Comparing phenotypic plasticity in bacterial prey traits and ecological consequences by using specialist vs. generalist strains and organic aggregates as model systems (BactiTrait)

Trait-based approaches use functional traits of organisms – instead of names or numbers of species - to better understand the distribution and abundance of communities and individuals. These traits can be rather variable due to i) phenotypic plasticity (induced) or ii) inherited plasticity (eco-evolution) that influence the performance or fitness of an organism under a given set of environmental conditions. This concept also includes adaptability (either by induced or inherited plasticity) with regards to magnitude and frequency of environmental change. Thus, by focusing on functional traits, in particular for bacteria, one may be able to better predict (than classical biodiversity approaches) how organisms respond to and affect their environment (i.e., ecosystem functioning).

Changes in cell size and attachment to particles/aggregates can be regarded as key features (traits) of pelagic bacteria, which may change in response to protozoan grazing or environmental changes, e.g. availability of organic matter. Specialists with low phenotypic trait plasticity (either free-living or attached to particles) can be separated from generalists (with high phenotypic trait plasticity ranging from free-living to particle-associated). Also for bacteria, plasticity in traits can be either induced (phenotypic plasticity, i.e. generalists) or inherited (eco-evolution, i.e. specialists).

Theoretical, presence of specialists with low trait plasticity (free-living or attached) should result to pronounced predator-prey cycles, whereas generalists with high trait plasticity should dampen such cycles. In theoretical models, generalists are promoted by environmental fluctuations, e.g. ecosystem disturbances, and their stabilizing effect on environmental conditions will favor the specialists. In nature, plastic genotypes constantly compete with fixed genotypes, whereby a faster response is advantageous only in fluctuating environments. Consequently, generalists (plastic genotypes) can out-compete specialists (non-plastic ones) under externally oscillating changes such as high predation pressure. In contrast, specialists enjoy advantages over plastic genotypes when an environment is stable. **Yet, such differences in bacterial life-style have not been taken into account to analyze predator-prey interactions.**

Our project addresses the core question of DynaTrait: by which mechanisms does the present trait-variability (prey and predator) affect the dynamics of both trophic levels, which then control the maintenance of trait variability itself. To answer this question, we want to link experiments with theoretical modeling. We aim to better evaluate effects of eco-evolution and phenotypic plasticity on predator-prey cycles and their consequences on carbon and energy cycling in aquatic systems. In our chemostat experiments, instead of a single predator with high phenotypic trait variability, we will use 2 predators with low phenotypic plasticity (the 1st predator specialized on free-living and the 2nd predator specialized on attached bacteria). Further, we will use bacterial communities with a highly variable trait plasticity, i.e. specialist free and attached genotypes (non-plastic) and generalist bacteria alternating between the two lifestyles (plastic). We propose to compare the specialist vs. the generalist bacteria in the presence of the two specialist predator species. At the same time, we will change the ratio between dissolved (DOM) and particulate organic matter (POM) mimicking fluctuating environmental conditions to manipulate the ratio between free-living and surface attached bacteria.