Isolation and Characterisation of Novel Environmental Bacteriophages Which Target the Escherichia coli Lamb Outer Membrane Protein

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Abstract : Bacteriophages are viruses which infect bacteria specifically. Over the past decades, phage λ has been extensively studied, especially its interaction with the Escherichia coli LamB (EcLamB) protein receptor. Nonetheless, despite the enormous numbers and near-ubiquity of environmental phages, aside from phage λ , there is a paucity of information on other phages which target EcLamB as a receptor. In this study, to answer the question of whether there are other EcLamB-targeting phages in the natural environment, a simple and convenient method was developed and used for isolating environmental phages which target a particular surface structure of a particular bacterium; in this case, the EcLamB outer membrane protein. From the enrichments with the engineered bacterial hosts, a collection of EcLamB-targeting phages (Φ ZZ phages) were easily isolated. Intriguingly, unlike phage λ , an obligate EcLamB-dependent phage in the Siphoviridae family, the newly isolated ΦZZ phages alternatively recognised EcLamB or E. coli OmpC (EcOmpC) as a receptor when infecting E. coli. Furthermore, ΦZZ phages were suggested to represent new species in the Tequatrovirus genus in the Myoviridae family, based on phage morphology and genomic sequences. Most phages are thought to have a narrow host range due to their exquisite specificity in receptor recognition. With the ability to optionally recognise two receptors, ΦZZ phages were considered relatively promiscuous. Via the heterologous expression of EcLamB on the bacterial cell surface, the host range of Φ ZZ phages was further extended to three different enterobacterial genera. Besides, an interesting selection of evolved phage mutants with a broader host range was isolated, and the key mutations involved in their evolution to adapt to new hosts were investigated by genomic analysis. Finally, and importantly, two Φ ZZ phages were found to be putative generalised transducers, which could be exploited as tools for DNA manipulations.

Keywords : environmental microbiology, phage, microbe-host interactions, microbial ecology

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