南北气候梯度导致树木休眠解除的适应性变化

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摘 要：【目的】全球变暖正在对全球植物物候和活力产生前所未有的影响，可能导致食物网、碳、水循环和生态系统功能发生重大变化。前期对温带树木中的广泛研究表明，主要是秋末和冬季的低温(chilling)、冬末和春季的高温(forcing)和光周期驱动植物的春季物候，但这些因素很少在亚热带森林中得到研究，因此它们的潜在影响相对未知，并且亚热带树种和温带树种的具体差异也尚不明确。同时，目前对于相关内容在地理和气候梯度上的种间变异了解甚少。【方法】本研究通过分析中国长期的温度数据记录，研究了中国 20°至 55°经度范围内，植物休眠解除的低温效应的差异。主要是通过对中国 5968 个地点 1951-2019 年的网格温度数据（0.25°×0.25°）进行气候生态计算。并基于计算结果我们提出了相关假设：植物的低温累积上限随着纬度的升高在不断下降，即低纬度地区树种的低温累积上限阈值是高于高纬度地区的。随后，我们通过 1）4 个气候带总计 14 个树种的低温转移试验，2）6 个中国树种的物候观测历史记录以及 3）NDVI 数据来检验我们的假设。【结果】上述的三块内容均验证了我们基于历史温度数据分析提出的假设：南北气候梯度导致树木休眠解除的适应性变化。【结论】我们的研究结果表明，在不同气候梯度的物种间的差异是理解植物生理休眠和低温需求的适应意义，可以为评估树木对气候变化响应提供参考依据。

关键词：植物物候；生理休眠；休眠解除；纬度梯度；适应性变化

Abstract:【Objective】Global warming is having unprecedented effects on plant phenology and vigor worldwide, potentially leading to major changes in food webs, carbon and water cycles, and ecosystem function. Extensive previous research in temperate trees has shown that cold temperatures (chilling) in late fall and winter, high temperatures (forcing) in late winter and spring, and photoperiod drive spring phenology in plants, but these factors have rarely been studied in subtropical forests, so their potential impacts are relatively unknown, and the specific differences between subtropical and temperate species are not yet clear. At the same time, little is known about interspecific variation in related elements across geographic and climatic gradients. 【Method】In this study, we investigated the differences in low-temperature effects of plant dormancy lifting over the longitudinal range of 20° to 55° in China by analyzing long-term temperature data records in China. Mainly, we performed climate-ecological calculations by gridded temperature data (0.25° × 0.25°) from 1951-2019 at 5968 locations in China. And based on the calculation results, we proposed the relevant hypothesis: the upper limit of low temperature accumulation of

plants decreases with increasing latitude, i.e., the upper threshold of low temperature accumulation of tree species[3] at low latitude is higher than that at high latitude. We then tested our hypothesis using 1) chilling-forcing transfer experiments for a total of 14 tree species in four climatic zones, 2) historical records of climate observations for six Chinese tree species, and 3) NDVI data. 【Result】All the results confirm our hypothesis, based on analysis of historical temperature data, that the north-south climatic gradient leads to adaptive changes in tree dormancy. 【Conclusion】Our results suggest that differences among species across climatic gradients have adaptive implications for understanding plant physiological dormancy and low-temperature requirements, and could inform the assessment of tree responses to climate change..

Key words: Plant phenology; endodormancy; dormancy release; latitudinal gradient; adaptive change.

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