# Popular science summary of the PhD thesis



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| Title of the PhD thesis | Opening the black box on predator-induced phytoplankton defenses: mechanisms, traits, and trade-offs |
| PhD school/Department | DTU Aqua, Centre for Ocean Life |



## Science summary


Phytoplankton are small, mostly unicellular plants that form the base of the food web in aquatic environments and are responsible for roughly half of the planet’s primary production. To protect themselves from predation, they have evolved a wide variety of defensive characteristics. The defenses may be physiological, i.e. the production of various chemical substances, morphological, e.g., the formation of colonies or thick armor, and behavioral, i.e. motility or resting stages.

While the defenses may protect from predation, the general consensus is that they must have associated trade-offs. For example, if there were no costs, one could imagine that all phytoplankton would evolve defenses, but this is not the case. Nevertheless, these costs are largely still unknown or unexplored, which may complicate the process of accurately describing ecosystems and predicting changes in the oceans. In a similar manner, how the defenses actually work and affect the interactions between predator and prey is poorly understood. This is in part due to the use of experimental set-ups where one cannot fully study the actual mechanisms that cause the reduced predation mortality in defended phytoplankton, or so called “black box” experiments.

In this thesis, I take a mechanistic approach to improve the understanding of interactions between predator and prey. We use a combination of tested and novel experimental approaches and directly observe predator behavior in the presence of phytoplankton with different types and levels of defense. We explore the benefits and trade-offs of three common phytoplankton defenses—toxin production, colony formation, and structural changes in the cell wall—using several species of different shapes and sized. I exploit the fact that many phytoplankton defenses are inducible, i.e. they are upregulated in the presence of predators, allowing me to examine costs and benefits at different levels of defense.

The mechanism by which adult copepod predators select prey was similar independent of the type of defense. Phytoplankton are caught and individually handled by the copepods before they choose to ingest or reject the prey. The rate at which phytoplankton were caught or rejected was closely tied to the level of the defense.

I find that both the trade-offs and benefits of the defenses vary with predator community composition and predator abundance. I find that some trade-offs are direct, i.e. in terms of reduced growth rate, while others are likely ecological that will not manifest in laboratory conditions.