

Environmental signals from leaves – a physiognomic analysis of European vegetation

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Summary

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- Leaf physiognomic traits vary predictably along climatic and environmental gradients. The relationships between leaf physiognomy and climate have been investigated on different continents, but so far an investigation based on European vegetation has been missing.
- A grid data set (0.5° × 0.5° latitude/longitude) has been compiled in order to determine spatial patterns of leaf physiognomy across Europe. Based on distribution maps of native European hardwoods, synthetic chorologic flora lists were compiled for all grid cells. Every synthetic chorologic flora was characterised by 25 leaf physiognomic traits and correlated with 16 climatic parameters.
- Clear spatial patterns of leaf physiognomy have been observed, which are statistically significant related to certain, temperature-related climate parameters. Transfer functions for several climatic parameters have been established, based on the observed relationships.
- The study provides evidence that synthetically generated floras represent a powerful tool for analysing spatial patterns of leaf physiognomy and their relationships to climate. The transfer functions from the European data set indicate slightly different relationships of leaf physiognomy and environment compared with results obtained from other continents.

Key words: environmental gradients, leaf physiognomy, spatial pattern, synthetic chorologic floras, transfer functions.

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Introduction

A central problem in plant ecological research is to identify environmental factors that may be affecting different aspects of plant physiology and morphology, from an individual cell up to complex ecosystems, and to understand in which ways all these parameters may interact during the evolution of ecosystems. Among other factors, physiognomic characteristics of the vegetation are considered to be determined by environmental factors such as climatic and edaphic conditions, and thus to be strongly adapted to their corresponding habitat. For example, vegetation types from regions of similar environmental conditions exhibit distinct physiognomic similarities, even if the individual taxa which comprise these vegetation types have completely different

phylogenetic histories. In contrast, there may be obvious differences in physiognomic patterns among vegetation types from different environments. Many environmental studies have analysed physiognomic characters of plants, for example growth and life form (e.g. Raunkiaer, 1907), tree architecture (e.g. Hallé *et al.*, 1978) and leaf physiognomy (e.g. Wolfe, 1993), or have combined different physiognomic characters to describe or classify vegetation (e.g. Webb, 1959; Vareschi, 1980).

Leaf physiognomy in particular can be regarded as an excellent tool for ecological studies because leaves, as the primary photosynthetic organs of a plant, have to be optimally adapted to environmental conditions, and thus react most sensitively to the environment. Besides the general botanic interest in leaf physiognomic studies resulting in a characterisation