Large-tree growth follows a unimodal cascading pattern under the combined effect of allometric scaling and growth plasticity

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Abstract

Abstract: The continuously increasing trend of large-tree growth challenges the assertion of the unimodal pattern in classical growth theories. Here, we considered the effect of changes in functional traits on growth and extended classical growth equations (i.e., Gompertz and logistic curves) to reconcile this contradiction. We speculated that under the combined effect of allometric scaling and growth plasticity, tree growth trajectories likely follow different unimodal curves before and after different stages, showing a cascade characteristic. The increasing growth trend may be related to the appearance of a larger-scale unimodal curve in the late stage of growth, which depends on some changes in functional traits relative to tree size. To test this hypothesis, we measured tree growth in four plots across the subalpine Abies fabri forest belt on Gongga Mountain in the eastern Tibetan Plateau of China, and then analyzed the relationship of tree growth with important functional traits (i.e., leaf and stem economics and morphological traits). Our results indicate that the ideal and average growth dynamics of Abies fabri follow a unimodal curve with a cascade characteristic. On the individual-scale, cascading growth is more obvious, where the length and height of unimodal curves both increase with tree size, but may be still constrained by hydraulic constraints and tree longevity. This makes sense, because as trees grow, there is an increase in the relative volume of the crown and a decrease in the relative amount of sapwood, resulting in greater carbon accumulation. The results of this study imply the potential for significant improved carbon sequestration capacity of large trees in the later growth period. This model also offers a practical way to link traits and growth performance.

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