TITLE The οικοσ of marine bacteria

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Environment selects for the organisms that are present; but what are the environmental properties that describe the bacterial *οικοσ* – oîkos or house – the word from which ecology derives? Longhurst *et al.* made a very useful characterisation of marine provinces, which is helpful as a broad-brush approach to describing the conditions that plankton experience in any part of the global ocean. Yet, useful as they are, the Longhurst provinces do not consider space scales that are of primary relevance to marine bacteria – *i.e.* micrometres to millimetre scales.

At these dimensions, Reynolds number is very low and, to our anthropocentric view of the world, everything is very weird. Viscous forces dominate, which means for example that moving bacteria have no inertia. If a flagellum stops beating, the cell moves only a few angstroms before coming to a complete standstill. Physical and chemical properties of water at the microbial scale have implications for bacterial evolution, particularly in the oligotrophic oceans. Here, nutrient concentrations are very low – ammonium concentrations are typically ca. 10nmol L^{-1} – and microbes are widely spaced from each other. Although large numbers of bacteria are present (>10^5 mL^{-1}), because they are so small the distance to the next cell is many hundreds of cell diameters. The oceans are mostly empty space.

The bacteria that dominate in the oligotrophic ocean gyres (e.g. *Prochlorococcus,* and *Pelagibacter ubique*) are small cells and have streamlined genomes. It can be argued that streamlined genomes either reflect, or are, a consequence of the environment. For example, *Prochlorococcus,* and *Pelagibacter* are both non-motile. Why should this be? It is intuitive to think that, when nutrients are in short supply, it would be beneficial to swim to where nutrient concentrations are higher. However, at low Reynolds number, swimming merely drags with the cell as it moves any zone of depletion around it; it does not escape by moving, the consequences of depleting nutrients in its immediate environment. However, rates of molecular diffusion are extremely rapid and mean that there would be no advantage to a cell to be motile in the oligotrophic ocean.

Does thinking about the physical/chemical properties at spatial/temporal scales of relevance to bacteria, help to understand the process of genome streamlining? What predictions could be made about the evolutionary advantage for a bacterium to retain certain functions in the oligotrophic ocean, particularly in the context of life at low Reynolds number?