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Sequestration of organic nitrogen in a paddy soil chronosequence as assessed by amino sugars molecular markers

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Available nitrogen is a limiting factor in paddy rice systems due to ammonia volatilization, denitrification and stabilization in organic complexes. Soil organic nitrogen (SON) might therefore constitute a critical component of the nitrogen cycle in rice systems. The objective of this study was to elucidate the role of microorganisms for the sequestration of paddy N in organic forms. For this purpose we analyzed amino sugars as markers for the residues of bacteria and fungi in a chronosequence of soils that were used for paddy rice production for a period of 0 to 2000 years in the Hangzhou bay area in Southeast China.

Within the soil profile, amino sugar concentrations were generally highest in the puddled Ap horizon and decreased with increasing depth along with organic carbon concentrations regardless of the time of rice cultivation. Nevertheless, a sharp increase of total amino sugar concentration from 0.1 g kg^{-1} to 0.3 g kg^{-1} was observed in the Ah horizon when comparing tidal wetland to salt marsh that had been impoldered 30 years ago, indicating an increasing importance of microbial residues in SON stabilization following the conversion of the semiaquatic marsh to a terrestrial system. With increased time of paddy rice cropping, amino sugar concentrations continued to increase up to a maximum of 2.1 g kg^{-1} after 300 years of paddy cultivation but declined again to 1 g kg^{-1} in soils with 700–2000 years history of cultivation despite increasing organic matter accumulation. Changes in the composition of the amino sugars were also most pronounced at initial stages of paddy rice management. The proportions of glucosamine (abundant in fungal chitin) decreased during the first 50 years of cultivation relative to mainly galactosamine (abundant in bacterial gums) and muramic acid (abundant in bacterial peptidoglycan), that remained at constantly low levels. At later stages of paddy rice cultivation, the ratios of glucosamine to galactosamine and to muramic acid re-increased.

We conclude that microorganisms significantly contribute to the sequestration of paddy N in organic forms during the first 300 years of cropping, within an increasing contribution of bacteria as cropping time proceeds. At even longer periods of paddy rice cultivation, there appears to be a backshift to lower concentrations of microbial residues with higher proportions of fungal N remaining.