Master project on the evolutionary history of microorganisms involved in the nitrogen cycle

Location: Soil Microbiology Group, Swedish University of Agricultural Sciences (SLU), Uppsala.
Start: flexible but not earlier than September 2026.
Credits: preferably 60 hp but can be discussed.
Subject area: Biology or Bioinformatics.

Background: Ammonifiers are bacteria that use the enzyme NrfA to transform nitrate into ammonium and our work has shown that they are important players in the global nitrogen cycle[1]. Molecular clock analyses further suggest that NrfA diversified after the Great Oxidation Event (ca. 2-2.5 billion years ago), indicating that ammonifiers have co-evolved with the Earth's environment under approximately half the history of our planet.

At the same time, recent advances in the study of quinones, key components of energy metabolism that function across a wide range of oxygen conditions[2], raise intriguing questions about their potential role in ammonification. Yet, the evolutionary history of ammonifiers and the influence of oxygen on their diversification remain poorly understood.

Project aims and description: This project will investigate genome-level events (i.e. gene duplications, losses and transfers) that have contributed to the evolution of ammonifiers. Specifically, we will try to answer the following questions:

1. What horizontal gene transfers are likely to have occurred and do they involve entire operons or individual genes?
2. How has the evolution of quinone repertoires accompanied the diversification of ammonifiers?

The master's student will annotate genomes for genes associated to *nrfA* and perform phylogenetic analyses to identify patterns of evolution and diversification.

We aim to publish the results in a peer-reviewed journal, with the master's student as first or co-first author.

Supervisors: Aurélien Saghaï (aurelien.saghai@slu.se), microbial ecologist at SLU, and Sophie Abby (sophie.abby@univ-grenoble-alpes.fr), evolutionary biologist at CNRS, France.

Contact: Please send your CV and a one-page motivation to Aurélien Saghaï (aurelien.saghai@slu.se).

[1] https://doi.org/10.1038/s41467-023-44022-3
[2] https://doi.org/10.1093/ismejo/wrae253