How different successional stages of *Abies pinsapo* Boiss. fir forest affect understory and soil microbial diversity?

Hinojosa, M.B.[1]; Quesada, J.[2]; Carreira, J.A.[2]; García-Ruiz, R.[2]; Griffiths, B.S.[1,3]; Daniell, T.J[1].
[1]EPI, SCRI, Invergowrie, Dundee, DD2 5DA UK. [2]Universidad de Jaén, Spain [3]Teagasc, JCRC, Ireland (current address)
Email: Belen.Hinojosa@scri.ac.uk

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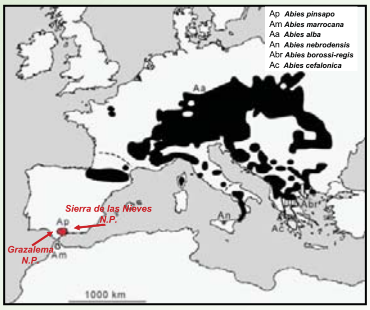
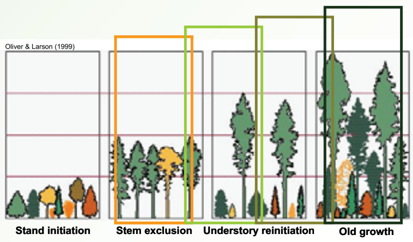
Background, Objective & Approach

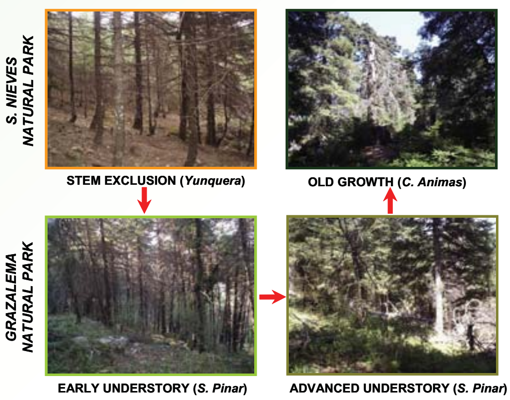
Along ecological succession, large changes in diversity and production occur in vegetation, and lead to the hypothesis that these changes should also affect structure of soil microbial community. However, this relationship between plant and soil microbial community structures could be minimized because they function with different time frames and posses different spatial scales of organization.

Abies pinsapo Boiss. fir forest was used as experimental model to test the relationship between plant and soil microbial community structure across different secondary successional stages.



A. pinsapo fir forest is a relict and endemic conifer forest, that growths in *Sierra de las Nieves* and *Grazalema* Natural Parks (Biosfere Reserves in Southern Spain). At higher altitude, it forms pure stands that resemble, in physiognomic terms, temperate-boreal conifer forests, despite being within a Mediterranean region.





Four *A. pinsapo* fir forest locations, with calcareous soil, representative of different successional stages were considered in our study (replicated with 3 plots per location).

	Stem exclusion	Early understory	Advance understory	Old Growth
% WHC	42.8	52.5	82.9	87.7
% total C	5.7	10.1	18.9	19.3
% total N	0.3	0.5	1.0	0.9
Nitrate (µg N g^{-1})	6.5	8	25.2	26.6
Ammonium (µg N g^{-1})	7.5	3.3	4.9	7.6
Phosphate (µg P g^{-1})	7.2	9.9	12.2	21.6

Table above: The pool of soil total C, total N, and available N and P increases along the forest succession.

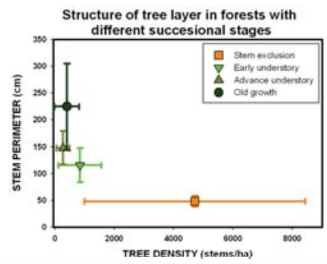
Main Results

Forest structure

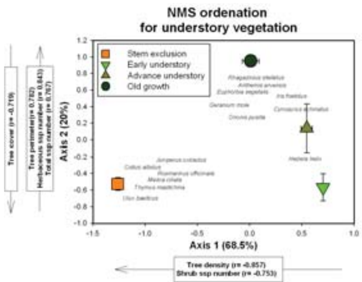
	Stem exclusion	Early understory	Advance understory	Old Growth
% tree cover	76.3±9.9 a	74.6±5.2 a	44.0±12.1 b	49.4±11.0 b
% sapling cover	2.2±2.1 a	3.8±6.5 a	17.1±7.2 b	42.1±9.2 b
% seedling cover	0.1±0.1	0.3±0.1	0.3±0.1	0.2±0.1

Cover values (mean± SD) of *Abies pinsapo* trees, sapling and seedling denoted an increase in the diversity of vertical structure with the maturity of the forest

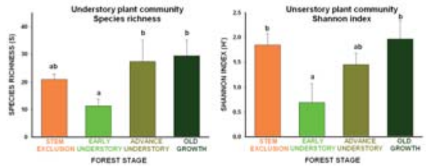
Figure to right: Stands in stem exclusion stage are dominated by trees with the lowest perimeter (one cohort) and the highest density. Old growth stands, with less density, are distinguished by having the largest trees but also trees with a wide range of perimeters (different cohorts). Stands in understory reinitiation phase have trees with and intermediate density and range of sizes.



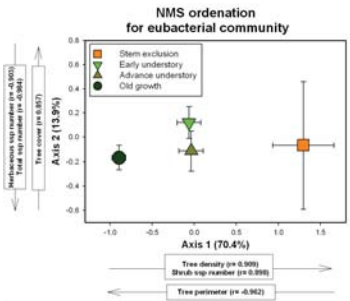
Understory plant community



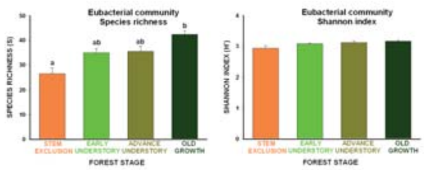
Multivariate ordination analysis of plant species (presence-absence) showed a clear shift in understory community composition along sucessional stages, from early understory to old growth (Axis 2). These changes were linked to a gradual increase in diversity. Interestingly, a strong differentiation of understory community in stem exclusion stage was found (Axis 1). It was mainly driven by a higher abundance of shrub species typical of Mediterranean climate, and not by a reduction in diversity.



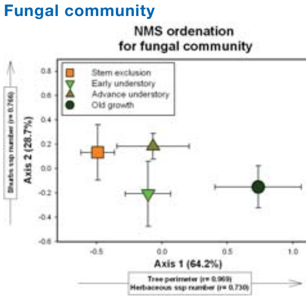
Eubacterial community



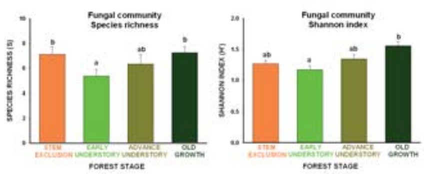
Soil eubacterial community structure (16S,T-RFLP) changes along different successional stages. These changes were associated with changes in species richness but not with differences in Shannon diversity index.



Fungal community



Shifts in soil fungal community structure (18S nuSSU, T-RFLP) were also evident along different successional stages (multivariate ordination analysis). However, changes in fungal diversity indexes followed a similar pattern that for understory plant community.



Conclusions

Each successional phase in *A. pinsapo* fir forest is accompanied by changes in stand structure, understory species composition and shifts in bacterial and fungal community structures.

A. pinsapo fir forests with a stem exclusion stage showed a relatively diverse understory plant community with high abundance of Mediterranean shrubs. This likely high diversity in the quality of vegetal debris probably drives a fungal community more diverse than it was expected.

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