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How Many Consumer Levels Can Survive in a Chemotactic Food Chain?

We investigate the effect and the impact of predator-prey interactions, diffusivity and chemotaxis on the ability of survival of multiple consumer levels in a predator-prey microbial food chain. We aim at answering the question of how many consumer levels can survive. To solve this standing issue on food-chain length, first we construct a chemotactic food chain model. A priori bounds of the steady state populations are obtained. Then under certain sufficient conditions combining the effect of conversion efficiency, diffusivity and chemotaxis parameters, we derive the co-survival of all consumer levels, thus obtaining the food chain length of our model. Numerical simulations not only convince our theoretical results, but also demonstrate the impact of conversion efficiency, diffusivity and chemotaxis behavior on the survival and stability of various consumer levels.