

First occurrence of archaeal tetraether lipids with 5 to 7 cyclopentane moieties in a mesophilic setting

GORDON N. INGLIS^{1*}, B. DAVID A. NAAFS¹,
SARAH J. FEAKINS², OUTI LÄHTEENOJA³,
CAMILO PONTON², MARGARET E. COLLINSON⁴,
MEGAN ROHRSEN¹ AND RICHARD D. PANCOST¹

¹Organic Geochemistry Unit, School of Chemistry and Cabot Institute, University of Bristol, UK (*correspondence: gordon.inglis@bristol.ac.uk)

²Department of Earth Sciences, University of Southern California, USA

³Department of Biology, University of Turku, Finland

⁴Department of Earth Sciences, Royal Holloway University of London, Egham, UK

Isoprenoidal glycerol dialkyl glycerol tetraethers (isoGDGTs) are cell membrane-spanning lipids belonging to a diverse group of Archaea. IsoGDGTs bearing up to 4 cyclopentane moieties are common in non-extreme environments, whereas isoGDGTs bearing 5 to 8 cyclopentane moieties have only been reported in hot springs and cultures of Euryarchaeota and Crenarchaeota grown at temperatures above 45°C (pH <1.5) and 65°C (pH 2-5.5), respectively. This suggests that the ability to synthesise more than 4 cyclopentane moieties is a unique adaptation of extremophiles. To explore this further, we report the distribution of isoGDGTs in a range of peat-forming environments from across the globe.

Our results demonstrate that high- and mid-latitude peats are dominated by GDGT-0 (typically > 80%). Smaller quantities of GDGTs 1 to 4 were also detected. In tropical peats, GDGTs 1 to 4 are more abundant (up to 60% of total isoGDGTs). Intriguingly, a number of ombrotrophic tropical peats contain isoGDGTs bearing up to 7 cyclopentane moieties.

This is the first reported occurrence of isoGDGTs bearing more than 4 cyclopentane moieties within a mesophilic setting. Their occurrence is likely driven by a combination of high mean annual temperatures (>25 °C) and low pH (3.5-4.0). The presence of isoGDGTs 0-5 within an early Eocene, ombrotrophic bog (Schoningen, NW Germany) also suggests that this signal is preserved in deep-time settings. Our results indicate that isoGDGTs with more than 4 cyclopentane rings are not unique to thermophilic settings and that these compounds are likely more widespread than previously thought.