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Tank bromeliad – a natural model ecosystem for methane cycling research

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Tank bromeliads are common epiphytes throughout neotropical forest ecosystems. They are relatively small discrete habitats for terrestrial and aquatic macro- and microorganisms and naturally replicated. Their tanks effectively collect leaf litter and water and harbor a diverse microbial community. Up to several thousands of these tank bromeliads per hectare of tropical forest create a unique wetland ecosystem responsible for significant methane emissions.
In a field study in tropical montane forests of southern Ecuador we sampled tank bromeliads of different species, size and canopy height and found that tank water availability controlled community composition of methanogenic archaea, determined by molecular analysis of the archaeal 16S rRNA genes. We set up a greenhouse experiment to investigate drying and re-wetting effects on microbial community composition and methanogenesis. Additionally, we conducted 13-CH-4 and 13-CO-2 labeling studies to investigate potential interaction of plant and microbial metabolism during methane cycling in tank bromeliads. Drying resulted in rapid change of the microbial community composition. The relative abundance of acetoclastic methanogens increased and that of hydrogenotrophic methanogens decreased with decreasing tank water availability confirming our field observations. Labeling studies showed that carbon was released from the plant into the tank supporting methanogenesis and that tank-produced methane was ventilated through the bromeliad leaf structure into the atmosphere which is analogous to the rhizosphere environment of wetland ecosystems.
The bromeliad ecosystem may therefore provide a natural model to study how environmental changes and plant-microbe interactions drive methane cycling in aquatic-terrestrial ecosystems.