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Can forest trees take up and transport nanoplastics?

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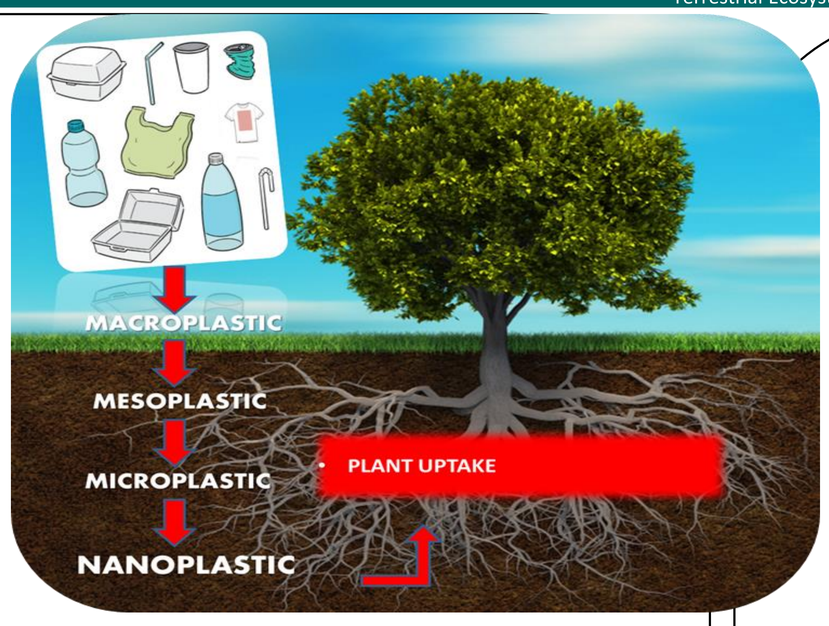
Background

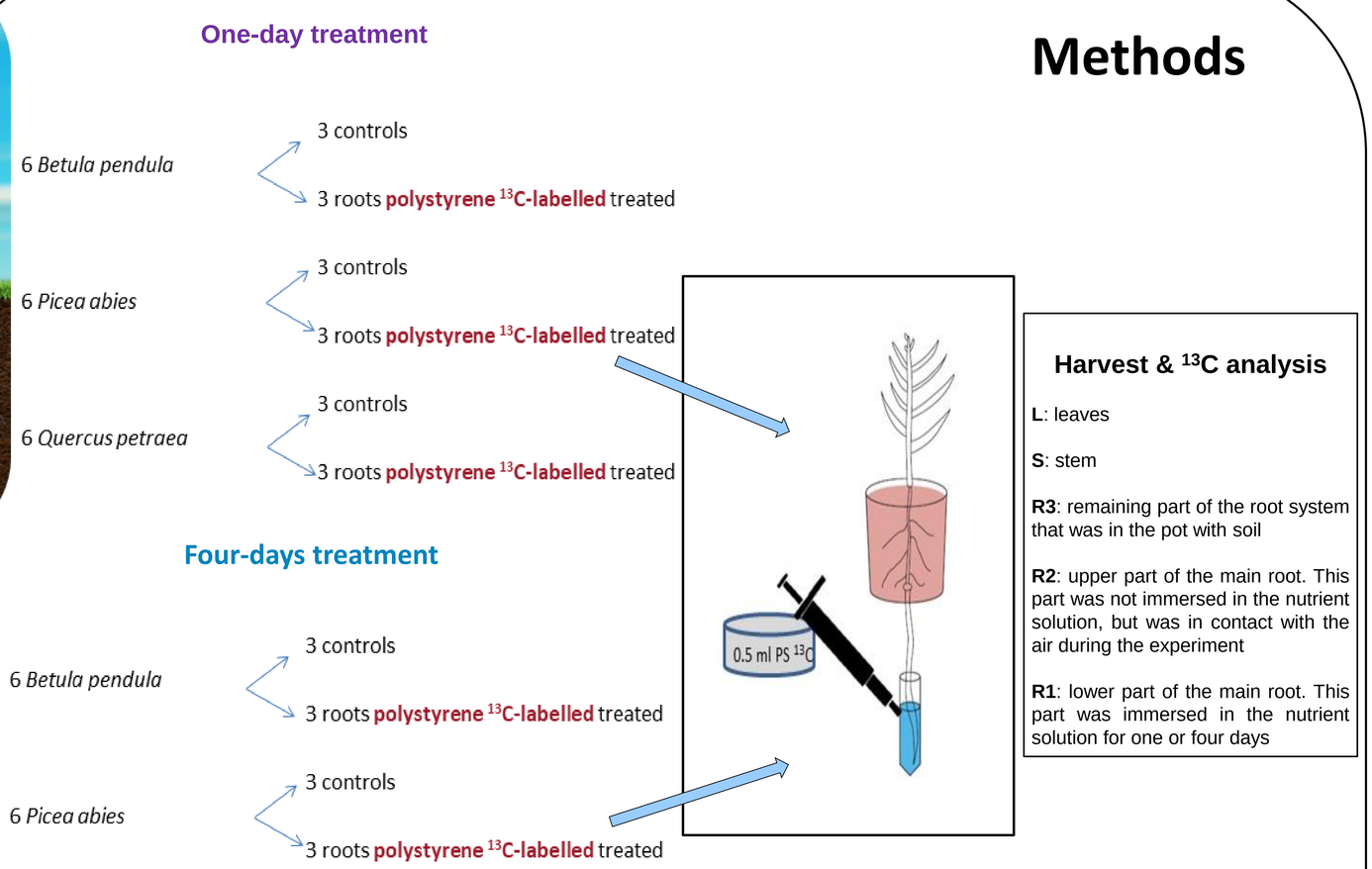


- Plastic pollution is widespread throughout the planet (Laure et al. 2021)
- Plastic litter slowly fragments into micro- (< 5mm) and nano-sized particles (< 1000nm) (Allen et al. 2019)
- At present it is still unclear whether trees are able to take up nanoplastic particles via their roots

Objective

- Use **^{13}C-labelled nanoplastics** (polystyrene) particles to assess whether and if so, to what extent, they are taken up in seedlings of birch, spruce and oak after **one** or **four** days of treatment

Methods



Harvest & ^{13}C analysis

L: leaves

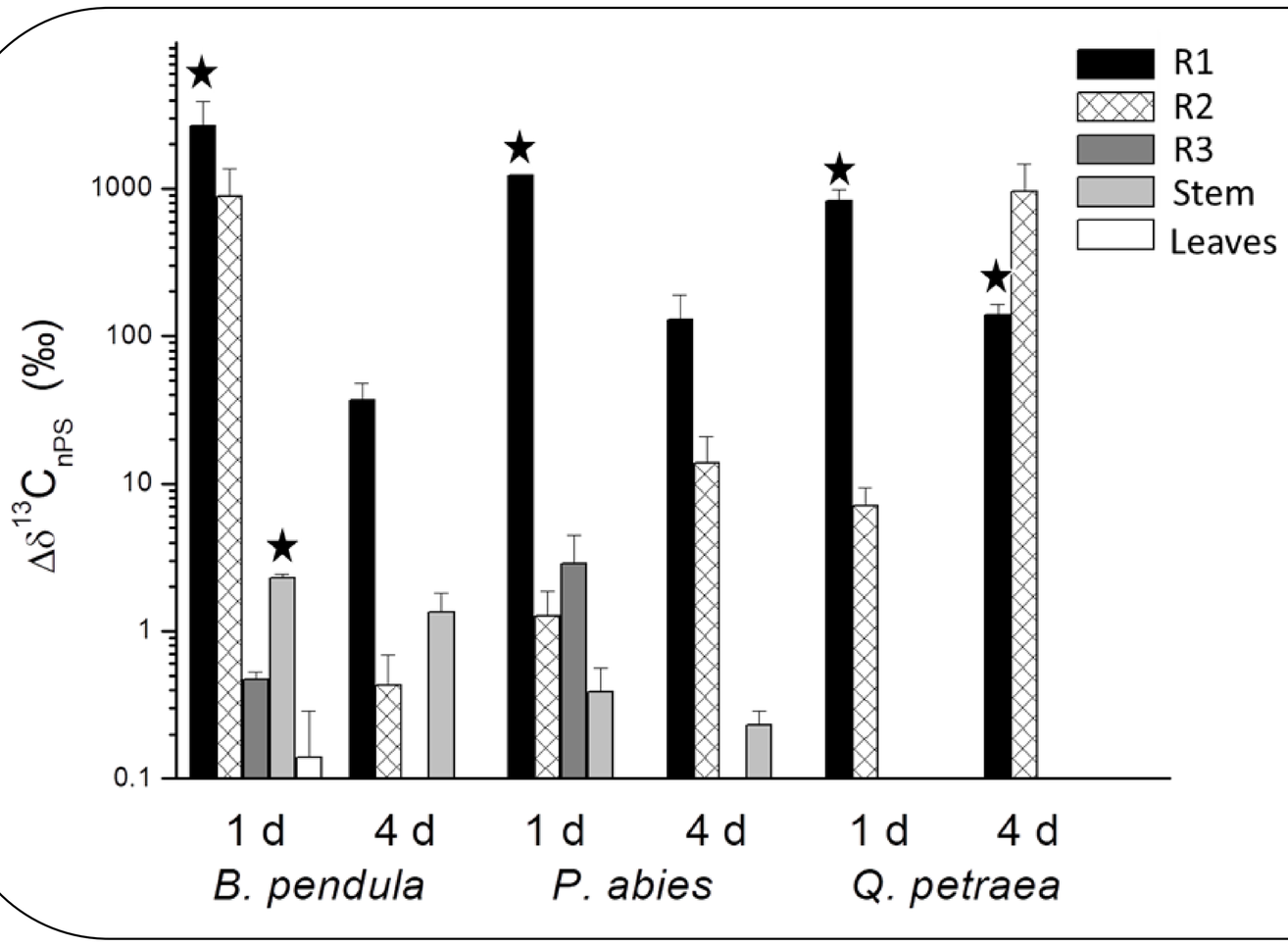
S: stem

R3: remaining part of the root system that was in the pot with soil

R2: upper part of the main root. This part was not immersed in the nutrient solution, but was in contact with the air during the experiment

R1: lower part of the main root. This part was immersed in the nutrient solution for one or four days

Results



		All tissues	Root1 (R1)	Root2 (R2)	Root3 (R3)	Stem	Leaves
	df	F-value	F-value	F-value	F-value	F-value	F-value
Tissue	4	66.8***	-	-	-	-	-
Treat	1	74.8***	178***	8.14**	0.05	2	4.63*
Species	2	4.1*	0.79	0.69	7.8**	6.9**	17.9***
Time	1	8.4**	22.7	0.02	1.3	0.58	0.01
Species x Treat	2	0.6	0.2	0.82	2.15	40.3***	1.41
Tissue x Treat	4	49.2***	-	-	-	-	-

Significance codes : 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Left Differences in ^{13}C between plants labelled with ^{13}C-nanopolystyrene ($\Delta\delta^{13}C$) for **one** or **four** days of treatment and control. Mean of 3 replicates and standard errors. Black stars indicate the statistically significant differences ($P < 0.05$; one-sided *t*-test) between controls and treatments

Right ANOVA testing the effects of exposing three tree species to ^{13}C-labelled nanopolystyrene for **one** or **four** days on $\delta^{13}C$ values in various tissues

Results

- The addition of ^{13}C-nanopolystyrene increased the $\delta^{13}C$ in all the three species significantly indicating that trees adsorbed and/or incorporated nanopolystyrene (ANOVA)
- Among the different tissues, the enrichment in ^{13}C was statistically significant (one-sided *t*-test, $P < 0.05$) in the immersed part of the root (R1) in all the species after a **one-day treatment** and in oak after a **four-days treatment**. Stem tissues of birch were also significantly enriched (one-sided *t*-test, $P < 0.01$) after a **one-day treatment**

Discussions and conclusion

→ The use of ^{13}C-nanopolystyrene gave some first evidence of the potential uptake of nanoplastics in trees

- There are some but limited indications for nanoplastic transport in trees, which might occur on the surface or in the central cylinder of trees
- Experiments with larger trees using more sensitive detection methods are needed to identify importance for forests. Long-term effects of plastic on tree physiological functions needs to be tested

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