Multi-Strain Assessment of Quorum Sensing in *Chlamydomonas reinhardtii*

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Background

- Quorum sensing (QS) allows microbial populations to coordinate phenotypic switching, selecting for specific behaviors that are only beneficial when expressed at high cell densities (HCD, >10^6 cells/mL) rather than low cell densities (LCD, <10^6 cells/mL)
- QS regulated phenotypes include biofilm formation, bioluminescence, and motility among others.
- QS is mediated through the production and exchange of species specific quorum signaling molecules (QSMs).
- *Chlamydomonas reinhardtii*, a model species of unicellular algae, is one of the few eukaryotes known to exhibit QS by increasing swimming speed at HCD in a common lab strain.
- However, the signal and mechanism of this QS system is unknown and could be widely dispersed among this ubiquitous genus which is relevant to microbial ecology and biotechnology.
- Here we investigate the conservation of QS across sequenced strains of *C. reinhardtii*. We hypothesize that quorum sensing will vary across different strains of *C. reinhardtii*. These variations can then be leveraged to identify potential candidates for the identity of the QSMs as well as the relevant synthase(s) and receptor(s).

Strain	Location	Source Type
CC-124	Amherst, MA	Ecological Isolate
CC-408	University of Tokyo, Japan	Lab Derived
CC-1690	Dana-Farber Cancer Institute, MA	Lab Derived
CC-2343	Melbourne, FL	Ecological Isolate
CC-3269	University of Chicago, IL	Lab Derived
CC-4414	Breckenridge, CO	Ecological Isolate

Table 1: Strains of *C. reinhardtii* examined. These six strains are used to examine variations in QS behavior.

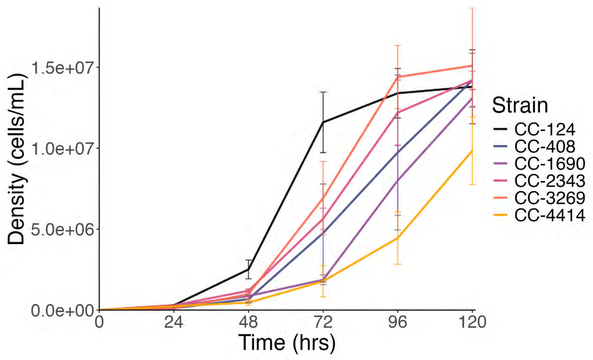

Figure 1: Growth rates of strains. Cultures were incubated at 23°C under 24-hour LED grow lights. They were incubated on a platform shaker set to 150 RPM. Cell densities were collected at 24-hour intervals and measured with a spectrophotometer.

Methods

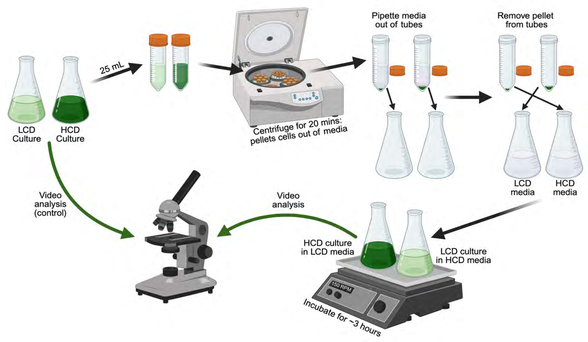

Figure 2: Methodology to obtain the initial swim speeds for high and low cell densities and the swim speeds after the media swap. Includes the procedure for the physical process of swapping the media and the cells of opposite densities.

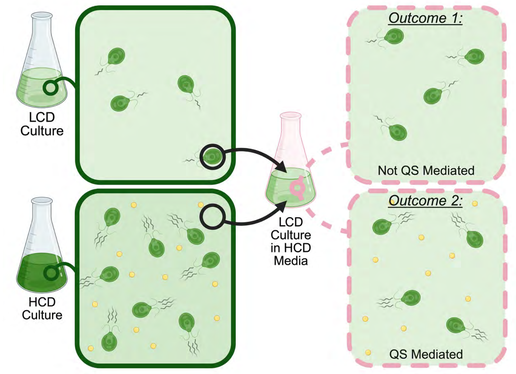

Figure 3: Illustrations of the possible outcomes of a media swap. In Outcome 1 there is no increase in the swim speed of *C. reinhardtii*; therefore, swim speed is not mediated by QS, or at least is not the primary mediator of QS. In Outcome 2 there is an increase in the swim speed of *C. reinhardtii*; therefore, swim speed is mediated by QS.

Results

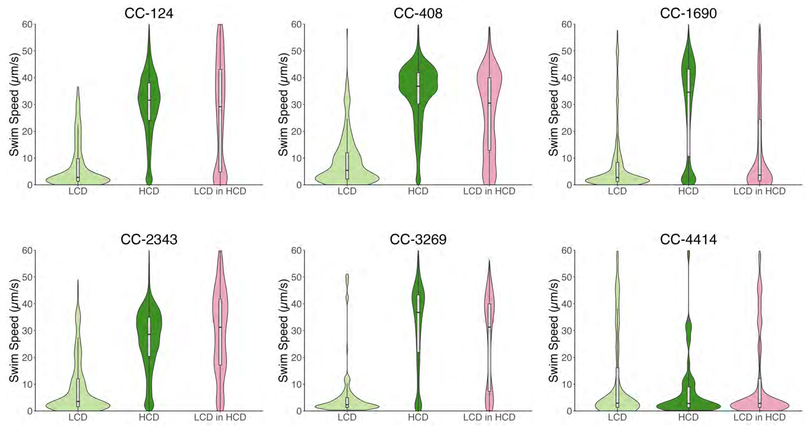

Figure 4: Violin plots from media swaps of CC-124, CC-408, CC-1690, CC-2343, CC-3269, and CC-4414. These plots show the initial LCD and HCD culture swim speeds and the change in swim speed of LCD cultures incubated in media extracted from an HCD culture.

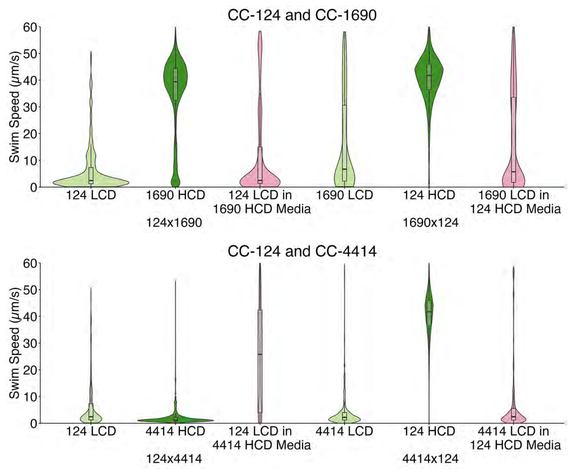

Figure 5: Violin plots from cross-strain media swaps of between CC-124 and CC-1690 and CC-124 and CC-4414. These plots show the initial LCD and HCD culture swim speeds and the change in swim speed in LCD cultures incubated in media extracted from an HCD culture obtained from another strain.

Discussion

- Strains CC-124, CC-2343, CC-3269, and CC-408 increase swim speed at HCD consistent with QS in *C. reinhardtii*.
- Strain CC-4414 produces the QSM but does not respond to it.
- Media swaps with CC-1690 were irregular, suggesting that either QS does not occur or that swim speeds in this strain are determined by more than just QS.
- Further research will investigate the mechanisms that dictate swim speed in CC-1690. On-going genetic analysis of CC-4414 may identify a receptor for this signal.
- In conclusion, the diversity of QS responses across strains of *C. reinhardtii* may be leveraged to characterize the signal and molecular elements of this phenomenon in this cosmopolitan species.

References

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- Figures 1 and 2 created with https://BioRender.com