Complex effects of habitat fragmentation on plant-soil-microbial interactions in Mediterranean Holm oak forests

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INTRODUCTION

Habitat fragmentation negatively impact biodiversity, although the consequences on ecosystem functioning (e.g. soil organic matter decomposition, enzymatic activity) are poorly understood. Furthermore, the impacts of habitat fragmentation on the ecosystem functioning will firstly depend on the environmental biotic and abiotic conditions of the remnant areas and the surrounding matrix, and secondly, on the size of resulting fragments because the smaller the fragment higher the influence of the matrix in which it is imbibed.

OBJECTIVES

(1) analyze the response of soil microbial functioning to the tree canopy cover and to the agricultural matrix where forest fragments were imbibed, and

(2) identify the role and relative importance of biotic and abiotic factors in soil microbial functioning, at a landscape scale.

MATERIAL & METHODS

Experimental design and sampling

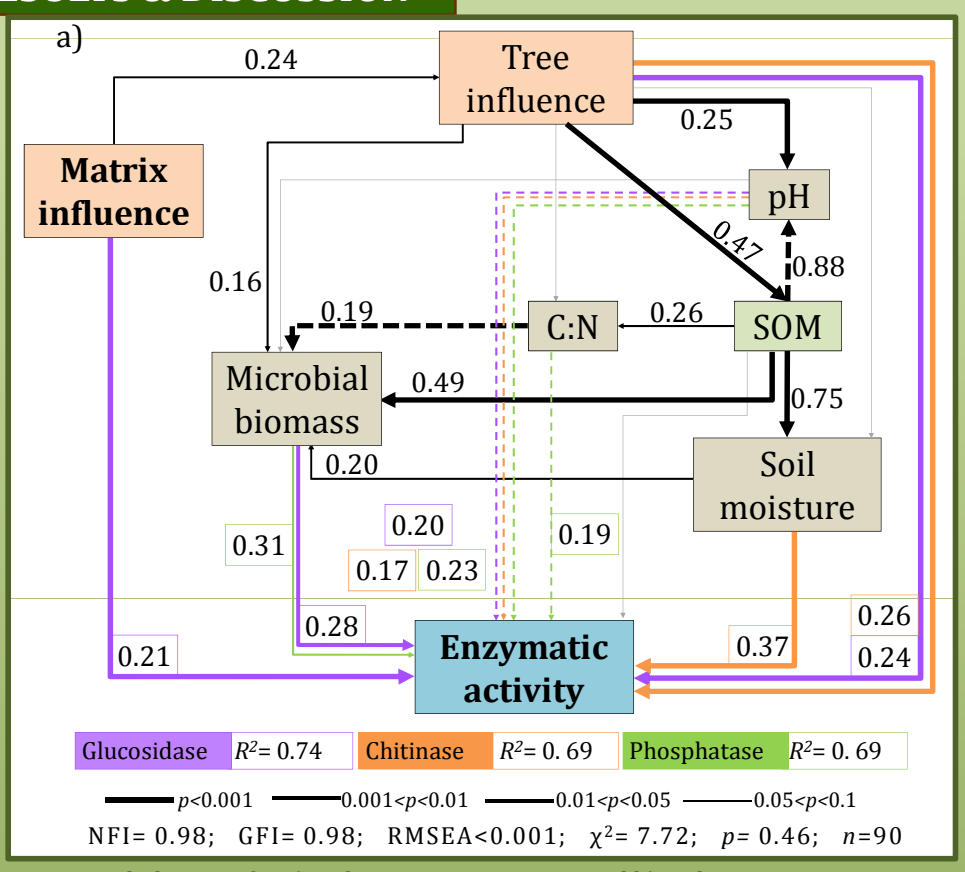
Two factors: matrix influence (low at interior of large fragments, medium at the edge of large fragments, and high at small fragments imbibed in the matrix; Fig. 1) and tree canopy cover (under tree canopy and adjacent open area). Total of 90 soil samples, half under the influence of 45 trees.

Variables: enzymatic activities (β-glucosidase, chitinase and phosphatase) and soil respiration; microbial biomass, soil moisture & temperature, organic matter (SOM), pH, C:N ratio. The factor tree cover was transformed in the new variable: Tree influence = tree basal area/distance to the tree.

Statistical analyses: ANOVAs, Pearson's correlations, structural equation models (SEM).

Fig. 1 Fragmented Mediterranean Holm oak forests in south-eastern Spain, with different agricultural matrix influence.

RESULTS & DISCUSSION



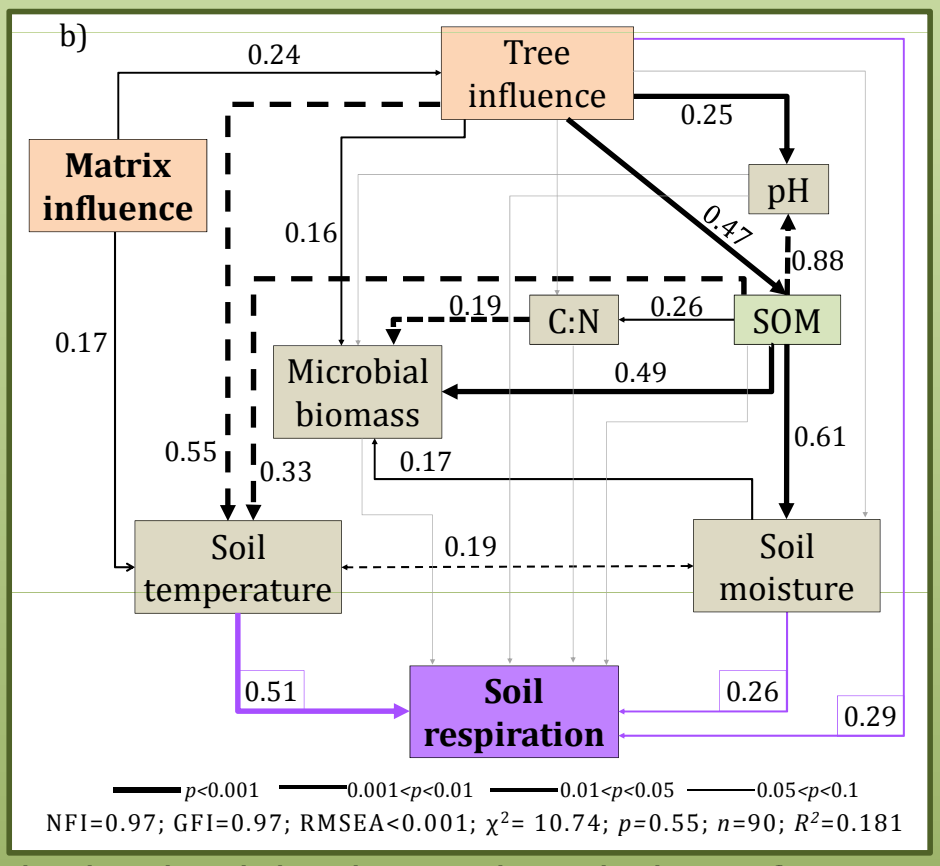


Fig. 2 Path diagram for a) soil enzymatic activities and b) soil respiration, representing hypothesized casual relationships among the agricultural matrix influence, tree influence and soil characteristics. Solid lines = positive effects, and dashed lines = negative effects, with standardized estimated regression weights indicated by numbers. Arrow's widths are proportional to significance values. Paths lines with coefficients non-significant, different from 0 ($p > 0.1$), are represented in grey.

The net effect of habitat fragmentation on soil enzymatic activities and respiration was dependent on its direct and indirect individual effects on soil characteristics, i.e. positively affecting the tree influence, which directly and positively influenced soil enzymatic activities (i.e. glucosidase and chitinase) (Fig. 2a) and respiration (Fig. 2b), and indirectly by increasing SOM, soil moisture and decreasing soil temperature and pH, raising the amount of microbial biomass and, therefore, enhancing soil functioning.

The main factor controlling soil enzymatic activities and respiration was the amount of organic matter (SOM), which in both cases exerted its influence indirectly through microbial biomass, pH, soil moisture, temperature and C:N ratio (Fig. 2).

CONCLUSIONS

Habitat fragmentation positively affects tree growth and productivity favoring SOM accumulation, in turn improving micro-environmental conditions for microbial activity.

Based on the higher enzymatic activity observed in the high agricultural matrix environments, forest fragmentation may favor C:N:P acquisition from SOM altering the ecosystem nutrient cycling, with unknown consequences in the long term.

Due to the important alterations that habitat fragmentation exerts on plant-soil-microbial interactions, it is necessary to incorporate them into global change predictions.

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