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CHEMICAL DIVERSITY OF SOIL LIPIDS REFLECTS SURROUNDING BIODIVERSITY IN A FRENCH PEATBOG

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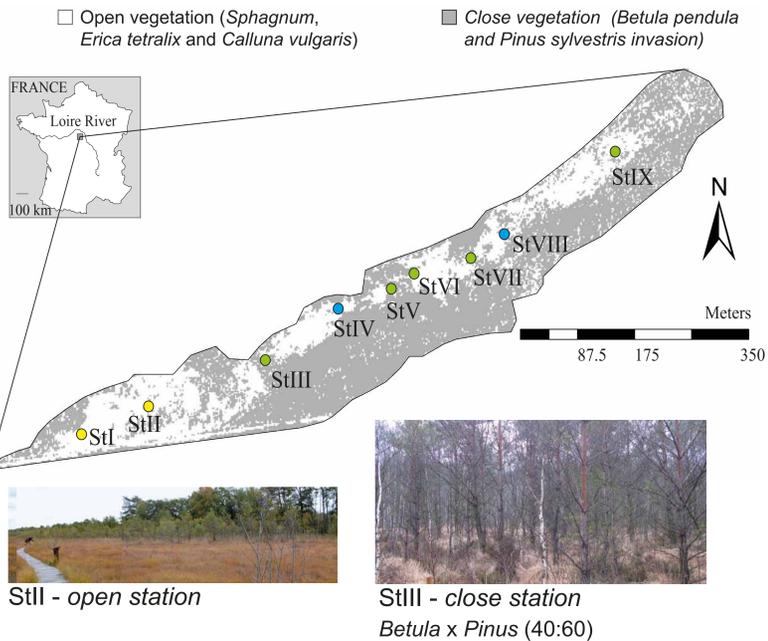
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Introduction

The spatial heterogeneity of molecular biomarkers preserved in soils and sediments, and their representativeness of the spatial distribution of the surrounding vegetation, are seldom taken into account in environmental or paleoenvironmental studies. Here we examine the distribution of lipids in peat soils in relation to their potential plant sources in the surroundings.

Sampling Site

La Guette peatland is located in Neuvy-sur-Barangeon (Sologne, Cher) in the French Centre Region (154 m a.s.l.; N 47°19', E 2°16'). This site covers 25 ha and is a transitional fen (pH about 4-4.5).



Specificity of biomarkers

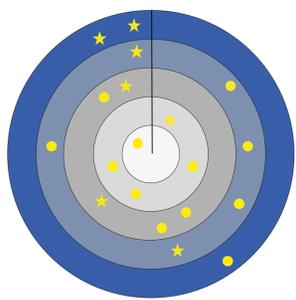
We first explored lipid compounds that could be specific for distinct vegetation by comparing molecular imprints in soils with those of the surrounding plants.

	Typical vegetation open vegetation			Invaded vegetation close vegetation	
	<i>Sphagnum</i> ssp.	<i>Erica tetralix</i>	<i>Calluna vulgaris</i>	<i>Betula pendula</i>	<i>Pinus sylvestris</i>
Non specific	n-Alkanes, n-Alkanols, Steroids, n-Alkanoic acids, Pentacyclic triterpene acids, Pentacyclic triterpenols, Pentacyclic triterpene ketones			n-Alkanes, n-Alkanols, Steroids, n-Alkanoic acids, Pentacyclic triterpenols, Pentacyclic triterpene ketones	
Specific		Pentacyclic triterpenyl acetates	Pentacyclic triterpenyl acetates	Betulin derivatives	Tricyclic diterpenes Methoxy-serratenes

Except for compounds that were indiscriminately found in every potential source plant (n-alkanes, n-alkanols, n-alkanoic acids, steroids, pentacyclic triterpenes with acid, alcohol or ketone function), the comparison of soil and plant lipids allowed us identifying pentacyclic triterpenyl acetates as tracers of Ericaceae (*E. tetralix* and *C. vulgaris*), betulin derivatives as specific for *B. pendula*, and tricyclic diterpenes and methoxy-serratenes as biomarkers of *P. sylvestris*.

Tree counting

Around each station, trees were counted in concentric circles of increasing radius (1, 2, 3, 4 and 5 m, giving areas of 3.14; 12.6; 28.3; 50.3 and 78.5 m², respectively). Then, tree density (d_{trees}) and cover index (CI) were calculated.



$$d_{trees} = \text{total number of trees} / m^2$$

$$d_{betula} = \text{total number of } B. pendula / m^2$$

$$d_{pinus} = \text{total number of } P. sylvestris / m^2$$

$$CI = \text{number of trees at a station} / \text{highest number of trees counted for this peatland}$$

$$P/B = n^\circ P. sylvestris / n^\circ B. pendula$$

Calculations of the tree count in La Guette peatland, spring 2011.

	Stations								
	I	II	III	IV	V	VI	VII	VIII	IX
d_{Pinus}	0.00	0.00	0.24	0.00	0.17	0.01	0.04	0.10	0.01
d_{Betula}	0.00	0.00	0.18	0.04	0.15	0.01	0.01	0.27	0.06
d_{trees}	0.00	0.00	0.42	0.04	0.32	0.03	0.05	0.37	0.08
CI	0.00	0.00	1.00	0.09	0.76	0.06	0.12	0.88	0.18
P/B (%)	0	0	58	0	52	50	75	28	17

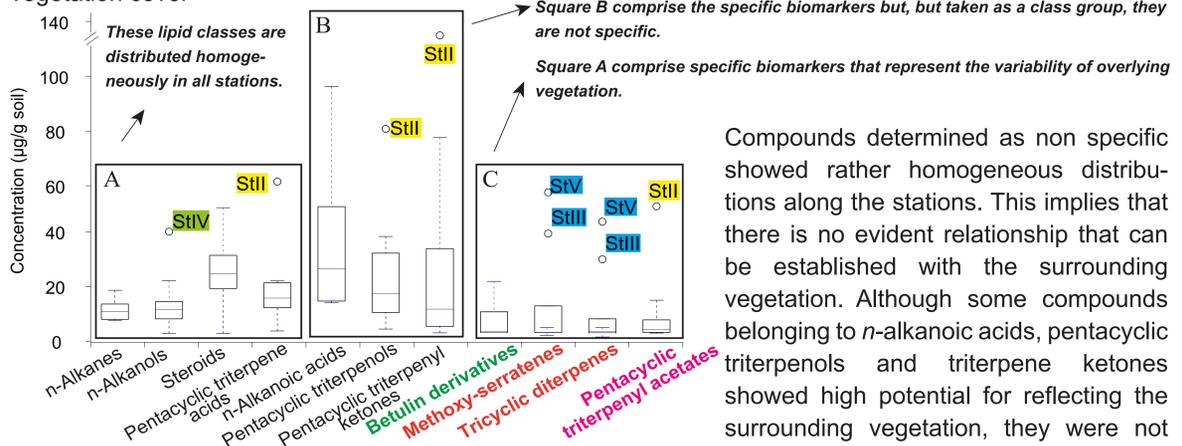
■ Open Stations ■ Semi-close Stations ■ Close Stations
StIV and StIX - slight dominance of B. pendula *StIII and StV - slight dominance of P. sylvestris*
StVII - dominance of P. sylvestris *StVIII - dominance of B. pendula*

Lipid Analyses

About 5 g of soil or plant sample were sonicated with CH₂Cl₂ (3 x 10 min x 15 ml). Total extract was fractionated into neutral and acidic compounds using aminopropyl-bonded silica. Neutral fraction was separated into five fractions using a sequence of solvents of increasing polarity. Alcohol fractions were silylated (BSTFA). Acid fraction was methylated and then, silylated. Extracts were analysed by GC/MS.

Variability of molecular imprints in stations

We then compared the distribution of these lipid classes among soil samples in stations under varying vegetation cover

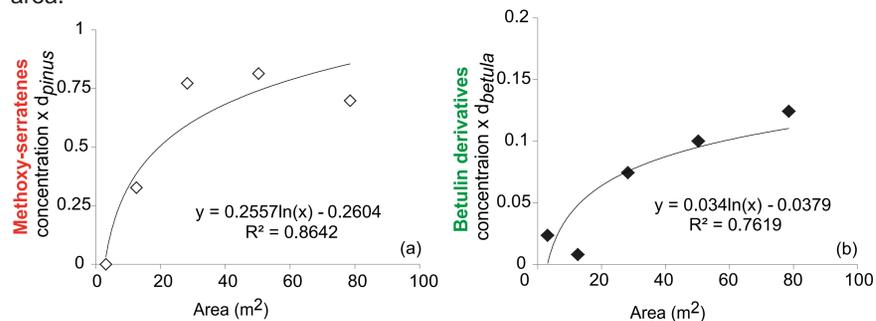


Compounds determined as non specific showed rather homogeneous distributions along the stations. This implies that there is no evident relationship that can be established with the surrounding vegetation. Although some compounds belonging to n-alkanoic acids, pentacyclic triterpenols and triterpene ketones showed high potential for reflecting the surrounding vegetation, they were not specific enough taken as a group.

Reversely, compounds supposedly specific, although less abundant, are more efficient. For example, outliers in methoxy-serratenes and tricyclic diterpenes are those exhibiting the highest d_{Pinus} .

Tree cover x Tree specific biomarkers

Once demonstrated the efficiency for some lipid classes to be reflective of the surrounding vegetation, we test to what extent they spatially represent the surrounding vegetation. This test is realized on tree species and achieved by comparing the correlation between biomarker concentration and tree density with the considered area.



For both *P. sylvestris* and *B. pendula*, our results indicate a strong relationship between the concentration of specific biomarkers in soils and tree density. This relationship is valid over an area of at least 80 m².

Conclusions

- Pentacyclic triterpenyl acetates detected in by *Erica tetralix* and *Calluna vulgaris* were found in high concentrations in open stations.
- Tricyclic diterpenes and methoxy-serratenes detected in *Pinus sylvestris* were found in high concentrations in semi-close and close stations dominated by *Pinus sylvestris*.
- Betulin derivatives detected *Betula pendula* were found in high amounts in semi-close and close stations dominated by *Betula pendula*.
- Non-specific compounds showed rather homogeneous distribution along the stations. Reversely, the spatial dispersion of specific compounds appears controlled by the surrounding vegetation.
- Concentration of *B. pendula* and *P. sylvestris* biomarkers in soils are well correlated with tree density when an area of 80 m is considered. Here, the influence zone is valid over an area of at least 80 m².
- Soil lipids can thus constitute valuable tools for reflecting the spatial heterogeneity in the distribution of past and present vegetation in continental ecosystems.

- **Perspectives:** Further work is now underway to apply the same approach to shrub, graminoid and moss strata. However, the spatial complexity of these types of vegetation impedes any simple direct estimation of density (unlike tree counting) and, thus, requires further development.