Molecular characterization of archaeal lipids across a hypersaline gradient

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Four halophilic archaeal strains, *H. utahensis, N. pharaonis, H. sulfurifontis* and *H. gomorrense*, were grown at a range of salinities (10-30% NaCl, (w/v)). These strains represent four archaeal genera and have a range of salinity optima. Molecular analysis of membrane lipids in each strain by GC-MS revealed structures consistent with saturated, unsaturated and polyunsaturated dialkyl glycerol diethers (DGDs) of both phytanyl (C_{20}) and sesterpanyl (C_{25}) isoprenoid chains. In addition, we observed three trends: (1) the percentage of unsaturated DGDs increased with increasing NaCl concentration in the growth medium; (2) strains with a higher optimal NaCl concentration had a higher percentage of unsaturated DGDs; and (3) $C_{25\text{-}20}$ DGDs occurred in the two strains with higher optimal NaCl concentrations, *N. pharaonsis* and *H. utahensis*. The strong linear correlation between optimal growth salinity and the amount of unsaturated DGDs (Fig. 1) suggests that the degree of membrane lipid unsaturation is an important adaptation to specific salinity niches in archaeal halophiles. In addition, in three of the four halophile strains we tested, the fraction of unsaturated DGDs increased above a salinity threshold or in response to increasing salinity in the growth medium. Thus, halophilic archaea may regulate membrane lipid unsaturation in response to environmental salinity changes regardless of their salinity optima.

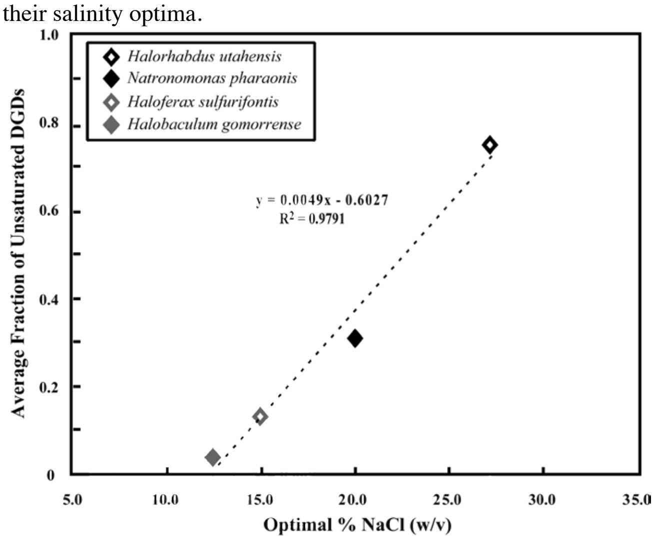

Figure 1: Average fraction of unsaturated DGDs versus optimal % NaCl (w/v) for four halophilic archaeal strains.

O and Ca isotopes in calcite grown under cave-analogue conditions

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Speleothem oxygen isotopes and growth rates are valuable proxies for reconstructing climate history. However, oxygen isotopes and growth rate are controlled by diverse environmental variables (including the climatically important variables rainfall and temperature) and there is a paucity of laboratory experiments to quantify the influence of these variables on speleothem chemistry. Quantitative data from such studies would dramatically improve our ability to reconstruct palaeoclimate from stalagmites.

We have completed a new series of carbonate growth-experiments in karst-analogue conditions in the laboratory [1,4]. The setup closely mimics natural processes (e.g. precipitation driven by CO_2-degassing, low ionic strength solution, thin solution film) but with a tight control on growth conditions (temperature, pCO_2, drip rate, calcite saturation index and the composition of the initial solution).

We derive a relationship between growth mass, temperature and drip rate, whilst in a more qualitative sense we observe a wider diameter of calcite growth with increased drip rate. $\delta^{18}O$ results show that speleothem growth from fast dripping, cold settings are most favourable for palaeoclimate work. $\delta^{18}O$ and $\delta^{44/42}Ca$ provide important insight into the mechanisms of stable isotope fractionation in speleothems, which we discuss in the context of surface entrapment controlling Ca and O isotopic fractionation [2, 3].

Collectively, these experiments therefore provide a more robust understanding of the way that stalagmite carbonate responds to climatically important environmental variables.

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