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The preferential growth of branched GDGT source microorganisms under aerobic conditions in peat revealed by stable isotope probing experiments

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Branched glycerol dialkyl glycerol tetraether (brGDGTs) membrane lipids are widely distributed in aquatic and terrestrial environments and are being increasingly used as temperature proxies. Nevertheless, little is known regarding the microorganisms that produce these lipids, which are found in especially high abundance in the anaerobic horizons of peat bogs. We initiated stable isotope probing incubations of peat samples from a *Sphagnum*-dominated peatland (Jura Mountains, France) to measure the incorporation of (D)-D₂O and ¹³C-labeled dissolved inorganic carbon (DIC) into brGDGTs, and thus gauge the activity, growth, and turnover times of their source organisms. Peat samples were collected from two adjacent sites with contrasting humidity levels (hereafter called “fen” and “bog” sites). For each site, samples from the surficial aerobic layer (acrotelm) and deeper anaerobic layer (catotelm) were collected and were incubated under both anaerobic and aerobic conditions for the acrotelm samples and only anaerobic conditions for the catotelm. The incubations were performed at 12 °C, consistent with the mean summer air temperature at the sampling site.

After two months of incubation, there was no incorporation of ¹³C label in brGDGTs for samples incubated under either aerobic or anaerobic conditions, showing that brGDGT-producing bacteria are heterotrophic microorganisms, as previously observed in organo-mineral soils (Weijers et al., 2011). Similarly, little to no deuterium incorporation was observed for brGDGTs isolated from anaerobically-incubated deep samples. In contrast, in the aerobic incubations of acrotelm samples from bog and fen, the weighted average δD of brGDGT core lipids (CLs) increased by up to 3332‰ and 933‰ after two months, respectively, indicating that fresh brGDGT CLs were biosynthesized at the peat surface. D incorporation into brGDGT CLs converted to production rates ranging from 30-106 ng cm⁻³y⁻¹ in the aerobic acrotelm from bog and fen, whereas corresponding rates in the anaerobic acrotelm incubations were more than an order of magnitude slower (< 3 ng cm⁻³ y⁻¹). Production rates of bacterial fatty acids approached or exceeded 1 μ g cm⁻³ y⁻¹ in both aerobic and anaerobic incubations, and were therefore much higher than those of brGDGTs. This suggests that the brGDGT producers are a minor constituent of the microbial community in *Sphagnum*-dominated peatlands or brGDGTs are a small component of the microbial cell membrane in comparison to fatty acids, despite the typically high brGDGT concentrations observed in peat.

In conclusion, our results reveal that brGDGT source microorganisms preferentially grow under oxic to sub-oxic conditions, likely as facultative anaerobes. We show for the first time that these microorganisms are especially active at the peat surface, in contrast to the deeper layers, implying that the high abundance of brGDGTs observed in the catotelm should result from the accumulation of the brGDGTs actively produced in the acrotelm.

Reference

Weijers, J.W.H., Wiesenberg, G.L.B., Bol, R., Hopmans, E.C., Pancost, R.D., 2010. *Biogeosciences* 7, 2959–2973.