temperatures in late autumn and early winter (Worrall and Mergen 1967, Sarvas 1974, Leinonen 1996). In most northern species, including *Betula*, a relatively short chilling period is sufficient to obtain 100% budburst, but extended chilling results in reduction of the time to budburst (Heide 1993, Junttila et al. 2003). After the chilling requirement has been met, the timing of