Iron and arsenic redox cycling in paddy soil

FANGBAI LI*, WEILIN HUANG, MIM HU, SHUANG LI AND PENGCHENG CHENG

Guangdong Institute of Eco-Environmental and Soil Sciences (email: cefbli@soil.gd.cn)

Arsenic (As) is an important pollutant in soils of south China. Its accumulation in rice has caused public concern over food safety in recent years. Due to the periodical flooding, paddy soils have highly heterogeneous microbial community that constrains redox cycling of nitrogen, iron and carbon. Recent studies showed that such unique biogeochemical cycling dominates the oxidation/reduction reactions of As and control its bioavailability and bioaccumulation in the artificial wetland. The research of our group has focused on identification and characterization of anaerobes that can couple reduction of nitrate and redox of iron with reduction of As(V) or oxidation of As(III). Simple coupling processes involving nitrate reduction and oxidation of either Fe(II) or As(III) were well documented in literature. We examined two different mixed cultures that involve multiple processes including nitrate reduction, Fe(II) oxidation and As(III) oxidation or As(V) reduction. The first experiment showed microbes can quickly oxidize As(III) to As(V) when nitrate and/or Fe(II) was added to the microcosms, indicating that As(III) oxidizer(s) was greatly stimulated. Nitrate reduction was also enhanced by As(III) oxidation without Fe(II). The second experiment demonstrated that As(V) could be reduced slowly to As(III) under anoxic condition, and was nearly shut down in the presence of nitrate or/and Fe(II). Microbial community structure and functional bacteria related to each process of Fe/As/N redox cycling were studied to elucidate the coupled mechanisms. We further studied a pure culture (*Rhodocyclaceae sp*. strain Paddy-1) for the coupled nitrate reduction, Fe(II) oxidation and As(V) reduction. The results indicated that Paddy-1 has an As(V) reductase *arsC* gene likely responsible for the As reduction. Such an As(V) reduction was shut down when Fe(II) or nitrate was added. Our study may provide new evidence of the coupled Fe/As/N redox cycling that constrains As bioavailability at the interphase of mineral-root-microbe.