3-HYDROXY FATTY ACIDS: NEW (PALEO)ENVIRONMENTAL PROXIES IN SOILS?

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Paleoclimate studies are much less frequent in continental environments than in marine ones, as environmental proxies were mainly developed and used in oceanic settings. It is therefore essential to develop new proxies also applicable to continental environments, which would help in improving our understanding of past global climate. Membrane lipids biosynthesized by some microorganisms can be used to this aim. Thus, the structure of glycerol dialkyl glycerol tetraethers, produced by archaea and some unknown bacteria, is known to vary with environmental parameters. The analysis of bacterial-derived branched GDGTs (brGDGTs) in a large number of soils distributed worldwide showed that the methylation degree of these molecules (MBT index) is correlated with mean annual air temperature (MAAT) and to a lesser extent with soil pH, whereas their average cyclisation ratio (CBT index) depends mainly on soil pH (Weijers et al., 2007). brGDGTs have been the object of a growing interest over the last years, as they are to date the only available organic proxies which can be used for terrestrial paleoclimate reconstructions. Nevertheless, paleoenvironmental data derived from brGDGTs have to be interpreted with care, as we have only a limited knowledge about these compounds and their source microorganisms. Other parameters than temperature and pH, such as soil moisture, may notably impact brGDGT distribution. The development of new environmental proxies independent and complementary to brGDGTs is required to improve the reliability and accuracy of terrestrial environmental reconstructions and to provide constraints on brGDGT application.
3-hydroxy fatty acids (3-OH FAs), which are membrane lipids produced by Gram-negative bacteria, could be used as such proxies. Very recently, Wang et al. (2016) analysed these compounds in soils collected between 315 and 2840 m altitude along Mt. Shennongjia (China). They showed that the ratio of the summed *iso* and *anteiso* to the total amount of *normal* 3-OH FAs (defined as the RIAN index) was correlated with soil pH, and that the *anteiso* to *normal* 3-hydroxy fatty acids ratio of the C_{15} and C_{17} compounds (RAN_{15} and RAN_{17} indices, respectively) was correlated with MAAT. Nevertheless, these correlations are based on a limited dataset and have to be confirmed after analysis of a larger number of soils.

The aim of this work was to test the applicability of 3-OH FAs as temperature and pH proxies in 21 soils collected between 520 and 2800 m along Mt. Rungwe (southwestern Tanzania). These samples were previously investigated for their brGDGT content and distribution (Coffinet et al., 2014). 3-OH FAs were extracted from soil and then analysed by gas chromatography coupled to mass spectrometry as described by Wang et al. (2016). Compounds with a chain length varying between 10 and 26 C were detected in all samples, with odd- and normal chain 3-OH FAs being predominant. Total concentration in 3-OH FAs ranged between 1.3 and 26.1 µg/g dry weight soil.
The correlations between the relative abundance of the 3-OH FAs in soils from Mt. Rungwe and environmental parameters were investigated. RIAN was moderately negatively correlated with soil pH (R^2 0.43) along Mt. Rungwe, in contrast with Mt. Shennongjia, where this index

was strongly negatively correlated with pH (R^2 0.77; Wang et al., 2016). This discrepancy could notably be due to the fact that the range of pH for Mt. Rungwe soils is much lower (5.5-7.5) than for Mt. Shennongjia samples (4-8), which may weaken the correlation between RIAN and pH.
In the same way, RAN_{17} was more weakly correlated with MAAT along Mt. Rungwe (R^2 0.21) than along Mt. Shennongjia (R^2 0.48; Wang et al., 2016), which questions the global applicability of this index as a temperature proxy in soils.
In contrast, RAN_{15} was strongly negatively correlated with MAAT along Mt. Rungwe (R^2 0.70; Fig. 1), as also previously observed along Mt. Shennongjia (R^2 0.53; Wang et al., 2016). When combining the results of the two mountains, a significant ($p<0.05$) negative correlation between RAN_{15} and MAAT was obtained (R^2 0.70; Fig. 1). This suggests that RAN_{15} is a promising temperature proxy in terrestrial environments. 3-OH FAs will be analysed in a larger number of soils from all over the world to generalize the relationship between RAN_{15} and MAAT observed along Mt. Rungwe and Mt. Shennongjia.

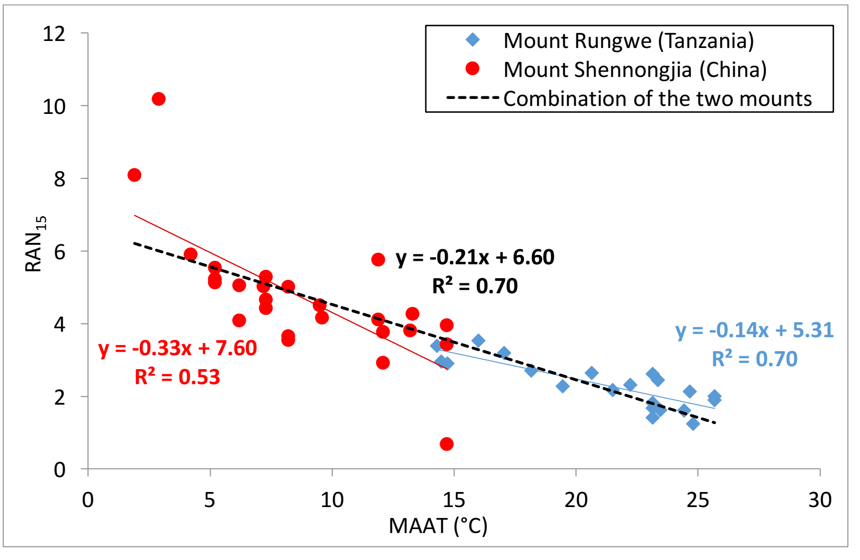

Figure 1. *Relationship between RAN_{15} ratio and recorded MAAT for soil samples collected along Mount Shennongjia (red circles; Wang et al., 2016) and Mount Rungwe (blue diamonds). The dark dotted line shows the correlation combining the data of the two mounts.*

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