Traits and trade-offs in microzooplankton feeding

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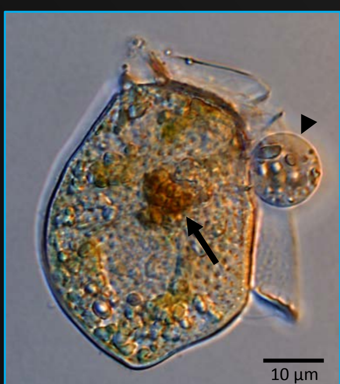
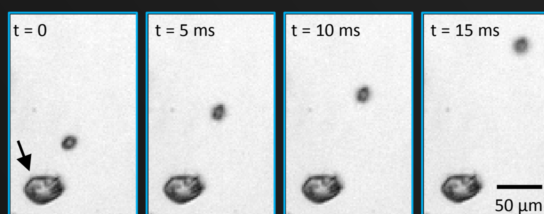
INTRODUCTION: Microzooplankton feed in various, often spectacular, ways, and the mechanisms can be grouped into classes such as ‘filter’, ‘cruise’ or ‘ambush feeding’. Each of these presumably has advantages as well as disadvantages, and the ‘choice’ of feeding mode involves some form of trade-offs. Using high-resolution microscopy and high-speed video, we unravel the feeding mechanisms in various microzooplankton organisms, from tiny (5µm) filter-feeding choanoflagellates to large (50µm) ambush-feeding dinoflagellates. The mechanistic understanding will hopefully provide insights into the constraints, limitations, advantages and disadvantages of each feeding mode, and facilitate quantification of the associated trade-offs.



The ambush-feeding dinoflagellate *Dinophysis acuta* has caught a prey cell, the ciliate *Mesodinium rubrum* (arrowhead), and is sucking out its cell contents (arrow).

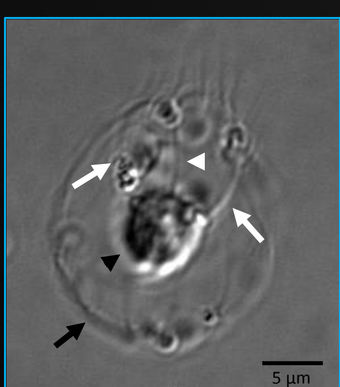


Dinophysis acuta (arrow) swims towards a *Mesodinium rubrum* cell, but the prey flees by a series of rapid (≈10^4 µm sec^{-1}) escape-jumps, leaving the slow-cruising predator far behind. To defeat the escape behavior, *Dinophysis* utilizes a harpoon-like capture filament, shot at the prey from a distance. It is currently not known exactly how the blind *Dinophysis* can sense where the prey cell is, and how it can hit it with the capture-filament.

Two *Dinophysis acuta* (arrowheads) have caught the same prey cell with their harpoon-like capture filaments (arrow).

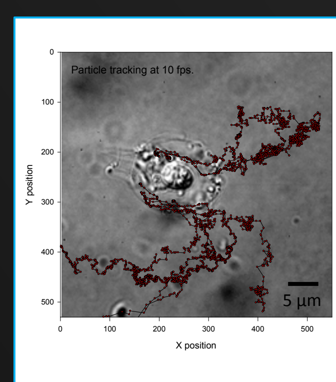
Ambush

Filter



The filter-feeding choanoflagellate, *Diaphanoeca grandis* with the cell itself (black arrowhead), the large lorica structure (black arrow), the flagellum (white arrowhead) and the filtering collar (white arrows). The function of the lorica has not been unequivocally determined, but it might play a role in flow optimization or as an anchor.

FILTER-FEEDING?: Choanoflagellate filter feeding is a poorly understood process. Studies indicate that the pressure differences created by the beating of the flagellum are insufficient to produce an adequate water flow through the collar – the mechanism believed to ultimately transport food particles to the cell. We use high-speed video of live material to explore the flagellar motion and prey capture mechanism.



Overlay particle tracks from a single video sequence. The 300 nm particles are tracked every 0.1 seconds. Particles pass through the back end of the lorica, and get stuck on the inside of the collar. In this case moving from right to left. Particle tracks can be used to calculate clearance rates and model flow fields.

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