A fitness model combining the structural and functional modular attributes in a Mediterranean perennial shrub, Retama sphaerocarpa (L.) Boiss

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The consideration of a plant as a system of iterative units organised at different hierarchical levels allows one the simulation of the within-individual modular dynamics from the knowledge of the structure (module length, bud density, etc) and functioning (bud fate, shoot mortality, developmental strategy, etc.) of the modules within the individual plant and, therefore, permits to analyze its consequences on the fitness of the plant.

R. sphaerocarpa plants have a very simple modular structure. The terminal shoot constitutes the basic unit of annual growth. In a year t, the terminal shoots produce flowers from their axillary lateral buds and new shoots and/or flowers from their axillary basal buds. The new shoots of first branching order can support second- and third-order new shoots. In the following growth period, those new shoots in a terminal position will behave as new terminal shoots in the year t+1.

In this work we develop a plant fitness model based on a hierarchical modular construction, as a tool for analyzing the behavior of plant fitness in response to variations in the modular dynamics within the plant. A modular growth model combining structural and functional attributes of plant modules at different levels of the hierarchical modular organization is developed for predictions on a range of several years.

Empirical data for the model were obtained from several previous investigations

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on R. Sphaerocarpa which focused on the analysis of fitness taking into account different aspects of the modular organization of the plant. The model and the simulations are implemented with the MATHEMATICA software.

An analysis of sensitivity is carried out to analyze the behavior of plant fitness (response variable) vs. variations in the different structural and functional parameters (causal variables) considered in this work. The analysis allows one to identify the critical points of the dynamics of modules within the plant.

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