Can tree rings be used to predict fungi production? A study case in Catalonian forests, NE Spain

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Climate plays a major role on the production and diversity of fungal communities. However, when investigating fungal production as related to climate and forest growth, clear trends and associations between these three components are rarely found.

The main objectives of this study were to determine the main **climate variables** influencing **seasonal wood formation** and **fungal productions**, and to analyse whether the production of mycorrhizal fungi is related to earlywood and latewood production.

- We used long inventories of mushroom production in Mediterranean forests dominated by four pine species in two areas located in Catalonia (NE Spain), representing mesic (Solsonès) and xeric (Prades) conditions (Fig. 1, Table 1).
- Two radial cores per tree (*n* = 10-15 trees per plot) were extracted in late 2014 and early 2015. Earlywood (EW) and latewood (LW) widths were separately measured.
- Mushroom production (fresh mass) and species richness were weekly inventoried from September to December in 10 m x 10 m plots. All epigeous ectomycorrhizal and non-ectomycorrhizal edible species were collected.
- Monthly climatic variables were obtained for the 1970-2014 period from the E-OBS gridded dataset (Haylock et al., 2008).
- Pearson and Spearman correlations were used to analyse the relationships between EW and LW series and mean annual mycorrhizal (MFY) and saprotrophic (SFY) fungi yield and monthly climate variables. Partial Spearman correlations between LW and MFY controlling for the main climatic and growth effects were performed.

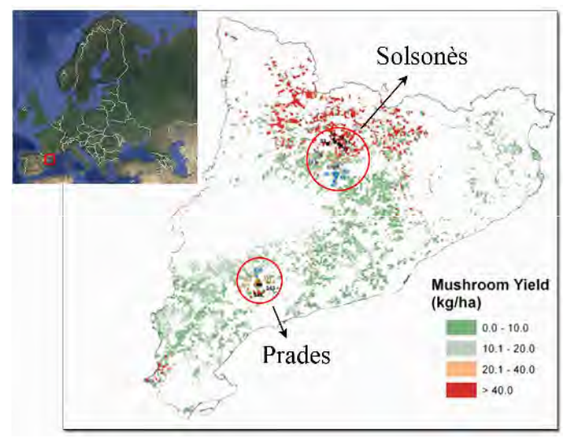

Fig. 1 Map of mean annual mushroom yields for Catalonia showing its location within Europe and the sampled sites in the Solsonès and the Prades study areas (Adapted from Bonet et al., 2014)

Table 1. Summary of mushroom yield data fresh weight (kg ha^{-1} yr^{-1}) in sampled plots. Ranges are given between parentheses.

Site	Pine species (code)	No. plots	Period of fungi data	Mushroom yield * MFY	Mushroom yield * SFY
Solsonès	*P. sylvestris* (PS)	5	1997-2001 2007-2014	79.1 (0 - 286.5)	2.4 (0 - 20.4)
	P. nigra (PN)	4	1997-2001 2007-2014	105.1 (0 - 472.7)	2.6 (0 - 21.4)
	P. halepensis (PH)	4	1997-2001 2007-2014	38 (0 - 281.2)	4.2 (0 - 63.6)
Prades	*P. sylvestris* (PS)	2	2008-2014	228.5 (0 - 551.2)	21.4 (0 - 87.3)
	P. pinaster (PP)	4	2008-2014	79.1 (0 - 450.7)	17.3 (0 - 81)

*Sampled plots corresponded to highly productive fungal areas. Total mushroom yields need to be considered with care inasmuch as they may not be necessarily representative of the expected productivity of a typical forest stand

MAIN RESULTS

- EW production was favoured by cold and wet climate conditions during previous fall and winter, and during current spring and summer. LW formation was enhanced by warm and humid conditions from spring to early fall.

Table 2. Spearman correlations between LW and MFY and partial correlations between LW and MFY controlling for cumulative precipitation from August to September (P) and EW.

Site	Pine	Plot	LW *vs.* MFY	Partial correlations: LW *vs.* MFY- P controlled	Partial correlations: LW *vs.* MFY- EW controlled
Solsonès	PS	29	0.37	0.33	0.09
		30	-0.07	-0.12	0.34
		31	0.07	-0.16	0.01
		32	-0.30	-0.37	-0.21
		33	0.15	0.06	0.31
	PN	8	0.21	0.14	0.52*
		9	0.47	0.48	0.31
		11	0.48	0.51	0.53*
		17	0.04	0.02	0.58*
		36	-0.41	-0.47	-0.25
	PH	40	0.19	0.19	0.32
		41	0.09	0.04	0.34
		42	0.40	0.43	0.63**
Prades	PS	343	0.04	-0.59	0.13
		344	0.43	-0.39	0.74*
	PP	301	0.64	0.07	0.69
		302	0.71	0.61	0.85***
		311	0.75*	0.85**	0.76**
		314	0.82*	0.79***	0.85***

Significance levels: *0.05<*P*≤0.1; **0.05<*P*≤0.01; ***0.01<*P*≤0.001

- Mushroom production was enhanced by wet late-summer and fall conditions, mainly in the most xeric area (Fig. 2).

The sensitivity of both LW production and mycorrhizal mushroom yields to the late growing-season water availability suggests that warmer and drier summer and fall conditions would lead to reduction in both variables in similar drought-prone forests

- Mycorrhizal fungi yield was positively related to latewood width in several study plots (Table 2).

Latewood formation may be **linked** to some extent with **fungal yields** in **drought-prone stands**

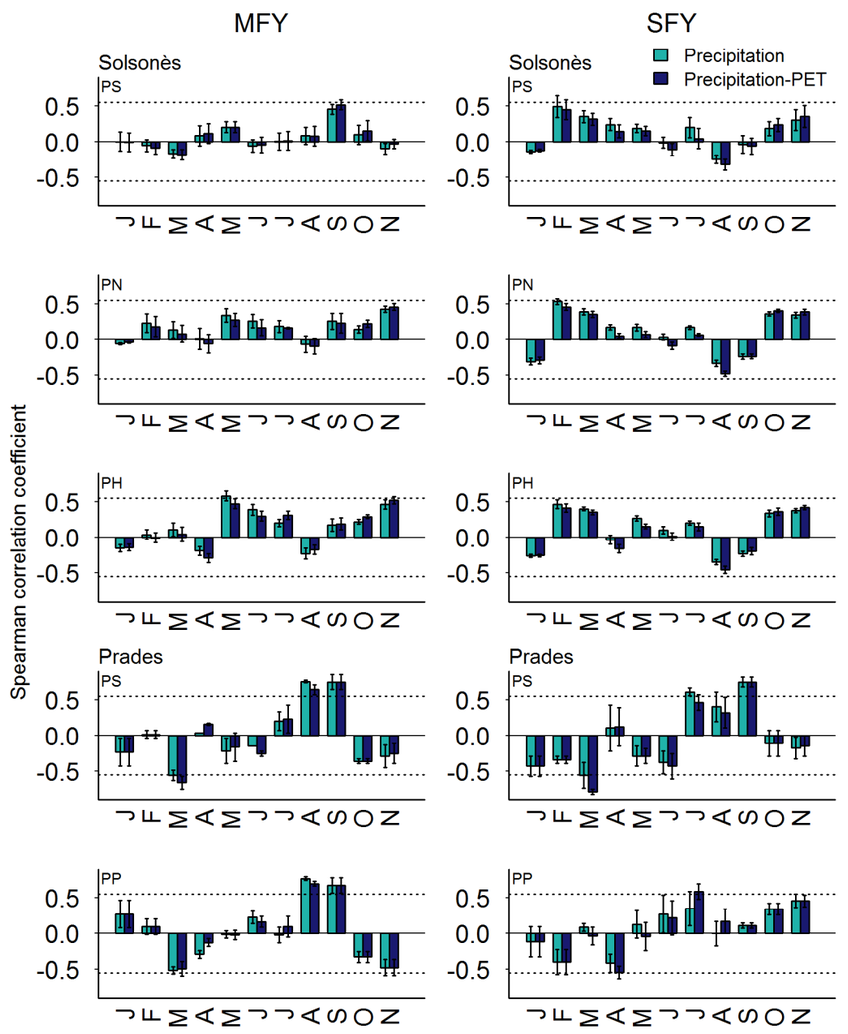

Fig. 2 Spearman coefficients between MFY and SFY and monthly precipitation and water balance (precipitation minus potential evapotranspiration, PET) variables for each tree species and sample site. Horizontal dashed lines represent *P* < 0.05 significance levels.

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