

Report on Short Visit Grant
Reference nr. 3142
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Purpose of the visit

Branched glycerol dialkyl glycerol tetraethers (GDGTs) are membrane lipids of as yet unknown bacteria occurring in soils and peat lands. It has been shown that their distribution in soils worldwide is determined mainly by annual mean air temperature and soil pH, a property that can be used in palaeoclimate studies. On smaller temporal scales, however, we do not yet know what the dynamics of GDGTs are in terms of sensitivity to seasonal weather changes and in terms of their stability in soils. This information is relevant to palaeoclimate studies as it is not known yet, for example, if the reconstructed temperatures are biased towards the season of maximum growth of the bacteria. Recent developments have now enabled the separation of intact GDGTs, i.e. still containing functional head groups, derived from living bacteria from the fossil core GDGTs, and thus make it better possible to study these dynamics. In November 2008 we have started sampling a time series of grassland soil at a plot of North Wyke Research, Devon, UK. The primary objective of this initiative is to compare changes in the abundance and distribution of both extant and fossil GDGTs over the seasons with on-site meteorological data and soil temperatures in order to better understand the dynamics of GDGTs in soils. A second objective is to try using microbiological techniques to screen the samples for weather related changes in the microbial composition in order to better constrain the source of the bacterial GDGTs, as this is still unknown.

This travel grant aimed at visiting the North Wyke Research soil institute to retrieve the first year's samples of a soil time series that has been sampled during 2009 and to carry out the first extraction steps (which should be done on site since the samples are stored at -80°C). This visit also aimed to discuss continuation and extension of the project by including additional molecular components of the SOM pool. In addition, exchange of ideas and discussion with soil scientists from other disciplines present at North Wyke Research, like sedimentology, (micro)biology, and chemistry, are foreseen in an effort to further upgrade the project into a valuable long term time series of soil samples.

Description of the work carried out during the visit

Laboratory part:

The stored soil samples have been freeze dried, sorted out, mixed where appropriate and grinded using a ball mill. The pH of the soils has been determined using an aliquot of the freeze dried sediment. Subsequently the samples have been extracted using organic solvents following a six step protocol. After determining yields, appropriate splits have been made and an aliquot of the extract has been separated into a fraction containing fossil tetraether membrane lipids and a fraction containing tetraether membrane lipids of extant organisms. All samples were dried and have been brought back to Utrecht University for further processing upon analysis.

Other:

Meteorological data have been extracted from the weather station database. These include hourly data on precipitation, air temperature, grass surface temperature and soil temperature at 5, 10 and 30cm soil depth.

The actual site where the samples have been taken has been visited which gave me a good idea of the field conditions and is very useful for future interpretation of the results.

I have talked to different researchers at North Wyke Research on the possibilities to do additional analyses on these samples and on possibilities to extend the sampling record.

Description of the main results obtained

Laboratory part:

The main result of the labwork is that the basic wet chemistry part of processing the samples has been carried out and that the samples are now ready now for further specific treatment (chemical cleaving of functional head groups off the core lipids) prior to GDGT analysis by high performance liquid chromatography / mass spectrometry (HPLC/MS).

Other results:

A proper precipitation and temperature dataset has been compiled which is needed for comparison to the tetraether membrane lipid abundance and distribution through the year.

Meeting with different members of staff learned me that the microbiological analyses could probably be carried out at North Wyke institute as they have hired more staff with experience in DGGE screening and 454 gene sequencing. As North Wyke Research has recently become part of the renowned soil institute Rothamstead near London, the microbiological analysis might also be carried out over there, since they have a larger and more specified microbiology research group. This will depend on capacity and available man hours at the different locations and is currently under investigation. As for the geochemistry part, additional analyses to screen for other, general bacterial phospholipid fatty acids (PLFAs) will be carried out at North Wyke Research by dr. J. Dungait. Besides creating a general reference background for interpretation of the GDGT data, this will also provide insight into changes within larger scale bacterial communities in a grassland over the course of a year.

I also talked with staff on the possibility to extend this project into a more long term valuable time series data set. It is clear to me that they are willing to do so, however, lack in finance, i.e. staff allocation, hinders this at the moment. It has been decided therefore to await the results of the sample series currently under investigation. Based on these results we will then try to write a proposal for continuation of the time series.

Future collaboration with host institution

Collaboration on the current project will continue, most likely extended with additional molecular biology work. Other potential future projects that we talked about include carbon isotopic labeling studies on this grassland soil which could provide additional information on the as yet unknown bacteria that produce the GDGT compounds.

Projected publications to result from your grant

Most likely there will emerge a publication on the abundance and distribution of branched GDGTs over four different seasons and its implications for the use of these compounds in palaeoclimate reconstructions. Publication of this paper is foreseen for the end of summer this year.

The PLFA analyses, together with the microbiological analyses are expected to result in a separate paper.

Data on archaeal derived GDGTs, might, depending on the results, also result in a separate publication.

Other comments

I am very grateful for the receipt of the MOLTER Short Visit Grant as this is an ideal means to stay over at a host laboratory for just that bit longer than a few days for a lecture. For me there have been multiple benefits to this two-week stay. First, I have been able to focus for two weeks on the labwork without a lot of distraction which means that in relative short time most of the wet-chemistry preparation of the samples has finished. Second, more time was available to brainstorm with the different researchers that are fully or partly involved in the project which might well result in extension of the current project or new future collaborations. Finally, being 'part of the community' for two weeks means that you really see what kind of research is carried out at the institute, what different analytical techniques are available and who is involved in that. This certainly has broadened my network into the soil sciences.