Cargo transport by schooling micro-organisms

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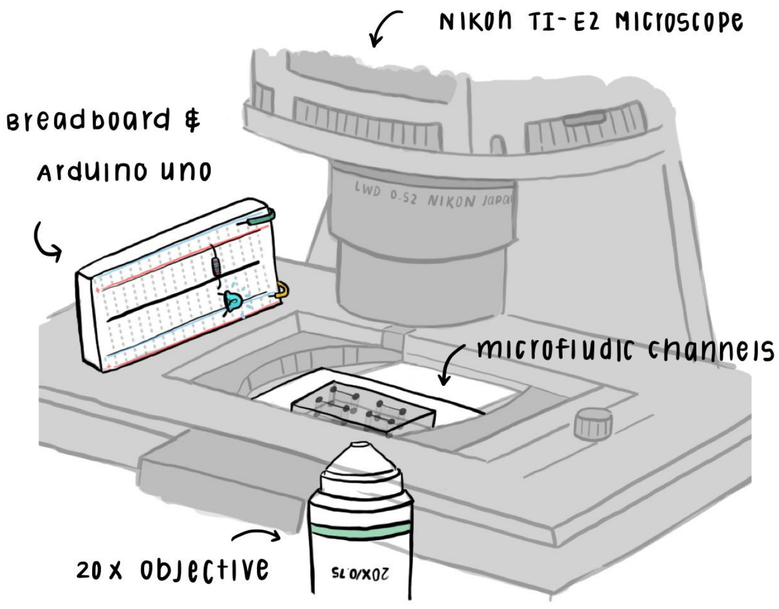
Abstract

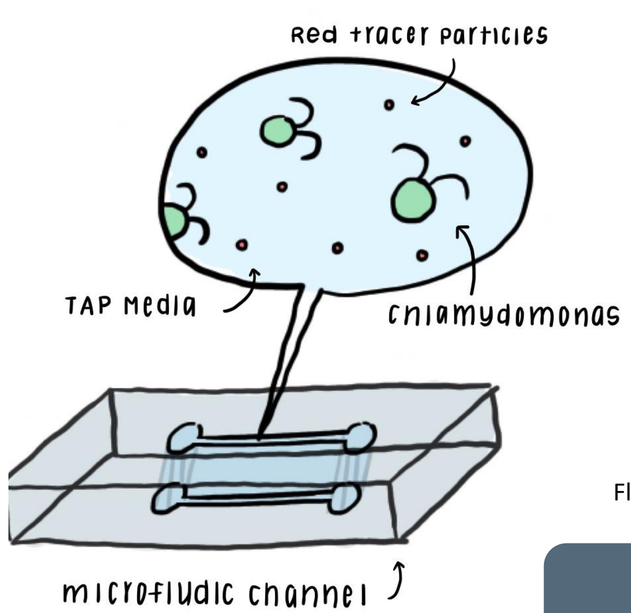
Over the summer I worked with *Chlamydomonas Reinhardtii* (CR), a motile unicellular green algae. CR is a biflaggelated micro swimmer, moving in breaststroke motions, and for some strains they are phototactic i.e., swimming towards (positive) or away (negative) from the light. Previous work in theoretical models and artificial micro swimmers show that for large populations swimming in the same direction, their ability to move particles are enhanced. Therefore, it is hypothesized that this collective movement of micro swimmers can be utilized to transport cargo, or small particles. Our goal is to implement this in populations of CR, controlling movement with phototaxis, inside microfluidic chambers. To accomplish this, I cultured two phototactic strains of CR, CC124 (+) and CC125 (-), and designed a suitable microfluidic chamber with a controlled external light source. Then I imaged fluorescent tracer particles and CR using high-speed microscopy.

Experimental Set Up

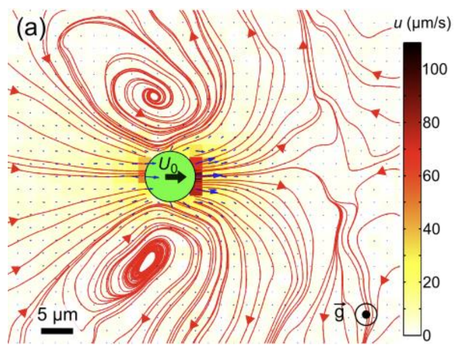
We observe swimming Chlamydomonas and tracer particles in our microfluidic channel using a fluorescence microscope. Using the breadboard, we can switch on a blue light that will attract CC 124 or repel CC 125.

*Pictures not drawn to scale**





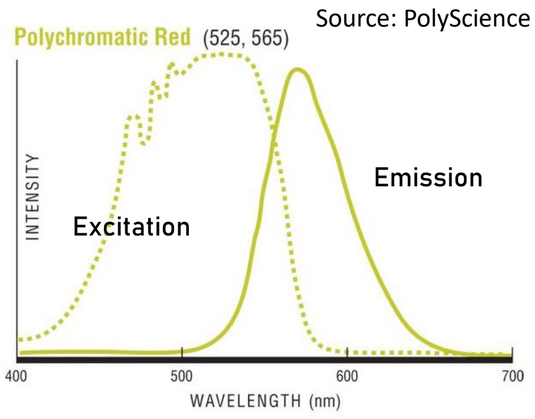
Flow Profile



Flow from swimming CR (Source: Polin et al. 2010)

Tracer Particles

Source: PolyScience



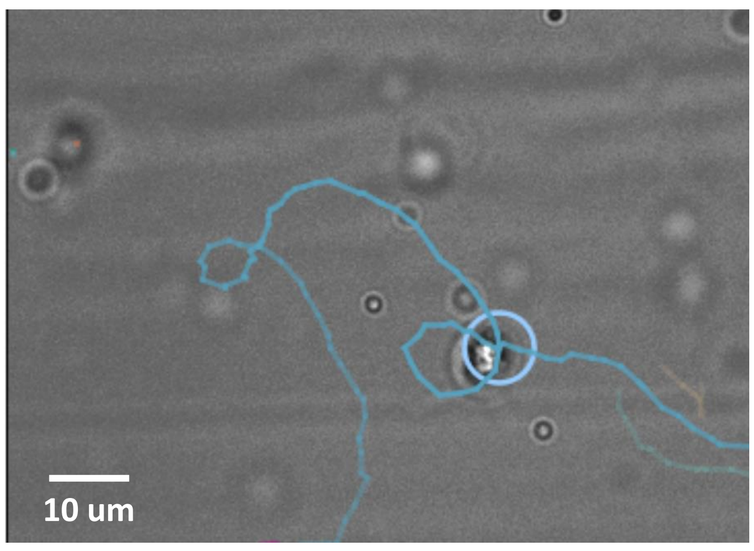
Absorption spectrum of tracer particles

Channel Dimensions (μm)

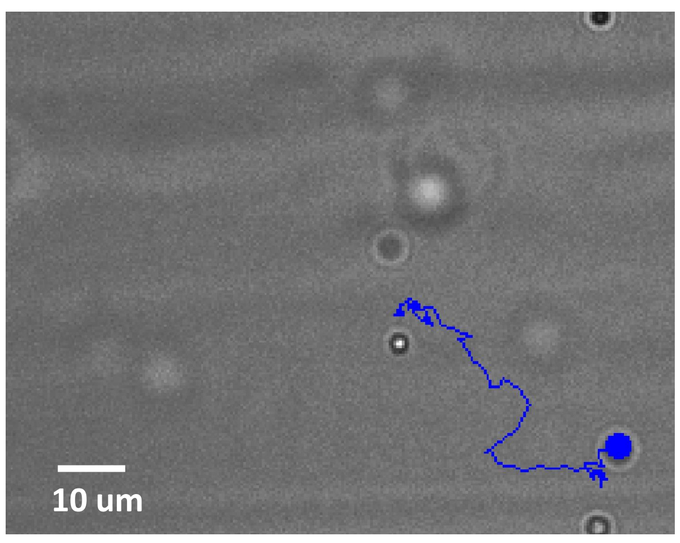
(H) 25 x (W) 100+50 → 250 x (L) 5 mm or 10 mm

Entrainment

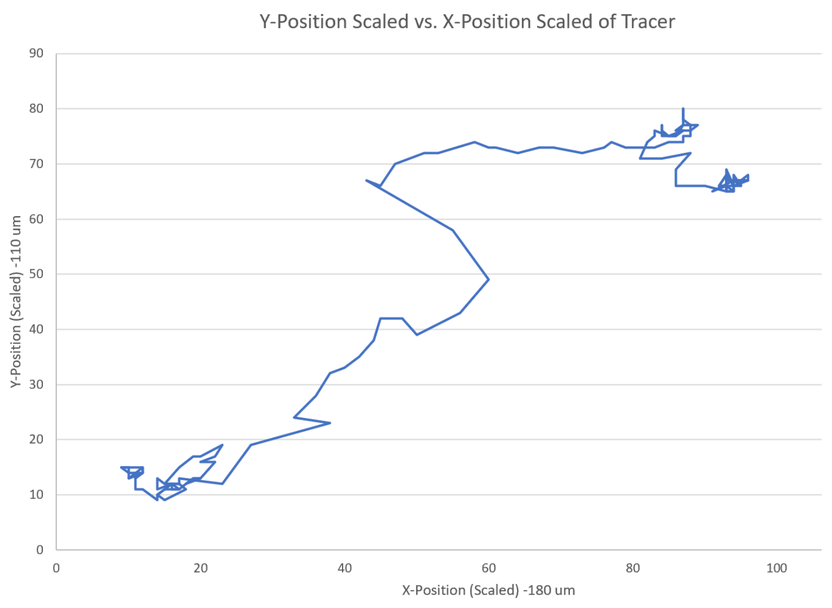
We filmed videos of CR and tracer particle interactions; from the videos we tracked the trajectories of both which we then analyzed to see the interactions.



Chlamydomonas Trajectory

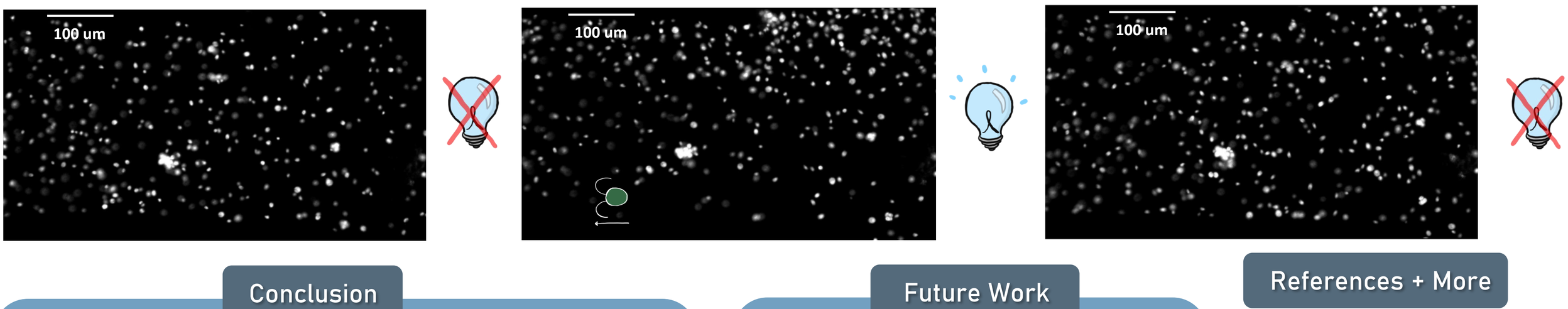


Tracer Particle Trajectory after CR moves around it



Phototaxis

For a suspension of CR, it is well dispersed except for some gravitational and sticking effects on the channel surface. When blue light is turned on for CC125 there is a visible net displacement left. When the light is turned off again CC125 returns to being dispersed.



Conclusion

- ✓ Established experimental set up and protocols
- ✓ Observed Entrainment of Tracer Particles by CR
- ✓ Observed phototactic behavior of groups of CR

Future Work

Combing phototaxis of groups of CR with tracer particles to observe collective entrainment

References + More

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