

Functional Genomics and Ecology of Nitrogen Mineralization and Nitrification

Jeanette Norton

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Human activities have dramatically altered the global nitrogen cycle by increasing the amount of reactive nitrogen in the environment; human associated inputs of industrially produced N fertilizers and N fixation by crops now exceed the natural N inputs to terrestrial systems. Nitrifying microorganisms play critical roles in the movement of this reactive nitrogen through ecosystems and in the availability of nitrogen for plant growth. In many agricultural soils when available nitrogen supply exceeds plant demand, nitrification increases leading to accumulation of nitrate that is reactive and mobile in the environment. The nitrogen use efficiency of our N fertilizers in agricultural systems remains quite low, typically only around 30% in cereal crops. Nitrification may lead to losses of nitrogen by leaching and denitrification. Nitrate leaching from agricultural systems is a significant contribution to the contamination of surface and groundwater. Nitrification therefore needs to be managed to protect the quality of surface waters and soils. Information is needed on the physiology and

ecology of the bacteria and archaea responsible for cycling nitrate in ecosystems. The transformations of organic nitrogen are of increasing importance in organic agriculture. We will further understand the role of organic versus mineral N fertilizers in promoting nitrification. We will improve understanding of the genomics of nitrifiers, characterize the processes in agricultural and wildland systems and examine links between nitrification and plants in soils. Improved understanding of nitrifying bacteria and archaea in soils and in wastewater systems may suggest management options for particular environments. Delineation of the limiting factors for nitrification in water delivery and wastewater treatment systems will help municipal and other government entities in preventing water pollution and planning for water reuse in the semi-arid and arid Intermountain West region.