

Competition between microorganism for a single limiting resource with cell quota structure and spatial variation

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Abstract:

Microbial populations compete for nutrient resources, and the simplest mathematical models of competition neglect differences in the nutrient content of individuals. The simplest models also assume a spatially uniform habitat. Here both of these assumptions are relaxed. Nutrient content of individuals is assumed proportional to cell size, which varies for populations that reproduce by division, and the habitat is taken to be an unstirred chemostat where organisms and nutrients move by simple diffusion. In a spatially uniform habitat, the size-structured model predicts competitive exclusion, such that only the species with lowest break-even concentration persists. In the unstirred chemostat, coexistence of two competitors is possible, if one has a lower break-even concentration and the other can grow more rapidly. In all habitats, the calculation of competitive outcomes depends on a principal eigenvalue that summarizes relationships among cell growth, cell division, and cell size.