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Evolution of tree architecture

The astounding biodiversity of the Earth's ecosystems is the outcome of competition, cooperation, and migration among species and within-species varieties. The potential for frequency-dependent selection to shape these biodiversity patterns is easily appreciated in plants, where height-asymmetric competition for light has not only driven the evolution of tall trees, but is also responsible for their coexistence with smaller plants. Less is known, however, of how frequency-dependent competition for light has affected other salient aspects of plant architecture. Here, we present a trait-, size-, and patch-structured model of vegetation dynamics to study the evolution of tree-crown architecture. Our study extends a related model by Falster et al. (2011), by incorporating self-shading within tree crowns and a more detailed representation of biomass-allocation to branches. Tree-crown architecture is described by two individual-level traits for crown shape and crown width. Three scenarios are investigated and contrasted for different combinations of sun angle, site productivity, and disturbance frequency. First, we consider optimal tree-crown architectures for solitary trees growing apart from competing trees. Second, we ask the same question for a monoculture of identical trees subject to density-dependent growth. Third, we investigate the coevolution of tree-crown shape and tree-crown width under competition and for potentially polymorphic traits, and determine the resultant evolutionarily stable state. Finally, we critically reassess the common belief that a low sun angle is a main force driving the conical tree-crown architectures observed in boreal forests.

References

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