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Dependence of CUE and microbial carbon pools on soil C:N ratios along a tropical altitudinal gradient

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High microbial carbon use efficiency (CUE) indicates greater proportion of metabolized C converted to microbial biomass, and thus it increases the potential for C to become stabilised in soil as dead microbial biomass remains according to the "soil microbial carbon pump" concept. According to the theory of ecological stoichiometry microbial CUE decreases with increasing soil C:N ratio, or increasing N limitation, but it is not known whether CUE could also directly predict the accumulation of microbial residues, such as amino sugars, into the soil, or whether this process is more affected by other environmental factors than CUE and stoichiometry.

In order to test the hypotheses on the linkage between CUE, soil C:N ratios and microbial carbon pools, we established soil sampling plots along an altitudinal gradient (900 to 2200 m above sea level) in the Taita Hills, in south-eastern Kenya. We hypothesised that microbial N-limitation will increase with altitude when moving from the low elevation drier forests to the moist montane forests. Increasing C:N ratios with elevation would allow us to test our second hypothesis that according to the theory of ecological stoichiometry microbial CUE decreases with increasing soil C:N ratio, or increasing N limitation. We will also study whether CUE is directly linked to accumulation of microbial residues (amino sugars) in soil.

Seven sites were investigated along the elevation gradient and three 10x10 m plots were sampled at each site. At each plot, 20 soil cores were taken from 0-10 cm depth and pooled to make up a composite sample.

To test the first hypothesis, we measured C and N concentrations in soil and microbial biomass. The average soil C% ($r=0.92$, $p=0.003$), soil N% ($r=0.90$, $p=0.006$) and soil C:N ratios ($r=0.90$, $p=0.006$) increased with elevation. There was also an increasing trend in the average microbial C:N ratios with elevation ($r=0.69$, $p=0.086$). We measured enzyme activities using MUF-substrates, and found that there was a trend of increasing NAGase activity with elevation ($r = 0.68$, $p=0.096$) and C:N ratio ($r = 0.74$, $p=0.059$), supporting the hypothesis of increasing N limitation with altitude. However, NAGase activity was not related to total soil N%, indicating that total soil N content, or bulk soil C:N ratio may not be good indicators for microbial N availability.

Microbial CUE was determined using two methods: ^{13}C glucose tracing (24 h incubation at 15 °C), and the ^{18}O method. We are currently calculating the results from these analyses. Preliminary results indicate that the specific respiration rates (μg CO_2-C produces per g soil C) were best correlated with the ratio of cellobiosidase/peroxidase enzyme activities ($r=0.95$, $p=0.001$) that can be used as an index of SOM quality. Specific respiration rates were highest in the two low elevation forest sites that had high cellobiasidase activity, while they were lower at high elevation sites with high peroxidase activity linked to decomposition of low quality, recalcitrant C. It seems therefore likely that along our gradient the quality of SOM is more important in determining CUE than stoichiometry.