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Cyanate – An overlooked energy and nitrogen source in soils?

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Cyanate (NCO-) is a reduced nitrogen compound that is toxic to organisms due to its reactivity with nucleophilic groups in proteins. To lower cyanate concentrations within cells, a wide range of microorganisms possess a cyanase, which catalyzes the conversion of cyanate to ammonium and carbon dioxide. However, cyanate can also be useful for microbes by serving as a nitrogen source for cyanase-encoding microorganism, such as marine cyanobacteria (Kamennaya et al., 2008). Unexpectedly, we could recently demonstrate that at least one ammonia-oxidizing thaumarchaeote as well as nitrite-oxidizers thriving in consortia with ammonia-oxidizers can grow aerobically on cyanate as only energy and nitrogen source (Palatinszky et al., 2015). Furthermore, published metagenomes revealed that cyanase-encoding genes closely related to those of nitrifiers (ammonia- and nitrite-oxidizers) are widespread in the environment and encompass also cyanases affiliated with anammox organisms. Therefore, cyanate presumably presents an alternative nitrogen and also energy source for many microorganisms in aquatic and terrestrial environments.

Surprisingly, cyanate concentrations and fluxes in natural environments are largely unknown, and environmental cyanate concentrations have only been studied in seawater so far, where it occurs in the nanomolar-range (Widner et al. 2013). No information about the importance of cyanate in soils is available, although urea that spontaneously decomposes to cyanate is the most used agricultural fertilizer on a global scale. Cyanate can have many fates in soils - it can be (1) used as nitrogen and/or energy source by cyanase-encoding microorganisms, (2) abiotically hydrolysed to ammonium and carbon dioxide, (3) adsorbed to soil particles, or (4) complexed with other compounds. Here we present the first measurements of cyanate concentrations in natural soils and results of experiments designed to differentiate between biotic and abiotic degradation of cyanate in soils. We also introduce new cultivation and labelling-techniques that should allow us to study the importance of cyanate for microbial metabolism in terrestrial ecosystems.

References

Kamennaya, N. A., M. Chernihovsky, and A. F. Post (2008). The cyanate utilization capacity of marine unicellular cyanobacteria. Limnol Oceanogr 53:2485-2494.

Palatinszky, M., C. Herbold, N. Jehmlich, M. Pogoda, P. Han, M. von Bergen, I. Lagkouvardos, S. M. Karst, A. Galushko, H. Koch, D. Berry, H. Daims, and M. Wagner (2015). Cyanate as energy source for nitrifiers. Nature 524:105-108.

Widner, B., M. R. Mulholland, and K. Mopper (2013). Chromatographic determination of nanomolar cyanate concentrations in estuarine and sea waters by precolumn fluorescence derivatization. Anal Chem 85:6661-6666.