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Heat or humidity, which triggers tree phenology?

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An overwhelming number of studies confirm that temperature is the main driver for phenological events such as leafing, flowering or fruit ripening, which was first discovered by Réaumur in 1735. Since then, several additional factors which influence onset dates have been identified, such as length of the chilling period, photoperiod, temperature of the previous autumn, nutrient availability, precipitation, sunshine and genetics (local adaptations). Those are supposed to capture some of the remaining, unexplained variance. But our ability to predict onset dates remains imprecise, and our understanding of how plants sense temperature is vague.

From a climate chamber experiment on cuttings of 9 tree species we present evidence that air humidity is an important, but previously overlooked, factor influencing the spring phenology of trees. The date of median leaf unfolding was 7 days earlier at 90% relative humidity compared to 40% relative humidity. A second experiment with cuttings shows that water uptake by above-ground tissue might be involved in the phenological development of trees. A third climate chamber experiment suggests that winter dormancy and chilling might be linked to dehydration processes. Analysis of climate data from several meteorological stations across Germany proves that the increase in air humidity after winter is a reliable signal of spring, i.e. less variable or susceptible to reversal compared to temperature. Finally, an analysis of long-term phenology data reveals that absolute air humidity can even be used as a reliable predictor of leafing dates. Current experimental work tries to elucidate the involved foliar uptake processes by using deuterium oxide marked water and Raman spectroscopy.

We propose a new framework, wherein plants′ chilling requirements and frost tolerance might be attributed to desiccation processes, while spring development is linked to re-humidification of plant tissue. The influence of air humidity on the spring phenology of temperate trees should improve phenological models, and help to design more realistic warming experiments. It should equally encourage physiological research to reappraise knowledge on temperature sensors in plants.