EBNet POC2021 Summary Sheet – Funded Projects

POC202101

Dr David Werner, Newcastle University (£25K desk-based)

Faecal pollution source tracking and quantitative microbial risk assessment methods for a suitcase laboratory

Proposal Summary

Using a suitcase laboratory that contains the MinION sequencing device of Oxford Nanopore Technologies, over 100 comprehensive water microbiome data sets have been collected from around the globe. This desk study will exploit the global data for the development of multivariate data analysis tools which facilitate faecal pollution source attribution and related quantitative microbial risk assessments by suitcase laboratory users. The aim is to facilitate the wider uptake of an affordable suitcase laboratory for molecular water microbiology in environmental surveying and wastewater treatment biotechnology applications around the world.

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POC202106

Dr Marta Vignola, University of Glasgow (£50K single discipline)

Bio-engineering of water biofilter communities for enhanced degradation of DOM

Proposal Summary

Dissolved Organic Matter (DOM) is ubiquitous in natural aquatic systems such as surface waters and deep or shallow groundwater, which are often the main sources for drinking water production. DOM is the prime contributor to heterotrophic regrowth in drinking water distribution systems and the main precursor of carcinogenic disinfection by-products (DBP). Thus, its removal is an essential component of water treatment and a primary concern for water utilities. The removal of DOM via biofiltration is an appealing technology: biofilters have been shown to degrade DOM biodegradable fractions; furthermore, they are characterised by lower chemical and energy consumption than conventional methods. However, the complexity of the ecological mechanisms controlling the microbial communities that drive the overall treatment process makes them unpredictable and difficult to control. Consequently, implementation within existing Drinking Water Treatment Plants (DWTPs) is complex, and technologies with higher chemical and energy demands have been traditionally preferred.

With this proposal, we aim to identify the ecological mechanisms underpinning the development of microbial communities at different depths of a biofilter with different abilities to degrade DOM fractions. We aim to translate these fundamental ecological theories into practical tools for biofilters design, taking the research in the field from technology readiness level (TRL) 1 to TRL3 with the potential to advance to higher TRLs. The outcomes of this work will be of interest to water utilities and biotech providers since mastering the mechanisms controlling the development of tailored microbial communities provides invaluable opportunities for any applications relying on these communities.

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POC202112

Dr Dana Ofiteru, Newcastle University (£50K single discipline)

Real time monitoring of Anaerobic Digestion microbial community as a foaming risk prediction method

Proposal Summary

The decomposition of the organic wastes generated by humans (estimated to be 105 billion tonnes/year) releases harmful methane and other greenhouse gas (GHG) emissions directly into the atmosphere. Methane is a much more potent GHG than CO2 and by simply managing the organic wastes more effectively we can cut global GHG emissions by 10% by 2030 (data from "Pathways to 2030", the report of the World Biogas Association published in March 2021). Anaerobic digestion (AD) is a "ready-to-use" technology which can prevent the methane emissions and generate biogas, bio-fertilisers, and other valuable bio-products.

One of the major concerns for the AD companies is foaming, which has a significant impact on process efficiency and operational costs. Foaming is a manifestation of the instability of the AD process, and microorganisms are the main functional body ensuring AD performance. Therefore, foaming mechanisms need to be explored at the microbial community level. Industry is very keen to have a way to predict foaming as it affects productivity, can damage the infrastructure and is dangerous for the operators.

We propose to use microbial community fingerprinting through low-cost metagenomics (to answer "who is there?") and metaproteomics (to answer "what are they doing?") to provide data in real time for the risk prediction and control of foaming in AD. For the first time, we are going to apply this method for monitoring a full scale AD treating mixed waste.

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POC202113

Dr Caroline Gauchotte-Lindsay, University of Glasgow (£50K single discipline)

Fluorescent Microbiofilter Assay for Rapid Real-time Monitoring of Organic Micropollutants Biodegradation

Proposal Summary

Biological treatment processes have been successfully employed for over two hundred years to remove pathogens, nutrients and transition metals in water systems. Microbial communities on biofilters form stochastically based on the chemistry and biology in the raw water. We contend that targeted design of microbial ecology for degradation of difficult-to-treat organic micropollutants (OMPs) could be achieved by optimising said chemistry and biology using genetic algorithms optimisation. While this would require in situ testing of the responses of microbial communities to OMPs, fast, inexpensive, reliable analytical methods to measure OMPs in microbial cultures are not available. Current gold standard methods provide precise and accurate results but at best hours and most likely days after sampling, by which time the conditions in the biological systems might have changed drastically. We aim here to design and validate a new microwell plate assay to measure the biological removal of OMPs in microscale biofilters. The plate wells will be filled with a transparent porous media that will act as the substratum for biofilms whose degradation of fluorescently tagged OMPs will be monitored using fluorescent excitation-emission. Our existing batch fluorescent assay has proven to be specific and sensitive with limits of detection relevant to observed environmental contaminations - another common challenge when investigating biodegradation. It provides degradation curves nondestructively and with no sample preparation; integrated to a microwell plate assay, it will offer real time monitoring. By the end of the project, we will deliver a robust, precise and sensitive assay that can be further integrated to high-throughput robotic platforms for rapid and site-specific optimisation of microbial seeds of full-scale biofiltration systems.