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Effect of temperature and pH on the membrane lipid composition of soil Gram-negative bacteria isolates: Implications for the use of 3-hydroxy fatty acids as (paleo)environmental proxies

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3-hydroxy fatty acids (3-OH FAs) are characteristic components of the membrane of Gram-negative bacteria. They were recently proposed as promising temperature and pH proxies in soils. Nevertheless, to date the relationships between the relative abundance of 3-OH FAs and environmental parameters were never investigated at the microbial level. It is now essential to better constrain the effect of temperature and pH on the membrane lipid composition of soil Gram-negative bacteria, as the response of these microorganisms to temperature and pH variations may vary between species. This could in turn impact the applicability of 3-OH FAs as environmental proxies in soils.

The aim of this study was to investigate the influence of growth temperature and pH on the lipid profile of three different strains of soil Gram-negative bacteria, belonging to the same phylum (Bacteroidetes) but isolated from soils collected at different altitudes in the French Alps. Even though the 3-OH FAs were less abundant than the non-hydroxy FAs in the three strains, they were shown to be involved in the membrane adaptation of these bacteria to temperature. A common temperature adaptation mechanism was observed for the three strains, with a significant increase in the ratio of *iso* versus *anteiso* or *normal* 3-OH FAs at higher temperature. Nevertheless, the variations of the relative abundances of the individual 3-OH FAs with temperature were shown to be strain-dependent. This might be related to the fact that the three investigated strains are different species, and also to the contrasting environment from which they were isolated. In contrast with temperature, the different Gram-negative bacterial strains did not share any common adaptation mechanism to pH, with distinct variations of the FA lipid profiles between the three species. As the whole suite of 3-OH FAs present in the lipid membrane of the Gram-negative bacteria can be influenced by either temperature or pH, this implies that models based on these organic compounds and envisioning the reconstruction of environmental changes in soils at the global scale should include all molecules rather than using indices based on a sub-selection of 3-OH FAs as initially suggested.