A Novel Quantification of the Complex Geometries of Low Light Surviving Plants using Fractal Analysis to Investigate a Basis of a New and Unique Allometric Measure of Plants

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This study explored plant architecture and growth using a novel application of mathematical tools. Fractal analysis of plant architectures was performed to quantify and describe functional obligations of plants, photosynthesis in particular. The methods used for this study included a) the assimilation of various plant species' profiles from the USDA database, b) computation of fractal dimensions and derived measures and c) statistical analysis of these measures. Initial results from this study suggests that a) plants surviving in low light conditions have fractal dimensions within a characteristic range of 1.6 - 1.85, suggesting that the fractal dimension strongly reflects a branching and photosynthesis strategy to maximize available light for energy production. b) Plants exhibit distinct fractal geometries at the leaf level and the whole plant level. The fractal dimensions of the plant (FDP), the leaf (FDL) and the ratio of the two (FDR=FDL/FDP) may serve as numeric descriptors of the photosynthesis strategy of related plants, suggesting its use as a new taxonomic descriptor. c) This study also suggests that there is a correlation between the fractal dimensions and the metabolic demand of a plant and could help identify deviations from the expected metabolic demand predicted by its expected FDR values due to growth. d) The fractal measures including the fractal dimension ratio is potentially a new and useful allometric tool. This could aid in refining biomass calculations and in the estimation of carbon sequestration potential of plants, as current models may be overestimating these values.

Awards Won:

Third Award of $1,000