Potential new frontier in wastewater treatment: Boosting sulphur-based denitrification using cable bacteria

Supervisors:

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Background

We offer a full M.Eng. or Ph.D. scholarship as part of an MBIE-funded SMART Idea project titled: "Cable bacteria biofilm reactor for low-cost, zero-emissions removal of nitrate from wastewater". This project is a collaboration between NIWA, the University of Auckland, and ESR.

The successful candidate will be part of a team that will pioneer the commercial development of a small-footprint carbon-independent wastewater denitrification in NZ. Specifically, they will be among the first to explore the incorporation of cable bacteria to boost efficiencies in wastewater denitrification.

The science

Autotrophic denitrifying sulphur bacteria (ADSB) use a broad spectrum of sulphur-containing compounds (e.g., elemental sulphur (S^0), pyrite (FeS_2) paired with nitrate to gain energy, resulting in zero CO_2 and extremely low N_2O emissions. Therefore, ADSB can be engineered for the denitrification of low-carbon wastewater or smaller wastewater treatment plants, a missing piece of NZ's broader wastewater management.

We propose that the efficiency of ADSB can be significantly improved through a globally novel approach of incorporating "cable bacteria" in the denitrification process. Cable bacteria are unique filamentous ADSB that can conduct long-range (centimetres) electron transfer from one end of a filament to the other. This unique physiology allows them to act like wires across a sediment layer or sandy structures in the marine environment, circumventing electron donor and acceptor mass diffusion limits, such as for sulphide and O_2. We have obtained preliminary genetic evidence showing cable bacteria dwelling in sludge samples taken from wastewater treatment plants in Auckland.

We anticipate that this research will support future improvements in wastewater management best practice, for example, by providing new approaches that are more consistent with Māori values (e.g., interconnectedness with Papatūānuku), and of relevance to a range of primary sectors that Māori are heavily invested in (e.g., agriculture, aquaculture).

The methodology will include cultivation-independent molecular biology approaches, including shotgun metagenomics and rRNA gene sequencing, to study the diversity and function of cable bacteria.

Eligibility criteria

Start date: Negotiable

Scholarship package: It is envisaged that this position will be based at the University of Auckland School of Engineering. It comes with a full tuition fee cover for up to 1.5 years for M.Eng. or 3 years for Ph.D., and a tax-free scholarship. Applications will remain open until the position is filled.

Application documents required

- CV including contact details for 2-3 referees (including at least one academic reference).
- Academic transcript from previous study undertaken.
- A personal statement (max 2 pages) describing your motivation, interests and background related to the research project.

Selection process

All applications will be considered on their merits. Given the project's strong relevance to Māori, experience working with iwi/Māori will be considered. Although prior experience with bioinformatics or microbiology is not necessary, a willingness to upskill in these areas is essential. Candidates who progress to the interview stage of the process will be notified.

Contact

Enquiries/applications should be directed to Dr. Wei-Qin Zhuang (wq.zhuang@auckland.ac.nz) and Dr. Louise Weaver (louise.weaver@esr.cri.nz).