Pollen deposition in throughfall samples at sixty ICP Forests plots throughout Europe

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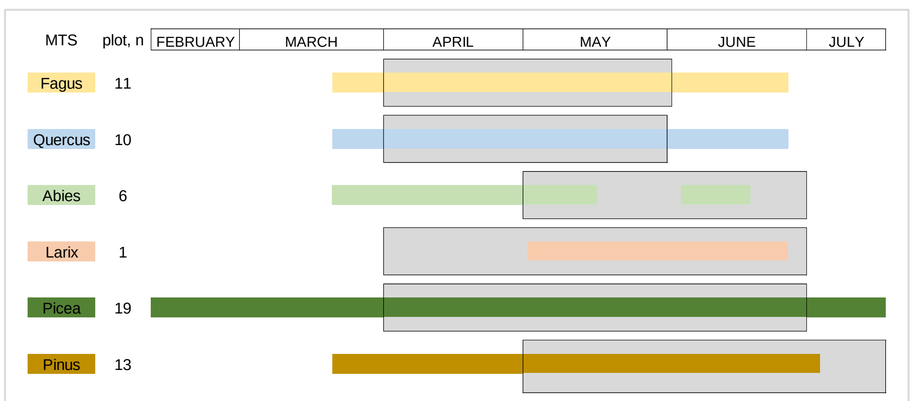
INTRODUCTION - Pollen released by plants in the atmosphere may have important impacts on human health and environment. Beyond seed plant reproduction, pollen can e.g. cause respiratory allergies, act as cloud condensation nuclei, be vector of microorganisms and nutrients (Hornick et al., 2021; *https://doi.org/10.1002/ppp3.10234*).

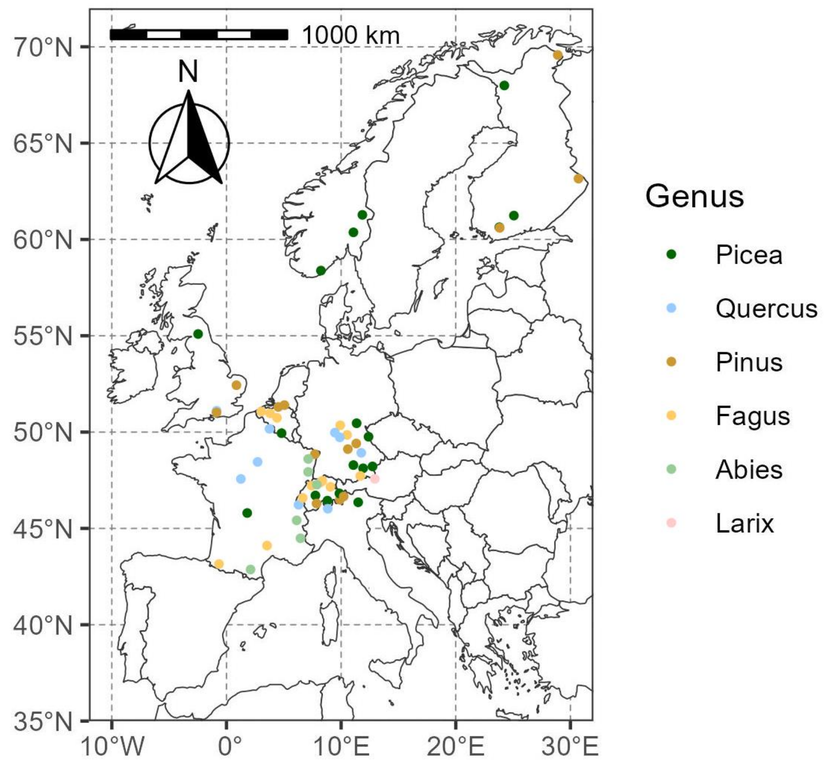
A multi-year study at European level (Verstraeten et al., 2023; *https://doi.org/10.1007/s10533-023-01082-3*) has proven a significant relationship between the seasonal airborne pollen amount and throughfall (TF) element fluxes measured during the main pollen season.

Aim of this study is to verify if a relationship exists between the variations in chemical composition of TF along a vegetative season and the concurrent presence and amount of specific pollen deposited in the same water samples, providing new insights on the possible role of pollen on TF biochemistry in European temperate and boreal forests.

METHODS - A total of n=196 weekly-to-monthly TF samples were collected in 2018 in n=60 ICP Forests Level II plots across 8 countries, representing 6 Main Tree Species (MTS) (Fig. 1). Sub-samples, previously analysed for the chemical composition, were treated for pollen extraction, microscopy identification and quantification (i.e., pollen sedimentation rate; $P*cm^{-2}*d^{-1}$). Most of TF samples covered the flowering period of the respective MTS (Fig. 2).

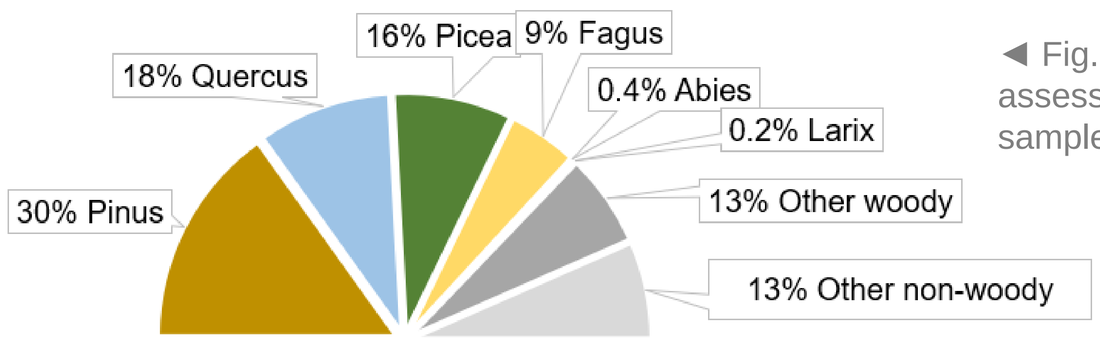


◄ Fig. 2. TF sampling periods grouped by MTS (coloured bars), considering all plots together; the flowering months for each plant genus are evidenced in grey.



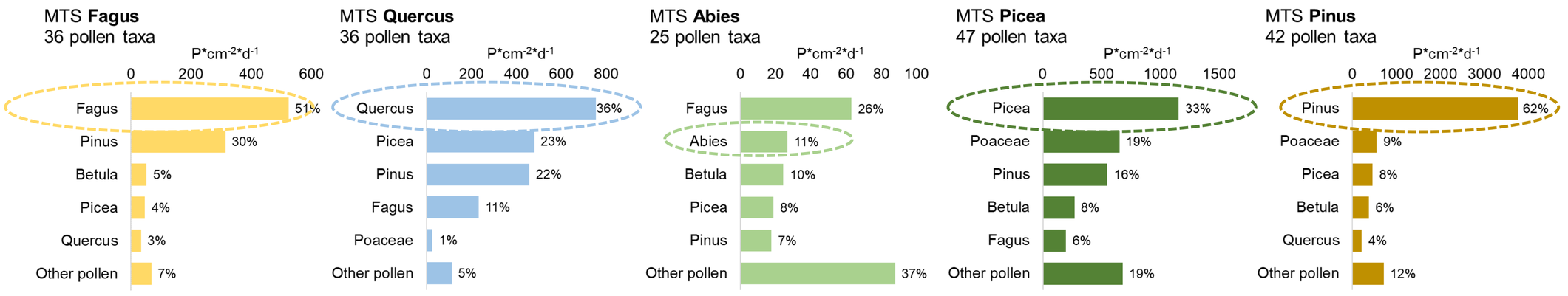
► Fig. 1. Location of the 60 ICP Forests Level II plots where TF samples were collected.

RESULTS - Overall, 54 (31 woody, 23 non-woody) pollen taxa were identified. 74% of analyzed pollen was identified as taxa related to the 6 MTS (Fig. 3). Among the non-woody taxa, Poaceae were the most abundant (85%).



◄ Fig. 3. Pollen spectrum assessed in the total n=196 TF samples.

The most frequent pollen taxon detected in each MTS belongs to the correspondent tree genus for *Fagus*, *Quercus*, *Picea*, and *Pinus* stands (on average, 45% of the pollen sampled in the relative plots). (Fig. 4). In *Abies* stands *Fagus* pollen prevailed likely because of the too early TF sampling period.



◄ Fig. 4. Pollen sedimentation rates of the 5 most abundant taxa, and all the others grouped, for each MTS. Larix has been excluded because its pollen was rare.

A negative correlation was found between TF nitrate-nitrogen (NO_3^--N) and the amount of *Fagus* and *Quercus* pollen. *Quercus* and *Picea* pollen strongly related ammonium-nitrogen (NH_4^+-N) and phosphate ion (PO_4^{3-}), likely representing a source of these nutrients (Tab. 1).

MTS	MTS, Pollen taxon	NO_3^--N	NH_4^+-N	DON	DOC	PO_4^{3-}	Ca	K^+	Na	Cl^-
Fagus	Fagus, n=31	-0.376	-0.198	0.034	-0.131	0.382	-0.318	0.146	-0.187	-0.121
Quercus	Quercus, n=30	-0.660	0.524	0.403	0.150	0.657	-0.139	0.393	-0.358	-0.314
Abies	Abies, n=11	-0.229	-0.563	0.067	-0.305	-0.327	-0.114	-0.095	-0.486	-0.400
Larix	Larix, n=8	0.577	0.577	0.412	0.412	n.a.	0.412	0.577	0.412	0.577
Pinus	Pinus, n=40	-0.195	-0.118	-0.067	-0.055	0.103	-0.383	0.110	-0.268	-0.207
Picea	Picea, n=76	-0.160	0.263	-0.101	-0.367	0.597	-0.276	-0.036	-0.474	-0.300

Tab. 1. Spearman Rank Order correlations (red text stands for a significant correlation; $p<0.05$) between pollen sedimentation rates ($P*cm^{-2}*d^{-1}$) and TF element fluxes ($mg*m^{-2}*d^{-1}$).

CONCLUSION - Pollen spectra in European temperate and boreal forests are dominated by woody species (a mixture of the MTS with other species). Pollen of *Fagus*, *Quercus* and *Picea* affects TF inorganic N and P fluxes.