Mechanical Engineering Department Seminar

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1130 Mechanical Engineering
111 Church Street SE, Minneapolis, MN 55455

Structure and Activity of Denitrifier Communities in Biochar-Amended Soil and Their Impact on N_2O Emissions

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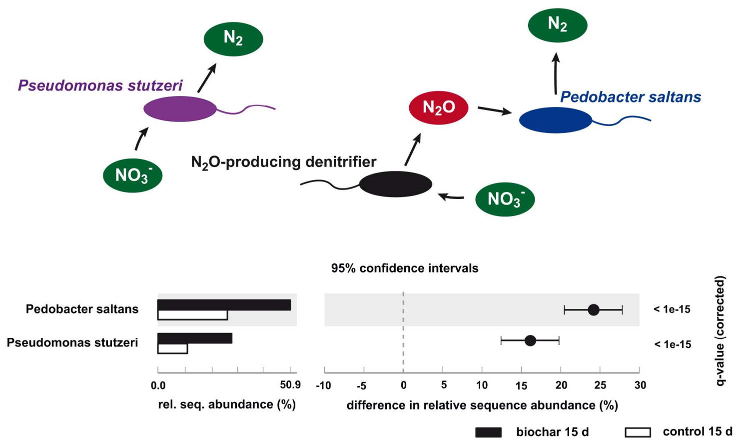
Nitrous oxide is a greenhouse gas with a global warming potential about 300 times higher than CO_2. The main sources of N_2O are microbial-mediated nitrogen transformation reactions in soils. Denitrification represents one of the major N_2O-producing pathways in oxygen-limited zones. Soil biochar amendment has been demonstrated to reduce N_2O emissions in microcosms and in the field. Although N_2O emission mitigation due to soil biochar amendment has frequently been reported for different soils and biochars it remains unclear how biochar affects the structure and activity of the denitrifying microbial community in soils. We setup soil microcosms containing wood-derived biochar and quantified $^{15}NO_3^-$-derived $^{15}N_2O$ and $^{15}N_2$ emission rates. Genes and transcripts of functional marker genes for microbial denitrification were quantified by qPCR and analyzed by Illumina sequencing. Soil biochar amendment did not alter N_2O sources, but decreased NO_3^--derived N_2O emission rates by increasing the quantity of N_2 entrapped in the soil matrix. Furthermore biochar addition promoted the expression of functional marker genes for complete microbial denitrification. Sequence analyses of the N-cycling marker genes and their transcripts revealed biochar induced community shifts. While 16S rRNA gene diversity was only slightly affect by biochar, functional gene abundance and transcription levels varied among taxonomic groups over time suggesting the contribution of rare but active taxa to soil N_2O emissions. Our findings further the mechanistic understanding of the complex coupling between nitrogen pools, nitrogen-transforming microorganisms and nitrogen gas fluxes in pyrogenic carbon amended soils. Implications of the presented research for the development of biofilter for the removal of nitrate from water will be discussed.



Bio: Sebastian F. Behrens is an Associate Professor of Civil, Environmental, and Geo- Engineering at the University of Minnesota. Dr. Behrens' research focuses on linking environmental processes to the spatial-temporal distribution and metabolic activity of key functional groups of microorganisms. He follows an interdisciplinary approach that combines the disciplines biogeochemistry, microbiology, and molecular biology to understand the ecological principles driving the biogeochemical cycling of metals and metalloids, the biodegradation of organic contaminants, and the emission of greenhouse gases from the microbial to the ecosystem level. The gained knowledge on microbial transformation processes in natural and engineered ecosystems is then implemented in order to optimize microbial remediation approaches, resource recovery, and the biological treatment of water (drinking water, surface water, groundwater, or waste water), thereby spanning the gap between basic and applied research aspects of bioremediation. Behrens received his B.S. in Biology (1997) and Diploma in Microbiology (2000) from the University of Bremen in Germany, and Ph.D. in Microbial Ecology from the Max Planck Institute for Marine Microbiology in Germany in 2003.