EDITORIAL

A golden age for microbial ecology

This month, microbiologists gather at ISME12 in Australia to deliberate advances in microbial ecology that could benefit the planet. What are the key challenges for this blossoming field?

Microbial ecologists study the relationships between microorganisms and their environments. All environments on the Earth are populated by microorganisms, ranging from the depths of the deep sea, to hot, acidic springs, soil, the frozen tundra, the surface of a leaf, nooks and crannies around the root hairs of a plant, the belly of a termite and the warm, moist epithelial surfaces inside mammals. Understanding microbial ecology is incredibly important, because the relationships between microorganisms and their environments have a crucial role in the health of the planet and all of its inhabitants. The widening reach of microbial ecology is readily revealed by considering the scope of several of the leading microbial-ecology journals, which include topics that range from marine biology to population biology, bioremediation and bioenergy and such diverse research areas as the impact of microorganisms on biogeochemical cycles and within-host dynamics of infectious disease.

Armed with ever-improving technologies, microbial ecologists are increasingly in the spotlight. Before the development of molecular techniques, microbiologists were largely reliant on traditional methods of identification and isolation to probe the structures of microbial communities. This approach has not disappeared, and indeed should still be used, together with molecular analyses, to fully understand community function. Since the 1970s, molecular techniques, such as whole-DNA hybridization and 16S ribosomal RNA sequencing, have gradually become widely used by microbial ecologists to differentiate species in communities, and, since the advent of whole-genome sequencing 13 years ago, molecular techniques have become more rapid and sophisticated. For microbial ecologists, the benefits of rapid sequencing technologies quickly became apparent. Research moved seamlessly to the collation of inventories of microorganisms in a sample from any environment using metagenomic analyses. Use of high-throughput genomics and metagenomics in particular has enabled analyses that are breathtaking in scope, including the sequencing of the Sargasso Sea. In light of these advances, what are the key areas for improvement that are necessary for microbial ecologists to tackle the big issues that face the planet?

In 2007, a group of microbiologists chaired by Caroline Harwood spent 3 days deliberating the main questions that face microbial ecologists and the specific requirements that must be met to ensure that the microbiology field continues to meet the important demands that have been placed on it by the need to understand the ecology of two pressing global problems: climate change and disease. A report that details the discussions and recommendations of this group was published in February of this year and can be accessed free online[1]. Important gaps in our knowledge were highlighted. These include a lack of knowledge on the most populous group of microorganisms, the phages, which have influential roles in horizontal gene transfer, host gene expression and the structure of microbial communities. Although technology is improving, there is a pressing need for improved methods to make measurements on the microscale (nanometre to millimetre scale), as it is this scale that is relevant to microbial activities and interactions. Although each and every member of a whole community could soon be identified through DNA sequencing, this will require improvements in DNA extraction and sequence assembly. Furthermore, although it might soon be feasible to sequence the complete genomes of all the members of a microbial community, including bacteria, archaea and viruses, cultivation of most species remains a challenge, and the report urged microbiologists to try and cultivate mixed communities to more accurately probe community functions. Such communities should also be perturbed to evaluate how communities of organisms, rather than single organisms, respond to change. This would be more meaningful than perpetuating the study of model organisms, which might respond differently to changing environmental cues in the presence of fellow community members.

Such research could be crucial if we are to understand the effects of therapeutics on communities that are hosted within our own bodies and might directly affect health or indeed the effects of changing environmental factors on the microbial communities that keep the biogeochemical cycles of the Earth turning. Microbial ecologists have an important part to play in investigations into both public and planetary health. This eloquently written report should provide food for thought for all those with an interest in this important field, and for those lucky enough to be attending ISME12, enjoy the meeting!

> “…the relationships between microorganisms and their environments have a crucial role in the health of the planet and all of its inhabitants.”

1. Harwood, C. & Buckley, M. The uncharted microbial world: microbes and their activities in the environment. *American Society for Microbiology* [online], http://www.asm.org/Academy/index.asp?bid=56412 (2008).