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BACTERIAL GLYCEROL DIALKYL GLYCEROL TETRAETHER LIPIDS IN HOT SPRINGS AND SURROUNDING SOILS

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Recently discovered branched glycerol dialkyl glycerol tetraethers (GDGT) membrane lipids (structures VI-XI, Fig.1) are biosynthesised by anaerobic bacteria which thrive in peats and soils. Studies of soils revealed that these branched GDGTs are ubiquitous and more abundant compared to archaeal isoprenoid GDGTs. Branched GDGTs are also found in coastal areas near major rivers in the marine environment, as erosion of soils and transport by rivers results in their delivery to the sea. Weijers et al. (2006) analysed 130 soils from 90 globally distributed locations to determine the environmental factors controlling the relative distribution of the different branched GDGTs. From this study it appeared that the GDGT-distribution is correlated with the mean annual air temperature (MAAT) and pH. In order to quantify the change in relative distribution, two indices were developed; the Cyclisation of Branched Tetraethers (CBT) index and the Methylation of Branched Tetraethers (MBT) index. The CBT index was found to be linearly correlated with pH, whereas the MBT index was both a function of soil pH and MAAT. By combining the CBT and MBT index it is thus possible to reconstruct MAAT.

In this study we examined the composition of GDGTs in hot spring microbial mats of Yellowstone National Park, USA. Besides archaeal isoprenoid GDGTs, branched GDGTs were also found in these microbial mats (Fig.1). As they are thought to be synthesised by anaerobic bacteria living in soils, their presence in hot springs suggests that the branched GDGTs are derived from the surrounding soils via runoff through precipitation. The pH and air temperature at which the GDGT-lipid producing bacteria were living were estimated using the CBT and MBT indices and empirical correlation equations with pH and temperature as given in Weijers et al. (2006). The GDGT distribution in one hot spring suggested temperatures approaching the mean annual air temperature of the area (2˚C). This is in agreement with an allochthonous source for these GDGTs. The GDGT distribution in the other hot springs, however, suggested much higher temperatures, up to 37˚C, although these temperatures were still substantially lower than those in the hot springs which were up to 60˚C. This suggests that they might be derived from soils close to the hot spring, where soil temperature is enhanced by the geothermal activity.

To further investigate this, we will sample a number of hot springs and surrounding soils in California and Nevada (USA). Analysis of these soils should reveal whether the anaerobic bacteria producing these branched GDGTs are present at elevated temperatures, nearby hot springs, for instance, and how GDGT-distribution changes with increasing distance from the hot springs. Soils will be sampled in a transect away from the different hot springs in order to include the complete range of temperature and pH surrounding each hot spring. In addition, the microbial mats in these hot springs will be sampled to be able to compare the GDGT distribution with those of the surrounding soils and get a better understanding of the transport mechanisms of GDGTs into the hot springs.

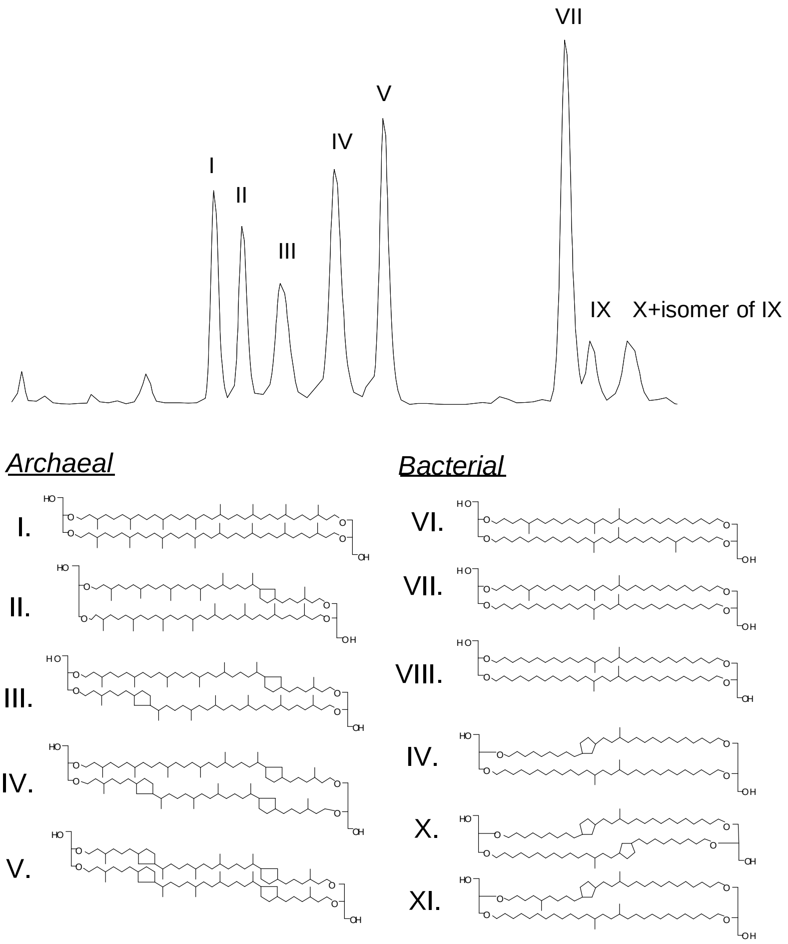

Figure 1. Base peak chromatogram of HPLC/MS analysis of microbial mats showing the distributions of GDGTs in Mushroom Spring (T=50˚C, pH=8.5), Yellowstone National Park (USA). Peaks I-V are archaeal GDGTs. Peaks VI-XI are bacterial GDGTs, with their structures depicted below.

REFERENCES

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