

Investigating the Spread of Antimicrobial Resistance near Animal Facilities: Mechanisms of Extracellular DNA Transport and Transfer

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Justification:

The dissemination of pathogens from animal production systems is an important public health concern, and it is compounded by the fact that many of these pathogens are resistant to antimicrobials.

Objectives:

To understand the transfer of antibiotic resistance genes and identify efficient measures to minimize these transfers, an interdisciplinary approach was used to identify physical and chemical factors that control the fate and biological availability of extracellular DNA. Quartz crystal microbalance with dissipation (QCM-D) was used to study extracellular DNA adsorption and the conformation of the adsorbed DNA on silica and natural organic matter (NOM) surfaces. In this work, gene transfer was assessed under the same conditions using natural transformation of chromosomal DNA into soil bacteria *Azotobacter vinelandii* to explore the relationships among environmental parameters, DNA adsorption, and the efficiency and rate of gene transfer for pure cultures. Solution chemistry was varied systematically to investigate the role of adsorbed DNA conformation on transformation.

Progress to date:

DNA adsorbed to silica surfaces has a more compact and rigid conformation in the presence of 1 mM Ca^{2+} compared to 200mM Na^+ , but the reverse is true when DNA is adsorbed to NOM. Transformation frequencies were measured for extracellular DNA either dissolved in liquid or adsorbed on silica and NOM surfaces, each under different solution chemistries. Transformation efficiencies of both dissolved DNA and adsorbed DNA with different conformations were within the same order of magnitude. Results indicate that solution ionic composition, such as Ca^{2+} content in groundwater, will influence the amount of DNA that is adsorbed and therefore resistant to enzymatic degradation, but the conformation, and indeed adsorption itself, does not change the availability of DNA for transformation of *A. vinelandii*.

Impacts:

The fact that similar transformation efficiencies were observed for dissolved and adsorbed DNA suggests that adsorbed DNA is fully bioavailable and could be an important source in environmental gene transfer. Our initial results suggest that mathematical modeling of natural transformation may need to include only the amount of DNA adsorbed to soil surfaces, not the conformation of the adsorbed DNA. We have presented our work at the American Geophysical Union Fall Meeting, December 15-19, San Francisco.