Gravitropism plays a key role in the diversity of tree ecological strategies at the advance regeneration stage. A case study in the French Guiana tropical rainforest.

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Abstract

Gravitropism is a major process in vertical growth as it allows the positioning of plant in the gravity field and thus, for trees, it takes part in the light foraging strategies. Without any gravitropism, trees would adopt a weeping habit or fall on the ground due to the increasing with growth supported weight, especially at the advance regeneration stage (sapling stage) in the understorey, where tree are very slender and poorly stiff. Most of the gravitropic studies are made by physiologists in order to understand the process and thus are associated to complex laboratory methods (genetic engineering, anatomical studies, accurate 2D ou 3D measurements of form changes with time). In order to study the ecological relevance and the specific diversity of gravitropic performances in natural forests, we developed a framework that uses different kinds of datas. Synchronical analysis has been done i) at the population level in large sample of trees and ii) at the tree level from destructive measurement of the dissymmetry maturation strains known to be the main motor of the posture control reaction of trees. In both cases, biomechanical models allows to estimate some aspects of the dynamic gravitropic process. Diachronical analysis has been done in natural conditions on permanent plots, or in a more traditional way, by observing in greenhouse experiments the righting movements of plants artificially tilted. In the first case, the problem is the high variability of natural disturbances and the slowness of growth and movements in the dark understorey. The second choice allows a measurement of a capacity (i.e. the ability of the species to react in quite extreme conditions of verticality disturbance but good for growth light and nutrient conditions) that is more easy to analyse, but is maybe not so relevant for estimating the ecological strategy (some species could have developed a high efficience of gravitropic reaction in natural conditions by avoiding the mechanical disturbance or adapting the reaction to slow growth and changing environments in natural conditions). All approaches use the same basic biomechanical modelling, i) to analyse simultaneously the reaction and the disturbance (due to the weight increase) during growth, or ii) to combine different parameters (geometry, growth, weight, maturation strains) involved in shape changes and posture control. They give a classification of the species according to their gravitropic performances. Results on 15 species are discussed, with relation to shade-tolerance or avoidance.