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Drinking Water Engineering and Science Discussions

Interactive comment on "MUWS (Microbiology in Urban Water Systems) – an interdisciplinary approach to study microbial communities in urban water systems" *by* P. Deines et al.

P. Deines et al.

c.biggs@sheffield.ac.uk

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Combined Response to Anonymous Referee #1 and #2

General Response: We agree with Anonymous Reviewer #1, that the concept of using an interdisciplinary approach that combines engineering and biological disciplines to address engineering challenges is not necessarily a new concept, and such an approach has been discussed in previous papers as highlighted by Anonymous Referee #1 (e.g. Daims et al. 2006, Rittmann et al. 2006, McMahon et al. 2007). We do not

claim that it is new, although it is worth pointing out, that even though the integration of microbial ecology and environmental engineering has been previously discussed, this is mainly within the scientific community, and has so far concentrated largely on environmental biotechnology/treatment processes.

This paper builds on the approaches used before but presents a conceptual outline for water engineers and water companies on how they could benefit from a partnership with microbial ecologists, specifically looking at urban water infrastructure. Our experience, via collaboration with UK water companies, has shown that their knowledge of genomic tools routinely applied by microbial ecologists is scarce, or even completely absent. In addition, the application of an interdisciplinary approach to study drinking water distribution systems and sewer networks has received far less attention compared to wastewater treatment processes, which have been studied extensively over the last decade.

Both Anonymous Referee #1 and #2 commented on the preliminary nature of the results. We are aware that the data we present is preliminary, and that the techniques are routinely used by molecular microbial ecologists. However, it was not the intention of this paper to provide a comprehensive study of a single system but to describe the types of culture independent molecular techniques (of which we present only a selection) available, and level of information achievable. In so doing, we were able to make the approaches and methods used in microbial ecology accessible for 'people on the practical side', for urban water systems, especially water companies. A key audience for DWES, as outlined in their aims and scope, are water engineers from water companies and environmental consultancy firms. As a consequence we demonstrated in this paper, the type of data that can be provided by microbial ecologists and how that information can be compared to what is already done in practice.

The number of samples presented in this study therefore demonstrates the potential of the techniques, if implemented within water monitoring programmes, but at present does not allow any significant interpretation with environmental parameters (as men-

tioned by Anonymous Referee #2). Studies with such a dataset, looking at biological and environmental parameters simultaneously, have been presented elsewhere by the authors (e.g. Biggs 2010, Deines et al., 2010) and are in preparation. Questions addressing the metabolic capabilities of microorganisms in urban water systems, or how they interact with each other or the environment are also being addressed at the moment by the authors (e.g. Biggs et al., 2010, Deines et al., 2010) (as raised by Anonymous Referee #1).

We agree that demonstrating differences between community compositions before and after selective enrichment has been shown (as highlighted by Anonymous Referee #1), but this culture-dependent method is still the industry standard used by water companies to assess drinking water quality. We therefore included such a study in this paper to show direct comparison between what is commonly used by water engineers and the molecular microbiological techniques (to which we propose that water engineers use in their monitoring programmes). We believe this gives greater weight to the value of genomic tools in studying urban water systems.

Both Anonymous Referee #1 and #2 commented on the integration with engineering. Since this paper focuses primarily on demonstrating the applicability of molecular microbiology techniques to urban water systems, rather than a comprehensive study of a single system, it is the potential of an interdisciplinary approach that is alluded to, rather than providing specific evidence in this paper where we have already used it in practice. The potential benefit of an interdisciplinary approach comes in a variety of different aspects. For example, existing engineering knowledge and/or computer models can provide insight into choosing the most appropriate sampling locations within drinking water distribution systems or sewer networks that enable specific research questions to be addressed e.g. influence of spatial or temporal changes on systems performance due to changes in microbial diversity. Sampling protocols across the different disciplines needs to be integrated to ensure the safe collection of representative samples within the urban water system in terms of both biological reproducibility as

well as engineering relevance. Also, in an integrated approach, molecular microbiological analysis of water and biofilm/sediment samples should also be conducted at the same time as the measurement of the physical and chemical properties of the urban water systems. Multivariate analysis of the different parameters, will then allow future interpretation of changes in biological diversity to specific environmental variables, hydraulic conditions etc. Finally, integration of such knowledge from the different disciplines, could then be incorporated as additional parameters in existing engineering models (or in new models), ultimately developing new management tools for urban water infrastructure.

Specific additional comments

Anonymous Referee #1

We will include the detail that “a” and “b” in Figure 2 refer to biological replicates. We agree that we should be consistent about the terms “multi” and “inter” disciplinary and will change the text to “interdisciplinary” throughout

Anonymous Referee #2

We will add the following additional detail about how the samples were collected (1) In addition to the detail given in Section 2.1.1. Samples collected for the analysis of planktonic bacteria in drinking water, were collected in February 2008, aseptically as outlined in Standard Methods (APHA). The samples were collected from cold water domestic tap in Sheffield. 6 L of water was collected in sterile bottles and transported to the laboratory. Water samples, rather than biofilms, were collected for the drinking water distribution system to provide direct comparison with the culture based methods currently used by water companies. (2) In addition to the detail in Section 2.1.2, we collected sewer biofilms from two different sewer systems, one in Nantes (France) and one in Frejlev (Denmark). Two sewer systems were chosen to demonstrate the applicability of the molecular techniques across spatial variability in sewer networks. The sampling site at Frejlev is run by the Environmental Engineering Group at Aalborg

University and samples were recovered from a 300 mm diameter combined sewer that served an 87ha catchment with mainly residential inputs. The samples are collected downstream of the town of Frejlev. The site has been established as a research station in 1996. The sampling sites in Nantes, France are run by the LCPC, Division Eau et Environnement, Bouguenais, France, and samples were collected from two sites, in combined sewers, located in the central part of Nantes. Both sites were located in large egg-shaped collectors and are part of ongoing studies carried out by LCPC. Sewer biofilm samples were collected in Nantes in November 2008 and in Frejlev in February 2009. All samples were collected in triplicates.

Finally, we will add the above detail about the role of engineering within the integrated approach to section 4.

References Biggs et al. (2010) Effect of temperature on the substrate utilisation profiles of microbial communities in different sewer sediments. Environmental Technology (in press) Daims et al. (2006) Wastewater treatment: a model system for microbial ecology. TRENDS in Biotechnology 24: 483-489. Deines et al. (2010) A new coupon design for simultaneous analysis of in situ microbial biofilm formation and community structure in drinking water distribution systems. Applied Microbiology and Biotechnology 87(2): 749-56 McMahon et al. (2007) Integrating ecology into biotechnology. Current Opinion in Biotechnology 18: 287-292. Rittmann et al. (2006) A vista for microbial ecology and environmental biotechnology. Environmental Science and Technology 15: 1096-1103.

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