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Responses, drivers and balance strategies of nitrogen-cycling microbial communities to nitrogen and phosphorus additions in subtropical and temperate forest soils

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There are negative effects from the current ongoing increases in nitrogen (N) deposition, such as soil acidification, imbalance in nutrient stoichiometry, and phosphorus (P) limitations. Even with concentrated research efforts on N cycling in forest ecosystems, we still do not have a comprehensive understanding of how N-cycling microbial communities respond to N and P additions in forest soils. The environmental conditions vary considerably between subtropical and temperate forests in eastern China, with subtropical soils are relatively N-rich and P-deficient while temperate forest soils are generally rich in P and organic C, but deficient in N. We investigated how major N-cycling microbial communities response to N and/or P additions, determined the importance of various environmental and biological factors on potential enzyme activities, and evaluated the microbial strategy in N processes in a subtropical and a temperate forest soils. We found that there were clear differences between the enzyme activities, and the characteristics of their corresponding microbial communities, in the temperate and subtropical forest soils, and that the functional groups were more abundant, and the potential enzyme activities were higher, in the former than in the latter. Our results showed that the abundances of most N-cycling functional genes positively responded to P-treated fertilizations in the N-rich subtropical forests soils. The abundance of ammonia-oxidizing bacteria positively while diazotrophic communities negatively responded to N-treated fertilizations in the relative N-poor temperate forest soils. We found differed genetic structures of most N-cycling communities between the subtropical and temperate forest soils while absent of change when fertilizers were applied. Stepwise multiple regression analyses indicates that the soil environmental conditions, such as soil N to P ratio, carbon to N ratio, ammonium and P concentrations, and soil pH are more important drivers than the abundances and community structures of N-cycling microbes for certain functional traits in forest soils fertilized with N and P. In the potential enzyme activity level, compared with control, the enzyme activity of N mineralization and N fixation decreased in the subtropical forest and the temperate forest soils, respectively to reduce available N inputs into soils with N additions. While most N-cycling enzyme activities were increased with P additions in both sites, suggesting that exogenous P could accelerate nitrogen turnover rates in forest soils. In the genetic potential level, the proportion of diazotrophic community decreased while nitrifying and denitrifying communities increased in the N fertilized temperate forest soils, which suggested increased available N loss potentials.