Performance of mixotrophic nanoplankton and resource specialists in a water column with contrasting light-nutrient supply regimes

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Résumé

Phago-mixotrophy is a nanoplankton nutritional strategy that combines phago-heterotrophic growth based on the consumption of other microorganisms and photo-autotrophic growth based on photosynthesis and mineral nutrient uptake. Along the opposing vertical gradients of light and nutrients found in stratified lakes, it is a generalist resource-acquisition strategy relative to pure photo-autotrophic or pure phago-heterotrophic specialist strategies. Phago-mixotrophy is widespread in aquatic ecosystems, but a gap remains between our theoretical understanding of mixotrophy and what we observe in nature. In particular, it is not well understood how mixotrophy can be a viable nutritional strategy against specialist strategies in a resource competition context.

Given the difficulty of measuring mixotrophy in the field, modelling allows us to test hypotheses pertaining to its role in the nanophytoplankton community and along typical environmental gradients. Our mathematical model simulates the dynamics of three competitors (pure photo-autotroph, phago-mixotroph and pure phago-heterotroph) and bacterial prey over the vertical dimension of a weakly mixed water column. We used this model to explore how nutritional strategy assemblages shift along gradients of nutrient and light availability and how the presence of the phago-mixotroph alters community dynamics. In nature mixotrophs can be more or less photo-autotrophic, a flexibility that was incorporated into our model.

Our modelling results show that mixotrophy is viable under most resource availability conditions. The mixotroph can displace either specialist and emerge as the dominant competitor if it displays a suitable functional balance between photo-autotrophy and phago-heterotrophy; the optimal degree of phototrophy being positively related to water transparency and negatively to nutrient supply. Our results also indicate that the spatial organization of nanophytoplankton communities in lakes could arise through vertical niche partitioning of multiple resource-acquisition strategies. Finally, the model suggests that phago-mixotrophy can promote overall community biomass production in clear oligotrophic lakes. Taken together, our

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results highlight the intricate network of facilitative and competitive interactions between nanoplankton nutrition strategies that arise purely from resource competition.

Mots-Clés: nanoplankton, phagomixotrophy, resource competition, spatial gradient, mechanistic modelling