What controls microbial growth in tropical soils? The role of carbon and phosphorus.

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Tropical forest ecosystems are important components of global biogeochemical cycling. Many tropical rainforests grow in old and highly weathered soils, depleted in phosphorus (P) and net primary productivity in tropical forests is often limited by P availability. It is unclear, however, if heterotrophic microbial communities in tropical soils are also limited by P or rather by carbon (C). Elemental limitations of microorganisms in soil have often been approached by measurements of respiration rates in response to additions of nutrients or carbon. However, it has been argued lately, that microbial growth rather than respiration should be used to assess limitations.

In this study we therefore ask the question whether the growth of heterotrophic microbial communities in tropical soil is limited by available phosphorus or by carbon. We collected soils from three sites along a topographic gradient (plateau, slope, bottom) differing in soil texture, total and available P concentrations from a well-studied, P-poor region in Nouragues, French Guiana. We incubated these soils in the laboratory with C in the form of cellulose, inorganic phosphorus and with a combination of both, and studied microbial growth by measuring the $^{18}$O incorporation from labelled water into microbial DNA. Moreover, we measured microbial respiration and determined microbial biomass C, N (nitrogen) and P.

Our results demonstrate that, although microbial biomass C and N was similar in soil collected from all three topographic sites, soil respiration rates were significantly higher in soils from the plateau indicating a more active microbial community. Microbial C and N did not respond to cellulose and inorganic P additions, only microbial P increased significantly when P was added in all soils. Although microbial biomass C was not increased, C and P additions stimulated microbial respiration in clay rich plateau soils. In slope soils microbial communities initially only increased respiration activity in response to P additions, however at the end of the incubation also C showed significant differences in respiration activity, with strongest increases when C and P were added in combination. In sandier bottom soils microorganisms responded with increased activity to C addition, but also here respiration showed strongest increases in response to combined carbon and phosphorus additions. We will discuss these findings in relation to the pattern of gross growth rates in these soils and evaluate the stoichiometric limitations of microbial activity and turnover.