

Towards a Mechanism for Eastern Deciduous Forest Mesophication: the Role of Litter Drying

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INTRODUCTION

Invasion of fire sensitive tree species into pyrogenic ecosystems may alter ecosystem attributes over time. Altered moisture dynamics via changes in litter composition may be an important component in the mesophication of deciduous forests in the eastern USA.

Objectives:

1. Quantify moisture dynamics of litter beds of 17 southeastern USA tree species and determine whether their moisture holding capacities group according to ecological pyrogenicity.
2. Determine if individual leaf morphology across all species controls moisture dynamics at the litter bed scale.

METHODS

Litter Collection

Litter was collected from 17 tree species that represented 2 ecological groups in the SE USA:

- Frequently burned upland species: *Pinus palustris*, *Quercus laevis*, *Q. falcata*, *Q. incana*, *Q. margaretta*, *Q. stellata*, and *Q. alba*
- Common invaders into fire-suppressed uplands: *Pinus taeda*, *Liquidambar styraciflua*, *Liriodendron tulipifera*, *Q. nigra*, *Q. virginiana*, and *Q. hemisphaerica*, *Magnolia grandiflora*, *Ilex opaca*, *Fagus grandifolia*, and *Acer rubrum*

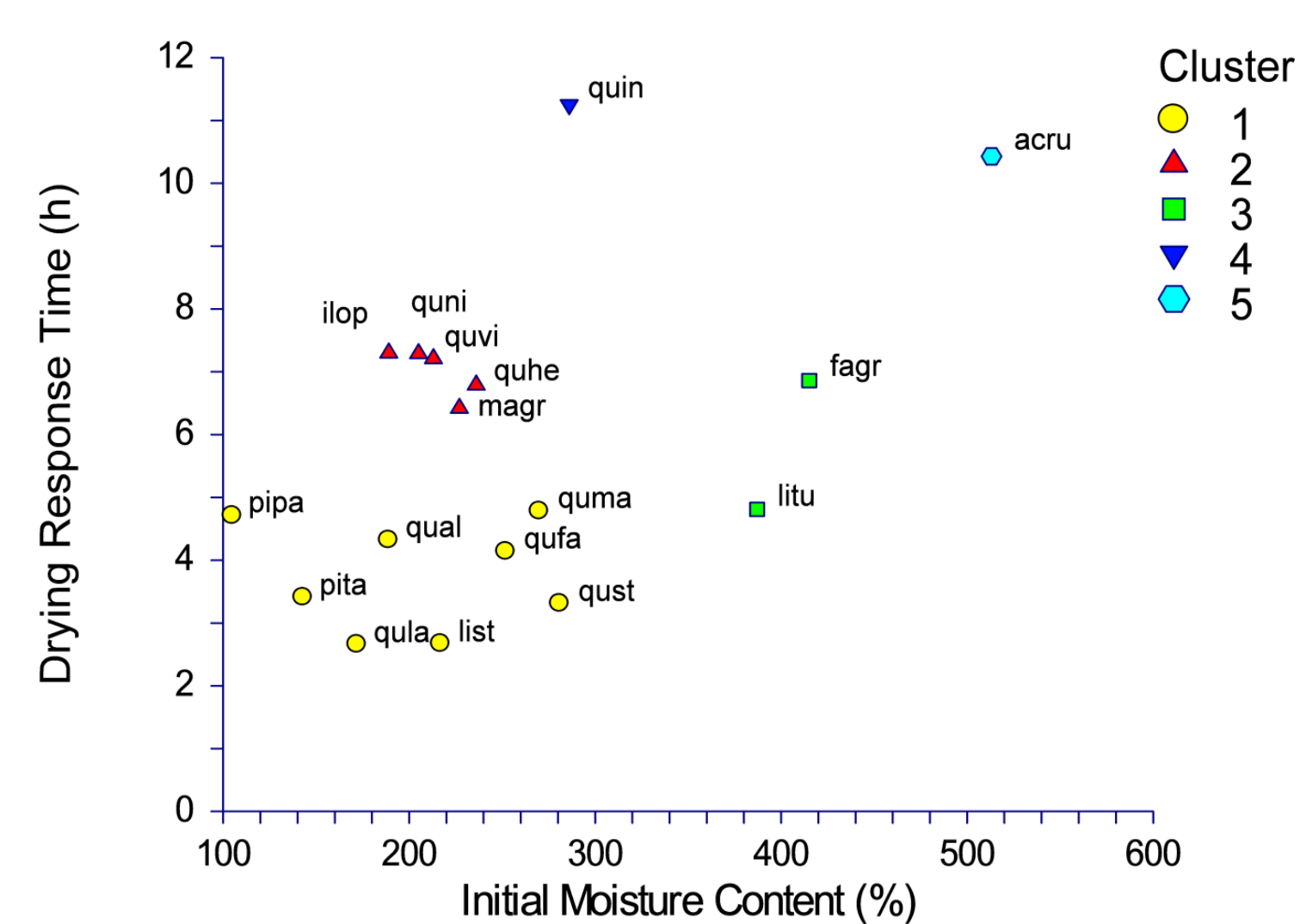
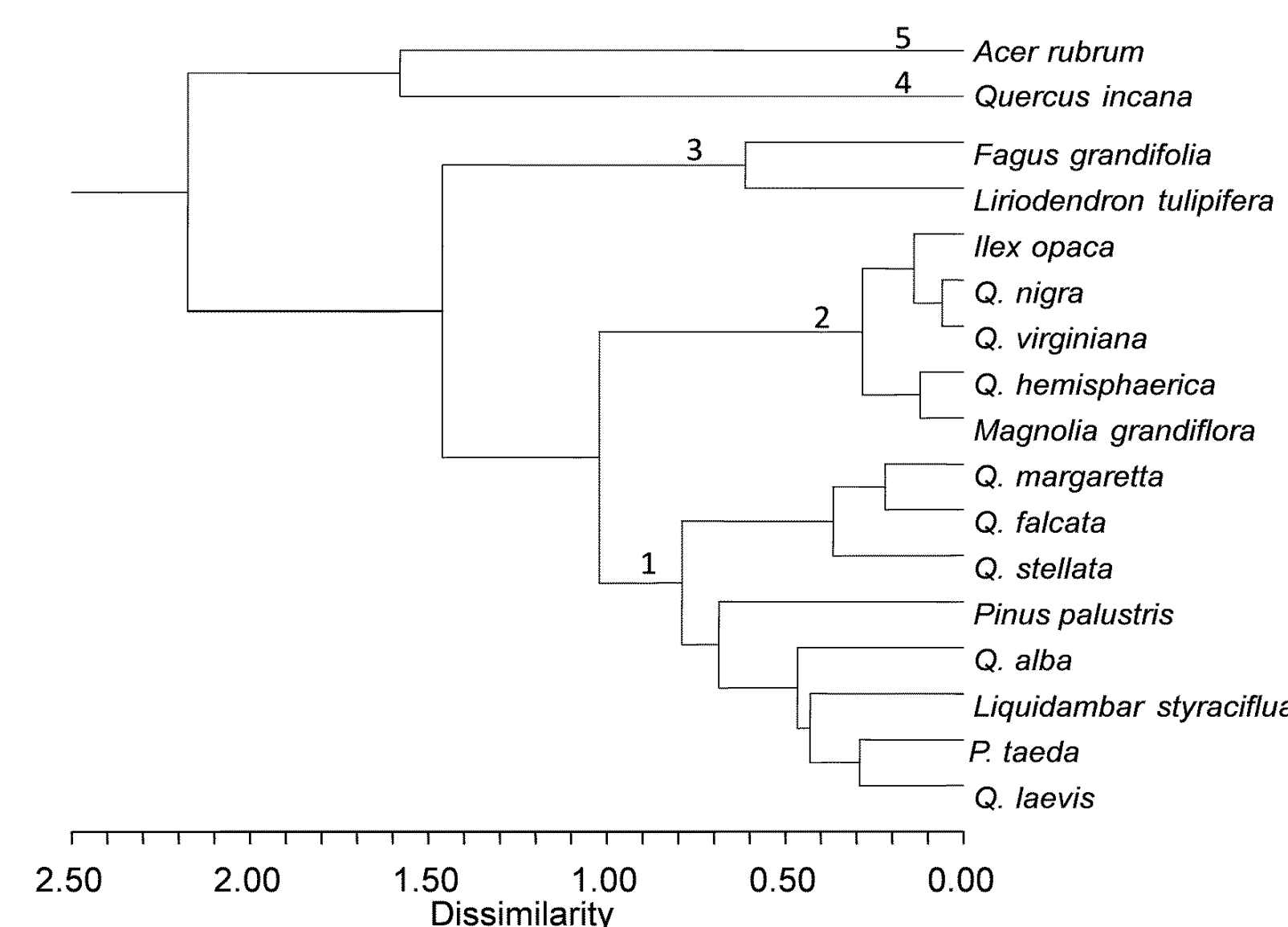
Laboratory Moisture Experiments

- 15g litter beds (N=4 per species) were water-bathed and total absorbed moisture content was determined.
- Drying response time (τ) was calculated for each fuelbed.
- Species were grouped according to absorbable moisture content and drying response time using cluster analysis.
- Leaf characteristics of broadleaved species were measured (N=7 leaves per species) and correlated characteristics were combined using principle component analysis (PCA).
 - Measured Leaf Characteristics: leaf curl, length, width, thickness, sinus depth, perimeter, surface area (SA), volume (V), SA:V, oven dry weight
- Total absorbed moisture content and drying response time were regressed against PCA factors of leaf characteristics.



Drying litter beds.

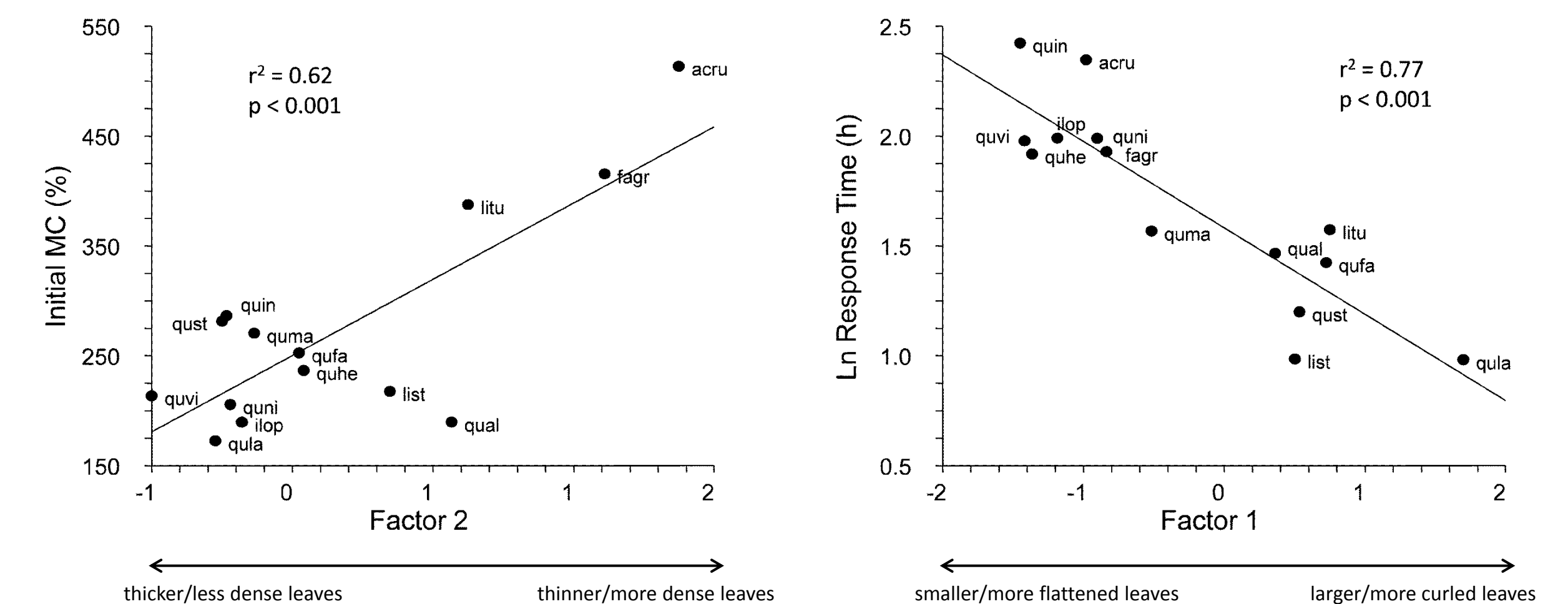
RESULTS



Species clustered into 5 groups according to their initial moisture content (absorption capacity) and drying rates.

Clusters

- 1 low absorption & fast drying
- 2 low absorption & moderate drying
- 3 high absorption & moderate drying
- 4 low absorption & slow drying
- 5 high absorption & slow drying



Absorption capacity was correlated with leaf density characteristics (Factor 2, left) while drying rates were correlated with leaf size characteristics (Factor 1, right) that including leaf curling.

PCA Factor Variables

Factor 1- leaf width, weight, volume, SA, sinus depth, curl, perimeter

Factor 2- leaf SA:V, density, thickness

Discussion

- Clustering of species by moisture retention capacity suggests that species level control over forest floor moisture dynamics may be an important aspect of stable state dynamics in fire dependent ecosystems.
- Larger leaved species had a higher propensity to curl and accelerated litter bed drying rates. These leaf characteristics likely influence litter drying potential via their impacts on fuelbed properties such as bulk density and porosity. Morphological traits within tree species may influence ecosystem level processes in a way that is important for their own perpetuation within the ecosystem.

CONCLUSIONS

Leaf litter from fire-sensitive tree species that invade pyrogenic uplands have a greater capacity to absorb and retain moisture than do the fire-resistant species that typified these frequently burned ecosystems.

Leaf-level morphology controls moisture dynamics across species, likely through its influence on fuelbed structure.

Evaluating the role of species composition on forest floor moisture dynamics in eastern USA forests may lend insight into the mesophication process implicated in shifting ecological stable states in historically fire-prone ecosystems.



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Key References:

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