Preface

For well over 100 years, humans have learned how to alter the biogeochemistry of the Earth toward our own benefit. Nowhere is this trend clearer than in the nitrogen cycle where humans are now responsible for greater than 50% of the reactive-N (nitrogen) input to the biosphere, mostly in the form of chemically produced ammonium-based fertilizer for agricultural production. Humans have also harnessed the power of the N cycle to clean wastewater in more efficient ways and are using N-cycle microorganisms and their enzymes to monitor toxicity and contribute to pollutant remediation in a variety of industrial processes and ecosystems.

Research on the transformation of reactive N in an environmental context has lagged behind similar research in the biomedical field. Until recently, this stagnation was largely due to missing instrumentation, tools, and molecular methods to describe and discriminate among the organisms and enzymes involved in transforming reactive N within a vast diversity of habitats. Due to several important breakthroughs over the past decade, the momentum has shifted and serious gains have been made in our understanding of how to measure and monitor reactive N transformations in nature. Through the application of improved methodologies and molecular tools, new groups of organisms including the anerobic ammonia-oxidizing bacteria (anammox Process: 1999; molecular verification: 2006) and the ammonia-oxidizing Thaumarchaea have been added to the growing list of microorganisms that carry out important, and perhaps ancient (anammox) to very recent (ammonia-oxidizing Thaumarchaea), steps in the conversion of reactive N. In large part, our discovery and understanding of environmentally relevant N-cycle organisms has accelerated due to a convergence with high-throughput genome sequencing and proteomics technologies. We now have an ever-increasing number of complete genome sequences to apply postgenomic tools for transcriptomic and proteomic analysis and were early adopters of metagenomics tools to better describe enriched or uncultivated microorganisms.

The idea for developing a volume on "Research on Nitrification and Related Processes" came after a productive international meeting on the Nitrogen Cycle organized by the Agouron Institute in Scottsdale, Arizona, in October 2009 (http://agi.org/pdf/nmtg-abstracts/NMtgAbstractsforWeb.pdf), where we presented work on N-cycle evolution and the function of aerobic ammonia-oxidizing microorganisms. The Agouron Nitrogen meeting succeeded another significant event in the N-cycle community: the first

International Conference on Nitrification (ICoN1) organized by the Nitrification Network (http://nitrificationnetwork.org/news%20and%20events.php#icon1) in Louisville, Kentucky, July 2009. We are now swiftly approaching the second meeting, ICoN2, which will be held in Nijmegen, the Netherlands, July 3–7, 2011. Both ICoN1 and ICoN2 were made possible by support from the U.S. National Science Foundation and the Gordon and Betty Moore Foundation. In addition, the University of Louisville supported ICoN1. Because of these international gatherings, we have become better informed as a community about the existing wealth of new approaches to gather and analyze data in N-cycle research, which led Martin to take on guest editorship for these two volumes 486 (Part A) and 496 (Part B) of *Methods in Enzymology* and Lisa to join as a guest editor of Part B to round out coverage on research areas on reactive N in environmental and application-based contexts. The chapters span the range of organisms and environments from basic to highly applied research areas. We believe that the readership will greatly benefit from both parts of this series, whether new or old to the field, as these chapters represent state-of-the-art techniques developed specifically to study reactive N transformations.

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