Heterocyst glycolipids: A tool to investigate the importance of cyanobacterial N_2 fixation in the global nitrogen cycle

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Nitrogen (N) is an essential element needed for the synthesis of organic matter. Its availability in the oligotrophic regions of the world's oceans as well as in freshwater and coastal marine environments, however, may severely limit biological activity. The fixation of N_2 by cyanobacteria is of major importance in replenishing the pool of bioavailable N and thus in fuelling aquatic primary productivity. Current estimates on the quantity of N that is derived from a cyanobacterial origin, however, are associated with large uncertainties due to our incomplete knowledge on the distribution and activity of these diazotrophs in natural environments.

An interesting novel tool to trace for the presence of diazotrophic (N_2-fixing) cyanobacteria in both marine and freshwater environments as well as in the biogeochemical cycling of N is provided by heterocyst glycolipids (HGs). These components are found exclusively in the heterocyst cell envelope of diazotrophic cyanobacteria with their distribution varying significantly between individual cyanobacterial genera and families [1]. Here, we show that HGs are widely distributed in coastal-marine and lacustrine environments from polar to tropical climates and that their absolute abundance shows strong climate related variations with increased rates of N_2 fixation observed during interglacial cycles. In addition, variations in HG distribution patterns indicate significant changes in the community structure of N_2-fixing cyanobacteria with potentially more toxic species occurring during periods of increased warming. The use of HGs in paleoenvironmental studies thus allows for detailed investigations of the spatiotemporal distribution of N_2-fixing cyanobacterial communities in present and past ecosystems, while the abundance of HGs is a direct measure for cyanobacterial activity and constitutes a conservative measure for the amount of N supplied by diazotrophic cyanobacteria to the nitrogen cycle.

[1] Bauersachs (2009) *Phytochemistry* **70**, 2034-2039.