Mechanistic interactions in plankton, fitness and behaviour

Marine ecosystems are a weave of many strands, the most fundamental of which is the life trajectory of an individual planktonic organism. The topology of such a trajectory is a function of the environmental factors an organism encounters (both biotic and abiotic), its physical abilities, and the behaviour it adopts. These latter attributes (abilities and behavioural algorithms) are a consequence of natural selection, and should therefore reflect the evolutionary tradeoffs that shaped them. These lectures will couple together principles from hydrodynamics, oceanography, evolutionary and behavioural ecology to provide a mechanistic rationale for the adaptive behaviour of zooplankton, and the consequences of fitness-seeking behaviour on the dynamics of marine communities. This development starts with the observation that all important life processes in the plankton (growth, reproduction, mortality) depend on encounter rates. Encounter rates represent not only a potential transfer biomass, but more importantly, an exchange of information – information that when processed, trigger behavioural responses that are attuned to an organism's evolutionary self-interest. A powerful concept here is a mechanistic link between behaviour and Darwinian fitness (*e.g.* the trade-off between benefit, cost and risk of foraging). Relatively simple arguments along these lines give insights as to why plankters behave the way they do: how fast they swim, their optimal path geometry, vertical positioning and time allocation in foraging. It also resolves some aspects of population dynamics – the paradoxes of omnivory and enrichment for instance – in that adaptive (*i.e.* fitness-seeking) behaviour has a stabilizing effect on community dynamics.