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Topological Phenotypes in Complex Leaf Venation Networks HENRIK RONELLENFITSCH, JANA LASSER, Max Planck Institute for Dynamics and Self-Organization, DOUGLAS DALY, New York Botanical Garden, ELENI KATIFORI, Max Planck Institute for Dynamics and Self-Organization — The leaves of vascular plants contain highly complex venation networks consisting of recursively nested, hierarchically organized loops. We analyze the topology of the venation of leaves from ca. 200 species belonging to ca. 10 families, defining topological metrics that quantify the hierarchical nestedness of the network cycles. We find that most of the venation variability can be described by a two dimensional phenotypic space, where one dimension consists of a linear combination of geometrical metrics and the other dimension of topological, previously uncharacterized metrics. We show how this new topological dimension in the phenotypic space significantly improves identification of leaves from fragments, by calculating a "leaf fingerprint" from the topology and geometry of the higher order veins. Further, we present a simple model suggesting that the topological phenotypic traits can be explained by noise effects and variations in the timing of higher order vein developmental events. This work opens the path to (a) new quantitative identification techniques for leaves which go beyond simple geometric traits such as vein density and (b) topological quantification of other planar or almost planar networks such as arterial vaculature in the neocortex and lung tissue.

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