Fractal Fingerprinting: Utilizing the Fractal Dimension to Height Ratio of Leaf Venation Structure as a Novel Morphological Characteristic for Plant Taxonomy

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Despite the recent, and to some extent controversial, advent of plant classification by molecular methods, such as DNA barcoding, morphological characteristics (relating to a plant's physical and macroscopic structure) remain prominent tools among botanists and taxonomists, in part due to their greater accessibility and more readily observable features. This novel study introduces and assesses an additional morphological feature of a plant's leaf that can be used to help distinguish the standard species of a plant: the fractal dimension to height ratio of its venation structure (D/H). Over 970 leaves from specified plants were collected. Computer programs were developed by the author to extract the venation structures of leaves via edge detection, and to determine the leaf height (H) and the fractal dimension of the venation structure (D). Preliminary analysis of sample leaf collections from the same plant revealed a positive correlation between D and H, prompting the use of the D/H. This D/H value was found to not differ significantly between leaf samples taken from opposite sides of a plant, or between samples taken from different individuals of the same standard species ($p>0.05$). When comparing D/H values of samples taken from 10 different plant species, significant differences were observed in most (43 out of 45) comparisons, suggesting that the D/H value could be useful as an additional morphological characteristic to aid in taxonomy and plant classification. This method would be especially effective for classification applications where only the leaf of a plant is present, such as for plant fossil identification.

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