



Historical climates explain contrasting dormancy-breaking requirements in North American, Asian, and European woody species

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Leaf-out times in temperate woody species are determined by winter chilling and spring warming, with day length playing a minor role. The species-specific relative importance of these phenological cues determines the sensitivity of leaf unfolding to climate warming in the globe's temperate forests. Using experimental and monitoring data on leaf-out cues in 495 woody species [about 1/3rd each from Asia, Europe, and North America (NA)], we show that NA species have higher winter chilling and spring warming requirements than do European and Asian species of similar genetic stock. The continent effect remained significant when controlling for the modern climates that species are adapted to, suggesting that contrasting historic climate conditions led to the differentiation of leaf-out strategies among NA, European, and Asian plants. The NA flora experienced more and longer periods of climatic instability and harshness (esp. since the Pliocene) than did southern Europe and East Asia, which may explain why NA species have higher dormancy requirements and leaf-out later than Asian species, which are characterized by a more shallow dormancy. That species from Asia require significantly less chilling than their NA relatives suggests contrasting responses of NA and Asian temperate forests to continued climate warming. Earlier leaf-out in NA trees and shrubs will be constrained by unmet chilling requirements as winters get warmer, whereas Asian woody species generally lack such temperature limitations.