Stream Biofilm Project Newsletter

October 2008

The Stream Biofilm Project team has been very busy collecting exciting data for the last year. So busy that we noticed only a few weeks ago that it had been quite a while since we wrote the last newsletter! It was about time for us to give you an overview of the progress that has been made in our research. Here are some of the highlights…

Catchment use affects bacterial communities

Human activity has had profound effects in rivers and streams worldwide, with many streams being impacted by multiple physical (e.g. channel straightening), chemical (contamination by organic and inorganic pollutants) and biological (e.g. introduction of invasive species) stresses. Our research, on the bacterial community composition within stream biofilms has shown that the bacterial communities within urban streams (figure 1 left) appear, overall, to be quite different to those within rural streams (figure 1 right). This indicates that the bacterial communities within stream biofilms are strongly influenced by the nature of the surrounding catchment. The response of natural bacterial communities to various anthropogenic stresses may have important implications for the many ecosystem services that they provide, such as the cycling of nitrogen and organic matter and the detoxification of contaminants.

Figure 1: Highly impacted stream vs rural stream

Techniques that save us time and money!

Our molecular bacterial community profiling techniques (Automated Ribosomal Intergenic Spacer Analysis for bacteria and terminal restriction fragment length polymorphism analysis for ciliate protozoa) have proved very quick and easy, allowing us to analyse and interpret the relationships between hundreds of samples in just a few weeks – and they are surprisingly economical! We are currently using these methods to investigate why a restored urban stream is not recovering, the effectiveness of stormwater treatment devices for reducing ecotoxic stormwater components, the effect of sediments and nutrients on bacterial populations (with the University of Otago) and the bacterial populations and functional characteristics of streams impacted by acid mine drainage (with the University of Canterbury).

Spreading the knowledge

It is not widely understood that the slimy biofilms found in streams are home to complex communities of micro-organisms with important ecological functions. Therefore Andrew Dopheide spent many hours generating images of biofilm-dwelling organisms using light and electron microscopes, and assembled them into an eye-catching microbial landscape. This educational poster provides a colourful and richly detailed view of the microscopic world of stream slime, or biofilms. It illustrates the diverse micro-organisms which constitute a stream biofilm, from the tiniest viruses and bacteria to the much larger (but still very small) algae, protozoa and rotifers – and explains their ecological roles and interactions in stream ecosystems.

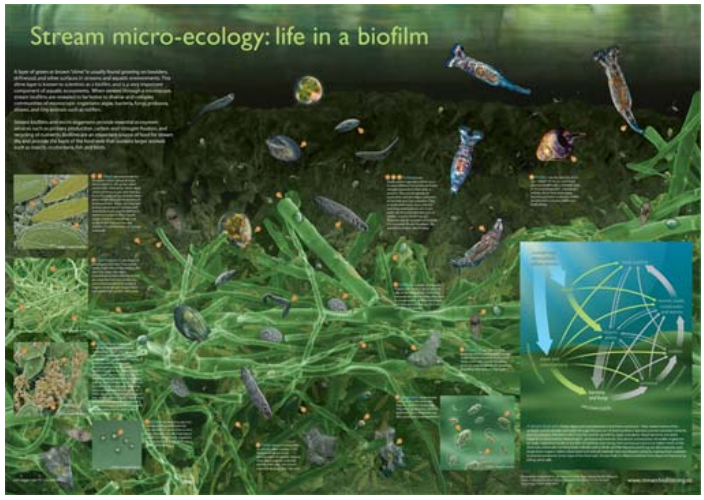

Figure 2:Award winning poster: stream micro-ecology: life in a stream biofilm

The poster has recently been awarded an honourable mention in the 2008 International Science and Engineering Visualisation Challenge, organised by *Science* Magazine and the National Science Foundation (USA). See http://www.sciencemag.org/vis2008/show/ for results of this competition. Please e-mail us if you are interested in obtaining copies of the poster (streambiofilm@gmail.com)

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Metabolomics reveal interactions between two key bacteria for biofilm formation

Besides molecular fingerprint techniques such as T-RFLP and ARISA that we have been using for years now, a method based on metabolic footprint profiling has been tested recently by Vidya Washington to study mixed microbial cultures. The purpose of this study was to understand the physiological challenges posed by each biofilm bacterium on the other in terms of the metabolites produced and secreted when grown as mixed species. Pairs of bacteria were tested in mixes and compared with pure culture controls. Extracellular metabolites were profiled using Gas Chromatography-Mass Spectrometry (GC-MS) and Direct Injection Mass Spectrometry (DIMS). Initial data showed that paired mixes presented distinct profiles of metabolites compared to pure cultures (figure 3).

This clearly demonstrated that metabolic interactions occurred between organisms in co-culture. We showed that metabolomics is the most appropriate approach to characterize the physiological relationships in microbial communities.

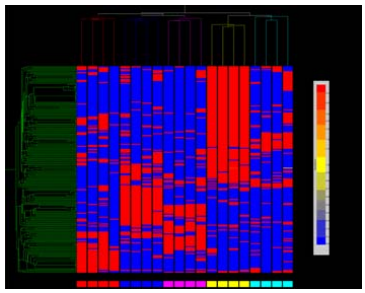

Figure 3: Metobolomic footprint profiles from GCMS data

Stormwater metal contaminants influence bacterial populations in stream biofilms

Urbanisation is known to have considerably increased pollutant concentrations in surface waters. Metals are among the most common contaminants in stormwater and they frequently constitute a threat to our aquatic ecosystems. So far, research has focused on the effects of metals on aquatic macro-organisms, especially fish and benthic invertebrates, but little is known about their effects on stream micro-organisms. Recently our experiments have shown that dissolved metals influence bacterial communities and accumulate quickly in biofilms.

Figure 4: stormwater drain

In addition, protozoa and small invertebrates seem to be strongly affected by this accumulation. These results underline the potential role biofilms could play in the transfer of metals to higher trophic levels such as protozoa, benthic invertebrates and fish which graze microbial slime.

Protozoan communities=water quality indicator?

In addition to our evaluation of bacterial populations, we have conducted similar studies which reveal populations of protozoa to be similarly affected by catchment development, typified by a reduction in diversity and significantly different community composition within urban streams.

Figure 5:A pair of ciliate protozoa

The results of these studies suggest that the community structure of microbial biofilms could therefore serve as a useful indicator of freshwater ecological health, analogous to the way that macroinvertebrate communities have been used for many years. We are now undertaking additional research to examine if the sensitivity of whole community microbial indicators may be further enhanced with the use of alternative molecular tools or statistical analysis, to gain maximum potential from the high-throughput analysis of freshwater microbial communities.

Conferences and publications

With so much going on we had to take the opportunity to present the results of our work at a number of national and international conferences (and take a little bit of a holiday at the same time!) including the NZFSS (New Zealand Freshwater Sciences Society) conference in Queenstown, NZMS (New Zealand Microbiology Society) conference in Wellington and the ISME (International Society for Microbial Ecology) symposium in Cairns. We also have published 4 papers this year in international journals. You can find the references for those papers as well as posters and presentations on our website www.streambiofilm.org.nz.

We are becoming well recognized as international research leaders in the area of stream biofilm ecology and we will continue to present our results. So if you want to attend one of our presentations, don't hesitate to contact us.

Want to know more?

If you want to know more about our research, please visit our website : www.streambiofilm.org.nz. If you have any questions, comments or suggestions please contact us at:

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