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Lifestyle assessment of branched tetraether source bacteria via root systems of different age and properties

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Branched glycerol dialkyl glycerol tetraethers (GDGTs) are complex lipids of high molecular weight, recently discovered in soils. They were suggested to be produced by still unknown anaerobic bacteria. The relative distribution of branched GDGTs was shown to depend on environmental parameters: the degree of methylation of branched GDGTs (MBT index) likely depends on air temperature and to a lesser extent on soil pH, whereas the relative abundance of cyclopentyl rings of branched GDGTs (CBT index) correlates well with soil pH. Even though over the last years an increasing number of studies have focused on the potential use of branched GDGTs as paleoclimate proxies, the ecological niche of their source organisms remains unknown. An improved knowledge of the habitat and lifestyle of branched GDGT-producing bacteria is essential to interpret the environmental data derived from these lipids. The aim of this work was to obtain more information on branched GDGT source bacteria via the analysis of branched GDGTs in the vicinity of root systems of different age and habitat. Calcified and non-calcified living and dead roots were selected. The distribution and abundance of branched GDGTs were determined in roots and surrounding soil/sediment collected from two forest sites on fluvial sand and loess near Sopron (Hungary). Living root samples and surrounding soil were collected between 0 and 0.5 m below present surface, whereas calcified root systems (rhizoliths) were collected at 1.5 – 1.8 m depth. Reference sediment samples without visible root remains were collected 50-70 cm distant from the rhizoliths. Ancient roots (ca. 3000-yr age) and surrounding sediments were also collected at 2.2-2.6m in a loess-paleosol sequence located in Nussloch (SW Germany).

In living root systems from Hungary, branched GDGTs were especially abundant in fine roots (<2 mm) and in the close vicinity of all roots (rhizosphere) and were less concentrated in the larger roots (>2 mm) themselves. This suggests that branched GDGT producing bacteria are associated with the root surface and most likely feed on root exudates in living root systems. In ancient root systems from Germany, the concentration of branched GDGTs was higher in the rhizoliths than in the former rhizosphere and the reference sediment, suggesting that branched GDGT source bacteria might also feed on root remains. In addition, some calcified root systems from Hungary were decarbonatized with hydrochloric acid prior to GDGT analysis. This did not significantly change the abundance and distribution of branched GDGTs, suggesting that branched GDGT source microorganisms are closely connected to the root surfaces. Consequently, in the close rhizosphere, branched GDGT distribution and thus GDGT-derived temperature estimates might be influenced by the presence of roots, which is likely not the case in distant soils.

In summary, the results from living and ancient root systems suggest that branched GDGTs might be produced by different bacterial communities in living and ancient root systems and/or that branched GDGT source bacteria might change their feeding depending on substrate availability.