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POLAR AND APOLAR LIPIDS OF ANAEROBIC METHANOTROPHIC COMMUNITIES FROM MARINE SEEP ENVIRONMENTS AND THEIR RELATION TO ENVIRONMENTAL CONDITIONS

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Intact polar lipids (IPLs) are biomarkers for live biomass and are taxonomically specific (Sturt et al., 2004; Biddle et al., 2006). After cell decay, loss of the polar head group leaves behind apolar derivatives such as archaeol and hydroxyarchaeol, i.e., compounds that for long were the exclusive targets in the study of anaerobic oxidation of methane (AOM).

In a set of samples from a wide range of AOM sites around the globe, we are performing an integrated analysis of both IPLs and their apolar counterparts. Unlike relatively uniform distributions of apolar microbial lipids known from various AOM sites, the IPL distributions are highly diverse. An example is provided from microbial mats from the Black Sea (Fig. 1A), where compositional variations on small spatial scales are accompanied by changes of both total abundance of IPLs and the relative ratio of archaeal over bacterial IPLs (Fig. 1A).

Moreover, molecular ratios of polar and related apolar derivatives, e.g., diglycosyl-archaeol over archaeol (upper row, Fig. 1B), vary widely in different samples and likely reflect yet unconstrained differences in the status of AOM communities. On the other hand, the ratio involving diglyco-hydroxyarchaeol and hydroxyarchaeol (second row) is uniformly low, indicating that most hydroxyarchaeol is present in its apolar form and may be a relict of past methanotrophic communities. This is supported by incubations of these compounds in anaerobic, live sediments that show that the glycosidic headgroups are hydrolytically cleaved off rapidly (nearly complete degradation in a few months, depending on conditions). Community composition, on the other hand, appears to be most sensitively reflected by the relative proportions of polar GDGTs compared to polar archaeol (bottom row), with high relative amounts of GDGT typically being associated with ANME-1 communities. The high variability of polar and apolar lipids of microbial mats from the Black Sea on a small spatial scale is consistent with a high heterogeneity of these mats in terms of their community composition.

The microbial mats from the Black Sea served as a first proof of concept; our global survey of AOM communities is currently being extended to a wide range of marine settings hosting AOM communities. Consistent with the diversity suggested by parallel 16S rRNA-based studies, the lipid compositions from the various settings differ far more greatly than already observed in the Black Sea. We will focus on highlighting the relationship between various molecular parameters and environmental variables such as methane flux, sulfate availability, temperature, pressure etc. This approach will be specifically powerful for a better understanding of the factors that control AOM community distributions on a global scale.

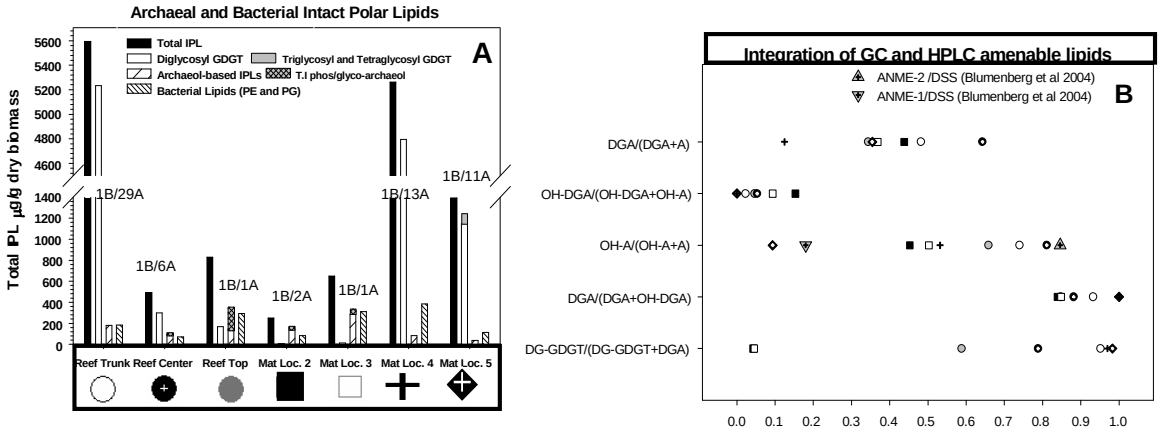

Figure 1. (A) Example of IPL concentrations (µg/g dry biomass) from five locations; archaeol base lipids include both Diglycosyl archaeol and Diglycosyl OH-archaeol, T.I is tentative identified as phospho/glycosyl-archaeol compound and B/A indicate the ratio of bacterial over archaeal lipids. (B) Integration of GC and HPLC amenable lipids (B); DG-GDGT (Diglycosyl GDGT), DGA (Diglycosyl archaeol), OH-DGA (Diglycosyl OH-archaeol), OH-A (OH-archaeol), A (archaeol).

REFERENCES

Biddle, J.F., Lipp, J.S., Lever, M.A., Lloyd, K.G,, Sorensen, K.B., Anderson, R., Fredricks, H.F., Elvert, M., Kelly, T.J., Schrag, D.P., Sogin, M.L., Brenchley, J.E., Teske, A., House, C.H., Hinrichs, K-U (2006) Heterotrophic Archaea dominate sedimentary subsurface ecosystems off Peru. Proceedings of the National Academy of Sciences of the United States of America 103, 3846-3851; 10.1073/pnas.0600035103.

Sturt, H.F., Summons, R.E., Smith, K.J., Elvert, M., Hinrichs, K.-U., 2004. Intact polar membrane lipids in prokaryotes and sediments deciphered by high-performance liquid chromatography/electrospray ionization multistage mass spectrometry - new biomarkers for biogeochemistry and microbial ecology. Rapid Communications in Mass Spectrometry 18, 617-628.