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

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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 phenotypic plasticity on growth and extended classical growth equations (i.e., Gompertz and logistic curves) to reconcile this contradiction. Tree growth is indeterminate and modular, and we speculated that a trajectory of tree growth should be viewed as a combination of a series of different unimodal curves, termed cascading growth. Mathematically, the increasing growth trend may be attributable to the later emergence of larger-scale unimodal curves, which depend on some beneficial change of functional traits relative to tree size. To test this hypothesis, we determined 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 effects of some important functional traits (i.e., leaf and stem economics and morphological traits) on the growth curve. Our results indicate that the ideal growth trajectory that is composed of the maximum growth increment of different trees follow a unimodal curve with a cascade characteristic. At individual levels, the emergence of a larger unimodal curve is caused by an increase in the relative amount of canopy and a decrease in the relative amount of sapwood. This study clarifies the general growth rule of large trees, offers a concise way to link traits and growth performance, and reveals the complexity and sustainability of a old forest acting as a carbon sink to some extend.

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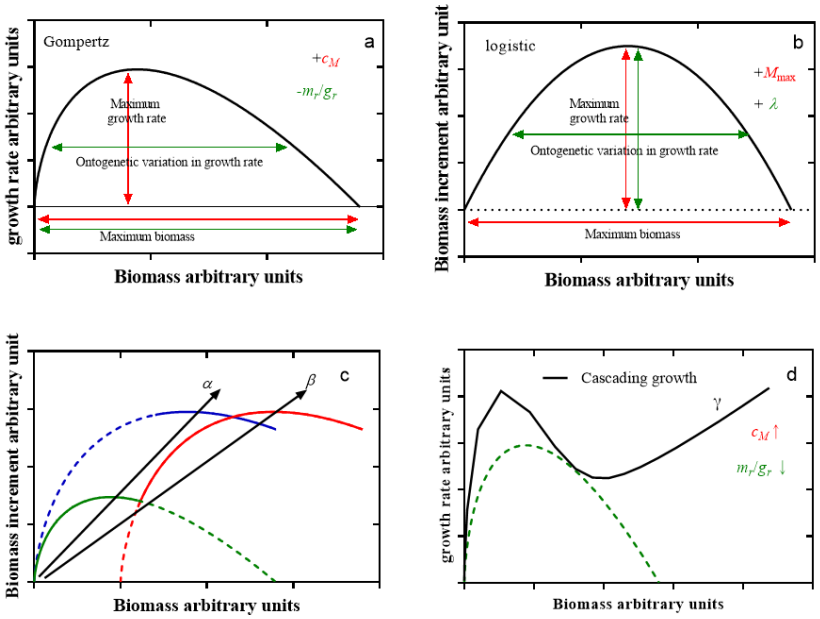

Fig. 1

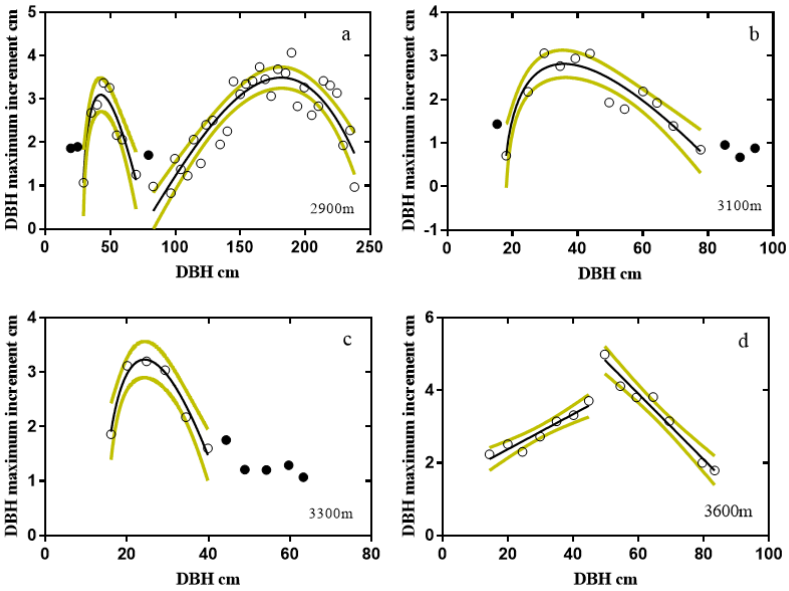

Fig. 2

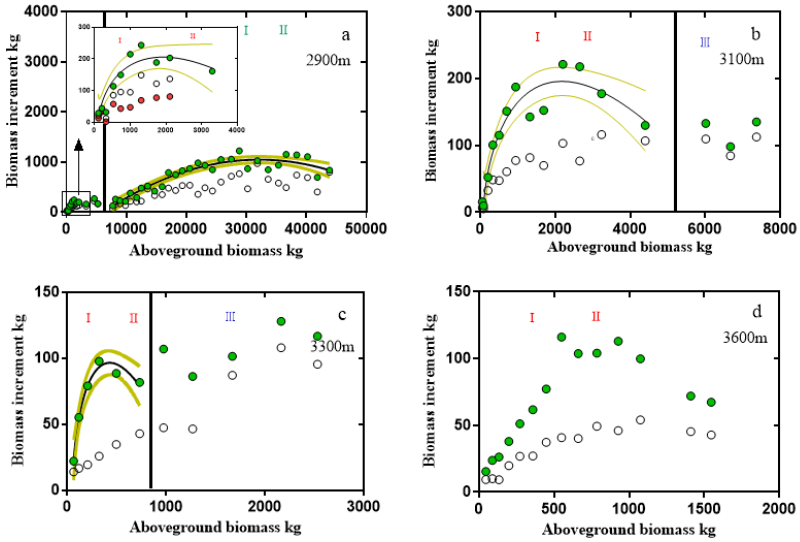

Fig. 3

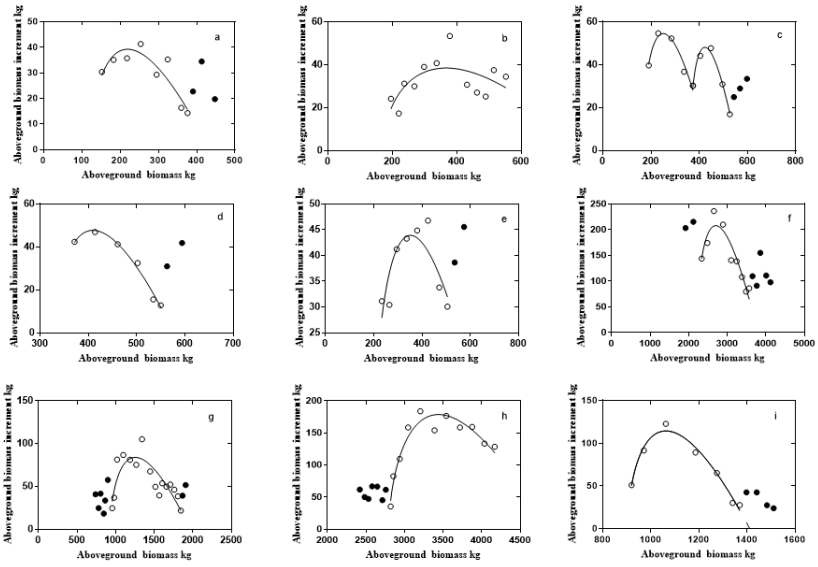

Fig. 4

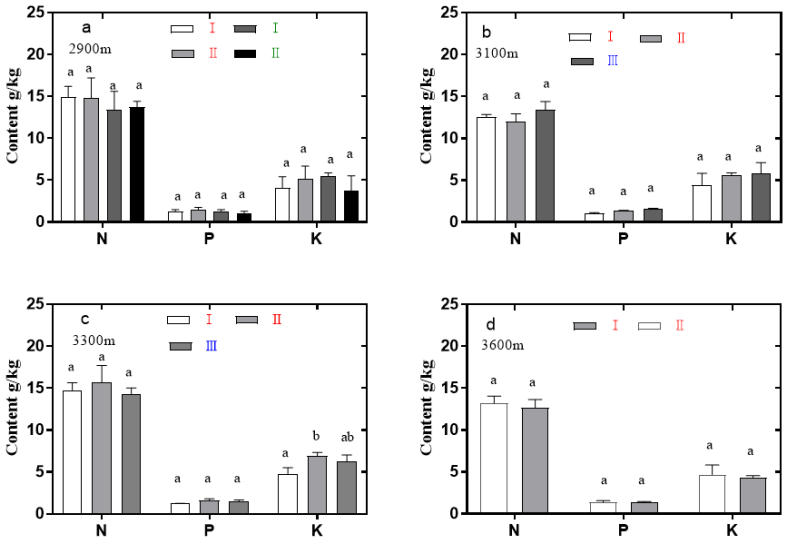

Fig. 5

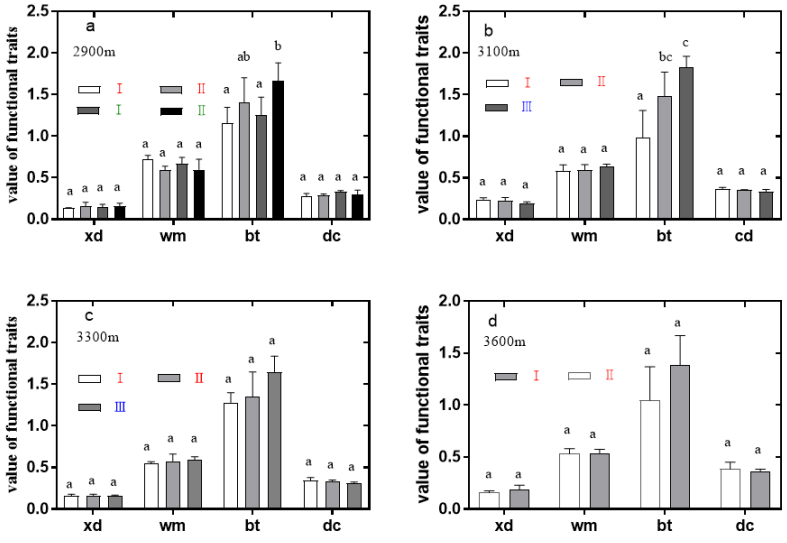

Fig. 6

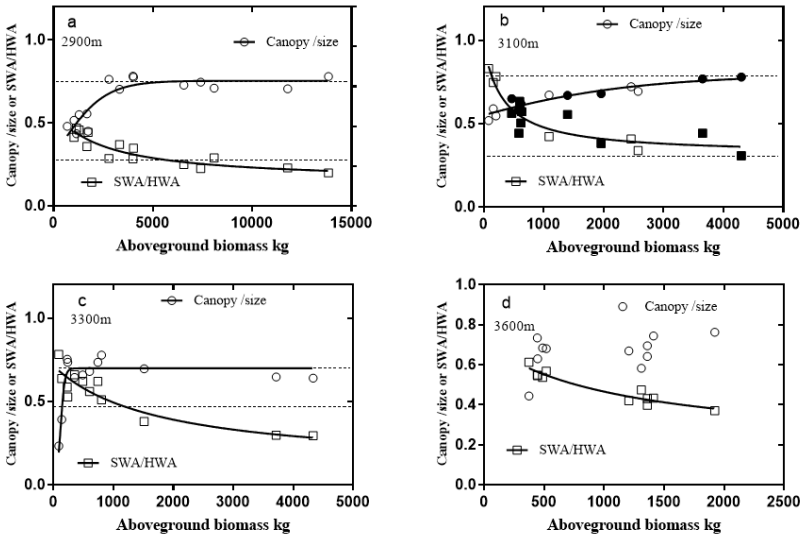

Fig. 7

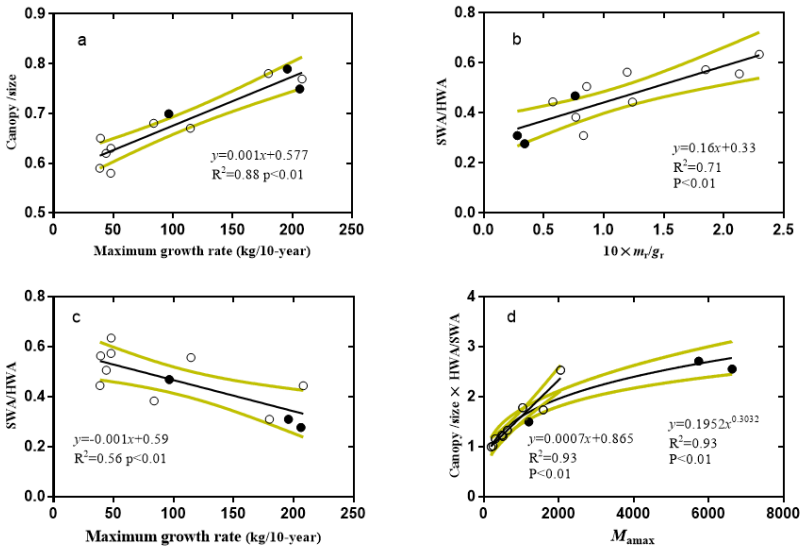

Fig. 8