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Forest strata drive spatial structure of bacterial and archaeal communities and microbial methane cycling in neotropical bromeliad wetlands

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Several thousands of tank bromeliads per hectare of neotropical forest create a unique wetland ecosystem that harbors diverse communities of archaea and bacteria and emit substantial amounts of methane. We studied spatial distribution of archaeal and bacterial communities, microbial methane cycling and their environmental drivers in tank bromeliad wetlands. We selected tank bromeliads of different species and functional types (terrestrial and canopy bromeliads) in a neotropical montane forest of Southern Ecuador and sampled the organic tank slurry. Archaeal and bacterial communities were characterized using terminal-restriction fragment length polymorphism (T-RFLP) and Illumina MiSeq sequencing, respectively, and linked with physico-chemical tank-slurry properties. Additionally, we performed tank-slurry incubations to measure methane production potential, stable carbon isotope fractionation and pathway of methane formation. Archaeal and bacterial community composition in bromeliad wetlands was dominated by methanogens and by Alphaproteobacteria, respectively, and did not differ between species but between functional types. Hydrogenotrophic Methanomicrobiales were the dominant methanogens among all bromeliads but the relative abundance of aceticlastic Methanosaetaceae increased in terrestrial bromeliads. Complementary, hydrogenotrophic methanogenesis was the dominant pathway of methane formation but the relative contribution of aceticlastic methanogenesis increased in terrestrial bromeliads and led to a concomitant increase in total methane production. Rhodospirillales were characteristic for canopy bromeliads, Planctomycetales and Actinomycetalis for terrestrial bromeliads. While nitrogen concentration and pH explained 32% of the archaeal community variability, 29% of the bacterial community variability was explained by nitrogen, acetate and propionate concentrations. Our study demonstrates that bromeliad functional types, associated with different forest strata, and their constrained environmental characteristics shape the spatial structure of archaeal and bacterial communities and microbial methane cycling in neotropical bromeliad wetlands.