Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2017-324-RC2, 2017

Biogeosciences
Discussions

Interactive comment on "The Holocene sedimentary record of cyanobacterial glycolipids in the Baltic Sea: Evaluation of their application as tracers of past nitrogen fixation" *by* Martina Sollai et al.

Anonymous Referee #2

Received and published: 15 September 2017

This manuscript is a substantial contribution to developing a molecular proxy for N2-fixation in the geological record, namely the diagnostic glycolipids indicative of heterocyst envelopes. The manuscript is very well written, structured, and points are well argued. The amount of analyses is staggering and I definitely support publication of the paper. An impressive set of analyses of these heterocyst glycolipids (HGs) in dated sediment cores from the Baltic Sea are the basis on which the authors explore some very interesting ideas: The modern Baltic Sea is known for massive blooms of two species of cyanobacteria and there is evidence from molecular and isotope data that

they occurred during much of the Littorina Sea (LS) Stage and subsequent brackish phases. Whether N-fixation was a feature in the pre-Littorina lacustrine stages was unknown (at least to me). A first objective was to test if the HG patterns give evidence for alternating communities mirrored in HG distribution patterns. That appears indeed to be the case. HG patterns have been remarkably stable over the last 7000 years or so, although HG abundances in the short core show a typical decrease in their contribution to total organic carbon (TOC) that suggests that they are more rapidly degraded than bulk TOC (Fig. 6 upper left). Below 200 cm in the longer core, both abundances relative to TOC and HG composition are highly variable. These variations characterize the lacustrine Ancylus Lake (AL) Stage, that must have received input of organic matter containing HGs. Here are my first questions: What are the HG patterns of soil cyanobacteria, and is the input of soil-derived TOC a possible source and also possibly a reason for differences in AL and LS sediments? I seem to remember that lignin biomarker abundance increased at the AL/LS transition. What are the levels of r.u. compared to other depositional settings? Is the Baltic Sea particularly rich in HGs? A second (and interesting) objective was to investigate a fundamental biogeochemical feedback: Because the brackish Baltic Sea (LS and younger stages) experienced several alternations between oxic and anoxic conditions, it is a well-chosen environment to investigate whether or not development of anoxia and the Redfield homeostat (nitrogen fixation balancing a surplus of P originating from sediment or from denitrification) are linked, and if cyanobacterial biomass has an influence on the development of anoxia (or if anoxia had an influence of HG production). This is a difficult question and I wonder if it can be answered at all if you normalize your r.u. to %TOC. Are the unnormalised r.u. linearly correlated with %TOC? Figure 3a in comparison to 3 e suggests this. That would mean that TOC preserved is the overriding control on HG abundances (but not composition) – by normalizing to TOC, any variation in HG abundance will then be masked. If TOC is high in anoxic and low in oxic phases, the effects of production and preservation can in my opinion not be segregated. Does the downcore decrease in PC1 in the MUC mean that the HG are more labile than bulk TOC? In particular,

the relative abundances in Figure 4 suggest to me that C28 keto-diol and C26 keto-ol must be more rapidly degraded that the other moieties. Have you analysed the principal components for the MUC and GC separately, and are the score patterns similar to those for the entire sample pool?

The following are some queries, remarks and details Why do some labs continue to use acidified samples for d15N analyses in the face of ample evidence that this affects the values? But that is not crucial to this paper. Page 10 L14-29 and Figure 7: What is the correlation coefficient of the two data series? Is there an estimate of how much of the present-day cyanobacterial detritus reaches the sea floor in comparison to biomass produced? P3 L2: what is “fully brackish”? Figure 4: Labels are too small; Y-axis unit left graph must be “cm” Page 5 L16: delete “)” P9 L7: delete “permil” after salinity value

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2017-324, 2017.