

## Peat-Forming plant specific biomarkers as indicators of paleoenvironmental changes in Sphagnum-dominated peatlands.

Fatima Laggoun-Défarge, Andreas Gattinguer, Laure Comont, Jean-Robert Disnar, Nathalie Lottier, Pascale Gautret, Michael Schloter

► **To cite this version:**

Fatima Laggoun-Défarge, Andreas Gattinguer, Laure Comont, Jean-Robert Disnar, Nathalie Lottier, et al.. Peat-Forming plant specific biomarkers as indicators of paleoenvironmental changes in Sphagnum-dominated peatlands.. IMOG, Sep 2007, Torquay, United Kingdom. pp.P200-TU. insu-00190973

**HAL Id: insu-00190973**

**<https://hal-insu.archives-ouvertes.fr/insu-00190973>**

Submitted on 23 Nov 2007

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## PEAT-FORMING PLANT SPECIFIC BIOMARKERS AS INDICATORS OF PALAEOENVIRONMENTAL CHANGES IN *SPHAGNUM*-DOMINATED PEATLANDS.

Fatima LAGGOUN-DÉFARGE<sup>1</sup>, Andreas GATTINGER<sup>2,3</sup>, Laure COMONT<sup>1</sup>, Jean-Robert DISNAR<sup>1</sup>, Nathalie LOTTIER<sup>1</sup>, Pascale GAUTRET<sup>1</sup> and Michael SCHLOTTER<sup>4</sup>

<sup>1</sup>ISTO, UMR 6113 CNRS - University of Orleans, BP 6759, F-45067 Orleans, France.

<sup>2</sup>Technical University of Munich, Chair of Soil Ecology, D-85758 Oberschleissheim, Germany

<sup>3</sup>Geohumus International GmbH & Co. KG, Vilbeler Landstrasse 17-19, D-60386 Frankfurt, Germany

<sup>4</sup>GSF-National Research Center for Environment & Health, Institute of Soil Ecology, D-85764 Neuherberg, Germany

The high preservation of organic material in peatlands that results from low pH, anoxia and rapid burial make the peat archives particularly useful for reconstructing natural or anthropogenic environmental changes. Nevertheless, up to now biochemical composition of peat OM has rarely been used as indicator for past environmental conditions, particularly in ombrotrophic peatlands. Within RECIPE, a European Union Framework 5 initiative, we aimed to identify combinations of site physico-chemical conditions, vegetation composition and below-ground microbiological characteristics that are beneficial to the long-term regeneration of cut-over peatland biodiversity and restoration of the carbon sink function (Chapman *et al.*, 2003).

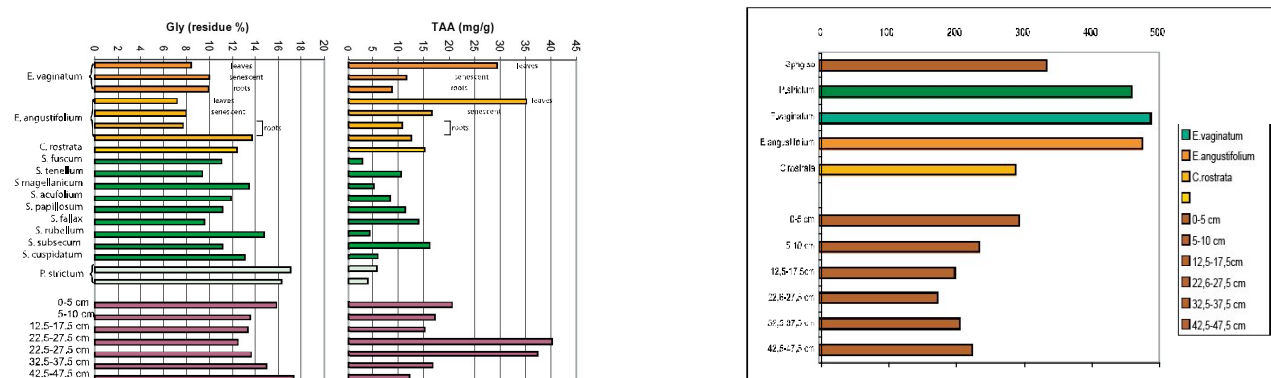
To infer plant inputs and identify biopolymer degradation in response to these anthropogenic changes, bulk and molecular indicators of modern peat-forming plants were determined and compared to those recovered from ca. 50 cm peat deposited in La Chau d'Abel peatland (Jura Mountains, Switzerland). Particular emphasis was devoted to carbohydrate and lipid analysis given (i) their important role in the constitution and metabolism of the peat-forming plants and (ii) the slight degradation they undergo in the peat, particularly carbohydrates. In fact, contrary to commonly perceived ideas which stipulate a highly biodegradability, we recently demonstrated that sugar compounds are well preserved in peat allowing their use both as indicators of humification and as tracers of plant sources (Comont *et al.*, 2006).

13 species of living plants: 10 mosses (9 *Sphagnum* species & *Polytrichum strictum*) and 3 sedges (*Eriophorum vaginatum*, *E. angustifolium* and *Carex rostrata*), as well as the peat core sections have been examined for C/N, light microscopy and distributions of their monosaccharide and lipid biomarkers. Among *Sphagnum* mosses, characteristic hummock-forming species (*Sphagnum fuscum*, *S. magellanicum*, *S. acufolium*) and hollow species (*Sphagnum cuspidatum*, *S. fallax*) were collected to test whether they differ in composition or not. Fatty acids were determined from plant derived neutral, glyco and phospholipids and are designated as NLFA, GLFA and PLFA, respectively. Neutral sugars were recovered after two hydrolyses releasing the total and the hemicellulosic sugars, respectively. The cellulosic sugars were determined by difference.

Neutral fatty acids (NLFA) showed the highest concentration in the investigated plants followed by PLFA and GLFA. The median fatty acid concentration was 0.16  $\mu\text{mol g}^{-1}$  plant dry matter. In all three lipid fractions saturated fatty acids (SATFA) were the most dominating (60.2-99.0% of total lipids), whereas mono- and polyunsaturated (MUFA and PUFA) occurred at similar percentages at far lower levels. Lipid concentrations (absolute value) did not vary significantly between the different plant genera in contrast, to the percentages (relative values) of SATFA, MUFA, PUFA.

Overall, no significant differences in total sugar contents were detected between the *Sphagnum* mosses (305 to 400 mg.g<sup>-1</sup>) and the sedges (289 to 440 mg.g<sup>-1</sup>). However, in contrast to the *Sphagnum* mosses, the sedges are much richer in hemicelluloses than in cellulose (ca. 223 vs. 157 mg.g<sup>-1</sup>) as previously reported for Cyperaceae plants collected in a tropical peaty marsh (Bourdon *et al.*, 2000). Among the *Sphagnum* mosses that exhibit comparable TOC values (41.2 to 44.4 %), the typical hollow species, i.e. *S. cuspidatum*, are richer in total sugars (ca. 400 mg.g<sup>-1</sup>) than the hummock ones, i.e. *S. fuscum* (ca. 300 mg.g<sup>-1</sup>). The distribution of the hemicellulose monosaccharide content (wt%) shows contrasted signatures between the plants. The dominant hemicellulose monosaccharides are (i) galactose (13 to 19 wt%) and rhamnose (6 to 10 wt%) in the nine *Sphagnum* species, (ii) mannose (25 to 29 wt%) in *Polytrichum strictum*, and (iii) xylose (25 to 36 wt%) and arabinose (9 to 16 wt%) in the sedges. The richness of sedges in xylose and arabinose has already been reported in several studies, while to our knowledge only very few studies mentioned the occurrence of high proportions of galactose, rhamnose and mannose in the hemicellulose of the primary cell walls of mosses; these latter compounds being usually attributed to microbial syntheses.

These results show the source biomarker potential for sugars and fatty acids, which are currently under-utilised as proxies for plant inputs in peatland ecosystems. Another outcome of this study is the applicability of various PLFA biomarkers for microbial investigations in peatland ecology.



Amounts of total amino-acids (left) and sugars (right) in (i) vascular plants and mosses (*Sphagnum* and *Polytrichum* spp.) and (ii) the 50cm depth peat samples from Le Russey peatbog (Jura Mountains).

## REFERENCES

- Bourdon, S., Laggoun-Défarge, F., Maman, O., Disnar, J.-R., Guillet, B., Derenne, S. and Largeau, C. (2000) Organic matter sources and early diagenetic degradation in a tropical peaty marsh (Tritrivakely, Madagascar). Implications for environmental reconstruction during the Sub-Atlantic. *Organic Geochemistry*, 31, 421-38.
- Chapman, S., Buttler, A., Francez, A.-J., Laggoun-Défarge, F., Vasander, H., M., S., Combe, J., Grosvernier, P., Harms, H., Epron, D., Gilbert, D. and Mitchell, E.A.D. (2003) Commercial exploitation of peatlands and maintenance of biodiversity – A conflict between economy and ecology. *Frontiers in Ecology and the Environment*, 1(10), 525-32.
- Comont, L., Laggoun-Défarge, F. and Disnar, J.-R. (2006) Evolution of organic matter indicators in response to major environmental changes: the case of a formerly cut-over peatbog (Le Russey, Jura Mountains, France). *Organic Geochemistry*, 37, 1736-51